Rehabilitated bare-nosed wombats (*Vombatus ursinus*): dispersal, activity patterns and survivorship: A pilot project.

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Introduction

Wildlife rescue and rehabilitation is extensively practiced throughout the world for a variety of reasons. Wildlife are frequently injured through collisions with vehicles or other man-made features, diseased animals require in-care treatment or problem animals need removal and relocation. Many of these rescues involve animals that have already experienced and demonstrated the capacity to survive as wild individuals. In Australia however, marsupials pose a unique problem when females with pouch young die and their surviving orphans enter care. Often these animals are in an underdeveloped state and have had limited opportunity to acquire wild behaviours. These animals must rely on innate survival skills or skills taught during rehabilitation to successfully integrate into wild populations.

The bare-nosed wombat (*Vombatus ursinus*) is one marsupial that face high mortality from vehicle collisions (Triggs 2009). The majority of collisions result in the immediate death of the adult but survival of the pouch young. Without rescue the pouch young will eventually die, often from either hypothermia or starvation. Each year hundreds of pouch young wombats are rescued from roadkill mothers and cared for by wildlife rescue volunteers for up to two years before they are considered ready for release. Anecdotal evidence suggests that survivorship of these animals is variable, however little rigorous research has investigated the behaviour or survivorship after release (Mui *et al.* 2003). Studies to date have concentrated on short-term survival and mortality factors (Mui *et al.* 2003; Sarren 2007), and less on behavioural patterns, such as dispersal, habitat use and activity. There are also no comparisons with wild wombat populations, limiting our understanding of how 'normal' the survivorship and behaviour of rehabilitated wombats are.

Here we report on a pilot project to examine the viability of recent technologies for monitoring wombat behaviour. We use GPS datalogging radiocollars to compare dispersal, activity and survivorship of a released rehabilitated wombat and a wild counterpart for 8 months.

Methods

Study area

The study was conducted near Majors Creek in the NSW Southern Tablelands (35^{O}37'S 149^{O}43'E; 780m). The climate is characterised by mild summers and cold winters. January is the hottest month, where minimum and maximum average temperatures are 11^{0}C and 26^{0}C respectively. The coldest temperatures occur in July (0^{0}C, 11^{0}C). Rainfall averages 719mm annually and is distributed evenly throughout the year. Throughout the study, average maximum daily temperatures were lower than the long-term averages for most months, in particular the summer months (22.5^{0}C). Annual rainfall was higher than average (1280mm, 294mm in March) resulting in burrows flooding in autumn, including those burrows monitored. The majority of the vegetation is classed as dry schlerophyll forest dominated by ribbon gum *Eucalyptus viminalis*, swamp gum *E. ovata* and silver wattle, *Acacia dealbata* with an understorey of kangaroo grass, *Themeda australis*, snowgrass, *Poa sieberiana* and weeping grass, *Microlaena stipoides*. Historically the site was lightly grazed by sheep and cattle. However for the duration of the study no livestock grazing occurred.

Wombat release and trapping

The rehabilitated wombat was released using a semi soft-release method. The release pen consisted of multiple aluminium panels erected around a suitable, empty burrow (Figure 1a). The wombat was supplied with supplementary food and water until it dug out of the pen. The open release pen remained on site for 2 weeks after wombat had escaped.

The wild wombat to be collared, of similar size and sex as the released individual, was identified using Scoutguard SG550 infrared remote cameras (HCO Outdoor Products, Norcross, USA). Once identified, traps were placed in the burrow and set approximately 1 hour before sunset. Alternatively, if collared wombats required trapping the individual was tracked to the resting burrow and trapped. Traps were large steel-mesh cage traps (800x400x400mm) with an inward swinging door and locking mechanism (Figure 1b). A light trap alert mechanisms allowed animals to be removed and sedated soon after trapping using an intramuscular injection of Zoletil (4 to 6 mg/kg). Sedated wombats were removed from the trap for processing.

Released and trapped wombats were weighed, measured and general body condition assessed (See Appendix 1 for details). A blood sample was collected for parasite screening using blood smears and serum (toxoplasmosis antibodies). A uniquely identifiable ear tag was attached and collars fitted, adjusted or removed. GPS datalogging radiocollars (Sirtrack, Havelock North, New Zealand) recorded the wombat's position hourly and remained on the wombat for 10 months. Wombats were tracked weekly to ensure the individuals remained within the area.

a. b.

Figure 1. The release pen (a) and trap arrangement (b) used for this study. Note in (a) R1 pushing under the trap door, which releases trap door and activates locking mechanism.

Statistics

The home range of each wombat was calculated using fixed kernel 95% analysis in R (R Development Core Team 2010) with the adehabitatHR package (Calenge 2011). To examine the difference in diurnal activity between wombats and the seasonal differences in diurnal activity for each wombat we used two sample z-tests for proportions.

Results

Collar performance

Collars were on the wombats between 257 and 294 days (Table1) and successfully recorded data for 217 and 291 days for the wild (W1) and rehabilitated (R1) wombat respectively. The difference in collar life can be attributed the difference in the amount of time each wombat spent above the ground. The collar uses more battery when a wombat is in the burrow and results in a shorter battery life. There was minimal impact of the collar on the welfare of the wombats, with only minor skin irritation and hair loss (Figure 2).

a. b.

Figure 2. Effect of the collar on R1 (a) and W1 (b). Arrows indicate areas of skin irritation and hair loss.

Wombat trapping data

Morphological data for each trapping event is presented in Table 1. W1 was trapped twice, to attach and remove the collar, while R1 was also trapped on a third occasion to adjust the collar. During a site visit I was approached by R1. A general assessment of body condition identified weight loss and a substantial decrease in his neck circumference, resulting in loosening of the collar. Both wombats lost weight throughout the study period (Table 1) with R1 displaying a recovery after the dramatic weight loss in the first 10 weeks. The neck and chest circumferences mirrored the pattern of weight loss. Both wombats remained alive for the duration of the study.

No obvious forms of infection were identified for either wombat, as either clinical signs of mange or blood parasites in blood smears. Serum collected for toxoplasmosis testing has yet to be analysed.

Table 1. Trapping measurements and percent changes over study period. Percent changes from initial measurement in brackets.

Wombat	Date	Days post collar	Weight (kg)	Head-body (cm)	Neck (cm)	Chest (cm)
Released (R1)	23 June 11	0	27.4	91	51	74
	7 Sept 11	76	22.6 (-17.5%)	96	39.5 (-22.6%)	68 (-8.1%)
	9 April 12	294	26.4 (-3.7%)	96	42 (-17.7%)	76 (+2.7%)
Wild (W1)	30 July 11	0	23.0	85	47	75.5
	12 April 12	257	20.8 (-9.6%)	88	42.5 (-9.6%)	66 (-12.6%)

Wombat activity

The released wombat (R1) dug out of the release pen at day 2 and displayed exploratory behaviour for the following 5 weeks. After this period R1 was not detected at the released burrow again. The eventual home range of R1 was 5.16ha (Figure 3) and apart from a single foray of 700m in the second week of release was not detected outside of this area. W1 displayed a similar home range size of 5.05ha (Figure 4).

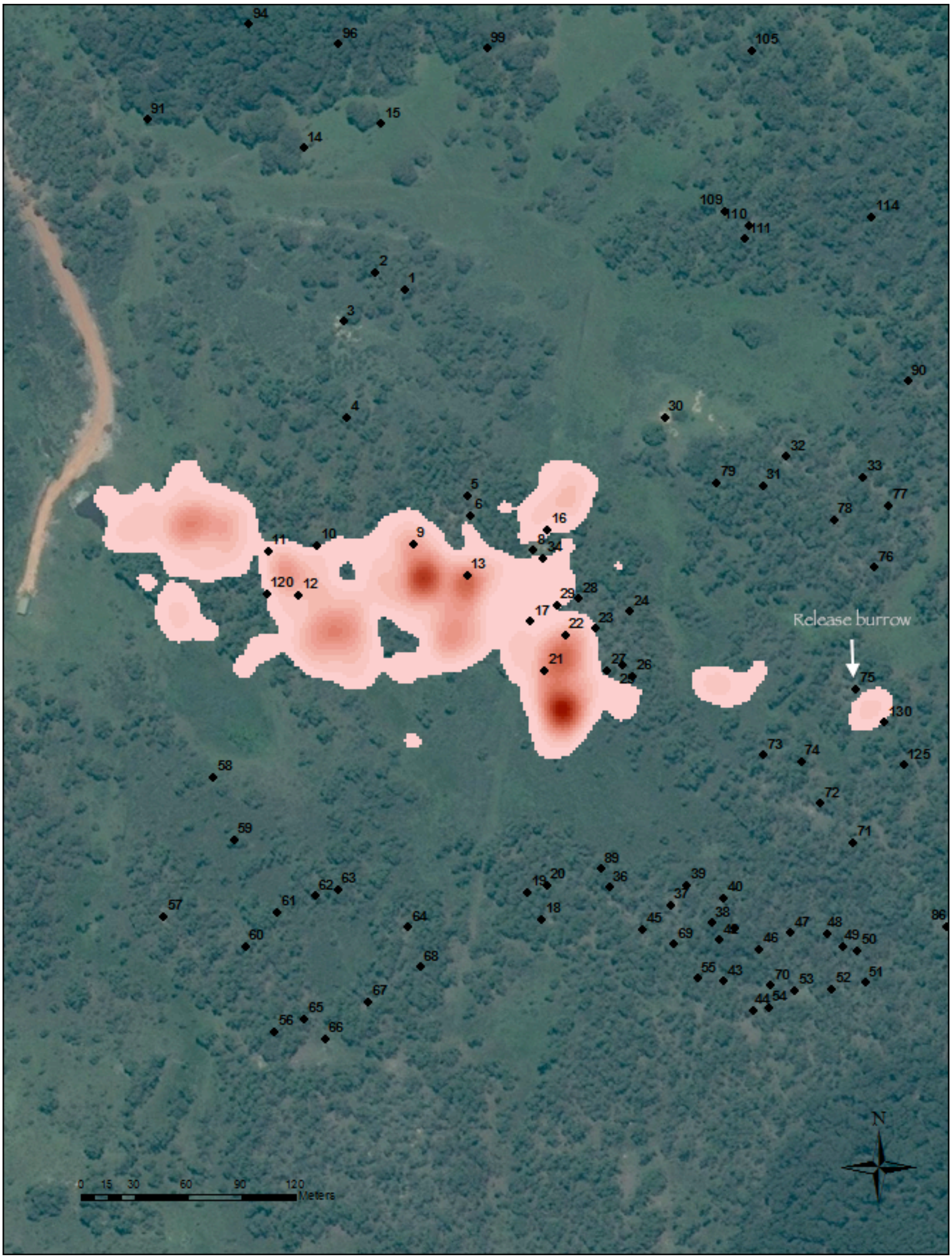


Figure 3. 95% home range estimates (5% contours) of R1 for the collar duration. Black points indicate burrow position and number within the site. The release burrow #75 is highlighted.

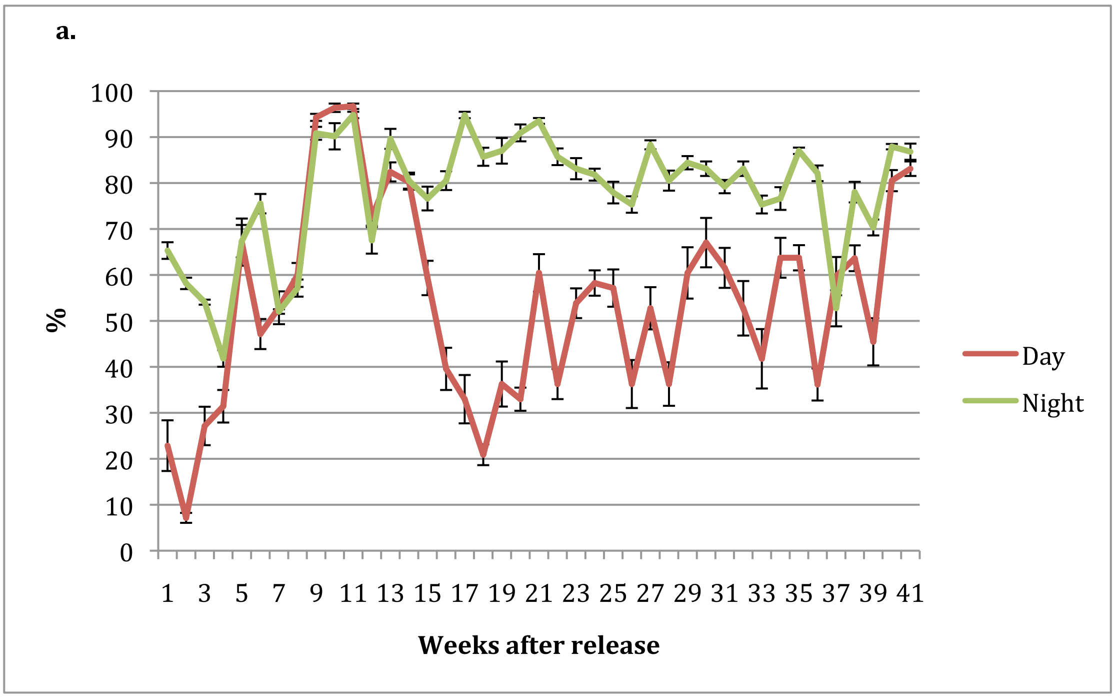
Figure 4. 95% home range estimates (5% contours) of W1 for the collar duration. Black points indicate burrow position and number within the site.

Temporal Activity Patterns

The rehabilitated wombat (R1) was found to consistently log more daily positions (activity records) than the wild counterpart (W1), an indication that R1 spent less time utilising burrows. R1 was above ground on an average of 15.8 ± 5.3 hours per day and almost half of this (41.7%) occurred during daylight hours. In comparison W1 was above ground for an average of 9.2 ± 1.8 hours per day with only 8.3% of this activity during the day. When compared, the overall difference in diurnal activity was found to be significantly different between the two wombats ($z=27.362$, $p<0.01$). The pattern of diurnal behaviour also varied between the two wombats, with average weekly activity in W1 consistently low, while R1 displayed greater fluctuations (Figure 5).

Despite the differences in the diurnal activity, the patterns observed across seasons were similar, with wombats spending a greater proportion of their time above ground in cooler seasons (Figure 6). The proportion of daytime activity in winter was significantly higher than summer (W1, $z=11.669$, $p<0.01$: R1, $z=5.806$, $p<0.01$) and spring (W1, $z=7.619$, $p<0.01$: R1, $z=3.607$, $p<0.01$) for both individuals. Diurnal activity in autumn was also significantly higher than summer for R1 ($z=3.159$, $p<0.01$), however autumn data for W1 was limited to 5 days so was omitted from analysis.

Observations of wombats during radiotracking and with remote camera photos indicate that much of the diurnal ground activity was spent resting or investigating burrows. On the 15 occasions that R1 was found above ground while radiotracking he was resting in either tea-tree scrub or near a burrow. Foraging was only observed if he was disturbed.



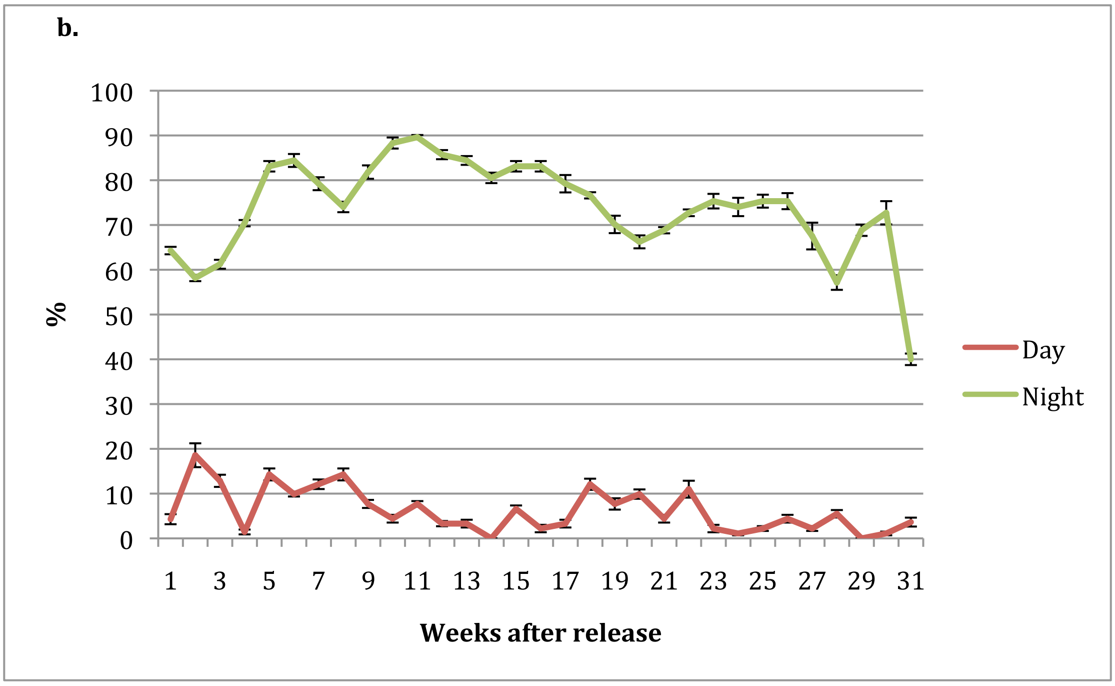


Figure 5. Percent of activity records (±se) out of burrows for R1 (a) and W1(b) throughout day and night periods.

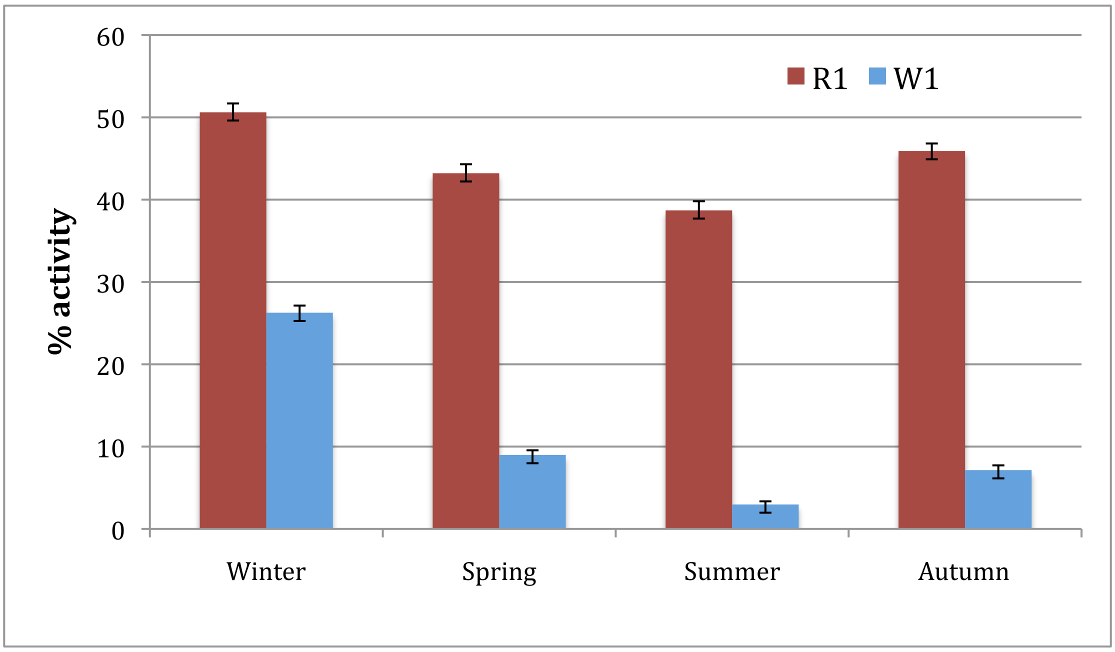


Figure 6. Seasonal variation in the average percent of diurnal activity records per day (±se) for the released (R1) and wild (W1) wombat.

Discussion

The success of released rehabilitated animals can be measured in many ways but very often it is only the survival of the animal that is recorded. The results presented here, while only preliminary, demonstrate that behavioural factors other than survivorship can differ from wild animals and should be considered. The main behavioural variation highlighted in this study was a reduced burrow use by the rehabilitated wombat, at almost half the number of hours than the wild wombat. This was despite an abundance of vacant burrows within the rehabilitated wombat's home range (unpublished data). Burrows are considered critical for wombat persistence, primarily for thermoregulation and protection from predators (Brown and Taylor 1984; Triggs 2009). The impact of spending so few hours within a burrow is unknown.

Burrow use is linked to thermoregulation in wombats because individuals are incapable of regulating their body temperature when air temperature rises above 25^0C (Brown and Taylor 1984). Wombats do not possess sweat glands and are therefore restricted to maintaining a stable body temperature by retreating to suitable ambient temperatures, salivary cooling and belly cooling (Wells 1989). Temperature fluctuations recorded in wombat burrows are minimal and maximum temperature does not exceed 25^0C, thereby providing the ideal refuge during temperature extremes

(Brown and Taylor 1984). The average maximum temperature during the study period was below average, particularly during summer, with maximum temperatures that rarely exceeded 25^0C. Under such conditions, the constraints of burrow use for thermoregulation would have been relaxed, allowing the rehabilitated wombat survive with limit burrow use. Temperature however does not explain the discrepancy in burrow use between the two wombats. The behaviour displayed by the wild wombat was consistent with nocturnal, burrow dwelling behaviour considered normal for wombats (Evans 2008; Triggs 2009).

Dispersal patterns and home range estimates were similar between wombats. Dispersal in wombats is thought to be a female behaviour. Mothers bequeath their home range to juvenile males, although the timing of this separation is unknown (Triggs 2009). The two wombats followed in this study were both male and most likely past the age of weaning. Therefore it would be expected that both would display the sedentary behaviour observed. Wombat home range is known to vary from 3.8 to 17.8 hectares (Skerratt *et al.* 2004; Evans 2008). The home range sizes for the animals in this study were almost identical and within the previously recorded range.

The GPS datalogger collars have provided detailed information on activity and habitat use for comparison between wild and rehabilitated wombats. They have also provided baseline data from which we base refinements on for future releases. Monitoring and logging periods for future releases will be for 2 months immediately after release and a further two months six months after release. Logging intervals will be set at 10 minutes to provide finer scale movement patterns and enable behavioural activity to be determined.

The results of this project have identified that some differences exist in the behaviour of rehabilitated wombats and indicates that further investigation is necessary. By monitoring future releases at more frequent intervals we can assess any patterns or behaviours attributed to the process of rehabilitation. The outcomes have also identified areas of fine-tuning in the monitoring protocol. The hour interval between position fixes has proved too long to enable interpretation of spatial patterns to behaviours. The trade off of shorter intervals is a reduced collar life. The results of this research would suggest that two periods of 2 months, one immediately post-release and a second at 6 months post-release is suitable.

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