

# What time of day does a Rufous Scrub-bird sing?

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The daily pattern of male Rufous Scrub-bird *Atrichornis rufescens* singing behaviour in the New South Wales Gloucester Tops was investigated for each month of the year as part of a 4-year study at five scrub-bird territories. It was found that time of day did not significantly affect singing behaviour. However, singing activity during the day was unpredictable in the period January-August. Between September and December acoustic monitoring programs for scrub-birds can be conducted at any time of day.

## INTRODUCTION

The southernmost population of the Rufous Scrub-bird *Atrichornis rufescens* lives in the New South Wales Gloucester Tops (Ferrier 1984). These cryptic birds are heard more often than they are seen. Males make a variety of calls, including mimicry (Gole & Newman 2010). Some of the calls are difficult for inexperienced surveyors to correctly identify which species produced them. However, scrub-birds have a characteristic song – a series of loud monosyllabic “chips” delivered in rapid succession. In survey work, the chipping song is taken as definitive evidence that a scrub-bird is present (Newman *et al.* 2014). The number of syllables varies, but typically the subspecies *ferrieri* (the subspecies present in the Gloucester Tops) produces 2-8 syllable songs in each singing event.

Because monitoring programs for the Rufous Scrub-bird are reliant upon hearing singing male birds (Newman *et al.* 2014; Andren 2016; Stuart & Newman 2018), we have been studying the singing behaviour of male scrub-birds in the Gloucester Tops. Our initial focus was to examine how the daily average singing activity varied during the year. We showed that the activity increased markedly from mid-September and remained at a high level for the rest of the year. Rufous Scrub-bird singing activity declined significantly during January and February. From then onwards, until mid-September, the birds sang unpredictably but, on average, their singing activity was significantly lower than for the other months (O’Leary & Stuart 2021).

For the design of effective monitoring programs, another important aspect of Rufous Scrub-bird

singing behaviour is whether scrub-birds call more frequently at certain times of the day or, conversely, whether there are any times of the day when scrub-birds are less likely to sing. For example, if males were found to sing more frequently in the morning, then surveys in the afternoon perhaps should be excluded from plans.

Ferrier (1984) investigated this aspect at two locations (Border Ranges National Park, Gloucester Tops) and concluded there were no significant singing activity differences between times of day at either study site. In the Gloucester Tops, Ferrier conducted transect surveys on 18 occasions over two years, but only for six months of the year (and mostly his surveys were done in Spring).

In this current study we investigated how the singing behaviour of scrub-birds in the Gloucester Tops varied throughout the course of a day. We did that by collecting and analysing a large data set of recordings for each month of the year.

## METHODS

### Data collection

We selected five known scrub-bird territories for the study (Stuart 2020; Stuart & Newman 2018). The territories were well-separated; the shortest distance between any two territories was ~1 km. Data collection activities commenced in January 2015 and continued until March 2019. On numerous occasions within those dates, we recorded for periods spanning 3-8 days in at least one scrub-bird territory, and often at 1-2 additional territories at the same time. We used automated recording units (ARUs), programmed to record daily from 30 minutes before dawn until 30 minutes after dusk for as

long as there was sufficient remaining battery power. Typically, we obtained 6-8 full days of recordings from each deployment of an ARU before the batteries failed. Details about the ARUs and how we positioned them have been described elsewhere (Stuart & O'Leary 2019; O'Leary & Stuart 2021).

## Data analysis

We recorded data onto SD cards, which later we transferred to computer and analysed using Raven Pro 1.5 software operated under licence from the Cornell Laboratory of Ornithology. We used the conditions previously developed for rapid semi-automated analysis of recordings of the scrub-bird's chipping call (Stuart & O'Leary 2019).

We analysed the recordings in 20-minute periods, noting the number of singing events per period. For this study, a singing event was defined as each instance of the scrub-bird producing its territorial "chipping" song regardless of how many syllables were uttered. We used Australian Eastern Standard Time throughout the study i.e., we did not adjust the ARU clocks for the period when daylight saving time was in operation. We exported the results from the Raven Pro analyses into Microsoft Excel for further processing, and then into the statistical software R for statistical analysis and to generate graphs using the ggplot2 package. For each month we calculated the mean number of calls made in each 20-minute time period of the day, using the results from every day of that month for which we had data for that 20-minute period. Within any month, we ignored that there sometimes were differences in the number of daylight hours per day between the beginning and end of the month.

## RESULTS

At the five territories combined, we obtained 432 full days of recordings plus for an additional six days there were recordings spanning at least four hours. We used all the data from those 438 days. Thus, we analysed *c* 4,500 hours of recordings for this study. About 45% of the recorded hours were from one territory and about 22% were from another territory. Each of the three other territories contributed *c*10% of the total recordings.

In **Figure 1** we show, for each month, box and whisker plots summarising the number of singing events for each daily 20-minute period for that month. To assist with comparisons between months, all the plots have been set to the same scale on both the X and Y axes.

During September to December, the mean numbers of singing events per 20-minute period were greater in the first 2-3 hours of the morning and they rose to similar levels in the 2-3 hours before dusk.

However, there were no statistically significant differences in scrub-bird singing behaviour at any time of day.

The pattern for January was similar to that for September-December but the mean singing activity levels were lower. Also there were more outliers i.e. occasions when a scrub-bird sang considerably more often than was the average for that particular 20-minute time period. Similarly, the proportion of outlier results was high throughout the February-August period.

In June and July, when the singing activity levels on average were low, the mean numbers of singing events per 20-minute period were highest in the 1-2 hours before dusk. However, throughout the February-August period, there were no statistically significant differences in singing activity at any time of day.

## DISCUSSION

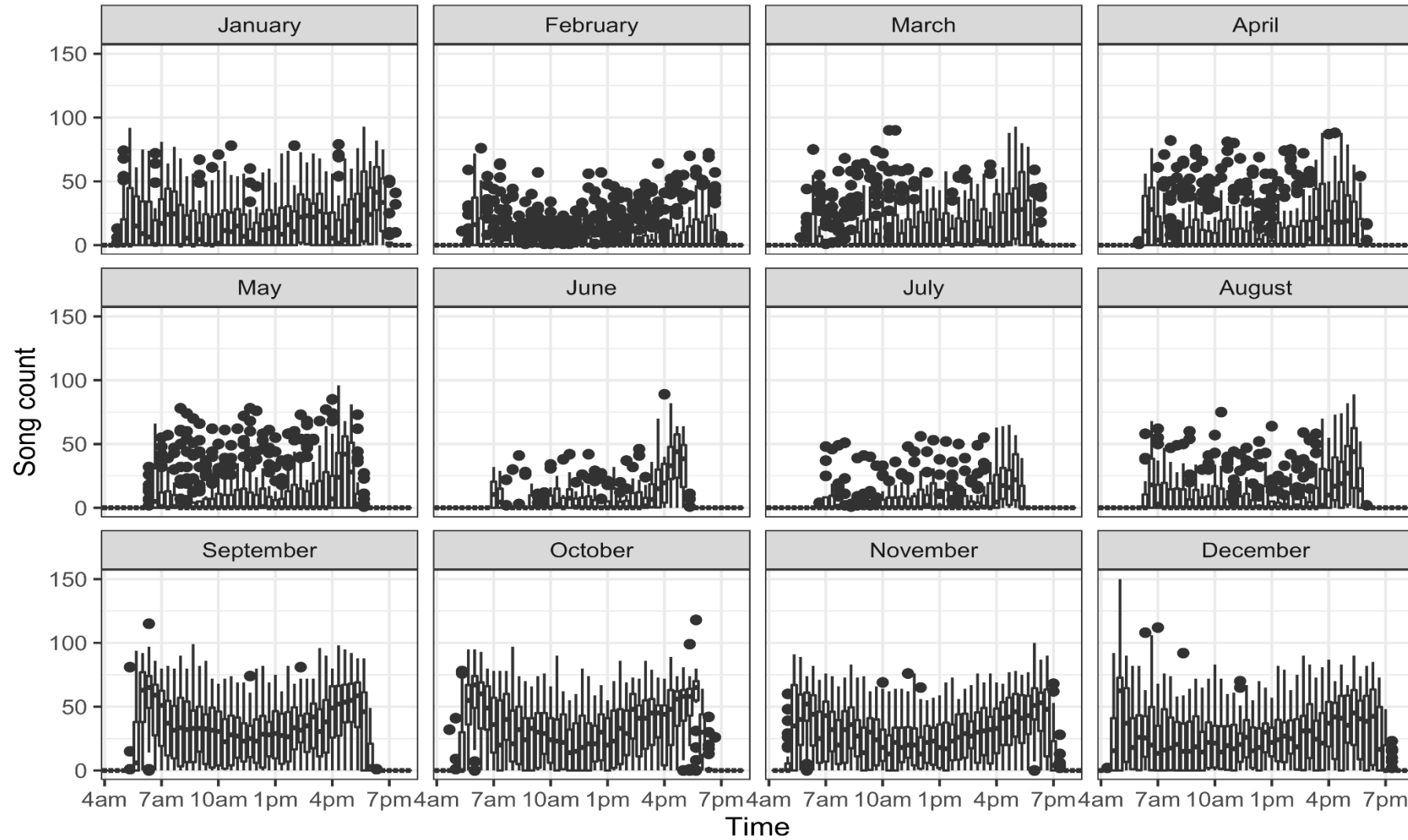
The pattern for singing events per 20-minute period during the day for any given month reflected the findings of the earlier study of daily average singing activity (O'Leary & Stuart 2021). Scrub-bird singing activity rose significantly for the period September-December because there were, on average, more singing events per 20-minute period and more 20-minute periods when the scrub-bird was actively singing. Also, there were more daylight hours than for the preceding months i.e. more opportunity for the scrub-bird to sing. February and June/July had the least amount of singing activity.

Little is known about Rufous Scrub-bird breeding biology in the Gloucester Tops; however, September-December spans the putative breeding season (O'Leary & Stuart 2021).

Previous studies have shown that scrub-birds do not sing at night (Stuart *et al.* 2012; O'Leary & Stuart 2021). The current study supports that conclusion. There were no instances of a scrub-bird singing before dawn. Occasionally a bird sang at around dusk; however, when it did so it was only for a brief period of time.

During September to December, scrub-birds were likely to sing at any time of the day, and often their singing activity in the middle of the day exceeded the average post-dawn and pre-dusk singing activity.

**Figure 1.** Box and whisker plots of daily singing activity per month, in 20-minute increments, by Rufous Scrub-bird in the Gloucester Tops. Time units are not adjusted for daylight saving. The medians are represented as horizontal lines between the interquartile ranges (boxes) and 1.5 x interquartile ranges by whiskers. Outlier values are presented individually (as ●). The months from February to August had many outlier results.



The large number of outlier results each month for January to August arose because of a combination of two effects:

- For each month the median number of singing events in any given 20-minute time period was low.
- In any given 20-minute time period, sometimes the scrub-bird sang prolifically i.e. it was considerably more active than on average for that time period in that month.

The many outliers for January-August highlight the unpredictable singing behaviour by scrub-birds outside of the supposed breeding season.

As well as singing, scrub-birds have many other vocalisations, including mimicry (Gole & Newman 2010). Establishing behavioural patterns for these other vocalisations using ARUs is problematic, because of the difficulty in most cases of differentiating them from the calls of other species inhabiting the same area. The difficulty is compounded from the absence of directional information from automated recordings. A listener in the field is able to identify when a variety of calls are from the same location and that their source therefore is likely to be a Rufous Scrub-bird.

## CONCLUSIONS

This study has shown that, at any given time of the year, male Rufous Scrub-birds in the Gloucester Tops are about as likely to sing at any time of the day. Thus, in monitoring programs for them, the survey work can be carried out any time between dawn and dusk. However, the period January-August should be avoided because singing activity is variable and seemingly unpredictable.

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