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Radio-tracking Grey Grasswrens *Amytornis barbatus barbatus* in north-western New South Wales: a pilot study

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A pilot study to radio-track the movements of Grey Grasswrens *Amytornis barbatus barbatus* in north-western New South Wales was conducted during September, 2017. Four birds were tracked for 5–7 days using small radio-transmitters attached to the interscapular area. Minimum foraging areas varied from approximately 18 to 53 ha and encompassed a variety of plant associations dominated by Lignum *Muehlenbeckia florulenta.* The longest daily movement recorded was approximately 1.6 km. We also established that these birds returned to roost at night in a central area of thick Lignum. This study showed that it is possible to track Grey Grasswrens through dense thickets of Lignum and to identify their minimum foraging areas.

INTRODUCTION

The Grey Grasswren *Amytornis barbatus* comprises two subspecies, both of which frequent the arid region of the 'corner country' where New South Wales, Queensland and South Australia abut. Their present distribution is limited to four discrete and isolated areas. *Amytornis b. diamantina* occurs in a small area along Eyre Creek south of Bedourie, at Goyder Lagoon south of Birdsville and near the junction of the Wilson River and Cooper Creek near Ballera (Black *et al*. 2011), although this last location may harbour a separate subspecies (Black and Gower 2017). The nominate subspecies *Amytornis b. barbatus*, the subject of this study, has a known distribution that extends from the Bulloo River near Yandacoopa Waterhole (28.664° S; 142.505° E) on Bulloo Downs Station (Jaensch *et al*. 2013) in south-western Queensland, south through Caryapundy Swamp and its eastern outflow channels, to the northern margin of the Bulloo River overflow in north-western New South Wales (NSW) (Hardy 2010). In NSW, the species is largely confined to the remaining areas of dense, tall Lignum *Muehlenbeckia florulenta* and the periphery thereof, in mixed Lignum, Swamp Canegrass *Eragrostis australasica*, Old Man Saltbush *Atriplex nummularia* and Samphire *Halosarcia* spp vegetation in the north-east of Narriearra Station (Fig. 1).

Research on the Grey Grasswren was conducted on the edge of the Caryapundy Swamp in south-western Queensland from 1984 to 1996 (Hardy 2002). In 2000, a new banding and observational study focusing on the Grey Grasswren commenced in north-western NSW where the species had been listed as *vulnerable* under the New South Wales Threatened Species Conservation Act, 1995. The aim of this study was to determine the species' status and distribution in NSW and it was designed to complement the earlier work in south-west Queensland (Hardy 2010).

The original trapping sites in NSW were near Adelaide Gate and Barton's Crossing on Narriearra Station, roughly 40 and 50 km, respectively, to the south-east of the Queensland study site. Despite a similar intensity of trapping effort and the employment of identical trapping methods, the density of Grey Grasswrens in NSW was found to be far less than that in Queensland. During eight visits from 2000 to 2009 only 36 Grey Grasswrens were captured and none were re-trapped (Hardy 2010). In the period 2010 to 2016 an additional seven grasswrens were captured, but over the 16 years from 2000 to 2016 there were only five re-traps and these all occurred within four days of the original banding event and near the original capture site (Hardy, unpublished data). The NSW experience contrasts markedly with that in the twelve-year Queensland study in which 193 Grey Grasswrens were captured and banded, with 35 being re-trapped. Of these, 23 had been banded during previous trips to the study area over time spans ranging from 1 year 11 months to just over three years (Hardy 2002).

In 2014, the original two NSW sites (Adelaide Gate and Barton's Crossing) plus another mid-way between them (Two Mile Tank) were sampled and in 2015 two additional sites were added (Bullagree Tank and Bob's Hole Tank) to meet contractual survey requirements under the Saving Our Species Program of the NSW Office of Environment and Heritage (Farrell *et al.* 2014 and 2015, respectively) (Fig. 1).

The lack of recaptures between visits to the study sites or recorded movements between these sites created a gap in our data which required filling. Attempts, over the course of the study, to follow movements of foraging birds proved frustrating and unsuccessful because of the nature of the often-dense Lignum and canegrass habitat and the birds' rapid movements, in addition to their 'secretive' and quiet behaviour (Farrell and Hardy, unpublished data). This lack of data was the impetus for undertaking a radio-tracking study.

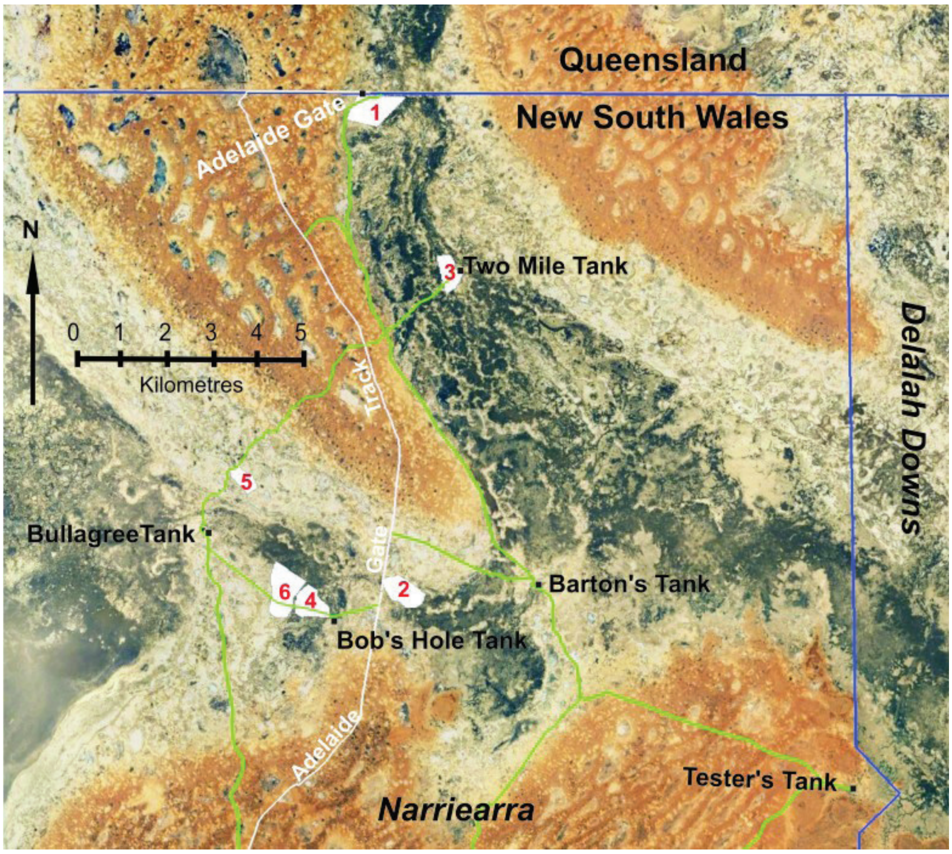

Figure 1. *Satellite image of the north-east section of Narriearra Station and adjacent property with the six study sites highlighted. 1 = Adelaide Gate; 2 = Barton's Crossing; 3 = Two Mile Tank; 4 = Bob's Hole Tank; 5 = Bullagree Tank; 6 = Bob's Hole Tank West.*

Images in this and all subsequent figures (except Figure 4) courtesy of Google Earth.

The use of small radio-transmitters to track the movements of birds has become more widespread as technological advances have resulted in the development of increasingly sophisticated equipment (see Diemer *et al.* (2014) for an extensive list of radio-tagged species overseas). Some transmitters are now small and powerful enough to be placed even on large arthropods. In Australia they have been used on a variety of bird species, for example: the Noisy Miner *Manorina melanocephala* (Clarke and Schedvin (1997); New Holland *Phylidonyris novaehollandiae* and White-checked Honeyeaters *Phylidonyris niger* (O'Connor *et al.* 1987); Helmeted Honeyeater *Lichenostomus melanops* race *cassidix* (Runciman *et al.* 1995); Eastern Bristlebird *Dasyornis brachypterus* (Baker and Clarke 1999); Gouldian Finch *Erythrura gouldiae* (Woinarski and Tidemann 1992); Red-browed Finch *Neochmia temporalis* (Todd 1997); Plains-wanderer *Pedionomus torquatus* (Baker-Gabb *et al.* 1990) and Ground Parrot *Pezoporus wallicus* (Jordan 1988). Some more recent studies include those on the Black-throated Finch *Poephila cincta* (Tang 2016), Masked Lapwing *Vanellus miles* (Lees *et al.* 2017) and, particularly relevant to this study, the Thick-billed Grasswren *Amytornis modestus* (Louter 2016).

Baker and Clarke (1999) examined several Australian and overseas studies on the effects on birds of using radio-transmitters to track their movements; they concluded that although some minor effects on movement and some 'irritation' (birds pecking at the tag) were reported, overall the method proved to be an important tool to map foraging territories and movement patterns. Most of the studies listed above were conducted in more open environments where some birds, although feeding in the lower shrub layer, frequently ventured higher into the canopy where they could readily be seen and the radio signal was not impeded. This was not the case with the Grey Grasswren, which rarely ventured out from thick cover.

Our aim ultimately is to document movement patterns of this species, but before embarking on a larger study of their movements in their only remaining habitat in NSW we needed to test the viability of using radio-transmitters in the very thick, entangled clumps of Lignum forming the major component of the birds' habitat. Our findings could potentially supplement those of Hardy (2010) and Farrell *et al.* (2014, 2015) and extend the growing knowledge of the species' behaviour and ecology.

METHOD

Description of study sites

The Bulloo River is an ephemeral watercourse comprising numerous channels that are usually dry except for a series of water holes. These channels only flow during years of monsoonal and cyclonic rains that fall over central Queensland during summer. Major flood events result in water flowing into the Bulloo Lakes, Caryapundy Swamp and the Lignum-filled flood channels to the east of the Bulloo in southern Queensland

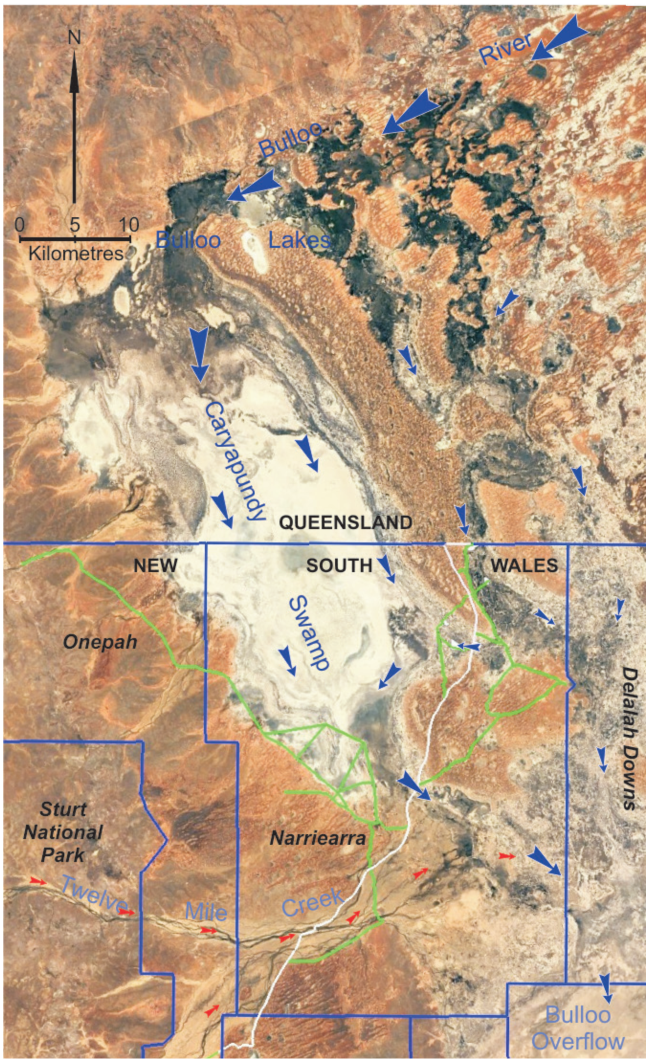

Figure 2. *Satellite image showing the hydrological inflow channels from the Bulloo River to the Bulloo Lakes, Caryapundy Swamp, the channels to the east thereof and eventually to the Bulloo River Overflow. The sizes of the blue arrows reflect the volume of water that is likely to flow through the various channels based on their height above sea level and the consequent proportion of floodwater that they are likely to disperse. The red arrows represent the easterly flow of Twelve Mile Creek, which only flows after heavy local rainfall.*

and then running generally south to the Bulloo River Overflow in NSW, where the water forms pools and eventually evaporates (Fig. 2). In dry years, annual rainfall can be as low as 100 mm throughout the region.

Five study sites were chosen where Grey Grasswrens had previously been trapped or sighted – Adelaide Gate, Barton's Crossing, Bob's Hole Tank, Bullagree Tank and an area located approximately 1 km west of Bob's Hole Tank (Bob's Hole Tank West) (Hardy 2010; Farrell *et al.* 2014, 2015). These sites are readily accessible via property management tracks (shown by green lines in the figures). Four of these are situated within the eastern flood channel where water flows west into Caryapundy Swamp (Fig. 3). The remaining site is in the flood channel to the north where it crosses the NSW/Queensland border at Adelaide Gate (Fig. 1).

Even though each site had slightly different combinations and densities of Lignum, Swamp Canegrass, Old Man Saltbush and Samphire, all are dominated by thick clumps of Lignum which average 1.7m high and 3.2m in diameter at Barton's Crossing and 2.6m by 4.9m at Adelaide Gate (Farrell *et al.* 2015). The size of the sampling area for each of the five sites varied due to the number of volunteers available and our aim of spreading nets across as wide an area and range of plant associations as possible.

Trapping and radio-transmitters

Trapping was conducted from 4–11 September 2017, but not on 9 September due to high wind. Mist nets, 2–4 shelf with 31 mm mesh size, were used, with the bottom shelf-string on the ground. The total number and length of nets used and hours that they were erected at each site are presented in Table 1. All birds trapped were banded on the right leg with a metal band (supplied by the Australian Bird and Bat Banding Schemes) and their sex was recorded.

We used 4 PicoPip glue-on transmitters LT5-337 (15 mm x 8 mm): frequency ranges 149.000–152.999 MHz; 57 ppm (10 msec) with 150 mm aerial, weighing 0.6 g and a battery life of ~14 days. The scanning receiver was model Australis 26K™ (149.0000 to 152.9999 MHz) and our folding omnidirectional antenna was a hand-held, Yagi three element type (151MHz). The weight of each transmitter (0.6 g) was well below the recommended maximum of 5% of the bird's body weight (Naef-Daenzer 1993), as Grey Grasswrens weigh between 15.5–21.5 g (Hardy 2002).

Attaching radio-transmitters (M. Louter pers. comm.)

- Prior to our study a small piece of bandage gauze (~1cm x1cm) was stuck onto the underside of the transmitters using Super Glue Gel. This gave a broader surface for attaching the transmitter to the bird.
- When a Grey Grasswren was removed from the net it was placed in a clean cloth bag and taken to a central processing site.
- Feathers in the interscapular area (~1 cm x 1 cm) were trimmed to approximately 2 mm using blunt-ended scissors and then rubbed with a surgical wipe to assist adhesion of the transmitter.
- Each transmitter was checked for signal strength.
- The underside of the transmitter was then covered with Super Glue and allowed to dry for about 10 seconds.
- The transmitter was then placed centrally on the trimmed area and held in place for 2 minutes to dry.
- The bird was placed in a calico holding bag for a further 5 minutes for the glue to set.
- Before release, the transmitter was checked to make sure it was securely attached (Fig. 4).

Position calculations

To calculate the positions of each bird, a 'Google Earth' satellite image of the area, with the coordinates of each reading pinpointed, was printed and the respective bearings from each position transcribed. As only one receiver was used in this

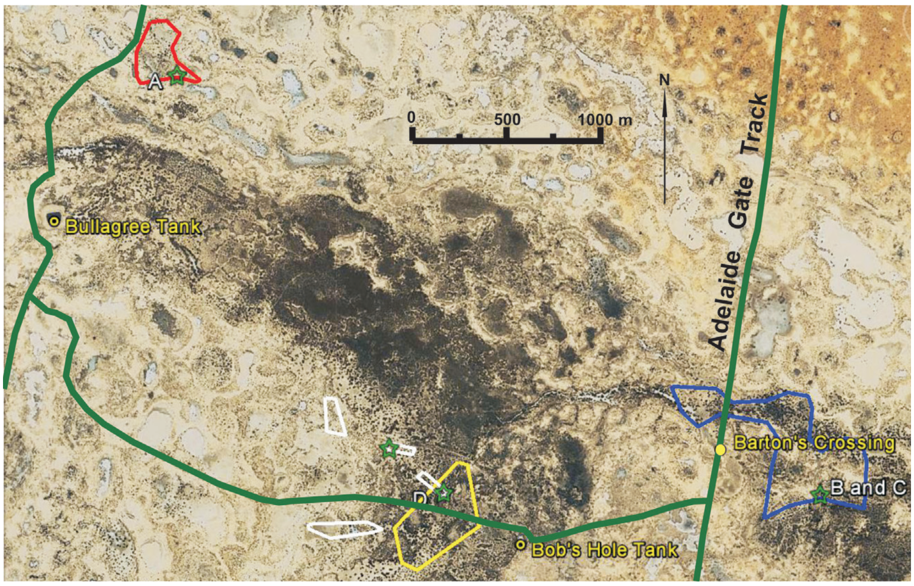

Figure 3. *Satellite image showing locations where Grey Grasswrens were captured (stars) and the approximate area sampled at four study sites along the west-flowing channel: Bullagree Tank (red), Bob's Hole Tank West (white), Bob's Hole Tank (yellow) and Barton's Crossing (blue).*

Table 1

Trapping effort.

Site	Date	Nets		
		No.	Length (m)	Time (hrs)
Bullagree Tank	4.9.17 and 5.9.17 am	20	282	14
Bob's Hole Tank	5.9.17 pm and 6.9.17 am	32	444	11
Barton's Crossing	7.9.17	33	417	10.5
Adelaide Gate	8.9.17	13	192	5
Bob's Hole Tank West	10.9.17 and 11.9.17	25	297	16.5

project, three bearings were taken at least 200 m apart and then triangulated to establish a bird's position. This gave an accurate position when a bird remained relatively sedentary for the approximately 20 minutes it took to take the three readings; however, if the bird moved, as many did, then their mapped position was 'centred' within the triangle formed by the intersecting three bearings. If the intersecting bearings were more than 20 m apart, the intersection of the second and first bearings was designated as one position and the intersection of the third and second bearings as a separate position.

RESULTS

The approximate areas of mist net coverage at each site where Grey Grasswrens were trapped are shown in Figure 3, as are the locations of each of the five grasswrens captured. Transmitters were attached to four birds (hereinafter Birds A, B, C, and D) whose movements were tracked over subsequent days. The availability of only one receiver and the distance between recording sites limited our observations, so signals were recorded for the first bird captured (Bird A) in the morning, around mid-day and in the afternoon of the first four days post-capture and then all four tagged birds (A–D) were tracked only in the morning and afternoon for the remaining eight days (Table 2).

Figure 4. *Grey Grasswren with transmitter attached.*

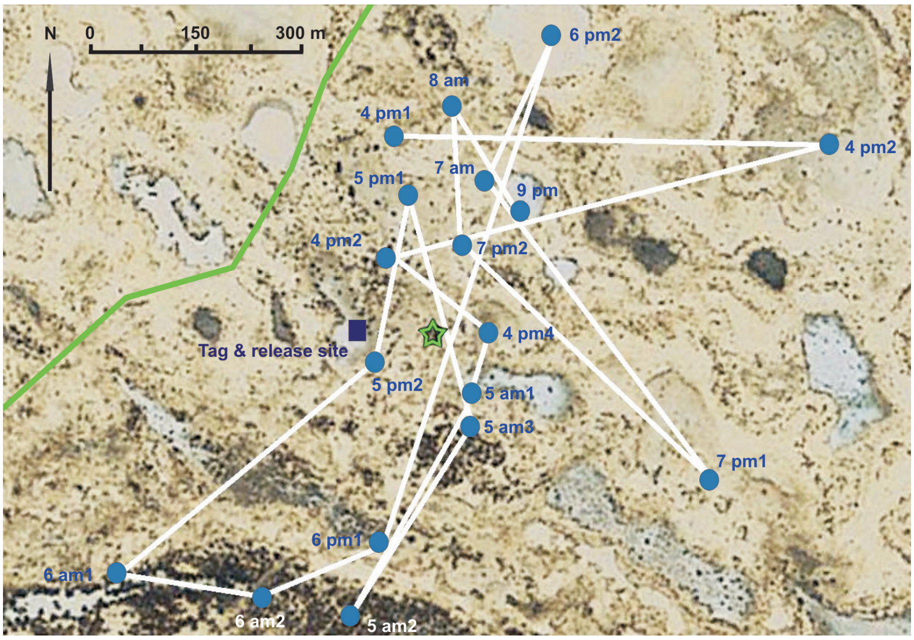

Figure 5. *Graphical representation of the movements of Bird 'A' (Bullagree Tank Site). Key (from left to right): 6 = date; pm = afternoon or evening; am = morning; 2 = record number; star = capture position.*

Table 2

Number of calculated positions of the four Grey Grasswrens over a 12-day period

Bird	4-Sep		5-Sep		6-Sep		7-Sep		8-Sep		9-Sep		10-Sep		11-Sep		12-Sep		13-Sep		14-Sep		15-Sep	
	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
A		4	3	2	2	2	1	2	1			1												
B								1	1	1	1	2	1	2	1	2		2		1				
C								1		1	2	2	1	2	1	2		1		1				
D															2	1	1	1	1	1	1		1	

The recorded movements of the four birds are shown in Figures 5 and 7–9. Lines connecting calculated bird positions are simply a graphical representation joining consecutive positions and do not necessarily represent the birds' direct movements between them. The polygon derived from these positions indicates the minimum area over which the bird was recorded (hereinafter foraging area), as birds may have ventured farther afield in the intervening time between the daily tracking readings.

Bird A: was trapped on 4 September at the Bullagree Tank site (Figs 3 and 5) and tracked for 6 days before its signal became faint on the afternoon of the fifth day and its position could no longer be triangulated. However, on the sixth day stronger signals were recorded and we ascertained its position in the afternoon but could not locate any signal on the following two days, so tracking of this bird was abandoned. On the afternoon after capture, 'A' foraged to the east and then returned to a Lignum thicket approximately 100 m from the capture site. On the mornings of 5 and 6 September, it foraged to the south of the capture site in dense Lignum along the main flood channel, but returned to the capture site late in the afternoon. On 7 September, it foraged to the south-east of the capture site. The last calculated

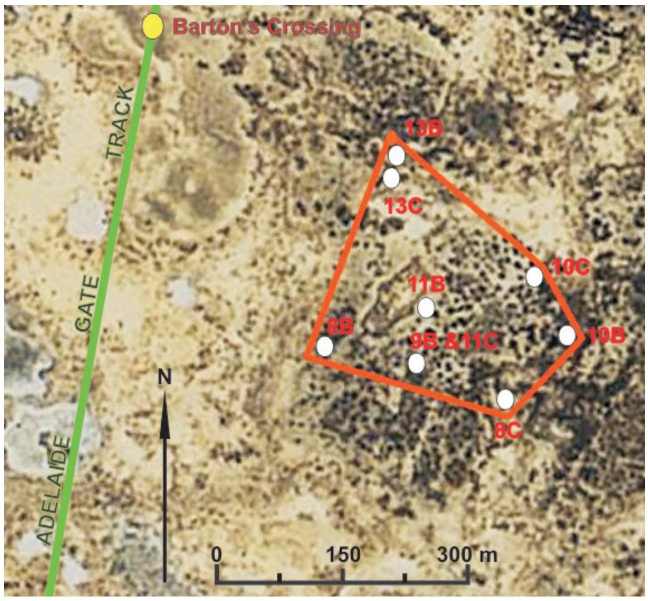

Figure 6. *Positions of roosting sites of Birds 'B' and 'C' from 8 to 13 September. Key: 6 = date; C and B = birds.*

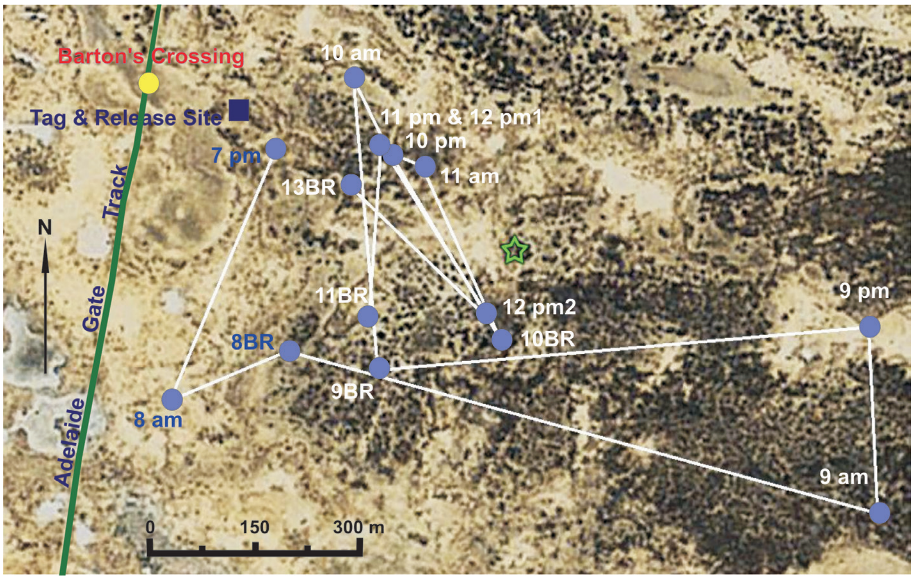

Figure 7. *Graphical representation of the movements of Bird 'B' (Barton's Crossing Site). Key: 9 = date; pm = afternoon and evening; 2 = record number; C and B = birds' identification; R = roosting site.*

positions for each day were mostly within an area ~200 m from its capture position (Fig. 5). Apparently this individual, although foraging up to 650 m from its capture location, had a specific area of thick Lignum where it returned to roost each night. We calculated its foraging area as approximately 53 ha, using the extremities of recorded movements as the perimeter.

Birds B (female) and C (male): were trapped together on the afternoon of 7 September and located at 1900 h that evening approximately 150 m apart. On the following evening (2230 h) the two birds were located roosting approximately 200 m apart. At least two other untagged Grey Grasswrens were heard roosting with 'C'. On 9 September, both 'B' and 'C' were located roosting together in the same Lignum thicket. On 11 September only 'C' was located; it was roosting in the same Lignum thicket used by both birds on 9 September. Throughout our study these two birds apparently mainly frequented a small ~5.5 ha area for roosting (Figs 6).

We tracked 'B' (Fig. 7) from the afternoon of 7 September until it roosted on the evening of 11 September, but we failed to locate it the following morning. It returned in the evening (12th) and we calculated two positions, but could not locate its exact roosting position as we had to terminate tracking due to extremely strong wind. The next morning (13th), when we could not locate it in its known foraging area, we traversed a much wider area to the east and west along the flood channel without success. However, it again returned to the roost area that night (Fig. 6). The longest recorded movement was from its roosting position on 8 September to the location recorded on the morning of 9 September (~ 850 m) and it travelled a minimum distance of ~1.6 km during that day, so it is conceivable that it moved beyond our receiver's range. No further signals were heard over the following two days (14th and 15th). We calculated that 'B' foraged over an area of approximately 45 ha.

Bird 'C' did not always stay with bird 'B' with which it had been captured. During daylight over the seven days of tracking it was recorded foraging in a smaller area (~18 ha). However, it returned to roost at night with, or close to, 'B' (Fig. 8). Like 'B', its signal could not be located on the mornings of 12 and 13 September, but it returned to its regular roosting site on both days.

When searching to the west of the foraging areas of 'B' and 'C', we encountered a foraging group of four grasswrens just west of the Adelaide Gate Track. Over the seven days of tracking, 'B' and 'C' remained to the east of this track. This might indicate that the track was a territorial boundary and that discrete foraging groups might not mingle at this time of year.

Bird 'D': this fourth bird was not trapped until the late afternoon of 10 September and, as our visit to the study area had to conclude by 15 September, we had limited time to track it. Perhaps for this reason, its foraging area (~ 26 ha) appears to be smaller than those of the other birds, but conceivably had we been able to track this bird over a longer period, its foraging range and area may have proved to be larger. Most of its tracked positions were within dense Lignum thickets, but it did venture onto a more open claypan with sparse vegetation on 11 September (Fig. 9).

Roost sites

All four visually identified roost sites were within large Lignum thickets having a circumference of between 20–30 m and a height of 2–3 m. All had new growth around the perimeter and a dense tangle of old growth stems in the centre. Three were surrounded by Swamp Canegrass with bare-earth patches in between, whilst the other was surrounded by bare ground and lacked any nearby Canegrass.

DISCUSSION

This pilot study showed that it is possible to track Grey Grasswrens through dense thickets of Lignum and to identify their minimum foraging areas. The varying size of these foraging areas is possibly related to variability in habitat and availability of food resources in the very dry conditions during

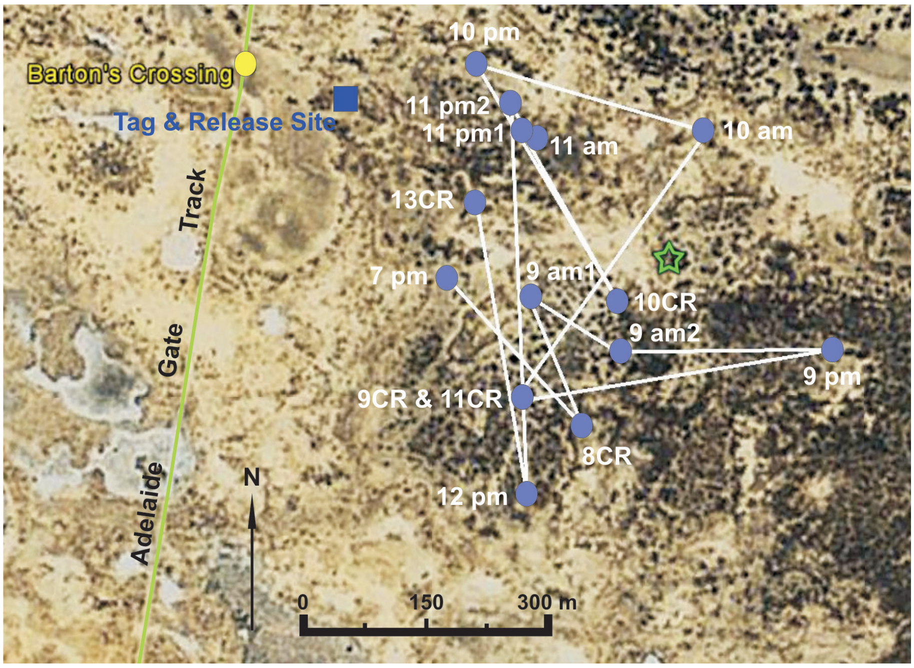

Figure 8. *Graphical representation of the movements of Bird 'C' (Barton's Crossing Site). Key: 9 = date; pm = afternoon and evening; 2 = record number; C and B = birds' identification; R = roosting site; star = capture position.*

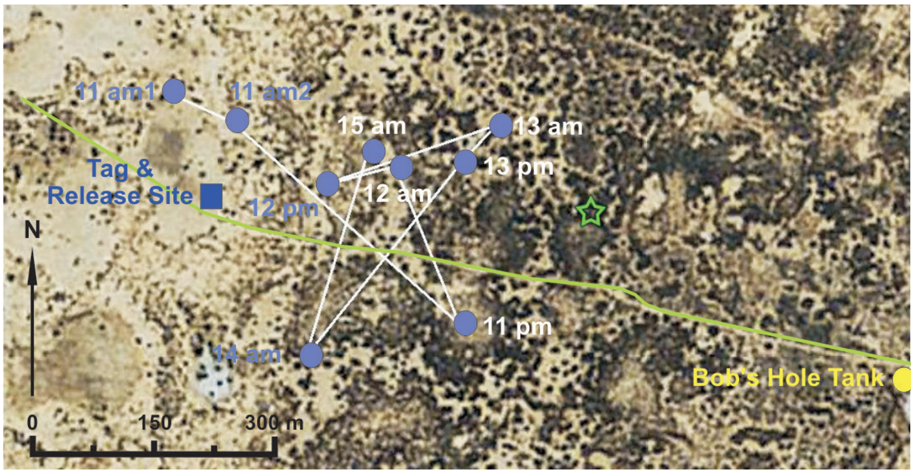

Figure 9. *Graphical representation of the movements of Bird 'D' (Bob's Hole Tank West Site). Key: 9 = date; am = morning; pm = afternoon and evening; 2 = record number; star = capture position.*

our study. Even though the areas had a rather dense central area of Lignum, grasswrens did venture out into more open habitats for foraging. This tracking study allowed us to determine that some birds returned each night to roost in favoured dense Lignum thickets in a small area within their foraging area.

The radio-transmitters remained attached to all four birds throughout our study, but they will fall off during annual moult, if not sooner, as the glue degrades (Baker and Clarke 1999). After attachment of the transmitters, all birds flew off unimpeded and did not appear to be affected by our presence, as on several occasions we inadvertently walked right past them while recording the signals and they did not leave the area. Some of the weak or temporarily lost transmitter signals may have resulted from tracked birds being in the swales between sand dunes or out of range of our receiver.

Even though Grey Grasswrens are known to breed from July to October (Robinson 1973; Black *et al.* 2011), we did not trap or observe any young birds. This may have been a consequence of there being no notable rainfall for the previous eleven months (B. O'Connor pers. comm.). A grasswren survey was carried out by an Office of Environment and Heritage officer and contractor concurrently with our radio-tracking. They surveyed areas of suitable habitat, away from our study area, where grasswrens had previously been observed, but did not record any grasswrens (P. Bell pers. comm.). This suggests that the local grasswren population may have declined since previous surveys (P. Bell pers. comm.) during this dry period and our sampling areas may have constituted a drought refuge area. The calculated foraging areas for the tracked birds may have therefore been larger than usual, to take advantage of the limited food resources available.

CONCLUSION AND RECOMMENDATIONS

This study demonstrated that the use of radio-transmitters to track Grey Grasswrens through dense Lignum thickets and across a variety of plant communities is a viable technique to map their movements and calculate their minimum foraging areas. It also provided data on the use of regular roosting areas.

Although this study added new information on movement patterns, foraging areas and roosting sites of Grey Grasswrens, it raised several questions which were not a focus of this research but which need to be addressed in future work. A larger sample size would facilitate analyses to better determine the carrying capacity for Grey Grasswrens of this remaining habitat on Narriearra Station. Additionally, an in-depth examination of the habitat should be conducted, utilizing up-to-date aerial photographs of the foraging areas and, if the timing is right, documenting the territories occupied by breeding pairs. Most existing aerial photographs and accessible satellite images do not have enough definition or clarity to allow identification of vegetation type or minor variations in topography, and they can be several years out of date, so they do not necessarily reflect the current state of the habitat. Current drone technology has the potential to address these issues at the time of survey, although as a precaution against the potential disturbance of birds that are being tracked, the drones should only be flown to photograph foraging areas after radio-tracking has been completed. Preferably a sample of birds should be tracked in several years and during different climatic conditions to better understand the birds' distribution, movement patterns, and the carrying capacity of their restricted habitat. These data would then allow for more informed decisions by conservation agencies on how to manage the species and its environment in NSW.

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