

Action Statement No. 62

Leadbeater's Possum *Gymnobelideus leadbeateri*
Flora and Fauna Guarantee Act 1988



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Note: the Leadbeater's Possum Action Statement #62 published in 1995, was revoked by approval of the Secretary as of 29 July 2014

Cover photo: Dan Harley

ISBN 978-1-74146-213-5 (pdf)

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Leadbeater's Possum *Gymnobelideus leadbeateri*

Description

Leadbeater's Possum *Gymnobelideus leadbeateri* (McCoy 1867) is a small, arboreal marsupial with a head and body length of 150–170 mm, a tail length of 145–180 mm and a maximum weight of about 165 g. Its fur is grey to greyish-brown above and paler below, with a prominent dark mid-dorsal stripe and dark facial stripe. The tail has short hairs at the base and much longer, somewhat paler hairs at the tip, conferring a characteristic club-shaped appearance (description from Smith & Harley 2008).

Distribution

Leadbeater's Possum is endemic to eastern Victoria, where it was once distributed from Mt Wills (north of Omeo) in north-eastern Victoria, to the Yarra Valley near Melbourne, and south to the Westernport region (Menkhorst & Lumsden 1995; Harley 2004a). There were initially only five records of this species, recorded between 1867 and 1909, all from lowland areas around Westernport Bay and from Mt Wills. It was not seen for another 50 years and due to clearing in areas where it was originally recorded, it was thought to have become extinct (Calaby 1960). However, in 1961 it was rediscovered in the Central Highlands (Wilkinson 1961).

The species is now confined to an area of approximately 70 x 80 km in the Central Highlands to the northeast of Melbourne and a small, lowland area east of Melbourne in the Yellingbo Nature Conservation Reserve, along the Cockatoo and Macclesfield Creeks (Menkhorst & Lumsden 1995; Harley *et. al.* 2005; Harley & Antrobus 2007). Most of its distribution is in the montane zone, with some occurrences in the sub-alpine zone, ranging from 500 m to 1,500 m in elevation, with the Yellingbo location at 110 m elevation (Harley 2004a). Within its range, the species is patchily distributed, occurring in areas of suitable habitat largely influenced by previous disturbance history. All extant populations occur in the South Eastern Highlands bioregion, and the species is now extinct in the South East Coastal Plain bioregion (Harley 2004a).

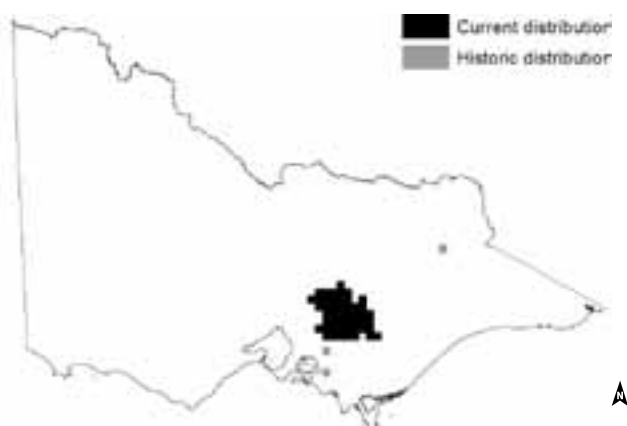
The 2009 Kilmore-Murrindindi fire had a significant impact on the distribution of the species. Recently-developed models predict that the current distribution of the species is centred on unburnt habitat, mostly in the southern parts of the Central Highlands from the Baw Baw area in the east to Warburton in the west, and the unburnt sections of the Toolangi area (Lumsden *et. al.* 2013). Not all areas of potential habitat (i.e. ash forests or Snow Gum *Eucalyptus pauciflora* woodlands) are likely to be currently suitable and occupied by Leadbeater's Possum due to a lack of critical habitat features (e.g. the necessary density of hollow-bearing trees or wattle understorey). Sites most likely to be occupied are lush, unburnt vegetation in gullies that are located in areas with relatively low summer temperatures and high summer rainfall (Lumsden *et. al.* 2013).

Habitat

Leadbeater's Possum is known to occur in three distinct habitat types: montane ash forests (Mountain Ash *Eucalyptus regnans*, Alpine Ash *E. delegatensis* and Shining Gum *E. nitens* and adjacent areas of Cool Temperate Rainforest and riparian thickets); sub-alpine woodland (Snow Gum *E. pauciflora*); and lowland floodplain forest (dominated by Mountain Swamp Gum *E. camphora* in the Yellingbo Nature Conservation Reserve) (Harley 2004a; Lindenmayer *et. al.* 1989). There are approximately 204,400 hectares of potential ash or Snow Gum woodland habitat within the range of Leadbeater's Possum, the majority of which is ash forest (96%), with only 4% Snow Gum woodland. The lowland floodplain forest habitat used by Leadbeater's Possum at Yellingbo covers approximately 181 ha, however less than 20 hectares of this area currently provides suitable habitat conditions (D. Harley 2014, pers. comm.). Regrowth from the 1939 wildfires, combined with fire-killed remnants of mature forest, has provided suitable feeding and denning habitat for Leadbeater's Possums during the past 50 years. Old-growth and mixed-aged forest containing hollow-bearing trees also support populations



Leadbeater's Possum (Dan Harley)



Distribution in Victoria (Victorian Biodiversity Atlas DEPI 2014)

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of the possum, although they may not be as suitable if the understorey is not sufficiently dense.

The most important components of Leadbeater's Possum habitat are den tree abundance, vegetation structure and food availability and they are more likely to occur in areas with higher densities of hollow-bearing trees (e.g. more than two or three hollow-bearing trees per hectare (Smith and Lindenmayer 1988, 1992; Lindenmayer *et. al.* 1990, 1991a). All forest types in which Leadbeater's Possum occurs are dominated by smooth-barked (or 'gum-barked') *Eucalyptus* spp., which provide long strips of bark that are used for building nests and opportunities to forage for insects (Harley 2004a). Large hollow-bearing, live trees, or dead trees such as those killed during bushfires are required for denning (Smith & Lindenmayer 1988; Lindenmayer *et. al.* 1991a). Another important habitat feature, related to vegetation structure, is 'connectivity' (Harley 2004a). Unlike some other small possums that can glide between trees, Leadbeater's Possums depend on connecting vegetation to move through their home range. Movement pathways for the possum are created either by high stem density or interconnecting lateral branches. In montane ash forest, maintenance of a wattle stratum is integral to Leadbeater's Possum habitat connectivity. In sub-alpine woodland, connectivity through the habitat is provided by dense stands of Mountain Tea Tree *Leptospermum grandiflorum* and Myrtle Beech *Nothofagus cunninghamii* present along the drainage lines as montane riparian thickets. In the floodplain forest at Yellingbo, a dense middle storey of tea-tree *Leptospermum* spp. or paperbark *Melaleuca* spp. provides important connectivity, although possums do also move through the Mountain Swamp Gum canopy (Harley *et. al.* 2005).

In montane ash forest, optimum habitat for Leadbeater's Possum is a young regenerating or mixed-aged forest that contains an ample supply of both large, hollow-bearing trees and wattles, especially *Acacia dealbata*, *Acacia obliquinervia* and *Acacia frigescens* (Lindenmayer *et. al.* 1991a). This reflects patterns of disturbance, as stand development is influenced by fire and/or timber harvesting operations. Hollow formation starts at about 120 years. However, hollows suitable for Leadbeater's Possum do not typically form until trees reach around 190–220 years of age (Lindenmayer *et. al.* 1991a; Smith and Lindenmayer 1988). Leadbeater's Possum requires large trees (often more than 2 m in diameter) that provide hollows with large internal dimensions, in the order of 30 cm in diameter, in which to build their nests. Preferred trees typically contain numerous holes and dense surrounding vegetation (Lindenmayer *et. al.* 1991a).

Life history and ecology

Denning groups of Leadbeater's Possum (often referred to as 'colonies') typically consists of two or three individuals (Leadbeater's Possum Advisory Group 2014), although larger colonies have been recorded in the past (up to 12 individuals). A colony usually consists of a single breeding pair and young or adult offspring that have not yet dispersed. A communal nest of shredded bark is

built in large hollows in living or dead trees (Smith 1980, 1984a; Harley 2005). Colonies live in territories of 1–3 ha that contain multiple den sites and are actively defended from neighboring colonies (Smith 1980; Lindenmayer & Meggs 1996; Harley 2005). In continuous habitat, adjacent breeding colonies tend to form discrete genetic units ('kin groups') that contain a significant level of the population's genetic diversity, but between which, only limited gene flow occurs (Hansen 2008). The breeding pair in each territory typically reproduces twice per year, producing 1–2 offspring per litter (Smith 1984a; Harley & Lill 2007).

Diet consists of arthropods, psyllid exudates, nectar and sap (Smith 1980, 1984b). Smith (1980, 1984b) notes the importance of gum from *Acacia* spp. as an energy source for the species in montane ash forest. However, the species inhabits sites lacking *Acacia* spp. in sub-alpine woodland and lowland swamp forest (Harley 2004a). In the latter, exudates from the trunks of Mountain Swamp Gum and *Melaleuca* spp. and *Leptospermum* spp., are consumed (D. Harley 2014 pers. comm.). Leadbeater's Possum's diet in sub-alpine woodland is unknown.

Important populations

The species comprises two separate Evolutionarily Significant Units (ESUs; as defined by Moritz 1994): a lowland ESU from the south-west of its range and a highland ESU from the remainder of its range (Hansen 2008; Hansen & Taylor 2008). The lowland ESU is now represented by a single population at Yellingbo that now contains fewer than 45 individuals following a decline of approximately sixty % during the past decade (Harley *et. al.* 2005; Harley & Antrobus 2008; D. Harley & J. Antrobus 2014 pers. comm.). This population is probably the sole existing remnant of a larger genetic unit that included the now extinct populations from around the Westernport Bay (Hansen 2008; Hansen & Taylor 2008). Due to its distinct ESU status, the isolated Yellingbo population is considered an important population albeit lowland swamp forest currently provides less than 1 % of suitable habitat for the species.

The highland ESU comprises the remaining populations, most of which occur in montane ash forest and the adjacent snow gum woodland. Populations in sub-alpine woodland are continuous with those in montane forests at lower elevations. However, rates of gene flow between these habitats and between population strongholds in ash forest are not known. The distribution of the highland ESU is on public land, occurring in parks and reserves managed by Parks Victoria, and in State forest, managed by the Department of Environment and Primary Industries (DEPI). Montane ash forest makes up the majority of the potential habitat for the species.

Due to the restricted distribution of Leadbeater's Possum, its predicted continuing decline in population numbers, and the risk of future fires, it is considered that all populations are important. Recent occupancy modelling of the Central Highlands population indicates that current strongholds for Leadbeater's Possum include unburnt habitat mainly in

the south of the Central Highlands including the Baw Baw Plateau and its southern slopes, the Toorong Plateau south of the Upper Yarra Catchment, north-east of Powelltown in the Yarra State Forest (e.g. the Doweys Spur and surrounding area), parts of Toolangi State Forest, and southern parts of the Yarra Ranges National Park (Lumsden *et. al.* 2013).

Although only representing 4% of the species range, the areas where the species is recorded in subalpine woodland are also important. There were estimated to be 200-300 individuals in sub-alpine woodland at Lake Mountain prior to the 2009 wildfire and the species' distribution spanned the entire breadth of the plateau (D. Harley, unpubl. data). The majority (>95 %) were killed in the 2009 fires and only a small number of individuals (<10) appear to remain.

The Mount Bullfight plateau, north-east of Lake Mountain supports an important Leadbeater's Possum population in sub-alpine woodland. While the 2009 fire impacts there were severe, small patches of habitat were burnt at lower severity. Targeted surveys for Leadbeater's Possum commenced at Mount Bullfight in 2010, and initial results show that the species survives in three distinct areas and probably supports approximately 30-50 individuals (D. Harley & J. Antrobus, unpubl. data).

The Mt Baw Baw plateau also supports an important Leadbeater's Possum population. Significantly, Mt Baw Baw was not affected by the 2009 Black Saturday fires. While no detailed broad-scale surveys have been conducted to date, several sources of Leadbeater's Possum records indicate the Baw Baw plateau and surrounding area is a key stronghold for the species (Lumsden *et. al.* 2013; G. Hollis pers. comm., L. Beilharz, pers. comm., D. Harley,

pers. comm.). Broad-scale surveys for the species on the Baw Baw plateau have commenced in 2014 (D. Harley & J. Antrobus, unpubl. data).

It is difficult to determine the total population size of Leadbeater's Possums across all three habitats, primarily owing to uncertainty about the number of occupied sites in montane ash forest. However, estimates based on recent surveys throughout the range of the species in the Central Highlands suggest there may be between 1,578 and 4,384 colonies at present (based on the number of adult breeding females). These estimates factored in variability in recording rate, ability to detect the species where it occurs, and the area able to be effectively sampled during the surveys. Assuming colony sizes are currently typically 2-3 individuals, this would equate to approximately 3,945 to 10,960 individuals (using 2.5 individuals as an average) (Leadbeater's Possum Advisory Group 2014). The large range highlights the uncertainty in these values. While these population estimates indicate that there may currently be more individuals than previously suggested, the predicted trend for the species is still a notable decline in population size over the next 70 years owing to stag collapse and fire (Lindenmayer *et. al.* 1990, 1997; Lindenmayer & Possingham 1995; Lumsden *et. al.* 2013). A recent Population Viability Analysis conducted by the Arthur Rylah Institute for Environmental Research highlights the potential severity of the projected population decline (Lumsden *et. al.* 2013). Despite this, it is considered that the estimated population size is large enough to provide opportunities for recovery of the species during this period, assuming that required actions can be implemented soon enough and that threats can be adequately managed.

Location name	Land manager	Catchment	Bioregion
Yarra State Forest, north-east of Powelltown	DEPI	PORT PHILLIP AND WESTERNPORT	Highlands - Southern Fall
Baw Baw Plateau and surrounds	Parks Victoria and DEPI	WEST GIPPSLAND	Victorian Alps Highlands - Southern Fall
Toorong Plateau	Parks Victoria	WEST GIPPSLAND	Victorian Alps
Yarra Ranges National Park	Parks Victoria	PORT PHILLIP AND WESTERNPORT	Victorian Alps Highlands - Southern Fall Highlands - Northern Fall
Toolangi State Forest	DEPI	GOULBURN BROKEN	Highlands - Northern Fall
Yellingbo Nature Conservation Reserve	Parks Victoria	PORT PHILLIP AND WESTERNPORT	Highlands - Southern Fall
Lake Mountain unit, Yarra Ranges National Park	Parks Victoria	GOULBURN BROKEN	Highlands - Northern Fall Victorian Alps
Mount Bullfight Nature Conservation Reserve	Parks Victoria	GOULBURN BROKEN	Victorian Alps

Conservation status

National conservation status

Leadbeater's Possum *Gymnobelideus leadbeateri* has been listed as "endangered" under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Victorian conservation status

Leadbeater's Possum *Gymnobelideus leadbeateri* has been listed as "threatened" under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act).

Leadbeater's Possum is considered "endangered" in Victoria according to the Advisory List of Threatened Vertebrate Fauna in Victoria – 2013 (DSE 2013).

Threats

Fire

Fire is an integral component of ash forests and has an important influence on the occurrence, extent and viability of the Leadbeater's Possum and its habitat (Lindenmayer & Possingham 1995a). The impact of bushfires can vary greatly depending on the frequency, intensity, location and extent of the fire. Over the last century, widespread bushfires have occurred in the Central Highlands on average once every 10 years, with the fires in 1939 and 2009 the most intense and extensive (Lindenmayer & Possingham 1995; McCarthy *et al.* 1999; Lumsden *et al.* 2013). Frequent, extensive, high-intensity bushfires are a major threat to the survival of Leadbeater's Possum, resulting in mortality, destruction of food resources, alteration of forest structure and loss of hollow-bearing trees, with dead hollow-bearing trees at particular risk (Lindenmayer & Possingham 1995; Lindenmayer *et al.* 2012). Because the species is confined to a relatively small area, a single large fire can impact on a significant proportion of the population. Future climate changes are predicted to lead to an increase in the frequency of such fires, increasing the risk to Leadbeater's Possum (DSE 2012; Mackey *et al.* 2002).

While patchy or lower-intensity fires can result in multi-aged ash forests (Ashton 1976) within which hollow-bearing trees are retained or can develop (McCarthy and Lindenmayer 1998; Lindenmayer *et al.* 1999), severe, high-intensity fires kill Mountain Ash trees, resulting in regeneration of single-aged stands (Ashton 1976). In these situations, until the regenerating forest matures and new hollows develop, hollows are only found in fire-killed trees (stags). It has been suggested that fire in younger regrowth forest (including 1939 regrowth and more recent regrowth) is less likely to produce suitable hollows than in old growth because the damaged or killed stems are mostly too small to form the large hollows needed by Leadbeater's Possum (Lindenmayer & Possingham 1995a; Lindenmayer 2009), although further investigations over coming years are required to test this suggestion.

Old-growth ash stands contain the highest densities of hollow-bearing trees (Lindenmayer *et al.* 1991c; Lindenmayer *et al.* 2000). All old growth ash stands have been protected from harvesting in the Central Highlands for over 20 years. The combination of landscape-wide fires and 30 years of salvage harvesting after the 1939 fires, has led to very little old growth ash forest remaining in the Central Highlands. It is estimated that old growth ash forest currently comprises less than two % of the Mountain Ash forest in the Central Highlands (Lindenmayer *et al.* 2012).

Wattles are usually killed by bushfires, which eliminates a major food source of Leadbeater's Possum. However, over the medium-term (within approximately 20 years of the fire), wattle regenerating after fire provides an important source of food and movement pathways. As wattles age and decline (e.g. more than 50 years after fire) (Adams and Attiwill 1984), opening up of the understorey leads to a lack of vegetation connectivity, which can limit possum movement patterns (Lindenmayer & Possingham 1995). If the interval between intense bushfires is short (less than the 20 to 30 years that is needed in order for trees to begin producing seed), ash forests may be eliminated and replaced by other species, such as wattles (Ashton 1981).

The 2009 bushfires had a significant impact on the Leadbeater's Possum population and its habitat. In total, 34 % of the potential ash forest and Snow Gum woodland habitat (68,000 hectares) within the range of Leadbeater's Possum in the Central Highlands was burnt in February 2009 (includes all fire severities) (Lumsden *et al.* 2013). Overall, 45 % of the Leadbeater's Possum Reserve (see below for description of Leadbeater's Possum reserve) was burnt. Post-fire, virtually no Leadbeater's Possums have been detected at burnt sites, irrespective of the fire intensity, including where the understorey was burnt but the canopy remained intact (Lindenmayer *et al.* 2013; Lumsden *et al.* 2013). More than 95 % of known individual Leadbeater's Possums occurring in Snow Gum woodland at Lake Mountain, where the fire intensity was severe, were killed in the 2009 fire (D. Harley 2014, pers. comm.).

Surveys in unburnt refuges within the overall area burnt in 2009 revealed Leadbeater's Possums in 16 % of sites, all in or close to gullies (Lumsden *et al.* 2013). If the likely small numbers of individuals in these fire refuges can persist until the surrounding regenerating habitat becomes suitable, recolonisation of this regenerating habitat could occur from within the fire-affected area as well as from outside. This will be important for the recolonisation and persistence of Leadbeater's Possum throughout the northern half of its range. However, the extent of such recolonisation may be limited by the paucity of refuges and consequent risk of extinction of these small, isolated populations before the adjacent habitat regenerates sufficiently (Lumsden *et al.* 2013).

Timber harvesting

Of the total potential Leadbeater's Possum habitat across the Central Highlands, approximately 63,000 hectares of the ash forest (31 %) is projected to be harvested and then actively regenerated over the length of harvesting rotation (around 80 years). Harvesting currently occurs primarily in 1939 regrowth, although stands resulting from fires between 1900 and 1936 are also harvested. Clearfelling, in which all trees suitable for harvesting (apart from those to be retained for wildlife habitat) are removed, has been the standard method of harvesting applied in the ash forests of the Central Highlands. After harvesting, the remaining debris (i.e. bark, tree crowns, branches) is burnt, which creates a receptive seedbed that promotes regeneration of a new stand of eucalypts. Clearfelling creates even-aged stands in the areas that are harvested, because all the trees and other plants that re-establish begin growing at the same time (DSE 2007).

In addition to the loss of hollow-bearing trees through fire, timber harvesting operations can impact on hollow-bearing trees (reviewed in Lindenmayer 2009). With the exception of trees retained as habitat trees (including those originating from pre-1900), those in the early stages of hollow formation are removed during harvesting. A harvest rotation of 80 years typically results in younger trees being harvested before they reach an age where they will develop hollows. Where large, old trees are retained in areas undergoing harvesting, they often have limited longevity with accelerated rates of collapse due to exposure and the impact of the high-intensity regeneration burns that are typically applied in harvested areas (Lindenmayer *et. al.* 1990; Gibbons & Lindenmayer 1996). Areas of retained habitat in the surrounding area leads to multi-aged forest that can contribute to suitable habitat for Leadbeater's Possum.

In addition to the Leadbeater's Possum Reserve system, high quality habitat in proposed harvesting areas is protected through Leadbeater's Possum habitat zones: buffers around known colonies and other prescriptions (e.g. streamside buffers). Leadbeater's Possum can, however, also reside in areas with fewer hollow-bearing trees than the number required to qualify for protection as Leadbeater's Possum habitat zones (i.e. Zone 1A or Zone 1B; Lumsden *et. al.* 2013).

In ash forest, Leadbeater's Possum occurs at highest densities in multi-aged forest containing several age classes of eucalypts, including live and dead hollow-bearing trees, together with a dense understorey of wattle (Lindenmayer *et. al.* 1990, 1991a; Smith & Lindenmayer 1992). Although forest regenerating after harvesting can provide habitat for Leadbeater's Possum, the small number of hollow-bearing trees typically present in these stands makes them generally unsuitable for the species, although retained habitat in the adjacent area may enable a colony to make use of regenerating habitat while using nearby retained habitat for nesting.

The suitability of regenerating forests for Leadbeater's Possum is reduced by thinning operations. Thinning involves the removal of smaller merchantable trees to increase the growth rate and/or health of retained trees and to obtain

timber from trees that would otherwise die before final harvest (DSE 2007). Regenerating stands are mostly thinned at 18-30 years. Thinning operations significantly increase the growth of the retained trees thereby enabling increased volumes of high quality logs to be harvested and can promote hollow development. Thinning opens forest stands and disturbs understorey vegetation through the passage of machinery, resulting in the loss of mid-storey connectivity that is required by Leadbeater's Possum in order to move through its habitat. Regenerating habitat (e.g. > 20 years) can provide habitat in the future, as long as there are sufficient hollows present.

Salvage harvesting involves the removal of trees burnt (and usually killed) in high-intensity bushfires and can be conducted to recover timber following events that result in significant tree mortality or damage (DSE 2007). Its effects on montane ash forest ecosystems (in addition to normal timber operations) are poorly understood (Lindenmayer *et. al.* 2008), owing to a lack of studies (Lindenmayer & Ough 2006) or monitoring of cumulative disturbance effects (Lindenmayer & Noss 2006). In the Central Highlands, salvage harvesting took place after bushfires in 1926, 1932, 1939, 1983 and 2009. The most extensive salvage operations occurred after the 1939 wildfires, with forests intensively salvaged until the late 1950s. Salvage harvesting removes dead and damaged trees, resulting in large areas of mostly single-aged forest, with only small areas of older or mixed-age ash-eucalypt forest remaining (NRE 1998; Lindenmayer *et. al.* 2008). Salvage harvesting is subject to prescriptions that aim to protect biodiversity values for hollow-dependent fauna. The Salvage Harvesting Prescriptions prioritise large, live hollow-bearing trees for retention (DSE 2008a). Areas that would have met the criteria for Zone 1A habitat prior to the fire are protected as the prescriptions specify that all hollow-bearing trees, even if dead, are to be assessed as alive.

Decline in habitat quality

In addition to the impact of the 2009 fires and timber harvesting, there have been significant natural losses of hollow-bearing trees that are the result of earlier fires. Long-term monitoring over the last 30 years in the Central Highlands has shown that approximately 3.5 % of dead trees collapsed per year during that period and approximately 1.5 % of large, live hollow-bearing trees died per year (with these figures higher in burnt areas) (Lindenmayer *et. al.* 2012). This loss of hollow-bearing trees is predicted to continue into the future, with most of the remaining dead trees from the 1939 fires predicted to collapse in the next few decades. There is currently negligible development of new hollow-bearing trees, as the majority of younger age-classes of live trees that now dominate the forest (1939 regrowth) are yet to form hollows. The combination of the loss of existing hollow-bearing trees and a lack of formation of new hollow-bearing trees is predicted to lead to a severe shortage of these trees in the next 30-70 years (Lindenmayer *et. al.* 1990; 2012).

Leadbeater's Possum populations inhabiting sub-alpine woodland and lowland floodplain forest at Yellingbo use a range of living and dead tree forms for denning (D. Harley

unpubl. data), but hollow availability has not been quantified. The number of suitable natural den sites in both habitats appears to be limited, as evidenced by the rapid rate of colonisation of artificial nest boxes by the species at both Lake Mountain and Yellingbo (Harley 2004b; 2006).

The Leadbeater's Possum population at Yellingbo is currently restricted to less than ten % of the floodplain area (<20 ha), due to the limited extent of high quality foraging habitat (Harley *et. al.* 2005, Harley & Antrobus 2007, D. Harley unpubl. data). Habitat deterioration caused by eucalypt dieback related to altered hydrology, habitat succession to a structurally open, mature age-class, and a lack of eucalypt regeneration is evident across most of the floodplain, degrading habitat conditions for Leadbeater's Possum. As a result, 60% of territories have been abandoned during the past decade (D. Harley, unpubl. data). Vegetation dieback is most common in wetter areas where hydrology patterns have been altered. Invasion by *Phragmites australis* as the canopy structure becomes sparser has also impeded eucalypt regeneration. Suitable habitat for Leadbeater's Possum at Yellingbo comprises young, structurally dense stands up to 50 years old, with the majority of individuals using nest boxes as den sites. Most of the high quality habitat is currently occupied (D. Harley 2014 pers. comm.), limiting the potential for expansion of the population in the reserve until effective habitat restoration measures are implemented. Without successful habitat restoration within the floodplain forest, continued population declines will occur.

Well-connected vegetation is integral to Leadbeater's Possum habitat suitability. In addition to the loss of habitat connectivity resulting from severe bushfires, and to a lesser extent timber harvesting, natural wattle decline and tree dieback, lack of connectivity can arise from road and track construction, maintenance and widening.

Climate projections for Victoria include more extreme weather days with temperatures over 35° Celsius, higher mean annual temperatures and reduced annual rainfall. These projections suggest an increased risk of bushfires, heatwaves and drought (DSE 2012). Leadbeater's Possum

occurs in areas characterised by cold, wet climates with relatively low summer temperatures and high summer rainfall (Lindenmayer *et. al.* 1991d; Harley 2004a; Lumsden *et. al.* 2013). A hotter and drier climate may reduce the area of suitable habitat available for Leadbeater's Possum. Hollow-bearing trees died at a higher rate between 2006 and 2009, which corresponded to a period of low rainfall, compared to outside this period (Lindenmayer *et. al.* 2012). This may have been a response to moisture stress. Increased frequency of drought could further exacerbate the loss of hollow-bearing trees in the future.

Population fragmentation

Landscape-scale disturbances that result in the creation of large areas of unsuitable habitat can lead to isolation of colonies and further fragmentation of the population, resulting in reduced genetic diversity at a landscape scale. Genetic differentiation has been detected in Leadbeater's Possum populations from the north of the species' range (e.g. in the Marysville/Lake Mountain area) compared to those in the south (e.g. near Powelltown), suggesting recent disruptions to the gene flow between these areas. Habitat fragmentation, timber harvesting and bushfires are likely to have contributed to these disruptions to gene flow (Hansen *et. al.* 2009), with extensive bushfires likely to be the key factor. The extensive bushfires in February 2009 have further isolated populations. For example, the subpopulation in the Toolangi area, which is surrounded by areas burnt in 2009, may be currently isolated from subpopulations to the south. The location and scale of fire and timber harvesting in relation to Leadbeater's Possum populations, as well as the spread of the population, determines the level of fragmentation to populations.

The Yellingbo population is isolated from the Central Highlands population to such an extent that it is now considered a distinct Evolutionarily Significant Unit. Even within the Yellingbo population there is evidence from DNA sampling to suggest some restriction to gene flow between the northern and southern sections of the reserve (Hansen 2008).

Previous management actions

Reservation

Thirty-four % of the ash forest and snow gum woodland potential habitat within the distribution of Leadbeater's Possum is protected in parks and reserves managed by Parks Victoria (DEPI unpubl. data). The largest areas of reserved ash forest are in the Yarra Ranges National Park, which includes three extensive water catchments. The major sub-alpine woodland sites inhabited by the Leadbeater's Possum are protected within the Yarra Ranges National Park (Lake Mountain), Mount Bullfight Nature Conservation Reserve and Baw Baw National Park. The lowland swamp forest inhabited by Leadbeater's Possum is fully protected within the Yellingbo Nature Conservation Reserve. The Yellingbo Nature Conservation Reserve, Baw Baw National Park and Yarra Ranges National Park Management Plans describe the conservation of Leadbeater's Possum and its habitat as a priority (Parks Victoria 2002; 2004; 2005).

Protection measures in State forest

Leadbeater's Possum reserve system

An interim system of retained habitat, based on areas of old-growth forest, was identified and protected as part of the Central Highlands Forest Management Plan (NRE 1998). This system was based on interpretation of aerial photography. Twenty-one Leadbeater's Possum Management Units (LMUs) were delineated across the range of the possum, based on the extent and spatial distribution of ash-type forest. The objective was to identify and where possible protect 600+ ha (where possible) of Leadbeater's Possum habitat in each LMU.

A Leadbeater's Possum reserve system was agreed upon in 2008 to protect priority areas of habitat. When this reserve was established it comprised 30,500 ha of high-quality Leadbeater's Possum habitat. A total of 127 patches, greater than 50 ha in size and containing predominantly old growth ash forest were incorporated (Smith & Morey 2001). Areas of old growth were primarily selected because these were likely to provide suitable habitat into the future, compared to areas of 1939 regrowth where the dead hollow-bearing trees were collapsing. The patches were spread across the species' range to reduce the risk of large areas being rendered unsuitable due to wildfire. Areas to be included in the reserve system were assessed independent of their tenure status. The majority of the reserves (85%) were located in areas that were in formal parks and reserves or existing special protection zones within State forest (58% in parks and reserves and 27% in special protection zones). Less than 3,000 ha fell within areas available for timber harvesting, reducing to 2,500 ha when unproductive forest was removed. In 2008, these areas were converted to special protection zones which excludes timber harvesting. In February 2009, 45% of the 30,000 hectares Leadbeater's Possum Reserve was burnt. Post-fire surveys indicate the possum is now absent from sites burnt in 2009 (Lindenmayer et. al.2013; Lumsden et. al.2013).

Overall within the Central Highlands, 69% of the total mapped area of potential habitat (i.e. ash forests or Snow

Gum woodlands) within the range of Leadbeater's Possum is located in formal national parks and conservation reserves, special protection zones in State forest (including the Leadbeater's Possum Reserve) or areas excluded from harvesting due to biodiversity and regulatory reasons. However a high proportion of this forest has been subject to widespread fires (for example, in 1939, 1983 and 2009). Other areas of high quality Leadbeater's Possum habitat are excluded through prescriptions (e.g. Zone 1A and 1B habitat) or for operational reasons.

State forest

A zoning system for managing Leadbeater's Possum in State forest was first proposed in the action statement in 1995. This system was then implemented through the Central Highlands Forest Management Plan (CHFMP), with prescriptions relating to the management of the species as described below (NRE 1998). This was in place from the mid-1990s until 2014, when the action statement was updated.

Zone 1A - Special Protection Zone

- > 12 living mature or senescing hollow-bearing trees (comprising Mountain Ash, Alpine Ash or Shining Gum) per 3 ha in patches greater than 3 ha

Zone 1B - General Management Zone but excluded from timber harvesting while Zone 1B attributes remain.

- > 12 dead mature or living senescent trees containing • hollows per 3 ha in patches greater than 10 ha, with wattle density (basal area) of > 5m² per ha

Zone 2 - General Management Zone

- Consists of the remaining ash-eucalypt forest: regrowth ash forest of varying ages; or areas with features of Zone 1A or Zone 1B but <3 ha or 10 ha respectively.

Timber harvesting and associated roading is currently excluded from areas of forest meeting the criteria for Zone 1A or Zone 1B.

Strategic fuel breaks

In 2006, Department of Sustainability and Environment began the construction of 600 km of strategic fuel breaks in the Central Highlands, to protect Melbourne's water supply from fire. Initial construction was undertaken as part of emergency response activities to the Great Divide Fire of late 2006. After the 2006 fires, the initial fuel breaks were linked to an a strategic network of fuel breaks having regard biodiversity conservation requirements under the Victorian FFG Act and Commonwealth EPBC Act. There is a risk that these fuel breaks can fragment Leadbeater's Possum habitat by disrupting middle-storey and canopy connectivity, which could lead to reduced dispersal and fragmentation of populations. Leadbeater's Possum may also be impacted by fuel reduction burns potentially operating along the fuel breaks. To mitigate these risks prescriptions are in place to minimise impacts on Leadbeater's Possum by retaining bands of wattle and Mountain Ash at 100 m intervals in

some areas, and restricting removal of hollow-bearing trees (DSE 2008b). Using an Exclusion Zone (DSE 2008b), fuel breaks must not be constructed in the majority of high-quality Leadbeater's Possum habitat. The impacts of strategic fuel breaks on wildlife, including Leadbeater's Possum, are being examined by the Australian Research Centre for Urban Ecology. Rope bridges have been installed to test whether these could be used to reduce fragmentation impacts of fuel breaks and roads (R. van der Ree 2014 pers. comm.).

Response to 2009 Bushfires - Supplementary feeding trials

Following the severe impacts of the February 2009 bushfire a winter supplementary feeding trial was undertaken at Lake Mountain from 2009-2011. Whilst the species' diet has not been studied in sub-alpine woodland, it is assumed that food availability may be at its lowest during the months of snowfall. It is likely that the severe impact of the fire on habitat conditions may have reduced food availability to critically low levels. Two Leadbeater's Possum colonies were provided with food at fixed feeding stations twice per week from June–October over three consecutive winters. The supplementary feeding program was coordinated by Parks Victoria, with extensive volunteer participation from the Friends of Leadbeater's Possum and support from the Lake Mountain Alpine Resort. Food preparation was undertaken by Healesville Sanctuary. Remote cameras were used to examine the pattern of visitation to the feeding stations. The data collected confirmed that both possum colonies made extensive use of the supplementary food provided (J. Antrobus & D. Harley 2014 pers. comm.).

Provision of nest boxes to increase den site availability

The number of suitable den sites in tree hollows has been recognised as a major factor limiting Leadbeater's Possum abundance (Lindenmayer *et. al.* 1991b), and the use of artificial nest boxes to supplement natural hollows has been trialled extensively in all habitats. Nest boxes are used extensively by Leadbeater's Possum in lowland swamp forest at Yellingbo and sub-alpine woodland at Lake Mountain and Mount Bullfight. Since 1995, 175 nest boxes have been installed at Yellingbo, and at least 80% of the total population at Yellingbo regularly use the nest boxes (Harley 2004b). Thirty nest boxes were installed at Lake Mountain in 2003, and 28 of these were colonised by Leadbeater's Possum prior to the 2009 bushfires (D. Harley unpubl. data). These high occupancy rates suggested that the availability of den sites may have been limiting these populations, and that a nest box supplementation program may significantly enhance territory quality at these localities. In addition, the installation of nest boxes has proved an extremely effective means of surveying the distribution of Leadbeater's Possum at these sites and gathering biological and ecological data (Harley 2004b, 2005). Recent nest box surveys in sub-alpine woodland at Mt Bullfight have also recorded extensive nest box use by Leadbeater's Possum (D. Harley & J. Antrobus unpubl. data 2014).

The success of nest boxes in the montane ash forests

has been variable. In 1998 - 2002, there were only low rates of occupancy by Leadbeater's Possum in nest boxes (Lindenmayer *et. al.* 2003b). This was possibly due to differences in vegetation structure or because natural hollows are usually located substantially higher in montane ash forest than the heights at which nest boxes were installed (Lindenmayer *et. al.* 2003b; Harley 2006). In addition there were management issues with a high rate of nest box loss due to falling branches and shedding bark (Lindenmayer *et. al.* 2009).

More recently, nest boxes have been installed in regrowth originating from fires in 1983 at Doweys Spur, Yarra State Forest. Colonisation rates have been higher here than at other montane ash sites, with seven out of ten nest boxes installed used by the species (D. Harley unpubl. data 2014). Similarly, eight out of ten nest boxes installed at an Alpine Ash site at Lake Mountain show evidence of use by the possum (D. Harley unpubl. data 2014).

The provision of nest boxes in montane ash forest and sub-alpine woodland is occurring through 'Project Possum'. This project is a collaboration between scientists, Parks Victoria, and the community-based Friends of Leadbeater's Possum. The Friends of Leadbeater's Possum have raised funds for 200 new nest boxes by asking members of the public to "adopt" nest boxes. Volunteers also contributed labour towards installing and monitoring the nest boxes. Project Possum has three aims: i. to survey the distribution and abundance of Leadbeater's Possum populations in sub-alpine woodland, ii. to determine fire impacts on local populations and monitor post-fire recolonisation in sub-alpine woodland, and iii. to install nest boxes in montane ash forest to reduce the likelihood of territory abandonment due to stag collapse (D. Harley 2014 pers. comm.). The initial goal in montane ash forest is to install two nest boxes per territory in 100 possum territories, which would ultimately provide den sites for about 350 individuals. Nest boxes will be concentrated in 5-8 different areas across the species' range in montane ash forest as risk-spreading against fire. In order to increase nest box longevity, a design has been developed using recycled plastic rather than timber. Extensive trials in all three forest types inhabited by Leadbeater's Possum have confirmed that the species will colonise recycled plastic nest boxes (D. Harley and J. Antrobus 2014 pers. comm.). Thus far, 130 nest boxes have been installed in Sub-alpine woodland and 110 nest boxes have been installed in Montane Ash forest as part of this den supplementation program (D. Harley 2014 pers. comm.).

Translocation and captive populations

In 1987, there was an unsuccessful attempt to establish captive-bred Leadbeater's Possums in montane ash forest (Macfarlane & Seebeck 1991). The reintroduction is thought to have failed due to the presence of resident possums at the release site.

During 2003 and 2004, six unpaired subadult/young adult Leadbeater's Possums were translocated from the Cockatoo and Macclesfield Creeks to the Woori Yallock Creek within Yellingbo Nature Conservation Reserve (D. Harley & J. Antrobus unpubl. data). The management trial

was prompted by a natural dispersal movement undertaken by a male possum (Harley 2002). It was a hard release (i.e. wild to wild translocation), although multiple nest boxes were installed at each release site. After initial success the attempt to establish the species in this section of the reserve was ultimately unsuccessful. A key finding was that predation rates were greatly elevated when animals dispersed through unfamiliar habitat (D. Harley & J. Antrobus unpubl. data). To create greater fidelity to release sites, it is suggested that future releases translocate entire established social groups in an attempt to reduce dispersal-related mortality rates (D. Harley 2014 pers. comm.).

In 2012, a captive-breeding program commenced for the last lowland population of Leadbeater's Possum at Yellingbo with the intent of providing insurance against the loss of this population (and its unique genetic diversity) and a future source of captive-bred young for release following habitat restoration. To date fourteen individuals have been collected and housed at Healesville Sanctuary.

Yellingbo Nature Conservation Reserve habitat restoration and revegetation

Since 2009, Parks Victoria have undertaken targeted revegetation in active Leadbeater's Possum territories at Yellingbo to compensate for the loss of dense vegetation structure and lack of natural regeneration. In 2014, a significant revegetation project coordinated by Greening Australia and Parks Victoria commenced to improve the condition of the FFG-listed Sedge Rich *Eucalyptus camphora* Swamp Community in Yellingbo Nature Conservation Reserve. The planned revegetation is part of the Victorian Government '2 Million Trees' initiative which aims to plant two million trees across Victoria from 2012 to 2014. Revegetation at Yellingbo has been directed at priority Leadbeater's Possum sites. The Judith Eardley Save Wildlife Association also provided a \$225 000 grant to increase habitat complexity for Leadbeater's Possum and Helmeted Honeyeater at Yellingbo and Warramate Hills Nature Conservation Reserves, and to improve the condition of the *E. camphora* swamp community.

A deer control program was introduced to Yellingbo Nature Conservation Reserve in 2014 in an attempt to reduce browsing on the revegetation. The program is a partnership between Parks Victoria and Australian Deer Association and the Sporting Shooters Association of Australia. In addition to this, Parks Victoria has funding for 2014 to fence revegetation plots to exclude deer and native browsers. Parks Victoria remote camera monitoring suggests that there are approximately 20 – 30 Sambar *Cervus unicolor* and at times (depending on daily movement) in excess of 80 Fallow in Yellingbo Nature Conservation Reserve. The continued presence of Sambar and Fallow *Cervus dama* populations within Yellingbo Nature Conservation Reserve will continue to damage critical native habitat and restoration efforts for the Leadbeater's Possum.

Surveys and Monitoring

Long-term monitoring of arboreal marsupials including Leadbeater's Possum has been conducted in the Central Highlands since the early 1980s (Lindenmayer *et. al.* 2003a, reviewed in Lindenmayer 2009). The current monitoring design, established in 1997, involves repeated sampling of a rotating subset of 161 one-hectare sites. Count data for arboreal mammals is obtained by observing all potential den trees (stag-watching) at a site at dusk when animals emerge to forage (Smith *et. al.* 1989). In addition, all hollow-bearing trees on the monitoring sites have been mapped and are surveyed annually to monitor trends in stag decline and den site availability for Leadbeater's Possum (Lindenmayer *et. al.* 1990, 1997).

Surveys to determine the extent of the Leadbeater's Possum population at Yellingbo were conducted from 1994 to 1999 (Harley *et. al.* 2005). Intensive population monitoring was conducted at 6-week intervals from 1995 to 1999 (Harley 2005). Since 2001, annual population monitoring has been conducted during April and May (Harley & Antrobus 2007). This project provides detailed long-term data on the population dynamics of Leadbeater's Possum at this locality and several measures of population condition are assessed annually.

Following the discovery of Leadbeater's Possum denning in sub-alpine woodland in 1993 (Jelinek *et. al.* 1995), targeted trapping surveys were undertaken to locate colonies (S. Smith unpubl. data). Surveys to examine the distribution and abundance of Leadbeater's Possum in sub-alpine woodland at Lake Mountain commenced in 2003 with the installation of 30 nest boxes. Colonisation of nest boxes was assessed annually between 2003 and 2008 (D. Harley, unpubl. data). In 2006 and 2007, 23 colonies occupying nest boxes at Lake Mountain were examined to investigate the size and composition of denning groups and to collect genetic samples (Hansen 2008; Hansen *et. al.* 2009). Following the 2009 fires, annual monitoring has been conducted at Lake Mountain, and the number of nest box survey sites expanded to 77 to examine Leadbeater's Possum's persistence and post-fire recolonisation (D. Harley & J. Antrobus unpubl. data). Since 2010, 52 nest boxes have been installed in sub-alpine woodland at Mount Bullfight to examine the species' post-fire distribution in sub-alpine woodland at that locality (D. Harley & J. Antrobus unpubl. data). In 2014, 61 nest boxes were installed at two sites in sub-alpine woodland at Mt Baw Baw. Baw (D. Harley & J. Antrobus unpubl. data). These surveys will be expanded to a further five sampling areas at Mt Baw Baw over the next two years (D. Harley 2014 pers. comm.). Other sub-alpine sites may also be surveyed

During broad-scale surveys at 180 sites across the Central Highlands in 2012, investigating the current distribution and habitat preferences to determine likely population strongholds, Leadbeater's Possum was detected at 16 % of all sites surveyed, or 19 % of the sites that had not been burnt in 2009 (Lumsden *et. al.* 2013). The data obtained was used to develop occupancy models to predict where the species is currently located (Lumsden *et. al.* 2013).

Research

There have been many studies investigating the biology and ecology of Leadbeater's Possum, including four PhD investigations (Smith 1980; Lindenmayer 1989; Harley 2005; Hansen 2008). A comprehensive review of 25 years of research undertaken by researchers at the Australian National University (ANU) in the montane ash forests of the Central Highlands was produced by Lindenmayer (2009). Recent key studies have investigated hollow-bearing tree decline (Lindenmayer *et. al.* 2012 see Decline in habitat quality section above) and the impact of the 2009 bushfire (Lindenmayer *et. al.* 2013).

Fire impacts

Lindenmayer *et. al.* (2013) investigated the impacts of bushfires in February 2009 on arboreal marsupials, including Leadbeater's Possum, based on data collected from a sub-set of their 161 long-term monitoring sites after the 2009 fire. Analysis revealed that Leadbeater's Possum is largely absent from sites that were burnt in the 2009 fire, regardless of the fire severity. The abundance of the Leadbeater's Possum was also significantly depressed on unburned sites where the surrounding landscape has been burnt (Lindenmayer *et. al.* 2013). These results highlight the severe negative impact of this fire on Leadbeater's Possum. A consistent pattern was found during the broad-scale surveys across the Central Highlands, with no Leadbeater's Possum recorded at the 30 sites sampled within areas burnt in the 2009 bushfire (Lumsden *et. al.* 2013). Additional sites were surveyed in unburnt 'fire refuge' habitat within the overall area burnt in the 2009 wildfires.

In the 2009 fires, the entire Lake Mountain plateau was burnt at high severity. Pre-fire the plateau was estimated to support 200 – 300 Leadbeater's Possums (D. Harley, unpublished data). Following extensive surveys, only two Leadbeater's Possum colonies were detected post-fire, totalling five individuals, (D. Harley & J. Antrobus, unpublished data). These results indicate that the fire resulted in mortality rates exceeding 95 % at this locality.

Population modelling

A number of population models have been developed to examine metapopulation viability including the impact of disturbance regimes (Lindenmayer & Lacy 1995; Lindenmayer and Possingham 1995a, b). This analysis investigated the extinction risk and predicted a higher probability of persistence in areas characterised by larger patches of old-growth forest. On the basis of this work, the authors recommended a key forest wildlife management objective to grow areas of existing regrowth forest through to ecological maturity or old-growth status (i.e. >250 years). This gave rise to the Leadbeater's Possum Reserve system implemented in 2008.

This population modelling was updated in 2013 to incorporate the impact of the 2009 fires and to predict future changes in numbers of Leadbeater's Possum (Lumsden *et. al.* 2013). This work initially focused on the Leadbeater's Possum Reserve. This modelling revealed significant fluctuations in population numbers over time due to past fires, especially the extensive fires in 1939 and

2009. All modelled scenarios (using different amounts of habitat loss and size of bushfires in the future) resulted in a high probability that the population within the Leadbeater's Possum Reserve would fall below 500 adult females over the next 200 years, making it highly vulnerable to extinction. The modelling was then extended to include national parks and conservation reserves, and although this reduced the risk of extinction, it concluded that the parks system in conjunction with the Leadbeater's Possum Reserve was insufficient to ensure the long term survival of the species (Lumsden *et. al.* 2013).

Alternative survey techniques

In montane ash forest, stag-watching has been the standard technique for detecting Leadbeater's Possum for many years (Smith *et. al.* 1989; Lindenmayer *et. al.* 2003). Although effective it is very labour intensive. Nest boxes have provided the major survey technique for the species in other forest types (Harley 2004b, 2006).

Following the 2009 fires, in an attempt to develop an efficient and cost-effective survey method to facilitate broad-scale surveys, the effectiveness of remote cameras (camera traps) activated by heat and motion at detecting Leadbeater's Possum was investigated (Holland *et. al.* 2012; Harley *et. al.* in press). Cameras were installed on trees at a height of approximately 3 metres facing a bait station which acted as an attractant to draw possums into the camera's field of view. All testing was conducted in territories known to be occupied by Leadbeater's Possum enabling the rate of 'false negative' results to be determined. The technology was highly effective and reliable at detecting Leadbeater's Possum. However difficulties were encountered in identifying a bait that would reliably attract the species. A total of 21 different baits/lures were trialled over eight survey rounds. In the final survey, which used creamed honey presented in an open feeder, a 100% detection rate was achieved for the eight possum territories surveyed (Holland *et. al.* 2012). Visitation frequency to the baits was found to vary between colonies. Camera traps have also produced promising results in sub-alpine woodland and lowland swamp forest (D. Harley, unpubl. data).

The imitation of Leadbeater's Possum calls has previously been used to successfully detect the species in a range of forest types (Lindenmayer *et. al.* 1989; Harley in press), however the technique had not been developed into a systematic survey method. Building on past results, the Arthur Rylah Institute for Environmental Research has recently developed this technique into an efficient method of conducting broad-scale surveys for Leadbeater's Possum (Lumsden *et. al.* 2013). This technique combines call playback to attract any Leadbeater's Possums present on survey sites, with thermal imaging cameras which detect the heat signature of animals. The thermal cameras greatly increase the likelihood of observers locating and identifying any Leadbeater's Possums investigating the broadcast calls, particularly in dense vegetation. Providing that each site is surveyed on multiple occasions in suitable weather conditions (i.e. little wind) this method appears to reliably detect Leadbeater's Possum and provides a viable alternative to stagwatching, particularly for surveys over

a large numbers of sites (Lumsden *et. al.* 2013). However, further testing is required to adequately characterise the species' response patterns to call playback (e.g. the rate of 'false negatives') and the distance over which animals will respond (i.e. area being sampled).

Alternative harvesting techniques

Long-term silviculture trials commenced in 2004 investigating alternative harvesting regimes, conducted by the ANU in partnership with VicForests and DSE. The Variable Retention Harvesting trials have examined the effects of retaining future habitat 'islands' in clearfelled areas for species with mixed-age habitat requirements such as Leadbeater's Possum. Retaining clusters of trees within a coupe should reduce the time for Leadbeater's Possum habitat to develop in clearfelled areas (≥ 200 years) by allowing trees to mature and form hollows along with a younger understorey to provide foraging substrate. The experimental design involves 24 montane ash forest coupes in post-1939 regrowth with one of four treatments: traditional clearfelled, control (unlogged), or with habitat retained in one 1.5 ha island, or three 0.5 ha islands scattered within the coupe. The coupes were surveyed for fauna before and after timber harvesting and after regeneration burning. This approach may allow hollow-bearing trees to be preserved within an 80-year harvest rotation.

Population genetics

The population genetics of Leadbeater's Possum were investigated using genetic material collected from parts of the species' current and historic range. Samples have been collected from all three of the habitat types inhabited by Leadbeater's Possum, although the sampling was heavily biased towards Yellingbo and Lake Mountain (Hansen *et. al.* 2009). High levels of genetic diversity were found in Central Highlands populations, but comparatively low diversity was detected at Yellingbo, which is an isolated, 'bottlenecked' population (Hansen 2008; Hansen *et. al.* 2009). Populations from lower altitudes in montane ash forest were significantly different genetically from populations at higher altitudes (e.g. Lake Mountain), suggesting the influence of anthropogenic fragmentation effects. The level of gene flow within and between populations is likely to be influenced by a combination of social dynamics and habitat integrity (Hansen 2008). Genetic structure obtained from museum specimens collected in montane ash forest during the early decades of European settlement indicated no population differentiation, emphasising the importance of habitat connectivity in maintaining high levels of gene flow.

Leadbeater's Possum Advisory Group

In 2013, the Minister for Environment and Climate Change and the Minister for Agriculture and Food Security established the Leadbeater's Possum Advisory Group to develop recommendations to support the recovery of Leadbeater's Possum while maintaining a sustainable timber industry. The Advisory Group was co-convened by Zoos Victoria and the Victorian Association of Forest Industries, with representatives from Parks Victoria, VicForests and the Leadbeater's Possum Recovery Team. The focus of the group was to recommend actions aimed at managing the near-term risks of decline of the species and medium and longer-term actions focused on ensuring the persistence of the species and its co-existence with a sustainable timber industry. In January 2014, the Advisory Group presented its recommendations to government. In April 2014, the Victorian government committed to fully supporting and implementing all thirteen of the Advisory Group's recommendations and committed \$11 million to support implementing them over the following 5 years. There will be detailed monitoring and review during this five-year intervention to assess progress and inform adaptive management and evaluate the effectiveness of the actions in achieving their intended outcomes. The 13 Advisory Group recommendations along with their supporting and enabling actions have been included in the 'intended management' section of this Action Statement. The corresponding action in the 'Intended Management Section' are marked to indicate which Advisory Group recommendations they refer too (e.g. Advisory Group recommendation 1).

Victorian Environment Assessment Council Yellingbo Investigation

In August 2011, the Minister for Environment and Climate Change requested Victorian Environment Assessment Council (VEAC) to investigate public land in the Yellingbo area, with a focus on conserving and enhancing biodiversity and ecological values. The Final Report was released in July 2013 and recommended an approach that brings together land management and protecting and enactment of natural values. The corresponding actions in the 'Intended Management Section' are marked to indicate which VEAC recommendations they refer too (e.g. VEAC recommendation 1).

Recovery Team

A Recovery Team was formed in the mid-1990s to advise responsible government agencies on the conservation efforts for Leadbeater's Possum, then was reformed in 2006 after several years of inactivity. In 2010 the Recovery Team refocussed on the plight of the species after the 2009 bushfires in the Central Highlands. At present, it comprises representatives of DEPI, Parks Victoria, Zoos Victoria, the Field Naturalists Club of Victoria, the Friends of Leadbeater's Possum and technical experts.

Recovery Plan

The first national recovery plan for the Leadbeater's Possum was approved in 1998 (Macfarlane *et. al.* 1998). A revision of this plan is currently being drafted and is expected to be published in 2015.

Community involvement and awareness

The conservation of Leadbeater's Possum has had considerable and diverse community engagement, both through community awareness programs and through public support and involvement in conservation activities. As a flagship species and one of the two faunal emblems of Victoria, Leadbeater's Possum receives considerable media attention, including popular articles, features on television documentaries and a wealth of scientific publications. Leadbeater's Possum management and conservation is discussed regularly at meetings of the Field Naturalists Club of Victoria, regional friends groups, school groups and events open to the general public.

Friends of Leadbeater's Possum Inc (FLBP) was formed in 2003, and remains active. FLBP is involved in implementing strategies to conserve Leadbeater's Possum such as monitoring and habitat improvement. It also monitors the actions and directions of private and public stakeholders

and agencies regarding Leadbeater's Possum conservation. FLBP engages the community through regular meetings and activities, and the development of education programs for primary and secondary schools, and the public. In 2007, the FLBP conducted a three-day field training program for members covering Leadbeater's Possum habitat identification, nest box placement and monitoring techniques. These skills have enabled FLBP members to more effectively participate in nest box installation and subsequent monitoring, a part of 'Project Possum'. FLBP volunteers also assist the ANU researchers with stag-watching in their research sites each summer. This friends group has also been successful in raising funds to support the 'Project Possum' nest boxes and habitat restoration activities at Yellingbo.

The Field Naturalists Club of Victoria has also contributed significantly to Leadbeater's Possum monitoring and research. Regular stag-watching surveys conducted by the club each year for the past 25 years have provided valuable data on the species' distribution and abundance. Between 2001 and 2008, the Earthwatch Institute provided field volunteers and funding for the ANU long-term monitoring program. Stagwatch monitoring activities in the Central Highlands are often open to the public and receive strong community involvement from conservation groups.

Objectives, actions and targets

To assist the conservation of the Leadbeater's Possum, DEPI will consider the following actions when developing regulation, investment strategies and ecological, fire and land management policies.

The intended management actions listed below are further elaborated for implementation in DEPI's Actions for Biodiversity Conservation (ABC) system. Detailed information about the actions and locations, including priorities, is held in this system and will be provided annually to land managers and other authorities. Where actions are marked as a regulatory commitment (see below) there will be no further elaboration or change. The Responsibilities are listed in alphabetical order.

Long term objective

The long-term conservation objective is to ensure the Leadbeater's Possum can survive, flourish and retain its potential for evolutionary development in the wild.

Objectives of this Action Statement

- I. To secure populations or habitat from potentially incompatible land use or catastrophic loss
- II. To maintain or increase the extent of habitat
- III. To increase knowledge of biology, ecology or management requirements
- IV. To maintain or increase community awareness and support
- V. To review and evaluate the ecological effectiveness of actions for the recovery of the Leadbeater's Possum

Intended management actions

Primary responsibility for implementing the following actions is indicated below. DEPI is responsible for overall co-ordination of the implementation of this Action Statement. The following actions are marked to show if they are a policy commitment (*), regulatory commitment (#) or included in the business planning of the responsible agents (^). Policy commitments are not enforceable obligations. The actions marked as regulatory commitments are measures specified for the purposes of clause 2.2.2 of the *Code of Practice for Timber Production 2007*. All special protection zones reserved for Leadbeater's Possum values added after July 2014 as described in the government response to the Leadbeater's Possum Advisory Group recommendations and implemented through this Action Statement and subsequently through the *Management Standards and Procedures for timber harvesting operations in Victoria's State forests 2014* will be in addition to the current level of biodiversity protection (at 30 June 2014). This will be revised in accordance with actions 1a and 21.

Objective 1	To secure populations or habitat from potentially incompatible land use or catastrophic loss
Explanation	A key objective for the Leadbeater's Possum Action Statement is to secure populations and habitat from potentially incompatible land use or catastrophic loss. The key areas of focus are protect Leadbeater's Possum colonies and habitat, protect and enhance old growth forest, protect habitat from incompatible development activities, transition into retention harvesting and manage fire around known colonies and high quality habitat. This objective also includes research actions that are directly linked to on ground management.
Action 1	Protect Leadbeater's Possum colonies
Action 1a #	Establish a Special Protection Zone (SPZ) to exclude timber harvesting operations from within a 200 metre radius centred on the verified detection site for each colony (Advisory Group recommendation 1) #
Explanation	<p>Bushfires in February 2009 and ongoing habitat decline have led to a reduced population of Leadbeater's Possum. The remaining wild population is therefore critical to the species' recovery. Ensuring the remaining colonies are protected will maximise capacity for the species to recover.</p> <p>All future harvesting activities, including thinning and the construction of new roads, are to be excluded from the timber harvesting exclusion zones around colonies. DEPI will create SPZs around all verified records from the 15 years prior to February 2014 (based on records within the Victorian Biodiversity Atlas), and all new records once the record is verified. Verification will occur to a standard developed by DEPI. All records and special protection zones will be mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library. This information will be made accessible to stakeholders to inform forest management planning, timber planning, compliance, enforcement and auditing, and fire planning and suppression.</p> <p>The effectiveness of this action in supporting the recovery of the Leadbeater's Possum is to be reviewed after two years of surveying (commencing July 2014) or once 200 new colonies are located whose exclusion zones impact the General Management Zone or Special Management Zone, whichever comes first.</p> <p>Responsible agent: DEPI</p>
Action 1b *	Delay harvesting for two years (until June 2016) in areas where the ARI 2013 occupancy model (Lumsden et. al.. 2013) predicts a greater than 0.65 probability of being occupied by Leadbeater's Possum to allow surveys to be undertaken (Advisory Group recommendation 2) *
Explanation	<p>To reduce the risk of harvesting in areas with a high probability of occurrence of Leadbeater's Possum, timber harvesting to be delayed for two years to enable surveys to be undertaken in these areas. The area of predicted high probability of occurrence is to be based on the ARI occupancy model for Leadbeater's Possum (Lumsden et. al.. 2013).</p> <p>Responsible agent: VicForests</p>

Action 1c *	Undertake targeted Leadbeater's Possum surveys focusing on predicted high occupancy areas, as identified by the ARI 2013 occupancy model (Lumsden et. al. 2013) and aligned with VicForests' harvest plan, to identify and map colonies and clusters of colonies within the known range (Advisory Group recommendation 1) *
Explanation	As it is likely that the locations of only a relatively small proportion of all colonies are known, it is important to undertake further surveys to locate additional colonies to be protected. Surveys are to be designed to maximise increasing records while also contributing to improving habitat models and understanding habitat requirements. Responsible agent: DEPI
Action 1d *	Actively seek out Leadbeater's Possum records from groups and institutions that are known to have undertaken survey work (Advisory Group recommendation 1) *
Explanation	It is important that all records of Leadbeater's Possum are consolidated, so records will be actively sought. To facilitate the assessment of records from external organisations, survey standards will be developed to outline the criteria required to verify a Leadbeater's Possum record. Where a report of a Leadbeater's Possum from the community cannot be confirmed, surveys will be undertaken to verify the report. Verification will occur to a standard developed by DEPI. All records will be published in the DEPI Victorian Biodiversity Atlas in a timely manner. Responsible agent: DEPI
Action 2	Protect Leadbeater's Possum habitat
Action 2a ^	Retain the Leadbeater's Possum Reserve ^
Explanation	There is an extensive parks and reserves system within the range of Leadbeater's Possum including a specific Leadbeater's Possum Reserve containing examples of high quality habitat. This reserve will be retained, potentially with some amendments to be made through the Central Highlands forest management zoning review. Where possible these reserves will be linked by wildlife corridors, streamside reserves, buffer strips and areas of State forest not suitable or available for timber harvesting. Responsible agent: DEPI, Parks Victoria
Action 2b # ^	Identify and protect Zone 1A and Zone 1B habitat (Advisory Group recommendation 6) # ^
Explanation	To complement the reserve, the best examples of Leadbeater's Possum habitat outside the reserve system are also protected as follows: Zone 1A # Establish an SPZ over areas of Zone 1A habitat where there are more than 10 live mature or senescent hollow-bearing ash trees per 3 ha in patches greater than 3 ha. In Zone 1A habitat hollow-bearing trees are defined as live mature or senescent trees of Mountain Ash, Alpine Ash or Shining Gum containing hollows. During salvage harvesting after fire Zone 1A habitat is assessed as if all the trees were live. Include this area as special protection zone in the zoning scheme. Zone 1B # Exclude timber harvesting operations from areas of Zone 1B habitat where there are more than 12 hollow-bearing trees per 3 ha in patches greater than 10 ha and wattle density exceeds 5 m ² /ha. In Zone 1B habitat hollow-bearing trees are dead mature or senescent living trees of Mountain Ash, Alpine Ash or Shining Gum containing hollows. This prescription applies until either of the Zone 1B attributes (the presence of dead mature or senescent living trees containing hollows, or wattle understorey) no longer exist. Responsible agent: DEPI, VicForests

Definitions #

'hollow bearing trees'

- In Zone 1A means live mature or senescent trees of Mountain Ash, Alpine Ash or Shining Gum containing hollows
- In Zone 1B means dead mature or senescent living trees of Mountain Ash, Alpine Ash or Shining Gum containing hollows.

'Leadbeater's Possum Management Unit' (LMU) means aggregations of one or more forest management blocks containing contiguous patches of ash-eucalypt forest within the known range of Leadbeater's Possum. These spatial units are used to distribute retained habitat areas across the known range of Leadbeater's Possum.

'mature' is a growth stage of trees. Mature Ash species have the following characteristics, in order of assessment priority. Note that no single characteristic defines maturity on its own, although the first characteristic (apical dominance) holds the most significant assessment weight:

1. Lack of clear apical dominance within the upper crown
2. Presence of permanent shaping branches with diameters at least one third of the bole diameter at their junction with the bole (clear of collar)
3. Shaping branches are not related either to the presence of a long term natural gap in the canopy, or to an open grown tree position. In the case of a natural gap, such branches often occur only on one side of the tree, and the 'assessment weight' given to this characteristic may need to be downgraded (i.e. the need for other indicators increases as part of the overall assessment)
4. The shaping branches contribute significantly to lateral crown shape and may be competing with other shaping branches for tree height position, creating a rounded crown appearance (related to (1) above)
5. Apical dominance will also cease at the shaping branch level (having reached maximum length), and can induce secondary (epicormic) branch development along shaping branches
6. Some branch death (dieback) and breakage is typical, but not a dominant feature. This loss of leaf area (photosynthetic capacity) can also induce secondary (epicormic) growth to replace lost photosynthetic capacity, and
7. Diameters of early mature trees may occur between 90 to 200 cm dbhob (i.e. diameter at breast height over bark), with typical heights of 50 to 100 m. Diameters of full mature trees may be expected between 150 to 300 cm, with typical heights of 60 to 100 m. This overlap of ranges between trees in different stages indicates why diameter and height are not good indicators of growth stage.

'senescent' is a growth stage of trees. Senescing eucalypts are characterised by dead branches and declining crown leaf area, with the trunk of the tree likely to contain burls and bumps. The top of the tree is invariably broken off with the resulting crown being composed of more than 95 % secondary, branches of epicormic origin.

'dead trees' are obviously (physiologically) dead. They are self-supporting (rooted into the ground) and would remain standing should any supporting material be removed. Dead trees must be more than 6 m in height and greater than 1.50 m in diameter at breast height. Dead trees must be Mountain Ash, Alpine Ash or Shining Gum. However, as it is not always possible to determine the species of a tree once it is dead, all dead eucalypt trees where species cannot be determined are assumed to be Mountain Ash, Alpine Ash or Shining Gum.

Zone 2 ^	<p><i>The following paragraphs on Zone 2 and protection of trees containing hollows should be considered as guidance (non-mandatory) in the General Management Zone. ^</i></p> <p>Zone 2</p> <p>Consists of the remaining ash forest-eucalypt forest: regrowth ash forest of varying ages; and areas with features of Zone 1A or Zone 1B but <3 ha or 10 ha respectively.</p> <p>Protection of trees containing hollows</p> <p>Protective measures to aid the continuing survival of nest-trees on logging coupes should be used, including the use of fire retardants and the provision of fire breaks around such trees. Special attention should be given to the protection of currently living nest-trees, regardless of zoning classification. Even if these trees die after subsequent fire or exposure they will still provide potential nesting sites for Leadbeater's Possum during the following rotation. Hollow-bearing trees should not be felled for seed collection.</p> <p>Responsible agent: DEPI, VicForests</p>
Action 2c *	<p>Undertake an inventory to improve the understanding of the extent of Zone 1A habitat, building upon previous assessments. (Advisory Group recommendation 6) *</p>
Explanation	<p>There is currently no spatial layer that maps the extent and distribution of Zone 1A habitat across the range of Leadbeater's Possum, due to the difficulty in remotely mapping mature or senescent hollow-bearing trees. A range of approaches need to be explored to determine which is most effective. The ability to predict where Zone 1A habitat occurs across the landscape in advance of timber harvesting planning would enable areas to be excluded during the planning phase, rather than when coupes are being marked out.</p> <p>Responsibility: DEPI, VicForests</p>
Action 2d ^	<p>Provide training for field staff in identification and protection of habitat. ^</p>
Explanation	<p>Appropriate staff are to be provided with training in the recognition and interpretation of Zone 1 habitat and the application of protection measures.</p> <p>Responsibility: VicForests</p>
Action 3	<p>Protect and enhance old growth ash forest</p>
Action 3a #	<p>Exclude timber harvesting operations from within 100 metres of modelled old growth ash forests (currently depicted in the DEPI spatial layer: MOG2009.shp) within the Leadbeater's Possum range. (Advisory Group recommendation 5) #</p>
Explanation	<p>Old growth ash forests contain the highest densities of hollow-bearing trees (Lindenmayer et. al., 2000). Hollow-bearing trees are an essential habitat component for Leadbeater's Possums. However, past and current disturbances and management practices, such as fire and timber harvesting, have resulted in old growth Mountain Ash forest now comprising less than 3 % of the Mountain Ash forest estate in the Central Highlands (Lindenmayer et. al., 2012). These areas are sparsely distributed as small and highly fragmented patches spread across the landscape. All existing patches of modelled old growth ash forest (currently based on DEPI Modelled Old Growth spatial layer, mog2009.shp) are currently protected from timber harvesting, however, applying a 100 m buffer around these patches should provide additional protection where adjacent to timber harvesting coupes. These areas are to be mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library and replicated in VicForests' information systems. The information will be accessible to all stakeholders.</p> <p>Responsibility: DEPI, VicForests</p>

Action 3b #	Protect from timber harvesting operations at least 30 % of the ash forest in each LMU within the range of Leadbeater's Possum to develop into old growth ash forests (Advisory Group recommendation 7) #
Explanation	<p>The extent of old-growth forest changes over time – stands become 'old-growth' as they reach their oldest growth stage, or as the effects of past disturbance become negligible. Currently less than 3 % of the ash forests in the Central Highlands is considered to be old growth forest, whereas prior to European settlement it is estimated that 30-60 % of the Mountain Ash forests of the Central Highlands were multi-aged or old growth (Lindenmayer et. al.. 2011). The reserve system within the Central Highlands allows for a significant proportion of the current forest to become old growth in the future if not disturbed by bushfire. Leadbeater's Possum Management Units (LMU) will be used as the basis for setting targets for future old growth to ensure a spread across the range of the species. Currently, two of the 21 LMUs have less than 30 % of their ash forests reserved. To reach the target of at least 30 % of the ash area protected within each LMU, an additional 274 hectares of ash forest would be required to be protected within these LMUs (66 hectares in LMU 1 and 208 hectares in LMU 15).</p> <p>DEPI will consider the following factors in the selection of retained areas:</p> <ul style="list-style-type: none"> - are they the least likely to burn during bushfires; - are they the oldest age class, that will develop into old growth the quickest; - whether they consolidate other patches that may develop in old growth. <p>Responsibility: DEPI, VicForests</p>
Action 3c *	Improve understanding of habitat survival to identify landscape features and habitats that are resilient to natural disturbance processes such as bushfires. (Advisory Group recommendation 7) *
Explanation	<p>Models are needed to predict the extent and spatial configuration of suitable habitat for Leadbeater's Possum under various scenarios of landscape-scale disturbance, principally fire and timber harvesting. The models should be based on historic disturbance patterns and likely future patterns, including those influenced by climate change.</p> <p>Responsibility: DEPI, Universities</p>
Action 4 ^ Protect habitat from incompatible development activities. ^	
Explanation	<p>The permitted clearing of native vegetation regulations, including the policy of avoiding, minimising and offsetting vegetation loss, is to continue to be applied to development proposals and other activities that may affect Leadbeater's Possum. Activities include road and track construction or maintenance in or adjacent to habitat, and recreational development in parks. Canopy connectivity is to be maintained across tracks and ski trails at Lake Mountain and on the Baw Baw plateau. The Lake Mountain and Mt Baw Baw Alpine Resort Management Boards will be provided with information to guide their site maintenance and development activities to avoid impacts on Leadbeater's Possum's habitat. Land managers/operational teams for the Baw Baw plateau are to be provided with information to guide their site maintenance/development activities so that they do not impact on Leadbeater's Possum conservation.</p> <p>Responsibility: DEPI, Parks Victoria</p>

Action 5	Transition to retention harvesting
Action 5a *	From July 2014, undertake retention harvesting in at least 50 % of the area of ash harvested within the Leadbeater's Possum range. (Advisory Group recommendation 3) *
Explanation	Retention harvesting aims to reduce the time for Leadbeater's Possum habitat to develop in clearfelled areas (normally ≥ 200 years) by allowing trees to mature and develop hollows along with the younger regrowth to provide foraging substrate. This design allows some hollow-bearing trees to be preserved within an 80-year harvest rotation. VicForests will provide a specific retention harvesting definition relevant to the Central Highlands Ash Forests, as part of implementation they will reconcile their harvest areas and report to DEPI annually. Responsibility: VicForests
Action 5b *	Investigate alternatives to high intensity regeneration burns linked to post-burn retention harvest criteria. (Advisory Group recommendation 4) *
Explanation	High intensity burning has been identified as a threat to retained habitat within and adjacent to areas harvested. However, high intensity burning is the most effective, safe and cost effective method of regenerating ash harvesting coupes. The move to retention harvesting may require alternative methods of regeneration. Investigations into how the risks to retained habitat may be managed while maintaining effective regeneration post-harvest are required. This investigation may include consideration of the objectives of post-logging regeneration which currently focuses heavily on eucalypt species regeneration. Alternative methods may produce reduced eucalypt regeneration but provide an improved ecological outcome. This may require amendments to the regulatory requirements after completion of the research. Responsibility: DEPI, VicForests
Action 6	Fire management of known colonies and high quality habitat
Action 6a *	Identify known colonies and high quality habitat as critical assets on the Natural Values database (part of DEPI's fire system) to inform fire operations and risk landscapes planning. (Advisory Group recommendation 8) *
Explanation	All recorded Leadbeater's Possum colonies and their associated timber exclusion zones and high-quality habitat, whether formally reserved or not, need to be mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library. This information will be made accessible to DEPI's fire operations and planning divisions to assist with fire operations planning, suppression and management. High quality habitat will be identified using a range of approaches, including, but not limited to occupancy and species habitat models; areas of Zone 1 habitat; the Leadbeater's Possum reserve system; areas known to contain comparatively large numbers or high densities of colonies; areas that were unburnt in the 2009 bushfires but are surrounded by burnt forest that may be acting as fire refuges; areas that were old growth ash forest prior to the 2009 bushfires; and long-term monitoring sites. Responsibility: DEPI, Parks Victoria
Action 6b *	Investigate and implement, where possible and appropriate, active fire management activities to protect identified colonies and high-quality habitat from bushfire, taking into consideration other threatened species requirements. (Advisory Group recommendation 8) *
Explanation	Intensive, widespread bushfires are the biggest threat to the ongoing persistence of Leadbeater's Possum. The aim of this action is to increase the protection of Leadbeater's Possum colonies and habitat through intensified fire planning and management, including suppression activities and fuel management in adjacent drier forest types, taking into consideration other threatened species' requirements. Areas of high quality habitat as identified in the previous action will be excluded from planned burns. Responsibility: DEPI, Parks Victoria

Action 6c *	Develop approved fire recovery protocols that can be enacted without delay following fire or other disturbance events that affect known colonies. (Advisory Group recommendation 8) *
Explanation	<p>Developing fire recovery protocols prior to the next large fire should assist in decision-making and timely emergency management responses. Fire recovery protocols will assist incident management teams in how to protect or extract important or at risk colonies during an emergency event. Such extractions may remove animals from harm's way. The protocols would include planning, resources, logistics, deployment of field teams and recipient site considerations and address issues such as under what conditions are animals to be brought into captivity, or provided with supplementary feeding or nesting sites.</p> <p>Responsibility: DEPI, Parks Victoria, Zoos Victoria</p>
Action 6d ^	Investigate the impact of strategic fuel breaks/habitat fragmentation on Leadbeater's Possum^
Explanation	<p>A research program to evaluate the impacts of strategic fuelbreaks on Leadbeater's Possum and the effectiveness of mitigation measures should be continued.</p> <p>Responsibility: DEPI, Universities</p>
Action 6e ^	Finalise the fire management plan for the area of the current Yellingbo Nature Conservation Reserve (Recommendation 1A - Government response to VEAC Yellingbo Investigation Final Report) ^
Explanation	<p>The fire management plan is to be finalised as soon as possible. In addition, DEPI is developing a Strategic Bushfire Management Plan for the East Central Bushfire Risk Landscape in collaboration with public and private land managers, community and interested stakeholders. The strategic planning process has identified Yellingbo Conservation Reserve as an important environmental asset in this landscape.</p> <p>Responsibility: DEPI, Parks Victoria</p>

Objective II To maintain or increase the extent of habitat	
Explanation	A key objective of the Leadbeater's Possum Action Statement is to maintain and increase the extent of habitat. This is in addition to the actions under Objective I. The key areas of focus here are in providing artificial nest boxes to support existing populations, investigating how to accelerate hollow development improving habitat and increasing the extent of habitat at Yellingbo Nature Conservation Reserve. The following objective also includes research actions that are directly linked to on ground management.
Action 7 * Provide artificial nest boxes in a targeted manner at key locations to support existing populations. (Advisory Group recommendation 9) *	
Explanation	<p>In many areas, den sites are a limiting resource for Leadbeater's Possum populations. While the maintenance of hollow-bearing trees should always be considered the highest priority when considering den site availability, in certain circumstances, the decline in den sites can be ameliorated to some extent through the targeted provision of artificial nest boxes. The situations in which nest boxes have proved most successful are where the vegetation structure allows boxes to be placed at the height that animals typically move through the vegetation. These include sites characterised by tea-tree in the midstory such as at Yellingbo where all the remaining colonies use nest boxes, and in Snow Gum woodlands such as at Lake Mountain and Mt Bullright, where nest boxes have been used extensively. Existing nest boxes at Yellingbo, in sub-alpine woodland and selected montane ash forest sites are to be maintained and monitored. In addition, new boxes are to be installed to investigate the extent of other populations occurring in sub-alpine woodland and ash forest, including the Baw Baw plateau and Mt Matlock. The projects in the Central Highlands are to be delivered through the Project Possum program, which is a partnership between Parks Victoria, Zoos Victoria and the Friends of the Leadbeater's Possum. Volunteers are to be involved in the monitoring of the boxes. Project Possum sites are predominantly in national parks, catchment areas and other reserve areas. The success of the program will be evaluated after five years.</p> <p>Responsibility: DEPI, Parks Victoria, Zoos Victoria</p>
Action 8 * Investigate approaches to accelerate hollow development (Advisory Group recommendation 10) *	
Explanation	<p>It is predicted that there will be a severe shortage of hollow-bearing trees suitable as nesting sites for Leadbeater's Possum over the next 50-70 years. This is due in part to the loss of dead stags from within 1939 regrowth forests before the live trees in this age class commence producing hollows. While the highest priority is to protect existing hollow-bearing trees, this may not be enough to ensure sufficient hollows are available through the bottleneck period and so approaches for accelerating the development of hollows are to be explored. If successful techniques can be developed there is potential to transform areas that are currently unsuitable as habitat for Leadbeater's Possum. However, it is currently unknown which techniques may be the most successful and cost-effective for creating the type of hollows needed by Leadbeater's Possum. There are two broad approaches that could be taken. One is to use silvicultural or other forest management processes, such as ecological thinning practices that promote hollow development in younger forest through enabling trees to grow larger more quickly, or modified harvesting practices that promote damage to retained trees. Alternatively, accelerated hollow development could be undertaken through mechanical or other processes, such as drilling or cutting a hollow into a tree, manipulating/pruning tree branches, or introducing fungus to accelerate hollow development. Both approaches will be investigated.</p> <p>Responsibility: DEPI, Universities, VicForests</p>

Action 9 ^ Undertake habitat management/restoration at Yellingbo ^	
Explanation	<p>Habitat management/restoration is urgently needed to address the lack of eucalypt regeneration in the floodplain at Yellingbo. Challenges to achieving this include the current lack of understanding of lowland swamp forest ecology, seasonal floodplain inundation, weed invasion and browsing by native and introduced herbivores. Habitat restoration is necessary to increase the amount of structurally dense forest, providing additional foraging habitat and connectivity. Until an appropriate disturbance mechanism is developed that can be applied over large areas, active possum territories should be revegetated with canopy and middle-storey species such as Mountain Swamp Gum, paperbark and tea-tree. The long-term target is to provide approximately 80 hectares of suitable foraging habitat for Leadbeater's Possum in the reserve. Effective habitat management at Yellingbo requires the following: 1. Hydrological restoration in the floodplains of the Cockatoo and Macclesfield Creeks (currently being investigated by Melbourne Water), 2. Development and application of a disturbance regime in the floodplain to promote the regeneration of dense stands of Mountain Swamp Gum, 3. Application of a disturbance regime to promote regeneration of canopy and midstorey species on the terraces immediately adjacent to the floodplain. Until appropriate disturbance mechanisms are developed to promote regeneration over large areas, revegetation should be undertaken in priority sites at Yellingbo, e.g. active possum territories.</p> <p>Responsibility: Melbourne Water, Parks Victoria, Zoos Victoria</p>
Action 10 * Establish the Yellingbo Conservation Area and coordinating committee (VEAC recommendation R5) *	
Explanation	<p>Yellingbo Nature Conservation Area be designated to include a 2940 hectare area and be managed in an integrated way to achieve the long-term security of biodiversity and other natural values, including the survival of the lowland Leadbeater's Possum.</p> <p>Responsibility: DEPI, Parks Victoria (for Secretariat of the Committee)</p>
Action 11 * Management of the Coranderrk Nature Conservation Reserve (VEAC recommendation A2) *	
Explanation	<p>The Coranderrk Nature Conservation Reserve, located north of the Yellingbo Conservation Area, has the potential to play an important part of the broader public land network for lowland Leadbeater's Possum in the future. This site could be used as an extension for the captive insurance program at Healesville Sanctuary, with a view to establish a free ranging insurance population and harvest the offspring to establish or supplement other wild lowland Leadbeater's Possum populations.</p> <p>The VEAC Yellingbo Investigation has recommended that this reserve be used in accordance with the general recommendations for nature conservation reserves, except that</p> <p>(a) public access and recreation including bushwalking, nature observation, heritage appreciation and picnicking may continue to be limited at the discretion of the land manager and</p> <p>(b) this area is managed in an integrated way to achieve the long-term security of biodiversity and other natural values and directions set by the Yellingbo Conservation Area Coordinating Committee.</p> <p>Responsibility: Zoos Victoria</p>
Action 12 * Management of the Haining Education area (VEAC recommendation E1) *	
Explanation	<p>The Haining Education area could be restored to provide important habitat for the lowland Leadbeater's Possum. The VEAC Yellingbo Investigation recommended that this area be used in accordance with the general recommendations for community use areas and the current use of the area be changed to provide for other forms of land management and educational opportunities with a greater emphasis on sustainability, including improved protection of riparian areas and restoration of habitat for the lowland Leadbeater's Possum. The Haining Education area could be an important location for future translocations of lowland Leadbeater's Possum.</p> <p>Responsibility: Parks Victoria, Zoos Victoria</p>

Objective III	To increase knowledge of biology, ecology or management requirements
Explanation	<p>A key objective of the Leadbeater's Possum Action Statement is to increase the knowledge of biology, ecology and management requirements of the Leadbeater's Possum. The key areas of focus are to examine the feasibility of translocations Leadbeater's Possums, investigate key ecological requirements, undertake population monitoring and investigate critical habitat characteristics.</p> <p>In addition to the research actions listed above linked directly to on-ground management, the following research actions will be undertaken to improve knowledge of the ecology of the species to inform management.</p>
Action 13	Examine the feasibility of translocating Leadbeater's Possums from wild to wild. (Advisory Group Recommendation 11)
Action 13a *	Examine the feasibility in Central Highlands*
Explanation	<p>There are likely to be areas that will be suitable in the future, but are currently unoccupied, Leadbeater's Possum habitat within the Central Highlands, especially in areas that were burnt severely in the 2009 bushfires. Where hollow-bearing trees are available and once the vegetation has recovered sufficiently to provide foraging habitat, this could potentially be ideal habitat but may take some time to be recolonised if there are not surviving colonies close enough for animals to naturally disperse into the area. Due to the distances required for dispersal and the low dispersal rates, it may take many years or decades for the species to naturally recolonise these areas. This is where translocation could be effective. However, there are many unknowns regarding the efficacy of translocation in this situation. This action will involve investigating the desirability and feasibility of translocating Leadbeater's Possums to establish new colonies in suitable but unoccupied habitat. Subsequent translocation, and monitoring the success of any re-establishments, could then be undertaken subject to the results of the feasibility study.</p> <p>Responsibility: DEPI, Parks Victoria, Zoos Victoria</p>
Action 13b ^	Examine the feasibility in Lowlands^
Explanation	<p>The desirability and the feasibility of undertaking translocation of lowland Leadbeater's Possum from wild to wild and from captivity to the wild is also to be investigated for Yellingbo Nature Conservation Reserve and surrounding areas. Protocols will be developed to guide decision making regarding translocation of colonies into unoccupied habitat. Potential localities to conduct assisted colonisation trials will be identified. Trial translocation guidelines for Leadbeater's Possum will be developed in alignment with DEPI's Procedure statement for translocation of threatened native fauna in Victoria</p> <p>Responsibility: DEPI, Parks Victoria, Zoos Victoria</p>
Action 14	Investigate dispersal and recolonisation capabilities of Leadbeater's Possum. ^
Explanation	<p>While extensive dispersal data have been collected at Yellingbo, currently there is limited knowledge of Leadbeater's Possum dispersal characteristics in montane ash forest. The latter needs to be investigated to improve our understanding of gene flow and population fragmentation at a landscape-scale, and determine the ability of the species to recolonise habitat disturbed by timber production or fire. Molecular techniques will be used to estimate rates of dispersal/gene-flow in local areas.</p> <p>Responsibility: DEPI, Universities</p>

Action 15 ^ Undertake population monitoring at key locations and collect demographic information. ^	
Explanation	<p>Monitoring of population dynamics is important for implementing effective site-specific and general management strategies, especially detecting response to conservation measures and disturbance. The long-term, broad-scale population and habitat monitoring being conducted by ANU is to continue across the Central Highlands. It is investigating the habitat requirements and population viability of Leadbeater's Possum, populations of large old trees, forest dynamics, fire dynamics, and impacts of timber harvesting and restoration ecology.</p> <p>Detailed long-term population monitoring is to continue at Yellingbo via the annual nest box monitoring program. Key areas investigated should include long-term site occupancy, colony sizes, reproductive rates, dispersal and recruitment. Continue to expand the captive 'insurance' and breeding program for lowland Leadbeater's Possum founded from Yellingbo animals in order to establish more lowland populations.</p> <p>Nest boxes are to be monitored in sub-alpine woodland at Lake Mountain and Mt Bullfight to examine the recolonisation rate by Leadbeater's Possums at sites that were severely burnt in 2009.</p> <p>Responsibility: DEPI, Parks Victoria, Universities, Zoos Victoria</p>
Action 16 ^ Investigate stag-fall rates in Leadbeater's Possum habitat. ^	
Explanation	<p>Monitoring stag-fall rates should continue on all long-term monitoring sites, and is a particularly high priority since the 2009 wildfire. Comparisons of pre/post-fire stag-fall trends should be undertaken.</p> <p>Responsibility: DEPI, Universities</p>
Action 17 ^ Determine habitat critical to survival of populations in sub-alpine woodland ^	
Explanation	<p>Leadbeater's Possum populations inhabit sub-alpine woodland dominated by Snow Gum at several localities. This action involves identifying and mapping suitable habitat at these locations. It should include an assessment of den characteristics and availability and other important habitat attributes.</p> <p>Responsibility: DEPI, Parks Victoria, Zoos Victoria</p>
Action 18 ^ Determine structure of Leadbeater's Possum populations. ^	
Explanation	<p>Priorities for further genetic sampling in montane ash forest throughout Leadbeater's Possum's range are to be identified. Genetic differentiation among Leadbeater's Possum populations in montane ash forest to be assessed to enhance understanding of the extent of population and habitat fragmentation.</p> <p>Responsibility: DEPI, Universities, Zoos Victoria</p>
Action 19 ^ Investigate den tree characteristics in lowland swamp forest. ^	
Explanation	<p>Data collected on den trees used by Leadbeater's Possum at Yellingbo should be analysed and used for conservation management of the species.</p> <p>Responsibility: Parks Victoria, Zoos Victoria</p>

Objective IV	To maintain or increase community awareness and support
Explanation	To create a significant increase in community awareness of Leadbeater's Possum, which should lead to an increase in community participation in community organised activities.
Action 20 *	Community engagement. (Advisory Group recommendation 12) *
Explanation	Implement ongoing community engagement, including with environment and industry groups. Involve community stakeholders in monitoring activities. Continue to implement and enhance education programs to improve understanding of Leadbeater's Possums and their management. Responsibility: DEPI, Parks Victoria

Objective V	To review and evaluate the ecological effectiveness of actions for the recovery of the Leadbeater's Possum
Explanation	Assess the extent to which these actions have supported the recovery of Leadbeater's Possum and assess if further interventions are required.
Action 21	Evaluate the effectiveness of actions to support the recovery of Leadbeater's Possum.*
Explanation	On-going monitoring and review will feed into an adaptive management process to continue to improve the management of Leadbeater's Possum. It will also help ensure that the community has timely information on progress achieved in implementation, which will assist in meeting their expectations for increased transparency and maintain support for recovery actions. There will be a full review of the Action Statement in 2017 to assess the extent to which these actions have supported the recovery of Leadbeater's Possum and to assess if further interventions are required, including quantitative measures of successful population recovery. For example after further investigation into the current distribution and habitat relationships, and the assessment of the availability of Zone 1A, review the adequacy of this retained habitat system for identifying areas of good quality habitat. Responsibility:DEPI, Parks Victoria, Zoos Victoria, VicForests, Recovery Team

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