

A trial of the use of motion-activated cameras to study Rufous Scrub-bird behaviour

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The Rufous Scrub-bird *Atrichornis rufescens* is a little-studied, cryptic species found only in a few remote locations in high altitude areas of south-eastern Australia; even its mode of locomotion and foraging methods are poorly documented. A trial of the use of motion-activated cameras (trail cameras) to study Rufous Scrub-bird behaviour was conducted in the New South Wales Gloucester Tops from 2020-2022. Cameras were deployed at two known Rufous Scrub-bird territories, targeting locations within the male bird's known singing areas. Through a process of trial and error, camera locations were found that yielded behavioural information about Rufous Scrub-birds, much of which is novel. Rufous Scrub-bird behaviours captured by cameras included foraging, eating, vocalisation and locomotion on the ground and through vegetation. Some insights into Rufous Scrub-bird territorial behaviour were also obtained, particularly the presence sometimes of more than one individual in the singing area. Locomotion was mostly by hopping (on the ground and in vegetation) or walking (in vegetation). When walking along grass stems or small branches, birds sometimes used their bill for assistance. Observations of birds flying were rare but sometimes they glided (i.e. wings outspread) and there were two recorded instances of birds flapping their wings when they ascended to a higher perch. Scrub-birds were seen eating, but the food items were too small to be identified. Vocalisations were usually emitted in brief interludes during another activity (locomotion or foraging) and often were given by birds at ground level or in only slightly elevated positions. All the insights gained from the trial are considered preliminary; many more data are required before definitive conclusions can be drawn about any of the observed behaviours. However, the initial results are encouraging and in this investigation motion-activated cameras have been shown to have a potentially valuable role in future Rufous Scrub-bird behaviour studies.

Keywords: Rufous Scrub-bird; motion-activated cameras; territorial behaviour; locomotion; foraging; vocalisation.

INTRODUCTION

The Rufous Scrub-bird *Atrichornis rufescens* is a cryptic species occurring in isolated populations in northern New South Wales (NSW) and southern Queensland (Stuart *et al.* 2021; Stewart *et al.* 2021). It is a threatened species, classified as Endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 2010 and on the IUCN Red List., and as Vulnerable under the NSW Biodiversity Conservation Act 2016. All the populations are monitored (G. Maurer, BirdLife Australia, pers. comm.), although there are publicly available status reports only for the Gloucester Tops, New England and Scenic Rim populations (Newman *et al.* 2014; Andren 2016; Stuart and Newman 2018; Stuart 2020; Andren *et al.* 2022). The species' range in southern NSW may be smaller than previously understood; targeted surveys in 2020 showed that many previous reports from locations outside the known core population were dubious or could not be confirmed (Kyte and Little 2021).

Adult male and female Rufous Scrub-birds can be distinguished by their plumage (Higgins *et al.* 2001). Males have a black throat and breast, this colouring extending onto the sides of the upper belly and through the centre of the throat to the base of the bill. Females have only small areas of black on the sides of their belly and upper breast, and their throat patch is dusky, not black. Juvenile scrub-birds lack any black underparts and their throat and chin have been described as ashy grey.

Rufous Scrub-birds are heard far more often than they are seen. Females seldom vocalise and have soft calls (Ferrier 1984) and thus a vocalising scrub-bird is almost certainly a male. Males have a small singing area, which Ferrier (1984) considered to be the bird's territory and home range. However, it is very difficult to know where a scrub-bird is when it is not vocalising; territory/home range size could be larger than has generally been assumed.

Rufous Scrub-birds have an unusually shaped sternum, poorly defined furculae and no clavicles; such characteristics are generally associated with flightlessness or poor flying ability (Chisholm 1951). There are descriptions of clumsy flying efforts by Rufous Scrub-birds (e.g. see Chisholm 1921); however, invariably those efforts involved alarmed birds which were trying to escape from potential human interference. The willingness with which Rufous Scrub-birds take to the wing in more normal circumstances is unknown.

Relatively little beyond the aspects outlined above is known about the behaviour of Rufous Scrub-birds. However, Ferrier (1984, 1985) studied birds at Wiangarie and in the Gloucester Tops and identified their habitat preferences, male territory sizes, inter-territory separation criteria, and some aspects of male singing behaviour and male-female interactions. His work also led to the recognition of two subspecies: *rufescens* in the north of the species' range and *ferrieri* in the south. More recently, colleagues and I verified Ferrier's findings about male territory

size in the Gloucester Tops (Stuart 2018) and obtained additional insights into the singing behaviour of males (O’Leary and Stuart 2021). Very little is known about the species’ breeding biology, although nests and eggs of some *rufescens* subspecies scrub-birds were collected in the late 19th and early 20th Centuries (Jackson 1911, 1921). However, nothing has ever been documented about the breeding biology of the *ferrieri* subspecies. Indeed, for the Gloucester Tops population of *ferrieri* birds there has not even been a confirmed breeding record.

Improving the long-term prospects of the Rufous Scrub-bird requires a better understanding of how individuals live. However, it is a difficult species for an observer to study in the field. Its preferred habitat has several challenging ground-level features e.g. extensive low-height vegetation and leaf litter, numerous fallen trees and branches, rocks, potholes, creeks and swamps. Thus, the habitat is difficult for an observer to traverse although relatively easy for the scrub-bird, which can move across distances of 10-20m quickly (pers. obs.). The terrain makes it difficult for an observer to see a scrub-bird except for brief moments, because it spends much of its time on or close to the ground and quickly becomes obscured behind vegetation, logs or rocks. Moreover, if the scrub-bird is not actively vocalising, the observer must rely on a chance sighting, a low probability event. The habitat-related difficulties in seeing a Rufous Scrub-bird and in traversing its territory make it difficult for an observer to study the bird’s natural behaviour, especially as the observer’s presence will almost certainly disturb the bird.

Motion-activated cameras (“trail cameras”) are used extensively in wildlife monitoring programs (e.g. Meek *et al.* 2012; Gillespie *et al.* 2015; Evans *et al.* 2019). They can be configured to record still images or video footage. Probably their main usage has been as so-called camera traps to record the types of animals present at a specific location. In such cases the cameras are programmed to operate at certain times of day or night and to activate when a movement of any sort is detected within their field of view. Species identifications are usually done manually after the camera data storage cards are downloaded. Less commonly, such cameras have been used to monitor wildlife behaviour remotely (e.g. Harrison *et al.* 2019; Randler 2021). In both applications (camera trap, remote monitor) a key benefit of using a motion-activated camera is that no human is present at the time. Therefore, there should be no disturbance to the natural behaviour of the species being recorded, except during a short period of human visitation during and shortly after installation of the camera.

It seemed possible that motion-activated cameras could have a role in documenting the natural behaviour of Rufous Scrub-birds, but a critical issue was whether they could capture useful information, given the limited field of view that they would have within a scrub-bird’s territory and the small size and cryptic nature of the target species. It has been suggested that the use of cameras for bird studies may generally be more appropriate for large, cursorial birds, such as pheasants (O’Brien and Kinnaird 2008). However, camera traps were effective in studying the behaviour of the Tasmanian Lewin’s Rail *Lewinia pectoralis brachipus*, a small, cryptic waterbird which is mainly, although not exclusively, a ground-dwelling species (Znidarsic 2017). Notably though, a Lewin’s Rail weighs about three times as much as a Rufous Scrub-bird (R. Kyte unpublished).

I trialled the use of trail cameras in two known Rufous Scrub-bird territories. The aims of the trial were to assess the potential of these cameras for assisting Rufous Scrub-bird behavioural studies and to identify operational criteria for using them in longer-term investigations.

METHODS

Investigations were carried out at two Rufous Scrub-bird territories in the NSW Gloucester Tops. Their precise locations are confidential, but they were within an area of radius ~1.5 km centred approximately at 32°05’S, 151°37’E. Both territories are being studied in a long-term investigation of Rufous Scrub-birds in this area (e.g. see O’Leary and Stuart 2021). They were selected because I was familiar with the areas within the territory that were used preferentially by the male scrub-birds for singing (Stuart 2018).

All the motion-activated cameras were placed 10-20 cm above ground-level, being affixed to a tree trunk when available at the selected position, or to a picket hammered into the ground. Camera sites were unbaited. Initially, in each territory I placed some cameras at somewhat arbitrarily selected locations within the singing area of the male scrub-bird. However, there were some criteria for selecting these initial camera positions, which were to minimise “ghost” triggering (i.e. the camera being triggered to record due to foliage moving in the wind or fluctuations in light levels associated with cloud movements) and to have a clear area in front of the camera for about 1 m. Other selection criteria for the camera locations were minimising exposure to inclement weather and the risk of human interference.

I left each camera in position for 2-3 months, servicing it occasionally (to replace the batteries or the SD cards). After that period, if a camera had not recorded any Rufous Scrub-bird images or videos, I moved it to another location within the singing area. Eventually, all the cameras within a scrub-bird territory became clustered within a 10-20 m radius of an area where scrub-birds were appearing regularly, such that all cameras were at least occasionally capturing scrub-bird images or videos.

During the trial, I varied the starting and finishing times of camera operation, as described later. For cameras producing still images, I configured them to record three consecutive images at 1-second intervals after a triggering event. For cameras recording videos, I varied the duration of the recordings, and the time intervals between them. I used 27 different motion-activated cameras at some stage during the trial. These came from a range of brands (Swann, Reconyx, Browning and Bushnell) and models. Some cameras only produced black-and-white still images (e.g. Reconyx), but many others were capable of recording video footage (which could be in colour when the ambient lighting conditions were favourable). All the cameras used infrared flash and passive infrared detection. Most of the cameras, when operating in video mode, had a 2-second delay between being triggered and commencing to record. Late in the trial I added three Bushnell Core DS cameras to the suite of cameras in use; these have a 0.2-second trigger delay.

Images and video recordings were stored on SD cards in the field and later downloaded to a computer for manual assessment using standard Microsoft photo or video processing software. When assessing video recordings, I categorised them according

Table 1

Summary of Rufous Scrub-bird video recordings produced during the trial. S = seconds.

Quality	Duration	Territory 1	Territory 2
High	<1 s	2	1
	1-3 s	6	5
	3-10 s	4	1
	>10 s	9	4
Medium	<1 s	9	-
	1-3 s	10	2
	3-10 s	3	3
Poor	>10 s	-	3
	<1 s	9	-
	1-3 s	4	3
	3-10 s	3	3
	>10 s	-	-

to the amount of time (in seconds) that a scrub-bird was visible in the recording (using four categories: less than 1; 1-3; 3-10; > 10 sec) and the quality of the recording (good, medium and poor). Assignments of video quality were subjective and rapid (a few seconds per assessment), but were based upon a combination of features, namely the degree of pixilation, whether recorded in colour or black-and-white, the proximity of the scrub-bird to the camera and the ratio of clear to obscured vision of the scrub-bird.

RESULTS

Camera performance

Between November 2020 and September 2022, the trail cameras captured 95 ‘Rufous Scrub-bird events’, an ‘event’ being whenever a scrub-bird was unambiguously identified as having been present in a video recording or a set of contemporaneous still images. In Territory 1, I obtained 59 video recordings and 11 sets of still images; in Territory 2, between May and September 2022, I obtained 25 videos of scrub-birds. The cameras also recorded many hundreds of movements by non-scrub-bird wildlife e.g. visits by other bird species (at least 15 species were recorded), marsupials such as wallabies and bandicoots and apex predators (quolls, foxes and cats).

Still images

After two months of trialling cameras in Territory 1, I stopped recording still images. I did not attempt to collect any still images in Territory 2. The still images were useful for proving that a scrub-bird had been present at a particular time, but they yielded no behavioural information. However, in several of the images it was possible to see a coloured plastic band on the scrub-bird’s leg and this assisted in evaluating the feasibility of catching, banding and re-sighting Rufous Scrub-birds (Kyte and Stuart 2022).

Video recordings

Initially I programmed the cameras to operate 24 hours per day (when triggered by movement). However, as that yielded numerous images and videos of nocturnal animals, I changed the settings, firstly to record from ~30 minutes before dawn to ~30



Figure 1. Screenshot from a video recording showing a Rufous Scrub-bird moving through vegetation in Territory 2.



Figure 2. A second screenshot from a video recording showing a Rufous Scrub-bird moving through vegetation in Territory 2.

minutes after dusk, and later to record from ~1 hour after dawn to ~1 hour before dusk. Ambient lighting was usually brighter in the latter time slot, and as a result the video recordings were of better quality and were more likely to yield useful behavioural information.

The 84 video recordings varied in quality and in the amount of time that the scrub-bird appeared on screen. Although all cameras were programmed to produce colour recordings, in situations when the ambient lighting was poor the videos were grainy (pixelated) and sometimes in black-and-white instead of colour. In Territory 1, I obtained 21 good quality video recordings and 22 medium quality ones (Table 1). All 43 videos should be useful for studying some aspect of Rufous Scrub-bird behaviour. The sixteen poorer-quality videos were mostly so because of low ambient lighting, which resulted in dark, grainy recordings in which the scrub-bird was marginally discernible. In contrast, in Territory 2 all 25 recordings had excellent light levels, the main factor affecting the quality of the recordings being the extent to which the views of the scrub-bird were obscured by vegetation (Table 1). Figures 1 and 2 are screen shots from video recordings collected in Territory 2; they show the quality of the images that could be obtained under ideal conditions.

The longest recording obtained was in Territory 2 when there was unobscured vision of a scrub-bird for 36 seconds. Several recordings in Territory 1 contained 20 seconds of scrub-bird behaviour; at that stage of the trial that was the maximum recording time set for the cameras. Each territory also yielded 3-4 videos that each had 10-20 seconds of scrub-bird activity.



Figure 3. Screenshot from a video recording showing a Rufous Scrub-bird (arrowed) in Territory 1 foraging on the ground, using its bill to probe the leaf litter.

Behavioural insights

Various scrub-bird behaviours were captured in the 62 medium and good quality videos. Some of these behaviours were also evident in the poorer quality recordings, but for present purposes I have excluded such recordings from further analysis. The behaviours recorded included foraging, eating, locomotion on the ground and through vegetation, and vocalisation. Additionally, some insights into Rufous Scrub-bird territorial behaviour were obtained. Many of the videos, particularly longer ones, showed more than one type of behaviour. Scrub-birds were seen foraging in 19 videos, moving on the ground in 26, moving through vegetation in 43 and vocalising in 21 videos.

Foraging

In most of the recordings showing foraging behaviour, the scrub-bird was on the ground. It searched for food by turning over leaf litter using its bill (never its feet) and seizing exposed food items in the bill (see Fig. 3). These items were too small for identification, the only indication of a successful hunt being the scrub-bird swallowing. A scrub-bird was also seen reaching into gaps between the fronds of a tree fern and collecting food (again, too small for identification); it inserted its head deep into the gaps, with almost all the head being immersed. Once a scrub-bird was recorded foraging in vegetation (a tree fern sp.) about 30 cm above ground; it was impossible to see if it was successful in finding food.

Locomotion

In all the recordings of a scrub-bird moving on the ground, it was hopping on both legs, covering distances estimated to range from 1-2 to 10-12 cm. Sometimes, as it neared the edge of a clearing, it leapt into the vegetation to heights of about 10 cm. This movement could be described as a ‘super-bound’; the bird used its legs but not its wings. However, in one recording the scrub-bird ascended higher, eventually to above camera height and thus out of sight. In that ascent, the bird flapped its wings to assist its climb.

Two forms of locomotion were recorded for scrub-birds moving above ground level through vegetation, namely walking and hopping. Scrub-birds walked along grass stems and small branches. Sometimes when doing so they also grasped the stem or branch with their bill and pulled themselves forward. It was also apparent in some recordings that birds had swung their tail

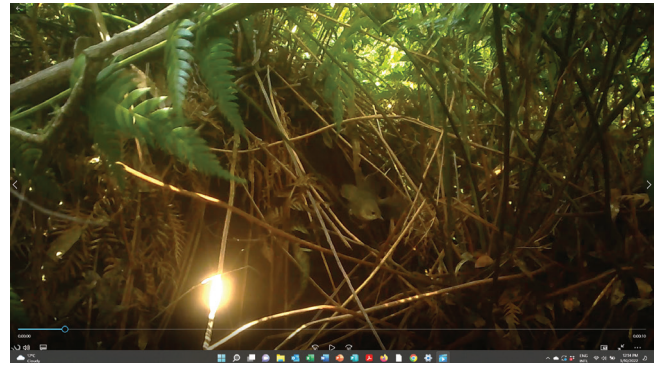


Figure 4. Screenshot from a video recording showing a Rufous Scrub-bird in Territory 1 in flight, flapping/gliding across a clearing.

to one side, presumably as an aid to balance. On many other occasions in denser vegetation, the scrub-bird hopped from one bit of vegetation to another, covering distances of up to about 10 cm. These movements resembled those of scrub-birds moving on the ground. However, birds sometimes covered longer distances, and in doing so they used their wings for assistance (see Fig. 4). When the movement was downwards through vegetation, the scrub-bird spread its wings out to glide to the new location. In one instance when the movement was upwards, the scrub-bird flapped its wings as it traversed the gap.

Vocalisation

In several recordings, the scrub-bird uttered its territorial ‘chipping’ song, a series of up to eight descending, single syllables (Stuart and O’Leary 2019). In some other videos, the scrub-bird produced a more staccato version of the song involving a series of ascending syllables, and sometimes it made single note calls (such as squawks, seeps and whistles). In two recordings, a soft tkk-tkk call could be heard; this call has been associated with female Rufous Scrub-birds (Ferrier 1984). In every instance when the bird vocalised, it was either foraging or moving around, and the vocalisation was produced during a brief pause in the ongoing activity. Some scrub-birds were on the ground when vocalising, others were amidst vegetation at heights of ~ 5-25 cm. Figure 5 shows a Rufous Scrub-bird vocalising (uttering the territorial song) from ~ 5cm above ground.

Territoriality

Territory 1

A male Rufous Scrub-bird was banded in Territory 1 in September 2020 with a pink band on its left leg (Kyte and Stuart 2022). Before and after this banding, in many of my visits to the territory a male was heard singing from the same small area, which suggested that the area was the centre of the bird’s territory. All the trail cameras in that territory were installed nearby, and the pink-banded male was recorded clearly in 20 of the videos from these cameras during the trial. In several other videos recorded at this site, the scrub-bird’s legs were obscured; it may/may not have been the banded male. However, in four recordings from this site there were unobscured views of an *unbanded* scrub-bird and these videos were obtained at locations where cameras had previously detected the banded male. In one of the videos, three interacting *unbanded* scrub-birds could be seen. The ambient light levels were low in all



Figure 5. Screenshot from a video recording showing a Rufous Scrub-bird vocalising in Territory 2.

four of these instances and consequently the video recordings of these unbanded scrub-birds were in black-and-white. Therefore it was not possible to draw conclusions about the sex or age of any of these birds, except that they were not adult males, as they lacked black breast and throat plumage.

Territory 2

A male Rufous Scrub-bird in Territory 2 was fitted with a yellow band on its right leg in November 2018; in September 2020, this bird was confirmed as still present (Kyte and Stuart 2022). However, none of the scrub-birds in the video recordings obtained from Territory 2 in 2022 were banded. All the recordings were obtained at distances of < 20m from the mist net lane at which the November 2018 scrub-bird capture occurred. The 25 recordings are probably of the same bird, because in those videos where an unobscured view of the bird was obtained the plumage seems identical. The scrub-birds in the recordings had a faintly black breast band, suggesting that they were females or young males.

DISCUSSION

Camera selection and settings

Using cameras set to record still images was only useful for providing evidence that a scrub-bird had been present within the field of view. No behavioural information was obtained, although the cameras did sometimes capture images of a colour-banded male Rufous Scrub-bird. The cameras had been set to record three contemporaneous images after triggering. Possibly, more useful information would have been obtained if more images had been collected after each trigger event. However, the video recordings yielded far more information and they seem to be the better option for future studies.

In most of the videos, the Rufous Scrub-bird was already mid-screen at the start of the recording, which limited the opportunity to obtain behavioural information. Most of the cameras used in the trial had a 2-second delay between triggering and the start of recording. Thus, when they were triggered by a scrub-bird moving into the field of view, the bird often had already traversed some distance across the field of view. The typical angle of view for a trail camera is around 40°, and so with a viewing distance of ~1 m into a clearing the maximum width of the field of view is around 70 cm. During the camera's 2-second trigger delay, the scrub-bird can easily have moved

such a distance. For Rufous Scrub-bird studies, cameras with short trigger times are clearly desirable (e.g. Bushnell Core DS cameras with 0.2-second trigger speed).

It also seems preferable to select recording times of at least 20 seconds for videos. Whilst this would often lead to recordings containing no wildlife activity after the first few seconds, which has implications for data storage, the upside is that sometimes there would be a lengthy recording of some type of scrub-bird behaviour. It is worth noting that some trail cameras have an option for a dynamic setting i.e. if there is a fresh trigger, the camera continues to record. Potentially this option could result in capturing long sequences of scrub-bird activity.

Vocalising

It is generally believed that male Rufous Scrub-birds sing their territorial song from the top of a shrub, consequently maximizing broadcast distance. Several times in the field I have observed such behaviour. However, it is clear from the video recordings that vocalisation at ground level or from only a minor elevation is quite common. It is also clear that vocalisations, whether the territorial song or other types of call, are made while the scrub-bird is going about its normal activities. The bird pauses briefly in the middle of some activity, vocalises and then resumes the same activity.

Territoriality

Researchers studying the related Noisy Scrub-bird *A. clamosus* found that females occupy and defend territories which can be a considerable distance (up to ~ 1 km) from the nearest male territory (S. Comer pers. comm.). In contrast, Ferrier (1984: p. 175) reported that the home range of female Rufous Scrub-birds overlapped with the associated male's 95% home range ellipse, but that it was usually well away from the centre of the male's home range. The four confirmed separate recordings in Territory 1 of unbanded Rufous Scrub-birds in this study occurred at cameras which had also captured recordings of the colour-banded male bird in the same general time frame. The unbanded birds were not adult males and thus were either females or juveniles. The cameras were well within the territorial male bird's singing area. This supports Ferrier's comments about overlapping home ranges of male and female Rufous Scrub-birds; however, the unbanded birds were quite close (probably within 5-10 m) to the male's home range centre.

Similarly, in Territory 2 the unbanded female or young male scrub-bird captured in 25 video recordings was within 20 m of what had been the core singing area of the male that was caught and colour-banded in 2018. Thus, they were quite close to that bird's home range centre. However, at the time of writing it is unclear whether the male from 2018 is still present, as there has not been a confirmed sighting of it since September 2020. A plausible scenario is that the bird in the videos is a young male scrub-bird that has replaced the previous bird. The fact that the bird in the videos uttered a territorial song several times suggests that it may be a male. This may provide an insight into how it is that many Rufous Scrub-bird territories are occupied for long periods of time i.e. because a young male has replaced a bird at the same location. However, there also are documented examples of long-occupied territories where the male Rufous Scrub-bird just suddenly disappears (Stuart 2019).

Other observations

A noteworthy aspect of the camera trials is that they took place during times of very restricted human access to the Gloucester Tops. Travel restrictions associated with the COVID-19 pandemic prohibited access for several periods during March-September 2021. Also, from October 2021 the sole access road was closed for eight months due to a bridge failure. Thus, during a period spanning about 14 months, there were only a few weeks when people could visit the Gloucester Tops and the opportunities for Rufous Scrub-bird studies in that period were decidedly limited. However, by and large the trail cameras kept working. During the eight months of there being no access at all, six cameras had been deployed. When they could finally be serviced, two of them were still operating and two others had only stopped recording a few weeks earlier. The cameras had recorded twenty medium to good quality videos of Rufous Scrub-birds in the 14-month period of limited human access. This highlights an additional value of using motion-activated cameras to record avian behaviour.

The Rufous Scrub-bird has been variously described as flightless or poorly-flying. The video recordings showed that it has a strong preference to not fly, but that it is not flightless. In two recordings (out of 84), a scrub-bird clearly flapped its wings as it left its perch and moved to a position out of camera view. In both cases, the birds flight seemed laboured, in keeping with the absence of clavicles. It thus seems appropriate to describe the Rufous Scrub-bird as “poorly-flying”.

All the results and interpretations from the trial should be considered preliminary. Only a few examples of most of the behaviours were captured on camera, insufficient for detailed analysis. More examples are required, ideally involving several different individuals. However, it seems clear that motion-activated cameras could have an important role in future Rufous Scrub-bird studies. The trial has shown that, with care and patience, valuable behavioural information can be obtained. My intention is that the current and future video recordings of Rufous Scrub-birds will be made available to ornithologists and ecologists working on this little-known species.

CONCLUSIONS

Motion-activated cameras were shown to have a valuable role in Rufous Scrub-bird behaviour studies. When a suitable location for a camera was found, the resultant video recordings yielded insights into several aspects of Rufous Scrub-bird behaviour. As the number of good quality recordings increases, there should be opportunities to analyse these behaviours more closely and learn more about the lives of Rufous Scrub-birds.

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