

**Inter-den tree movements by Leadbeater's Possum**

David B. Lindenmayer<sup>1,2</sup>

Lachlan McBurney<sup>1,2</sup>

David Blair<sup>1,2</sup>

Sam Banks<sup>1</sup>

<sup>1</sup>Fenner School of Environment and Society

The Australian National University

Canberra, ACT, 2601

<sup>2</sup>National Environmental Science Programme Threatened Species Recovery Hub

Fenner School of Environment and Society

The Australian National University

Canberra, ACT, 2601

Corresponding author: [david.lindenmayer@anu.edu.au](mailto:david.lindenmayer@anu.edu.au)

**Running head:** Movements by Leadbeater's Possum between dens

## **Abstract**

Many species of arboreal marsupials move regularly between den sites in hollow-bearing trees. We show, based on short-term radio-tracking data, that the Critically Endangered Leadbeater's Possum *Gymnobelideus leadbeateri* can move 100 m (and sometimes up to 600 m) between den sites in hollow-bearing trees. These movement data have significant implications for the design of buffers of unlogged forest to protect colonies of Leadbeater's Possum as well as for crude estimates of the species' population size.

**Keywords:** Hollow-bearing trees, den sites, buffer zones, arboreal marsupials, logging, radio-tracking,

## **Introduction**

Leadbeater's Possum (*Gymnobelideus leadbeateri*) is a Critically Endangered cavity-dependent arboreal marsupial that spends 75% of its life inside large, old hollow-bearing trees (Smith *et al.* 1982). Like almost all species of arboreal marsupials, Leadbeater's Possum nests and dens in multiple hollow-bearing trees and individuals swap regularly between these trees (Lindenmayer and Meggs 1996; Gibbons and Lindenmayer 2002). Here we summarize previously unpublished data, derived from a short-term radio-tracking study of Leadbeater's Possum, on the distances that individuals move between den trees.

## **Methods**

We completed a radio-tracking study of Leadbeater's Possum in a 30 ha area of 1939-aged and mixed-aged Mountain Ash (*Eucalyptus regnans*) forest at Cambarville (37°331'S, 145°53'E), approximately 10 km east of the town of Marysville, Victoria, in September 1990 (10 days), November 1990 (16 days) and June-July 1991 (27 days).

We radio-tracked 14 individual animals during the three tracking periods (see Lindenmayer and Meggs 1996 for further details). Thirteen of the 15 animals were adults (weighing between 79 and 156 grams) and were fitted with radio-collars weighing 6-8 grams. Two sub-adults were fitted with a 4 g transmitter.

The focus of the radio-tracking program was to locate den trees occupied by individual animals during the day. Collared animals were tracked on foot by the same observer (DBL) to individual den trees. Each occupied tree was marked using long-lasting paint to assist in tracking efforts on subsequent days. The spatial co-ordinates of each occupied tree were recorded, enabling the Euclidean distance between occupied den trees to be calculated.

Given the small number of animals tracked, we have not examined differences in movement between of life stages, or season.

**Figure 1. Leadbeater's Possum. (Photo by David Lindenmayer)**



**Figure 2. Radio-tracking animals to a large old hollow-bearing tree. (Photo by Esther Beaton).**



**Figure 3. A marked hollow-bearing tree occupied by Leadbeater's Possum. (Photo by David Lindenmayer).**



### **Results and discussion**

A total of 15 individual Leadbeater's Possums was tracked in our study. The total number of days of radio-tracking for a given individual animal ranged from 5 to 18 days (Table 1). Two individuals were tracked in all three tracking periods and three individuals were tracked in two of the three tracking periods. Longer tracking periods were not possible because of

transmitter failure, collars being dislodged by animals, or collar removal because collars were found to be causing physical injury (Lindenmayer and Meggs 1996). In addition, considerable difficulty in re-trapping animals limited the number of times individual animals could be repeatedly radio-tracked.

Across the short duration of the three periods of radio-tracking, we completed 234 animal x tracking day assessments of den location. Overall, we found that 10 of the 15 individual adult animals tracked used two or more hollow-bearing trees, with up to six trees used by a given individual (Table 1). In general, both adult males and adult females used more den trees the longer they were tracked. The two sub-adult animals we tracked used only one den tree.

We recorded 37 instances of inter-tree movement, with the distances moved (given that any movement occurred) ranging from 60 metres to approximately 600 m. Most inter-tree movements (24 of the 37 movements) were 100 m or more, and on nine occasions, longer movements of 190 - 600 m were recorded. The average distance moved (given any movement occurred) was approximately 135 m. Notably, other data gathered as part of this study reinforced that animals can move relatively long distances and also quite quickly. These data include remote tracking from radio-telemetry towers and trapping location information associated with the capture of animals prior to fitting radio-collars (see Lindenmayer and Meggs 1996).

**Table 1. Summary data on movements between den trees by adult female and male radio-tracked Leadbeater's Possum. The tracking periods correspond to Period #1 (September 1990; 10 days), Period #2 (November 1990, 16 days) and Period #3 (June-July 1991, 27 days).**

<b>Animal no.</b>	<b>Gender</b>	<b>Tracking period</b>	<b>Days of tracking</b>	<b>No of dens used</b>	<b>Max distance moved between dens (m)</b>
1	F	1	6	2	100
1	F	2	14	3	100
2	F	1	5	1	0
2	F	2	9	4	250
2	F	3	18	6	600
3	M	1	5	2	100
4	F	1	5	1	0
*5	M	1	5	1	100
5	M	2	17	3	190
7	F	1	6	2	100
8	M	1	5	1	0
8	M	2	12	1	0
8	M	3	16	2	230
9	M	1	11	4	190
13	F	2	13	1	0
14	F	2	13	1	0
16	F	2	9	1	0
17	M	2	13	2	80
17	M	3	15	2	60
19	M	3	8	4	110
20	F	3	15	2	100

21	F	3	14	1	0
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\*Animal #5 was a subadult when first tracked in period #1 of radio-tracking.

Our finding that some animals move long distances between den trees is congruent with other studies demonstrating den-swapping behaviour in Leadbeater's Possum (e.g. Thomas 1989; Harley 2005) as well as in numerous other species of arboreal marsupials (Kehl and Borsboom 1984; Lindenmayer *et al.* 1997b; Gibbons and Lindenmayer 2002; Lindenmayer *et al.* 2004; Crane *et al.* 2010). We note that for this study of Leadbeater's Possum, the period of radio-tracking was short (less than 32 days of telemetry for the most intensively tracked animal). The longest-tracked animal used the most trees, although inter-animal variation in den use is likely – as occurs in other species of arboreal marsupials (Lindenmayer *et al.* 1996). It is highly likely that over longer periods of time more den trees would have been used and that these would have been located over a larger area (again as seen in many other studies of arboreal marsupials) (Gibbons and Lindenmayer 2002; Lindenmayer *et al.* 2004; Crane *et al.* 2010).

An important caveat with our short-term study is that we focused on documenting the locations of daytime den trees and the straight-line distance between them. The distances moved by animals when foraging and undertaking other behaviour (e.g. territorial defence, access to mating opportunities) can be expected to be larger than delineated solely from the locations of den and nest sites (see Lazenby-Cohen and Cockburn 1991; Berry *et al.* 2016). Indeed, some species of arboreal marsupials move long distances from, and never forage close to, the trees where they nest (Cunningham *et al.* 2004). Yet other species complete occasional long distance reconnaissance, or 'sallies', well beyond their normal territory boundaries (How 1972).

Large numbers of hollow-bearing trees characterized our study area when this investigation was completed 27 years ago (Lindenmayer *et al.* 1996). Since then, our study area, as well as the entire region in the Central Highland of Victoria where Leadbeater's Possum occurs, has been subject to a drastic loss of hollow-bearing trees (Banks *et al.* 2011; Lindenmayer *et al.* 2016). It is possible that animals moved greater distances between den trees as the density of populations of hollow-bearing trees is reduced (Banks *et al.* 2011). In an effort to quantify if this is indeed the case, new work has recently commenced aimed at tracking Leadbeater's Possum using GPS-collars over long time periods and in places where hollow-bearing trees are uncommon.

The information presented here on the distances that animals move between den trees has major implications for the current management and conservation of the species. In particular, current prescriptions call for buffers with a 200 m radius of unlogged forest around confirmed sightings of Leadbeater's Possum. However, such buffers will be inadequate, especially if they are established at the point of an animal sighting which may be some distance from the centre of a home range or a denning range (*sensu* Lindenmayer *et al.* 1997b). Recent modelling suggesting a reduction in the size of protective buffers of unlogged forest to 100 m (Victorian Environmental Assessment Council 2017) will adversely affect Leadbeater's Possum populations. This will also elevate the risk of collapse of large old hollow-bearing trees (Lindenmayer *et al.* 1997a; Lindenmayer *et al.* 2016) which are the critical nest and den sites for Leadbeater's Possum. Indeed, we suggest that buffers of unlogged forest may be better placed around all hollow-bearing trees than sighting records of Leadbeater's Possum (Lindenmayer *et al.* 2013).

Recent work, based on call playback, has suggested that populations of Leadbeater's Possum are much larger than previously estimated (Lumsden *et al.* 2013). These new estimates are based on assumptions about the limited movement capability of animals relative to the area where they have been sighted in call playback surveys. In contrast, our data on the potential long distance movements that animals make between den sites (and indeed over very short periods of radio-tracking), identify that Leadbeater's Possum is more mobile than previously thought. Consequently, the recent estimates of population sizes will need to be moderated. Again, our new research using GPS-collared animals will allow us to document the distances over which these possums are moving in response to play-back calls and facilitate better estimates of population size. In the interim, we urge that the new information that we have provided in this paper be applied to challenge the suggestion that populations of Leadbeater's Possum are greater than previously estimated. Suggestions that the populations are much larger, based on assumptions of movement capability, could further endanger this Critically Endangered species. We are testing the assumption using GPS collars. We suggest that colonies of Leadbeater's Possum may need protection from logging by larger, not smaller, buffers of unlogged forest. Now is not the time to be reducing buffers. The conservation of Leadbeater's Possum should take priority, at least until the research on movement distances is complete, and thus the question of population sizes, based on movements, is resolved.

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