The use of nest boxes in logged and unlogged areas by pygmy possums

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Forest Practices Authority Scientific Report 23

May 2014

Disclaimers

The information presented is a broad overview of information considered relevant (by the authors) to the brief. Analysis and discussion has been undertaken to different levels of detail but the coverage of material is necessarily incomplete. We apologise for any errors of fact that may have crept into the report and acknowledge that the unreferenced material presented is based on the opinions and interpretations of the authors.

Acknowledgements

Thanks to Don Hird for providing the motivation to look at pygmy possums, and the nest boxes that were used in this study. Thanks to Sarah Munks from the Forest Practices Authority for feedback on this report. Thanks to Forestry Tasmania for access to the sites.

Citation

This report should be cited as Ohlsen, N, Koch, AJ and Cawthen L 2014, *The use of nest boxes in logged and unlogged areas by pygmy possums*, report to the Forest Practices Authority, May 2014. Forest Practices Authority Scientific Report.

Contents

Summary

A study was done looking at the use of nest boxes by pygmy possums at Mount Morrison in eastern Tasmania. The presence of nesting material in the nest boxes was used to assess suitability of the area for pygmy possum den sites. Insufficient data was available to do quantitative analysis, but this study showed that harvested areas will be used by pygmy possums if suitable habitat is available. This study also suggests that there are patch or stand-scale variables that influence use of areas by pygmy possums. Understorey and overstorey cover may be one of the factors influencing habitat suitability for pygmy possums.

1. Introduction

For many native fauna species worldwide tree hollows provide refuge sites for roosting and breeding. In Tasmania there are eight bat species, five arboreal marsupials (possums), about 29 bird species and an unknown number of invertebrates that use hollows to varying degrees. This includes several species that are listed as endangered (Koch et al., 2008b). Besides providing a safe site for roosting and breeding, hollows also provide refuge from weather and predators.

There is serious concern that the hollow resource across Tasmania is declining and native species may become threatened due to a decrease in availability and natural diversity of tree hollows (Koch, 2007). Hollows are formed by several processes such as fire, fungi and termites, and can take well over 100 years to develop until the hollow is suitable for use by fauna (Inions et al., 1989; Gibbons and Lindenmayer, 2002; Koch et al., 2008a).

Management strategies have been developed to ensure that a current and a future source of hollows is available to mitigate the impacts of forest harvesting on hollow-using fauna. In Tasmania, the main habitat retention strategy for hollow-using fauna is the retention of wildlife habitat clumps. Wildlife habitat clumps are patches of mature forest containing at least 2–3 mature trees with nesting hollows, and a range of other ages of trees/shrubs (Forest Practices Board, 2000). Tree hollows are also retained as part of broader forest retention strategies such as wildlife habitat strips. Wildlife habitat strips are intact corridors of forest, distributed every 3–5 km, designed to connect large patches of forest which are not to be harvested (e.g. formal and informal reserves) (Forest Practices Board, 2000).

Habitat retention strategies are not always effective for all species, because species vary in their habitat requirements (Koch et al., 2008b). How species use retained patches varies depending on the availability of habitat in the surrounding landscape (Cawthen and Munks, 2011), and competition may increase as habitat availability decreases. Furthermore, retaining hollow-bearing trees in wildlife habitat clumps is challenging for land managers as hollows are difficult to identify from the ground (Koch, 2008) and retained trees can be subject to high mortality (Duhig et al., 2000). As a consequence, supplementary management strategies need to be employed to ensure suitable habitat is retained for hollow-using fauna.

Nest boxes are commonly used as a research and management tool to provide habitat for hollow-using fauna (Goldingay and Stevens, 2009), although they are not considered a viable alternative to appropriate landscape-scale habitat management of hollows (Lindenmayer et al., 2009).

A nest-box program for pygmy possums in harvested and unharvested forest was developed by Don Hird and the Forest Practices Authority. Tasmania has two species of pygmy possum. The eastern pygmy possum (*Cercartetus nanus*) and the little pygmy possum (*C. lepidus*). Reliable locality records from a number of sources suggest the two species have a wide distribution, including a number of offshore islands, and use a wide variety of forest types (Munks et al., 2004). In some parts of Tasmania, *C. lepidus* is sympatric with *C. nanus* (Green, 1979; Duncan and Taylor, 2001; Munks et al., 2004). However *C. lepidus* is reported to occur over a much greater range in Tasmania than *C. nanus* and is more frequently encountered (Andrews, 1990; Munks et al., 2004). Both species are protected under the *Tasmanian Nature Conservation Act 2002*.

In Tasmania, the little pygmy possum favours dry forests and heathlands, and to a lesser extent wet sclerophyll forest, but not rainforest (Green, 1993) or terrestrial alpine or treeless subalpine habitats. *Cercartetus lepidus* may den in a tree cavity, stump or hollow log and have also been recorded in an old nest of the New Holland honeyeater (*Phylidonyris novaehollandiae*) situated about 1 m above the ground in dense tea-tree scrub (Green, 1979). The home range for the little pygmy possum is unknown, but it is thought that they can track available flowering resources in the landscape, switching from one species to another as they come into flower (Ward, 1990).

Across its range the eastern pygmy possum is a midstory specialist inhabiting shrubby components of a variety of habitats including rainforest, sclerophyll forest, shrubland, heathland, and woodland (Munks et al., 2004). The eastern pygmy possum uses a variety of cavities as shelters but tree hollows and stumps appear to be used principally (Harris et al., 2008). Nest sites are changed frequently and do not appear to be used exclusively by any single animal or group of animals (Ward, 1990; Bladon et al., 2002). Home range areas of males are usually larger than females (Harris et al., 2008), but home ranges may overlap both within and between the sexes (Bladon et al., 2002). Female *C. nanus* are thought to occupy better habitat than males in terms of potential nest sites and food quality and quantity (Turner and Mackay, 1989).

Available data suggests that Tasmanian populations of both the eastern and the little pygmy possum may be small and therefore at risk to habitat loss, intensification of forestry in unreserved areas (Munks et al., 2004), inappropriate fire regimes and fire wood collection (Harris et al., 2008). We have only limited knowledge of these species, so there is a need for monitoring of the distribution and population trends of the species and the efficacy of current conservation management prescriptions (Munks et al., 2004).

A small number of studies have looked at how forestry affects pygmy possums. The decline in resources that can result from forestry leads to the expectation that pygmy possums would extend

their home range and make use of larger patches of unlogged forest and alternate dens (Law et al., 2013). However, in McPherson State Forest on the central coast of New South Wales (NSW) pygmy possums continued to use areas after they had been logged, and logging was not found to influence their habitat selection (Law et al., 2013). Studies by Duncan and Taylor (2001) in Tasmania found that suitable habitat removed during forestry operations is replaced by stumps and logs produced during the operation. *Cercartetus nanus* is flexible in its den use which is likely to help it tolerate disturbance from forestry. The pygmy possum's ability to use a diversity of nest types over short term is an important survival strategy (Morrant and Petit, 2011).

In addition to understanding how pygmy possums use retained habitat in managed landscapes, there is also a need for further surveys to more clearly define the conservation status of the eastern pygmy possum and the little pygmy possum in Tasmania (Harris et al., 2008). *Cercartetus nanus* is one of the State's least known and rarely observed marsupials (Andrews, 1990) and only one ecological study pertaining to Tasmanian *C. nanus* has been published (Duncan and Taylor, 2001). Even less is known about the little pygmy possum and we need greater knowledge about threatening processes that potentially impact both these species in the Tasmanian context (Harris et al., 2008).

The main aim of this project is to assess the characteristics of the areas used for denning by pygmy possums in both harvested and unharvested areas where nest boxes have been deployed.

2. Materials and Methods

2.1 Study area

The study area was in the Mount Morrison forest block in south-eastern Tasmania, one logged and one unlogged site. Within the logged area, patches of hollow-bearing trees were retained as 'wildlife habitat clumps' as prescribed in the Tasmanian Forest Practices Code (Forest Practices Board, 2000). Individual trees were also retained as part of the silvicultural methods used during the partial-harvest operations at the logged site (Wilkinson, 1994). The logged site is mostly surrounded by private land to the north-west, whereas to the east it is a composition of wildlife habitat strip, wedge-tailed eagle reserve, stream side reserve and threatened fauna reserves (Figure 1). An expansive *Pinus radiata* plantation borders the eastern side of the state forest. The unlogged site was in low eucalypt forest, where one of the clusters was located in a wetter gully and one in drier forest (Figure 2). Hardwood plantations were nearby.

The logged site was a combination of dry *E. obliqua* forest, with an understorey of sedges and a wet *E. obliqua* gully. The unlogged site was variable, with the northern end being dry *E. pulchella, E. globulus* and *E. viminalis* forest, while the southern end was wetter forest with an understorey of *Ghania.*

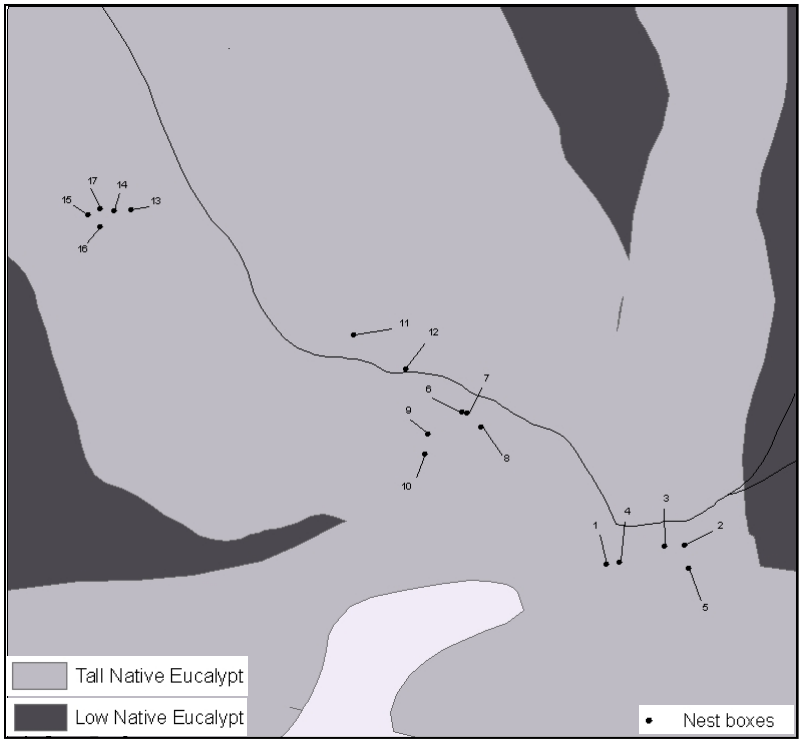

Figure 1. The location of the nest boxes at the logged site at Mt Morrison Forest Block

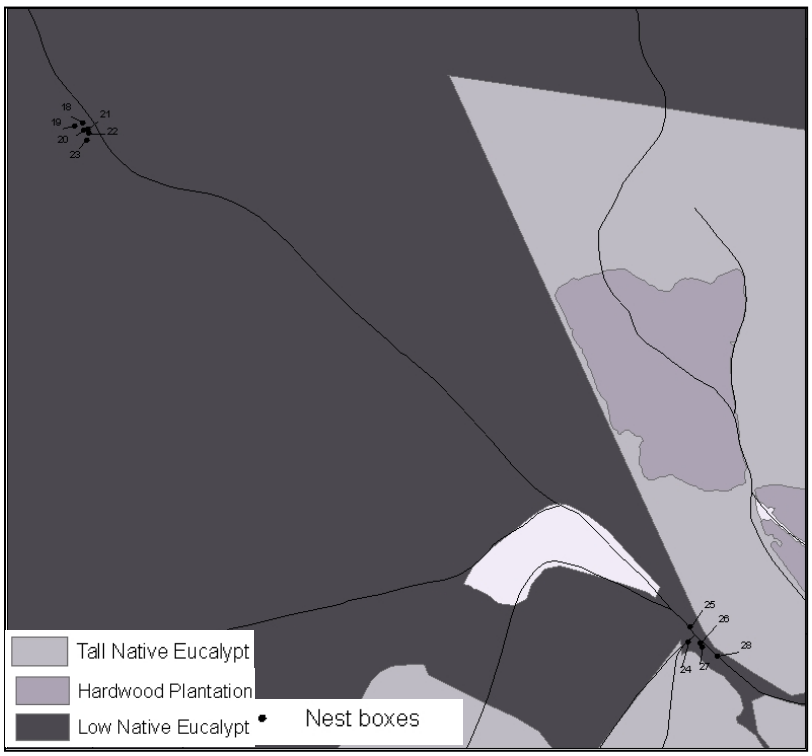

Figure 2. The location of the nest boxes at the unlogged site at Mount Morrison Forest Block

2.2 Nest box checks

Throughout both study areas, a total of 28 nest boxes were established in 2007. Seventeen nest boxes were set up at the logged site; in 2 wildlife habitat clumps, the wildlife habitat strip and on isolated trees (Figure 1). Eleven nest boxes were set up at the unlogged site in two different areas, one wetter and one drier area (Figure 2). Nest boxes were placed in clusters of approximately five and an attempt was made to attach the nest boxes on a variety of trees and aspects.

The dimensions of the nest-boxes used were 17 cm wide, 17 cm deep and 25 cm tall, constructed from rough sawn pine 18 mm thick. Across the front and under the lid is a 15 mm gap to allow animals to enter. Removal of the lid allows the contents of the nest box to be easily observed without undue disturbance to the animals. The bottom of each box is perforated to allow for any necessary drainage.

The mature habitat availability on both the logged and unlogged area was assessed using the mature habitat availability spatial layer on ArcGIS 10.0. The mature habitat availability class was defined using the mature habitat availability categories determined using PI-type, Sencode and TASVEG data (Forest Practices Authority, 2011). The logged site had nest boxes located in patches of high and low mature habitat availability. The mature habitat availability on the unlogged site was mapped as high. Nest boxes were either located in mature habitat or had <300 m to mature habitat.

The nest boxes were checked 11 times, at irregular intervals, for evidence of pygmy possum use between 2009 and 2013. The majority of nest box checks were conducted in spring and summer. In 2014 nest boxes were checked regularly between early February and early May with nest checks every second day at first, but changing to once a week later in the season. The nest boxes have been checked for approximately 6–8 weeks in 2014 with 10 nest box checks in total.

When nest boxes were checked, they were assessed for the presence of nesting material and the presence of animals. We assume that every nest box found with nesting material was used as a den site by pygmy possums at some point. Based on all surveys a nest box is classified as ‘empty’ when no pygmy possum and no nesting material were found. When pygmy possum or nesting material was found the nest box was classified as ‘used’.

Habitat variables that may influence use by pygmy possums were collected at each nest box as outlined in Table 1.To assess the characteristics of areas used by pygmy possums we graphically compared the habitat variables between used (with nesting material) and empty (no nesting material) nest boxes.

Possums may be more inclined to use nest boxes at some times of year more than others. We considered the seasonal use of nest boxes by graphically comparing nest box use (at any of the boxes) in relation to the season when the nest check was done.

2.4 Radio-tracking

During the 2014 nest box checks, any nesting material found was examined to see if animals were present. Any pygmy possums found were transferred into a cotton bag for further examination. Tail length (mm), body length (mm) and head length (mm) were measured using a vernier caliper (Mitutoyo and M.T.I.) to determine whether the animal was *Cercartetus nanus* or *C. lepidus* using *Field Companion to Mammals of Australia* (Van Dyck et al., 2013). In some instances animals were also checked for the presence of a 4th molar, which differs between the little pygmy possum and the eastern pygmy possum. Animals were weighed in a cotton bag to the nearest 0.5 g using a 50-g Pesola spring balance. Pouches and active teats were checked to assess reproductive status (lactating; non-lactating).

Pygmy possums without pouch young and where the transmitter did not exceed more than 5 % of the animals' body mass were considered for radio-tracking. A transmitter (LB-2X transmitters for pygmy possum, Holohil Systems Ltd, Carp Ontario, Canada, weighing 0.35 g) was attached with medical adhesive (Uro-bond IV or 3M Vetbond) between the shoulder blades so the antennae lay along the tail (Duncan, 1995). Transmitter aerials were cut to half-length before attachment to minimise the potential interference of the antennae on the animal's movement (Duncan, 1995). Every pygmy possum got an individual identification mark around their tail with a skin marker (NOKE, STD TIP). Once the transmitter was fitted the pygmy possum was placed in the cotton bag and released back in the nest box.

Animals with a transmitter attached were tracked every day until the transmitters battery expired or the transmitter had fallen off (if the possum was located in the same place for more than 4 days it was assumed the transmitter had fallen off). Pygmy possums were tracked by two people on foot using a hand-held R-1000 receiver (Communications Specialists Inc., Orange, CA) and Australis receiver (Australis 26K, Titley electronics) connected to a 3-element Yagii antenna (Sirtrack, NZ) using a combination of triangulation and homing techniques until a single point of location was found. Den site positions were recorded with a GPS (Garmin e-trek) and habitat assessments were made as outlined in Table 1.

Given the small amount of data obtained during this study, no statistical analyses were done.

Table 1. Habitat variables recorded for each of the nest boxes and denning habitat localities

Variable name	Definition
Tree species	Tree species was determined.
Location	The location of where the transmitter was found or the nest box was attached: tree, log or stump.
Tree DBH	For den sites/nest boxes located on trees, the tree diameter at breast height (1.3m) measured with a diameter tape (cm).
Stump DBH	For den sites/nest boxes located on stumps, the stump diameter measured at the height of the stump using a diameter tape (cm).
Log diameter	For den sites/nest boxes located on log, the diameter of log measured with a diameter tape (cm).
Burn damage	A measure of the intensity of damage done by fire to the tree for den sites/nest boxes located on trees: (1) bark burnt, (2) wood exposed and burnt, (3) fire hole, a hollow created in the tree by fire, (4) fire bridge, a fire hole that has burnt through the tree, creating a 'bridge', or 'tunnel'.
Tree decay class	A measure of tree decay class for den sites/nest boxes located on trees (modified from Smith and Lindenmayer, 1988): (1) regrowth or medium growth trees with no major branches off trunk and no hollows, (2) regrowth or medium growth tree with major branches off trunk but no hollows or less than 3 small hollows visible from the ground, (3) medium to large tree with at least one small hollow (no large hollows) but with no major branches off trunk, (4) medium to large tree with major side branches off trunk and a good variety of small and large holes (prime habitat tree), (5) medium to large tree with dead limbs apart from one or two live branches, (L3) dead tree with most branches still intact, (L4) dead tree with 0-25% of the top broken off (branches remaining as stubs only), (L5) dead tree with the top 25-50% broken away, (L6) dead tree with the top 50-75% broken away, (7) solid dead tree with ≥75% broken away, (L8) hollow stump.
Tree access	The quantity of vegetation in close proximity to the den tree (based on Lindenmayer et al., 1996). One point is scored for each 3 m vertical section of tree where surrounding vegetation was <10 cm from the tree, on either side of the tree. A cumulative score is calculated.
Topographic position	The topographic position of the site was categorized as: (1) ridge, (2) upper slope, (3) mid-slope, (4) lower slope, (5) gully.
Elevation	Elevation in metres of the site was assessed using GPS.
Den site entrance	Measuring the height (cm) of the den site entrance using a measuring tape.

Variable name	Definition
height	
Den site entrance width	Measuring the width (cm) of the den site entrance using a measuring tape.
Den site entrance depth	Measuring the depth (cm) of the den site from the entrance to back of the hollow using a measuring tape.
Internal cavity depth	The internal depth (cm) of the cavity from the bottom of the entrance to the bottom of the hollow.
Internal cavity width	The internal width (cm) from cavity measured from left to right inside the cavity.
Den site above ground	The height (cm) of the bottom of the cavity entrances above the ground.
Aspect	A compass was used to determine the aspect (degrees) of the entrance to the den site or nest box.
Hollow-bearing trees	The number of hollow-bearing trees within a 20 metre radius. A hollow has a minimum entrance diameter of 2.0 cm and a minimum depth of 2.0 cm.
Abundance of logs	The number of logs with a > 10 cm diameter within a 5 metre radius.
Stem density	The number of stems with a diameter at breast height > 10 cm, including dead ones, within a 5 metre radius.
Vegetation community	Vegetation community was determined using the Forest Botany manual (Forest Practices Authority, 2005).
Canopy cover %	Estimated canopy cover (%) within a 5 metre radius using a canopy cover chart.
Understorey cover %	Estimated understorey cover (%) within a 5 metre radius using a canopy cover chart.

3. Results

3.1 Nest box survey

At the logged site 11 of the 17 nest boxes were found to have nesting material at some stage between 2007 and 2014 (Figure 3). At the unlogged site 5 of the 11 nest boxes were found to have nesting material at some stage during the study (Figure 3). At the logged site 4 pygmy possums were found in the wildlife habitat strip, 5 pygmy possums were found in the wildlife habitat clumps and 2 pygmy possums were found on the isolated trees next to the road. At the unlogged site no pygmy possum has been found in the dry low eucalypt forest, whereas 5 pygmy possum were found in a wet gully in between tall native eucalypt forest. Pygmy possums were not identified to species during nest box checks outside of the radio-tracking period.

There were two instances where other vertebrate species were found in a nest box; a skink and a frog.

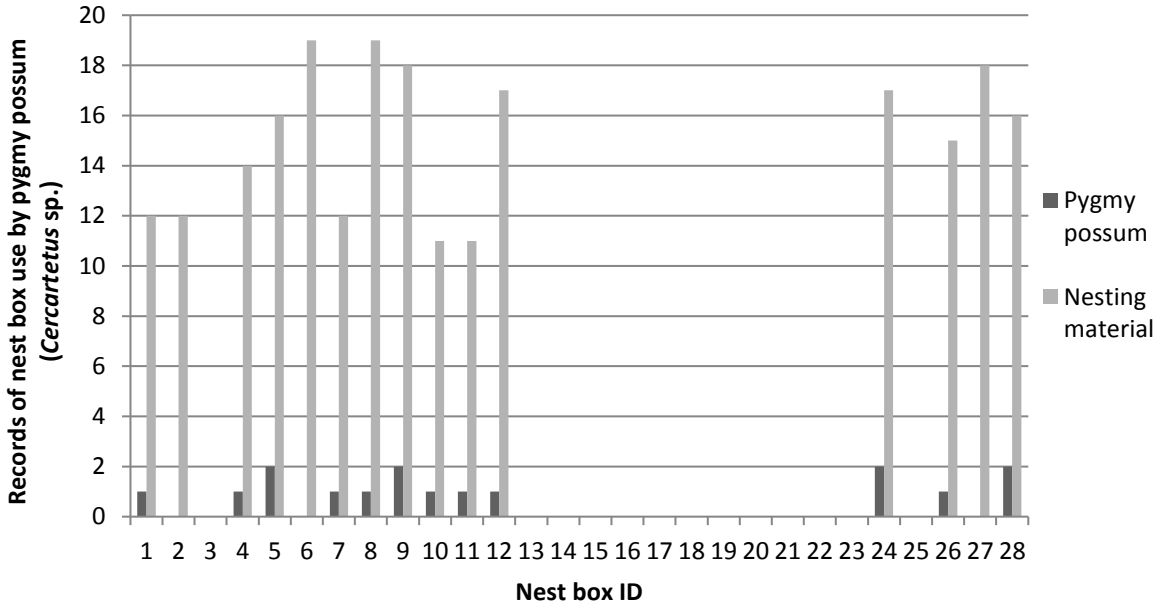

Figure 3. The number of instances where nesting material or a pygmy possum was found in a nest box between 2009 – 2014. Nest boxes 1 to 17 were located at the logged site and nest boxes 18 to 28 at the unlogged site.

The proportion of nest boxes being used as den sites within the Mount Morrison study site differed between the logged and unlogged site (Figure 3). At the logged site 65% of the nest boxes showed evidence of use by pygmy possums, either in the form of nesting material or

animals in the nest boxes, compared to the unlogged site where only 45% of the nest boxes showed evidence of use by pygmy possums. At both the logged and unlogged sites one cluster of nest boxes had neither nesting material nor animals in them.

Clusters of empty nest boxes were in dry *E. pulchella* forest with a mix of *E. viminalis* and *E. globulus* on the unlogged site and in dry *E. obliqua* forest at the logged site. In the clusters of nest boxes that had high levels of use, not all nest boxes were used.

There was some variation in the habitat surrounding the used and empty nest boxes. Most of the empty nest boxes, 8 out of 13, had a tree form of 2 whereas 12 out of 15 used nest boxes had a tree form ≥ 2. 69% of empty nest boxes had a stem density of ≤ 2 compared to the used nest boxes where 77% had a stem density of ≥ 2 (Figure 4, Table 2). Details of the attributes of the area around each nest box are provided in Appendix 1.

Table 2. The average and standard deviation of the site attributes surrounding used and empty nest boxes.

Nest box	Abundance of hollow-bearing trees	Abundance of logs	Stem density	Canopy cover (%)	Understorey cover (%)
Used	1.07 ± 0.80	8.2 ± 4.8	2.8 ± 2.0	25.2 ± 14.8	34.0 ± 21.9
Empty	0.92 ± 0.76	8.3 ± 5.1	2.46 ± 2.40	14.5 ± 10.6	16.5 ± 18.2

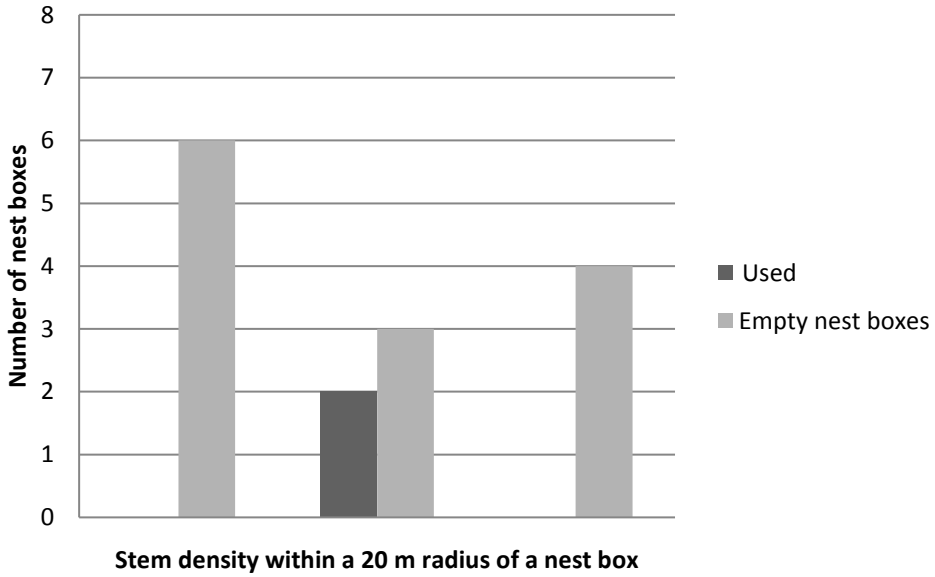

Figure 4. Stem density within a 20m radius of a nest box tree, indicating nest boxes that were used and those that were empty.

A range of topographical areas were used by pygmy possums (Figure 5).

Both clusters of nest boxes at the unlogged site are in mature habitat. However, one cluster was avoided completely by pygmy possums, the cluster in low eucalypt forest. The cluster of nest boxes with evidence of pygmy possum use were located in the wetter area.

In general, there was very little canopy connectivity between nest box trees. Empty nest boxes had less cover, in terms of both overstorey and understorey cover, than nest boxes that had evidence of use by pygmy possums (Figure 6, Table 2).

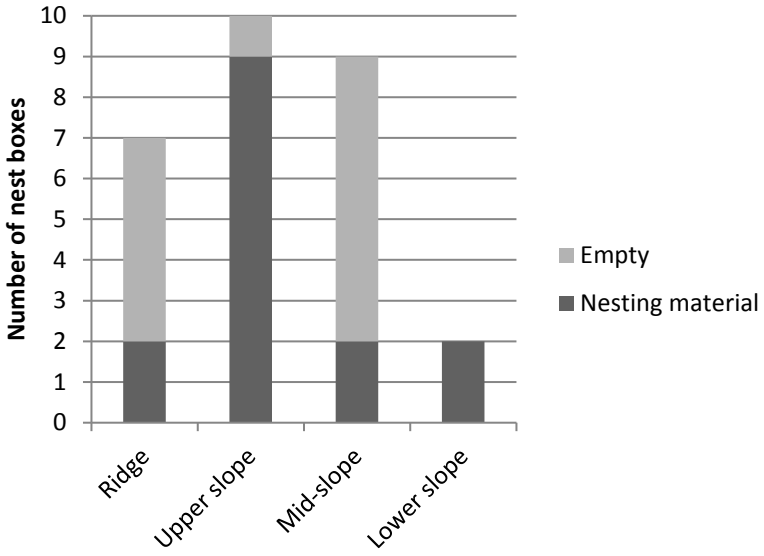

Figure 5. Topographic position of all 28 nest boxes, indicating if they were used or empty

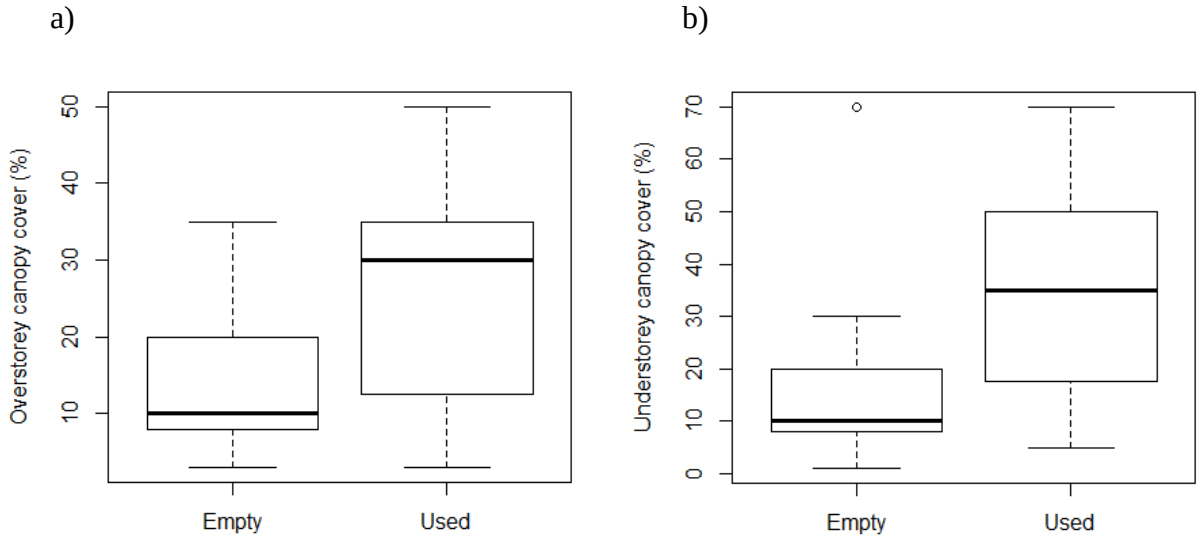

Figure 6. Boxplots of the (a) the overstorey and (b) the understorey cover in the 5m around used and empty nest boxes. The box length is the interquartile range and the circles are outliers.

A higher proportion of nest boxes facing north-west and south-west were used than other aspects, but nest boxes on all aspects, except the four facing north, were used at some point (Figure 7).

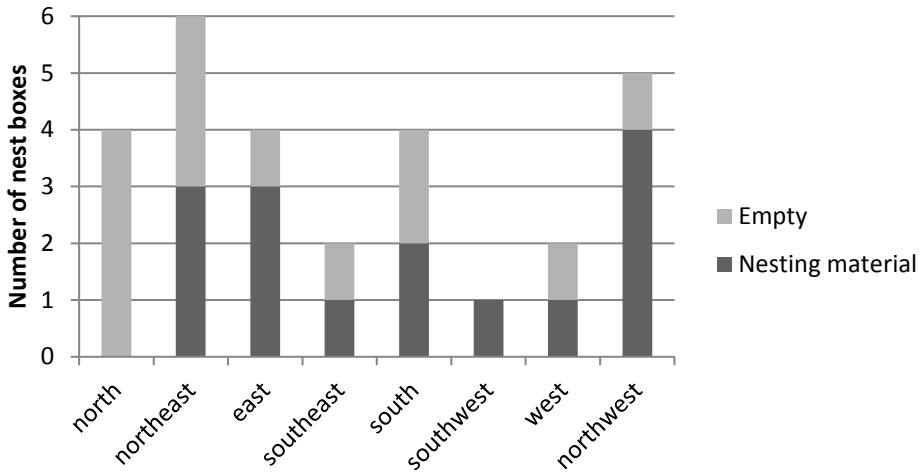

Figure 7. Nest box use by pygmy possums in relation to the aspect of the entrance

The number of surveys was highest in spring and summer. However, the highest number of pygmy possum was recorded in autumn and summer. On one instance in spring two adult pygmy possum were found in the same nest box (Figure 8).

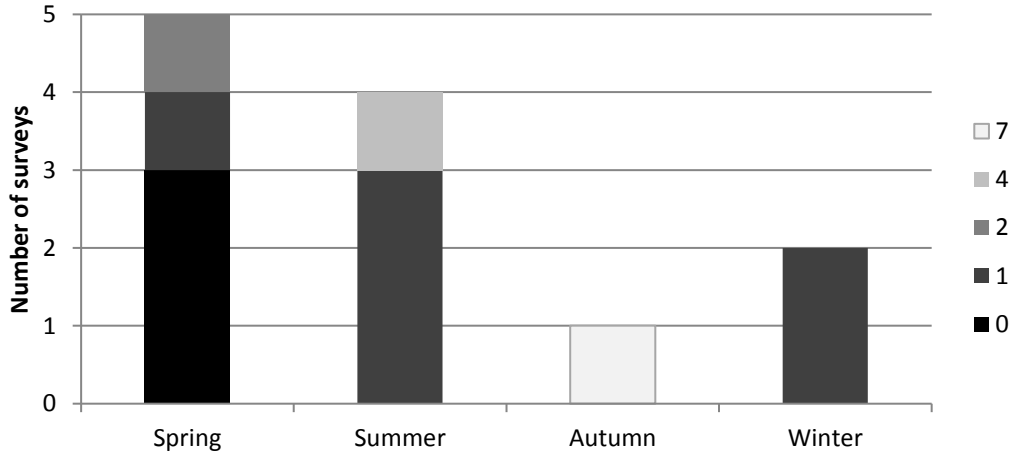

Figure 8. Number of pygmy possum found in any nest box during a survey in relation to the season.

3.2 Radio-tracking

During the surveys in 2014, three little pygmy possums (*C. lepidus*) were found (all females), only two of which could be radio-tracked. One was radio-tracked to a den site and the other was not radio-tracked continuously because of premature transmitter loss.

The first pygmy possum found, Maria, was found in nest box 9 at the logged site. Tail length, body length and head length were measured to determine if the animal was *C. nanus* or *C. lepidus* (Table 3). We attached the transmitter and commenced radio-tracking the following day. We located Maria in nest box 10 the next day and had good views of the animal due to the small amount of nesting material in the nest box. The following day the transmitter fell off, but we again found Maria in nest box 10. We weighed her to assess weight loss or any other sign of negative impacts from the radio-tracking. No signs of impacts on the animal were observed and we were able to re-attach the transmitter. Radio-tracking continued the following day and we located Maria in a small log approximately 6–7 metres from nest box 10. The transmitter signal was located in the log for the following 3 days and it was assumed the transmitter had fallen off the animal. It was not possible to directly measure the internal depth because of the small entrance. The location of the transmitter in the log (as determined using the receiver) was used to estimate the internal depth of the den site. The log used for denning was in the logged area. The den site entrance was 5 cm in height, 9 cm in width and 24.2 cm in depth. The log diameter was 7.2 cm and the den site entrance was 5 cm above ground. The burn damage was 3 and the log decay class 2. There was one stem in a radius of 5 metres and an abundance of logs ≥ 10 cm in diameter. The canopy cover was 30% in the understorey and <40% in the overstorey.

In late February we found the second pygmy possum, Rosalie, in nest box 8 at the logged site (Table 3). Rosalie was very active and alert during examination. Rosalie had similar dimensions to Maria but her pouch was more stretched and may have been used and she had no signs of previous attachment by transmitter. Radio-tracking commenced the next day, but no signal could be detected. We went out the following day and located the transmitter on the ground approximately 20 metres from nest box 8 on the edge of the wet *E. obliqua* gully.

In mid-March we found a female pygmy possum in nest box 24 at the unlogged site. When we checked her pouch for young, we observed one young of estimated 8 mm, so we could not attach a transmitter.

Table 3. A summary of the data collected on pygmy possums located during summer and spring 2014.

Site name	Pygmy possum ID	Species	Sex	Reproductive condition - lactating/non-lactating?	No. young	Weight (g)	Head length (mm)	Caudal diameter at the base of tail (mm)	Length of tail (mm)	Length of hind leg (mm)	Body length (mm)
Logged	Maria	*C. lepidus*	Subadult female	Non lactating	0	8	19.5	2.5	56	17.4	40
Logged	Rosalie	*C. lepidus*	Female	Non lactating	0	9	16.6	~3.5 (feels healthy)	64	16	45
Control	No name	*C. lepidus*	Female	Pouch young - 1 could be seen about 8mm (estimate)	1 in pouch, estimated from observations	13.5	15.4		60		65

4. Discussion

The small sample size of this study means that definitive conclusions cannot be drawn. However, this study does provide valuable insights into pygmy possum nests, the importance of different habitat attributes, and the value of nest boxes as a management strategy to the little pygmy possum in Tasmania's dry eucalypt forests.

During this study only nests made of shredded eucalyptus bark were found in the nest boxes and only *C. lepidus* were confirmed in the area. Previous study on Bruny Island found that two very distinctive nest types have been constructed by pygmy possums. Both are spherical with a diameter filling the width of the nest box, but one type is made from moss collected from forest floor and the other from shredded *Eucalyptus* bark (Don Hird, pers. comm.). The habitat at Bruny Island is open black gum coastal woodland with shrubby understorey. The different types of nesting material could indicate use by *C. nanus* and *C. lepidus* respectively, but no animal handling was involved on Bruny Island to verify this assumption. Duncan and Taylor (2001) were able to radio-track 5 little pygmy possum to their nests at Tooms in Tasmania. Similarly to our study, in four of the five cases the nesting material was shredded eucalypt bark in a small oval clump (10 × 5 cm), with an internal spherical space 3 cm in diameter (it is presumed the species was *C. nanus* but it is not clear from the publication). It is therefore uncertain if different nesting material can be used to identify different pygmy possum species using nest boxes.

At both the logged and unlogged site, pygmy possums showed evidence of being selective for nest boxes at particular locations, as nest boxes were more likely to be used when they had greater vegetation cover in the surrounding patch.

This study showed that the different habitat retention strategies used in forestry areas will all be used by pygmy possums provided suitable denning and foraging habitat is available, with used nest boxes located in wildlife habitat clumps, a wildlife habitat strip and individual trees within the harvested area. However, of the two wildlife habitat clumps that contained nest boxes, only one clump showed signs of use by pygmy possums. This suggests that attributes at the patch or stand scale may influence the use of nest boxes by pygmy possums. Similar findings have been found at these two sites in relation to hollow-use by the common brushtail possum (*Trichosurus vulpecular*) (Cawthen and Munks 2010) suggesting that particular areas may be unfavourable to small and medium sized arboreal hollow-using fauna.

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6. Appendix 1. Details of the area surrounding each nest box

Table 4. Details of the attributes of the nest box location as per Table 1, including an indication if the nest box showed signs of use (i.e. nesting material) at any point during the study.

Nest Box	Use	Location	Species	Diameter (cm)	Burn	Tree form	Tree access	Height above ground (cm)	Aspect
1	1	Tree	E. globulus	146	1	4	3	120	110˚
2	1	Tree	E. viminalis	99	1	2	2	120	185˚
3	0	Log	E. obliqua	36	1	L4	NA	100	25˚
4	1	Log	E. obliqua	80	2	L3	NA	75	165˚
5	1	Tree	E. obliqua	169	4	4	0	150	330˚
6	1	Stump	E. obliqua	60	2	NA	NA	80	35˚
7	1	Tree	E. obliqua	71	1	4	2	120	320˚
8	1	Tree	E. obliqua	62	2	2	0	120	310˚
9	1	Tree	E. globulus	61	1	2	0	106	230˚
10	1	Stump	E. viminalis	NA	4			110	260˚
11	1	Tree	E. obliqua	88	1	2	0	120	320˚
12	1	Tree	E. obliqua	75	2	2	0	115	30˚
13	0	Tree	E. obliqua	104	4	2	0	120	35˚
14	0	Tree	E. pulchella	54	1	2	0	120	60˚
15	0	Tree	E. pulchella	62	3	2	0	115	90˚
16	0	Tree	E. pulchella	85	3	4	0	110	175˚
17	0	Tree	E. obliqua	62	1	2	2	120	5˚
18	0	Tree	B. marginata	33	1	2	1	110	160˚
19	0	Tree	E. viminalis	79	2	2	0	100	60˚
20	0	Tree	Dead	40	0	3	2	125	10˚
21	0	Tree	E. amygdalina	26	1	2	2	110	285˚
22	0	Tree	E. amygdalina	46	3	2	3	110	20˚
23	0	Tree	E. pulchella	82	1	2	2	90	20˚
24	1	Tree	E. globulus	92	3	2	2	117	150˚
25	0	Tree	E. obliqua	97	1	4	2	120	135˚
26	1	Tree	E. obliqua	37	1	1	2	130	90˚
27	1	Tree	E. globulus	141	3	4	2	130	55˚
28	1	Tree	E. viminalis	76	3	3	2	120	80˚

Table 5. Details of the site attributes around each nest box, as per Table 1, including an indication if the nest box showed signs of use (i.e. nesting material) at any point during the study.

Nest Box	Use	Site	Topographic position	Occurrence of hollow-bearing trees	Abundance of logs	Stem density	Canopy cover %	Understorey cover %
1	1	Logged	Upper slope	1	5	5	40	25
2	1	Logged	Upper slope	0	5	6	15	5
3	0	Logged	Upper slope	2	5	4	5	10
4	1	Logged	Upper slope	2	14	3	5	10
5	1	Logged	Upper slope	2	10	1	30	30
6	1	Logged	Upper slope	1	9	5	30	25
7	1	Logged	Upper slope	2	11	1	3	70
8	1	Logged	Upper slope	2	14	2	10	50
9	1	Logged	Ridge	1	9	0	40	70
10	1	Logged	Ridge	1	7	2	40	40
11	1	Logged	Upper slope	0	15	0	30	5
12	1	Logged	Upper slope	0	12	1	30	5
13	0	Logged	Ridge	1	14	0	20	10
14	0	Logged	Ridge	1	12	2	15	5
15	0	Logged	Ridge	1	7	5	10	1
16	0	Logged	Ridge	2	20	1	3	8
17	0	Logged	Ridge	2	7	1	20	2
18	0	Unlogged	Mid slope	0	6	1	35	20
19	0	Unlogged	Mid slope	0	13	1	10	8
20	0	Unlogged	Mid slope	0	5	1	3	25
21	0	Unlogged	Mid slope	1	7	3	35	30
22	0	Unlogged	Mid slope	1	7	2	8	10
23	0	Unlogged	Mid slope	0	2	2	15	15
24	1	Unlogged	Mid slope	0	9	3	50	40
25	0	Unlogged	Mid slope	1	3	9	10	70
26	1	Unlogged	Mid slope	1	1	5	5	50
27	1	Unlogged	Lower slope	2	1	3	30	50
28	1	Unlogged	Lower slope	1	1	5	20	35