

Territory occupancy by Southern Rufous Scrub-birds *Atrichornis rufescens ferrieri* in the New England region, New South Wales monitored over two decades

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Over two decades (1999 to 2018), three monitoring programs have been undertaken on the Southern Rufous Scrub-bird *Atrichornis rufescens ferrieri* in the New England region, New South Wales. The most recent monitoring was conducted over three breeding seasons (2016 to 2018) along 12 km of transects located in scrub-bird habitat in the Horseshoe Road area. The aim of this recent monitoring program was to document territory occupancy, facilitate comparison with previous occupancy patterns and provide critical population information valuable in the conservation of this endangered species. Transects were each surveyed 10 times and, based on male birds calling on three separate occasions from the same site, 12 territories were identified. This result resembles those obtained in the two previous survey periods, with 12 territories also being found in 2010-13 and 14 in 1999-2004. In the 2016-18 period, scrub-bird presence was recorded an average of 5.6 times at an occupied territory and scrub-birds were detected at such sites on 58% of systematic surveys. Nine of 12 (75%) territories occupied during the 2016-2018 survey period were in the same locations used in 2010-13. Over the two decades, 18 different territories are known to have been occupied and the locations of seven of them were unchanged over the entire period. We estimate that there may be 36 sites along the study transects that have been or could potentially be used as territories; 28 of them have yielded at least one record of a scrub-bird. Future surveys are therefore likely to identify 'new' territories. The habitat in the study area remains of high quality for the Southern Rufous Scrub-bird; however, it is becoming increasingly threatened by drought and fire.

Key words: Southern Rufous Scrub-bird; territory occupancy; calling males; long-term monitoring; conservation

INTRODUCTION

Climate change is having a tangible impact on the Australian environment through higher ambient temperatures and increasingly intense droughts, fires and floods. Monitoring programs will be crucial in identifying the effects of these climatic changes on native species. Monitoring was established for the Southern Rufous Scrub-bird *Atrichornis rufescens ferrieri* in the New England area in 1999-2004 (Ekert 2005) and resumed in 2010-13 (Andren 2016). The program was continued in 2016-18 as part of the Key Biodiversity Area (KBA) program of BirdLife International (BirdLife International 2013) and BirdLife Australia (Dutson *et al.* 2009), and implemented by volunteers from BirdLife Northern New South Wales.

The Rufous Scrub-bird is listed as endangered nationally (Commonwealth of Australia 2014; Garnett and Baker 2021) and internationally (IUCN 2022). In the *Action Plan for Australian Birds 2020* (Garnett and Baker 2021), both the Southern Rufous Scrub-bird and the Northern Rufous Scrub-bird *A. r. rufescens* were assessed as endangered. The Rufous Scrub-bird is a species with a unique evolutionary history, and in one international assessment of such species was rated the 24th highest conservation priority among birds in the world (Jetz *et al.* 2014).

Key Biodiversity Areas are sites of global conservation significance. The identification of five of them in eastern

Australia is based on localities where the Rufous Scrub-bird occurs, in the relictual high elevation Gondwanan wet forests of northeast New South Wales (NSW) and far southeast Queensland. Two northern KBAs (Scenic Rim and Gibraltar Range) contain the Northern Rufous Scrub-bird and the southern three (New England, Werrikimbe and Barrington Tops) the Southern Rufous Scrub-bird. The New England KBA is in northern NSW, approximately 15–50 km southwest of Dorrigo on the eastern edge of the New England tableland. A detailed description of the area can be found in Andren (2016).

Here, we compare the occupation of territories in the Horseshoe Road area of the New England KBA with that described from surveys carried out using the same methods in 2010-13, as well as in earlier surveys in 1999-2004. The aim is to provide a snapshot of Southern Rufous Scrub-bird territory occupancy in this area, not to assess trends in the wider population. This information is vital in attempts to conserve this endangered species.

METHODS

The methods used are described in detail in Andren (2016) and were implemented by a small number of observers experienced in the identification of Southern Rufous Scrub-bird calls. In summary, the systematic surveys involved walking 12 established 1 km transects along roads at a rate of 30 minutes per kilometre listening for males' calls. They were mostly conducted

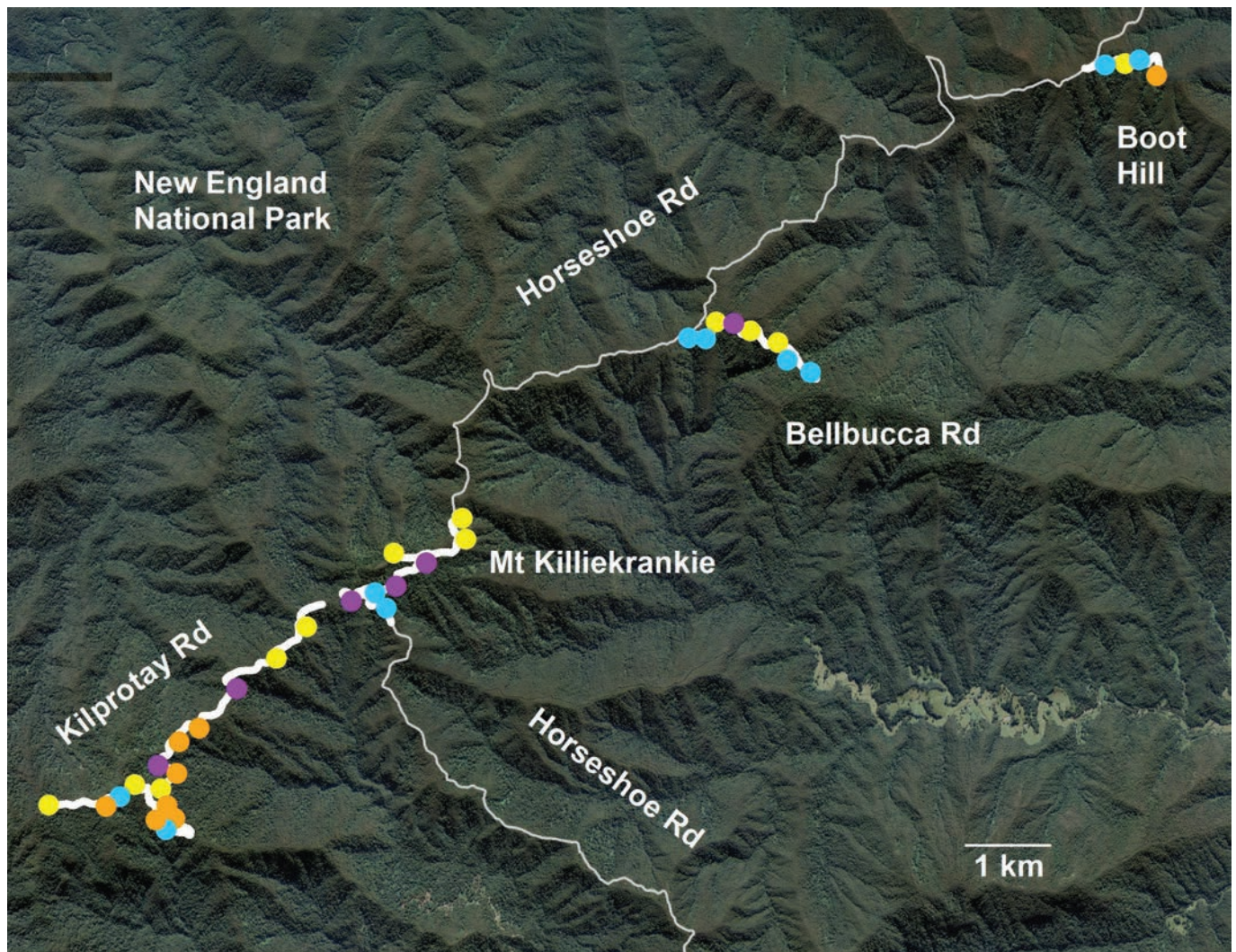


Figure 1. The locations of the 36 known or potential Southern Rufous Scrub-bird territories along the 12 km of transects. Of these, 12 were occupied in 2016-18 (yellow), and over the two decades another six were occupied at some stage (purple); 10 yielded a record of the species, but a territory is not known to have been established at that location (blue) and 8 appeared to comprise suitable habitat, but lacked any records (orange).

between 08:00 and 14:00 hrs. The location of each calling bird was mapped by estimating the distance and direction of the call from the observer. Surveys were conducted mainly in spring (September–early December) during the breeding season when calling rates are highest (Ferrier 1984; O’Leary and Stuart 2021).

The twelve transects were in the Horseshoe Road area in or near New England National Park (30.4760° S, 152.6602° E) (see Andren 2016 and Fig. 1). They were located along roads in five areas: Boot Hill (1 transect), Bellbuca Road (2 transects), Mt. Killiekrankie (3 transects) and Kilprotay Road (6 transects). All transects contained habitat that was previously known to support scrub-birds.

A ‘territory’ was defined as a site where a male Southern Rufous Scrub-bird was heard calling on at least three occasions, with the records being at least one month apart. Records of males calling that did not meet this criterion were considered ‘incidental’. A site was considered to be approximately one hectare in area based on the area reported by Ferrier (1984) in which a territorial male spends 95% of its time (1.13 ha). This

definition resembles that used by Newman and Stuart (2011) in the pilot stage of their scrub-bird surveys of Gloucester Tops, NSW, although they used the less stringent criterion of two records at least three weeks apart; after the first year of their study, they used the more exacting criterion that territories should also be occupied in successive years (Newman *et al.* 2014).

Sites that appeared to be potentially suitable for use as territories but were not currently in use were also identified. These were areas of at least 1 ha of rainforest or wet sclerophyll forest with a dense understorey. They were initially mapped using electronic imagery (Aerial Digital Sensor 40 imagery licensed to the NSW Department of Planning and Environment) and then validated through site inspection. Most of the occupied territories identified were estimated to be within 100 m of a transect, so the potential sites were also limited to this distance.

RESULTS

Over three breeding seasons from 12 September 2016 to 11 December 2018, each transect was systematically surveyed 10

Table 1

Results of the 2016-18 Southern Rufous Scrub-bird systematic surveys at the 12 identified territories. A 'Y' denotes the detection of a scrub-bird. Most territories (10 of 12) were considered to be occupied for the duration of the study, being detected within the first two surveys and still active within the last two surveys. The exceptions were Killiekrankie 2, which was only detected in the last two surveys, and Kilprotay 5, which was only detected in surveys three to eight. At territories occupied throughout the study (i.e. all except Killiekrankie 2 and Kilprotay 5), scrub-birds were detected, on average, on 58% of the systematic surveys. *Killiekrankie 2 was also recorded incidentally, satisfying the criterion for defining a territory.

Territory	Survey Number										% Recorded
	1	2	3	4	5	6	7	8	9	10	
Boot Hill	Y	Y	Y	Y	Y	-	Y	-	-	Y	70
Bellbuca 1	Y	Y	-	Y	Y	-	Y	Y	Y	Y	80
Bellbuca 3	-	Y	-	Y	-	-	Y	-	Y	Y	50
Bellbuca 4	-	Y	-	Y	Y	-	-	Y	Y	Y	60
Killiekrankie 1	Y	-	Y	-	Y	-	Y	Y	Y	Y	70
Killiekrankie 2*	-	-	-	-	-	-	-	-	Y	Y	20
Killiekrankie 3	Y	-	-	-	-	-	Y	Y	Y	Y	50
Kilprotay 1	-	Y	-	-	-	-	Y	-	Y	-	30
Kilprotay 2	Y	-	Y	-	Y	-	-	Y	Y	-	50
Kilprotay 5	-	-	Y	Y	Y	-	-	Y	-	-	40
Kilprotay 6	Y	-	Y	-	-	-	Y	Y	-	Y	50
Kilprotay 7	Y	-	Y	-	Y	Y	Y	-	Y	Y	70

times. Twelve territories were identified (Table 1) based on the criterion described above. All but one territory was occupied in more than one year. On those territories occupied throughout the survey period, scrub-birds were located on 58% of systematic surveys (Table 1).

The number of Southern Rufous Scrub-birds detected declines with distance from the observer (Ferrier 1984). This decline is illustrated for the present study in Fig. 2, which shows a significant decrease in detections more than 50 m from the observer.

The locations of the 12 territories identified in 2016-18 were compared with those recorded in previous surveys. Figure 3 illustrates the method used to make this comparison. Over the 1999-2016 period, a total of 18 territory sites were identified along the 12 km of transects (Table 2). Fourteen sites were occupied in 1999-2004, 12 in 2010-13 and 12 in 2016-18. Seven territories were occupied in all three survey periods. Nine of the same sites were occupied in both of the first two survey periods (1999-2004 and 2010-13), nine in both of the last two periods (2010-13 and 2016-18) and nine in both the first and the last period (1999-2004 and 2016-18).

The locations of the 36 sites identified as either known or potential territory habitat are shown in Fig. 1.

DISCUSSION

Our results need to be assessed critically, considering the methodological issues that have previously been identified with these sorts of surveys (Andren 2016). Foremost of these issues is that sites were not selected randomly, but were in some of the best quality and most accessible areas known to support Southern Rufous Scrub-birds. This bias in site selection prevents the findings from being legitimately extrapolated from the study area to the wider landscape.

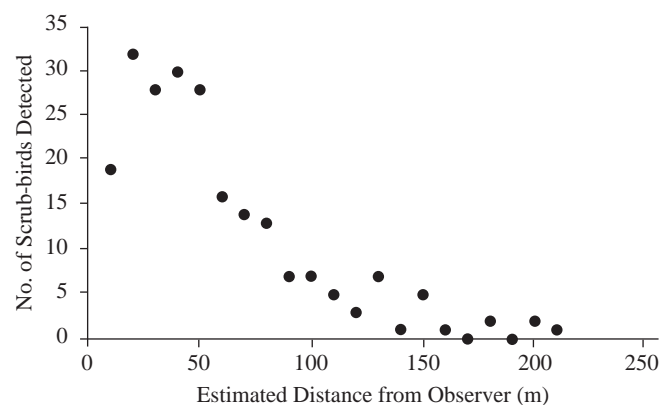


Figure 2. The decline in Southern Rufous Scrub-bird detections with increasing distance from the observer compiled from the combined data for the two decades of monitoring. The effect of the observer's presence on a road is probably also evident in the low number of detections very close to the observer (at 10 m).

Secondly, a 'territory' was defined as a site where three records (each at least one month apart) were obtained of a singing male, giving us confidence that it had been occupied for at least one whole breeding season. The rationale of this definition was to prevent just one or two incidental records of a male calling at a site allowing the site to be considered a territory, because this might be insufficient to indicate that it could support breeding. However, we know that territories *can* be established for short periods of time such as a single breeding season, so the definition we used possibly mitigated against identifying these short-term territories. Surveys were not done every year, which also makes it less likely that all short-term territories were identified. The definition of territory that we used has, however, been shown to be effective in identifying long-term territories. For example, when all records (i.e. systematic survey records

Table 2

A comparison of Southern Rufous Scrub-bird territories in 1999-2004, 2010-2013 and 2016-2018. The elevation of each territory was taken from a point in the centre of each minimum convex polygon. There were 76 records of scrub-birds in the 1999-2004 dataset used, 105 in the 2010-2013 set and 86 in 2016-2018 set. An extra territory has been included in 1999-2004 compared with Andren (2016), as one large territory at Killiekrankie that previously encompassed a dry ridge was split into two.

1999-2004 Territories (14 in total)	2010-2013 Territories (12 in total)	2016-2018 Territories (12 in total)	Years occupied	Approx. elevation (m)
Boot Hill	Boot Hill	Boot Hill	20+	750
Bellbucca 1	Bellbucca 1	Bellbucca 1	19+	800
Bellbucca 2			7+	790
Bellbucca 3	Bellbucca 3	Bellbucca 3	20+	800
	Bellbucca 4	Bellbucca 4	8+	790
Killiekrankie 1	Killiekrankie 1	Killiekrankie 1	20+	775
Killiekrankie 2		Killiekrankie 2	6+	775
Killiekrankie 3	Killiekrankie 3	Killiekrankie 3	21+	890
	Killiekrankie 4		6	860
Killiekrankie 5			4+	860
Killiekrankie 6	Killiekrankie 6		16+	790
Kilprotay 1	Kilprotay 1	Kilprotay 1	20+	750
		Kilprotay 2	6+	815
Kilprotay 3			5+	750
Kilprotay 4	Kilprotay 4		17+	850
Kilprotay 5		Kilprotay 5	6+	875
	Kilprotay 6	Kilprotay 6	8+	960
Kilprotay 7	Kilprotay 7	Kilprotay 7	19+	925

Av: 823

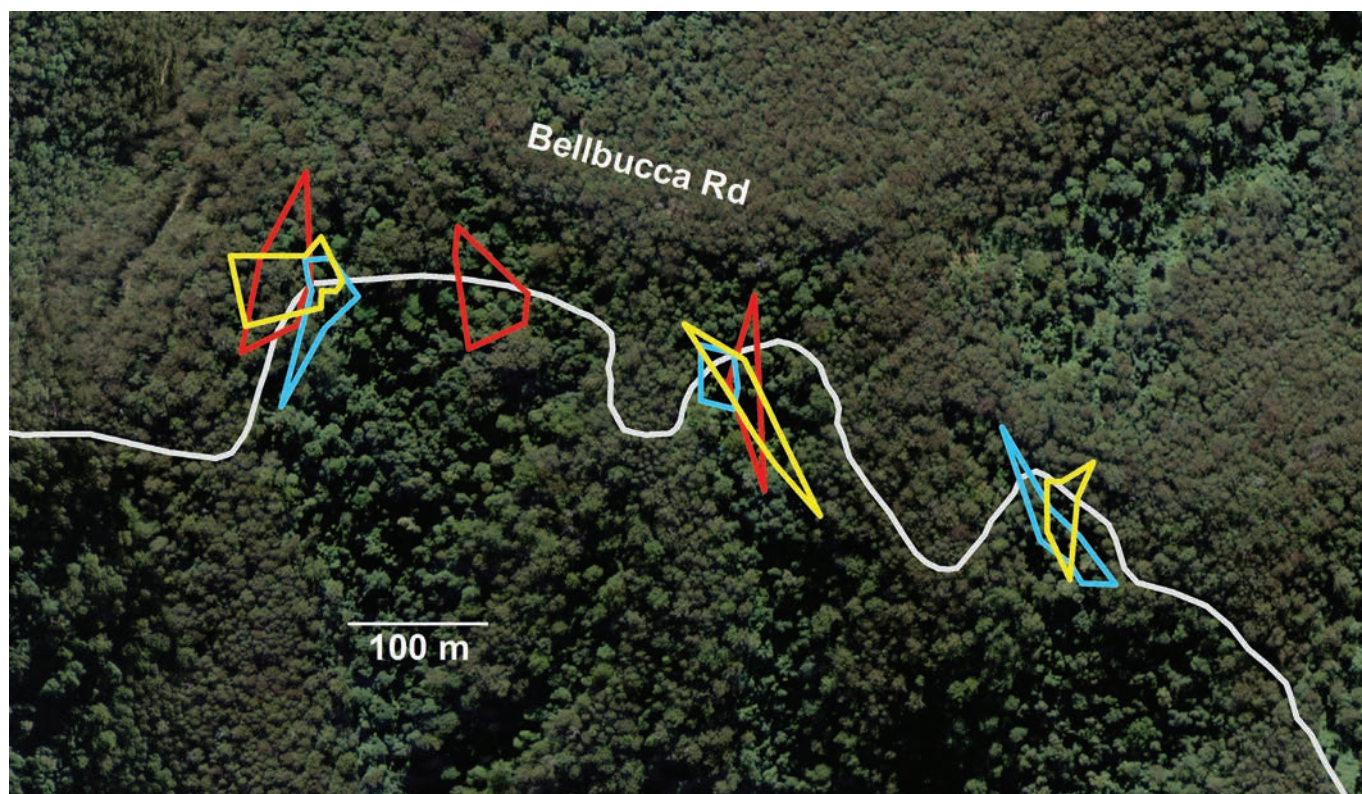


Figure 3. An example of how the 2016-2018 territories (yellow minimum convex polygons bounding records from the 2016-18 survey) were compared with those from 2010-2013 (blue) and 1999-2004 (red) survey periods. This example from the Bellbucca Road area shows two territories occupied in all three surveys (three overlapping polygons), one occupied in the two latest surveys (two overlapping polygons) and one that was occupied only in the first survey (isolated red polygon).

and incidental ones) obtained during the 2016-18 survey period are considered, 87% were at the territories identified using the 3-records criterion; there was an average of 5.6 records at each territory, spanning multiple years. This greatly increases our confidence that at least all long-term territories were identified.

Detection of the Southern Rufous Scrub-bird declines with increasing distance from the observer, because it becomes increasingly difficult to see or hear them (Ferrier 1984). In our study, detection appeared to decrease markedly beyond about 50 m from the observer (Fig. 2). This implies that some territories further away from the observer may have been missed. However, the number missed will have been limited by the relatively large number of repeat surveys carried out (both systematic and incidental) that enabled the 3-records threshold to be passed comprehensively, even for territories relatively far away from the observer.

The decline in scrub-bird detections with increasing distance from the observer may partly reflect the birds' actual distribution and not be entirely due to the increasing difficulty in detecting them. Transects were located on roads that were on or near ridge tops and the less steep, cool and moist uppermost catchment through which the transects ran may be favoured by scrub-birds for their territories. Thus the scrub-birds may predominantly have been located close to the observer rather than further down the steep catchment slopes. This possible spatial distribution is reinforced at a broader landscape scale by the absence of any reliable records (including historical ones) at low elevations, including in populated valleys where there are some experienced bird observers. The territories in our study area are at relatively low elevations for contemporary scrub-birds (average 823 m), but even in this region there are very few recent reliable records below 600 m.

The number of occupied Southern Rufous Scrub-bird territories has been relatively consistent in the study area over the two decades being considered here. At the occupied territory sites, birds were recorded on 58% of surveys in 2016-18, compared with the 64% in the previous survey (Andren 2016). In surveys at Gloucester Tops from 2010 to 2016, a similar, although not directly comparable, statistic calculated was the 'reporting rate', which averaged 56.5% (Stuart and Newman 2018). These results collectively demonstrate the high frequency at which the male Southern Rufous Scrub-bird calls in spring.

Over the two decades considered in this study, the occupancy of territories was remarkably stable. The turnover of territories was slow, with only one territory becoming unoccupied and a new one becoming occupied about every three years. Seven territories remained occupied in all three survey periods and we suggest it is likely that they have been continuously occupied over the two decades. At the most frequently visited territory, on the Mt Killiekrankie walking track, a scrub-bird was recorded as being present in the NSW BioNet in 13 of the 31 years from 1987 to 2018. Such durations are likely to be beyond the longevity of a particular calling male in the wild and imply that a male that disappears from a particular site may be quickly replaced by another. However, Stuart (2019) suggested that, unlike the situation in the Noisy Scrub-bird

Atrichornis clamosus, subordinate males may not be present in a territory ready to replace the dominant male. This feature of Southern Rufous Scrub-bird social behaviour clearly requires investigation.

Territorial stability has also been suggested by surveys elsewhere. At Gloucester Tops and the Border Ranges, surveys in 2010-12 found similar numbers of territories to those recorded in surveys conducted 30 years previously (Ferrier 1984) and birds using many of the same sites (Newman *et al.* 2014). We speculate that an implication of this may be that, in core habitat under relatively stable environmental conditions, experienced adult scrub-birds can persist in habitats containing significant numbers of predators. Feral (foxes, dogs and cats) and native predators (including Spotted-tailed Quolls *Dasyurus maculatus* and Carpet Snakes *Morelia spilota*) are well known in our study area and territory occupancy would be unlikely to be so stable if the adult birds were being highly depredated. Of course, a significant negative impact could still result from the predation of young or dispersing birds, or elevated predation levels after disturbance (e.g. post-fire or post-logging).

The potential for territories to be occupied for multiple decades underlines the sites' conservation importance and the need to provide a high level of protection, particularly from fire. A total of 36 sites that have either been used as territories or might potentially be used were identified along the 12 km of transects. The number of these sites positively identified as scrub-bird territories has slightly increased over the two decades under consideration, from 14 originally to 16 in 2012 and 18 in 2018. Another 10 sites have yielded one or more incidental records, possibly indicating that they may have been investigated as potential territories or used as short-term territories by males. The other eight of the 36 potential sites have not provided any scrub-bird records. Future surveys will very likely document an increase in the number of sites being used as territories. A conservation plan should aim to protect all 36 sites, not just those that are currently occupied.

The density of Southern Rufous Scrub-birds in the New England region is similar to densities estimated in other areas that are considered to contain high quality habitat. Over two decades at New England, 1.1 territories were found per kilometre of transect, the same density as that found at Gloucester Tops from 2010 to 2019 (Stuart 2020). In the Border Ranges from 2010 to 2012, 0.9 territories were found per kilometre (Newman *et al.* 2014). Overall, about one territory per kilometre of road transect was found across the three study areas.

Territory density is constrained foremost by the spatial arrangement of suitable habitat. In our study area, suitable habitat occurs in the heads of wet gullies in rainforest or wet sclerophyll forest (with a rainforest understorey), with the intervening drier and more open eucalypt-vegetated ridges apparently not being suitable. The spatial distribution of the 36 sites assessed as suitable habitat in our study area is variable, ranging from 2 to 6 per kilometre (mean 3.1). A third of these sites were occupied in 2016-18 survey period.

Ferrier (1984) considered that social behaviour may also be playing a role in structuring the spacing of territories. If all the potential sites in the New England study area were occupied,

densities could be three times higher. However, even where habitat is abundant, the scrub-bird calling sites are still usually at least 200-300 m apart, a pattern also observed at Gloucester Tops (Newman *et al.* 2014). Social behaviour may be inhibiting the establishment of more closely packed territories.

Rapid fluctuations in territory occupancy have been observed in Gloucester Tops, perhaps in response to drought (Newman *et al.* 2014; Stuart 2020), and in Werrikimbe in response to fire (R. Peacock pers. comm.). Severe drought conditions prevailed in the Horseshoe Road area in 2019, and subsequent fires entirely burnt one territory and partially burnt several others. Climate change is now probably the key threat to the Southern Rufous Scrub-bird, especially because they already occupy high elevation wet refugia. Future monitoring in the New England region will help assess the scale of the impact from the 2019 drought and fires.

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