



Australian Government

Department of the Environment

Review of the Recovery Plan for the Leadbeater's Possum (MacFarlane, Smith and Lowe, 1997) – February 2016

INTRODUCTION

Leadbeater's possum is a small, nocturnal, arboreal possum which is endemic to Victoria. The core location of the species is an area of approximately 70 x 80 km in the Victorian Central Highlands at altitudes between 400-1,200 m above sea level (Lindenmayer et al., 1989) where it is patchily distributed (Macfarlane et al., 1997) and occupies montane ash forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum. Genetic work indicates that Leadbeater's Possum consists of two genetically-distinct subpopulations that have historically occupied different habitats (Hansen, 2008). An outlier 'lowland population' located near Yellingbo (Smales, 1994) and a core highland/midland population which is located in the Central Highlands of Victoria (Lindenmayer et al., 1989). The current status of taxon is:

- *Environment Protection and Biodiversity Conservation Act 1999*: **Uplisted to Critically Endangered - 2015**
- *Advisory List of Threatened Vertebrate Fauna in Victoria*: **Endangered – 2013**
- *Flora and Fauna Guarantee Act 1988 (Victoria)*: **Threatened**
- *IUCN Red List of Threatened Species*: **Endangered**

The ongoing reduction in the extent, quality and connectivity of suitable habitat has occurred and continues to occur through a range of drivers:

- impacts of severe fire and changes in fire regime;
- timber harvesting; and
- eucalypt dieback and altered hydrology (for lowland subpopulation)

The original Victorian 'Leadbeater's Possum (*Gymnobelideus leadbeateri*) Recovery Plan was written by MacFarlane, Smith and Lowe in 1997. This recovery plan was adopted as a national plan under the *Endangered Species Protection Act 1992* in November 1997. Its objective was to downlist Leadbeater's Possum from endangered to vulnerable within ten years based on the IUCN criteria of population trend and size, extent of occurrence, probability of extinction, and the management of habitat towards a target of no more than a one per cent probability of extinction over 250 years throughout the forest within its current range.

In 1998, the Central Highlands Regional Forest Agreement (RFA) was established between the Victorian and Commonwealth Governments to create a framework for forest management in the Central Highlands (DAFF 1998). The Central Highlands Forest Management Plan was also prepared in 1998 and aligned closely with the RFA. Most of the Leadbeater's Possum habitat is within the Central Highlands RFA boundary.

In 1997 the Leadbeater's Possum Management Team (Recovery Team) included representation from academia, the community, Australian Nature Conservation Agency (ANCA) and staff from the relevant Victorian Government areas. Its role was to report on actions being implemented and to provide a forum for discussing problems and recommending modifications to the Plan. The LBP Management Team was to provide an annual written report to the Leadbeater's Possum Steering Committee, which would include an evaluation of progress towards achieving objectives of this original Recovery Plan.

EXECUTIVE SUMMARY

1.0: PROGRESS OF RECOVERY ACTIONS

The majority of the recovery actions have been implemented over the life of the plan and a range of measures have been introduced to protect designated Leadbeater's possum habitat through a formal reserve system, retaining habitat within State forest using a zoning system and prescriptions, habitat resource assessment and early mapping of key habitat requirements has been undertaken. Additional management actions have been implemented recently through the Leadbeater's Possum Advisory Group recommendations.

Extensive population monitoring of the Leadbeater's Possum has been undertaken but this has not been conducted for all the sub-populations over the known range, and the focus has been on population trends rather than absolute numbers, except for at Yellingbo and in some snow gum woodlands.

There has been a very substantial investment over several decades in research and management actions, and notable conservation policy initiatives. Notwithstanding such effort, the current and projected trends for the species and its habitat is one of continuing decline. Existing management and protective mechanisms have been insufficient to stop the decline and support the recovery of the species.

2.0: EVALUATION AGAINST OBJECTIVES

While the recovery plan identified the need for protection of habitat, and protection has been implemented largely in line with the actions outlined in the Recovery Plan, decline has continued and threats have not been abated. In addition, severe bushfires in large parts of the Central Highlands in 2009 have substantially reduced the overall population and the available habitat for Leadbeater's Possum.

3.0: CHANGES IN KNOWLEDGE AND CONSERVATION TRAJECTORY

In its recent assessment of the conservation status of this species, the Australian Government Threatened Species Scientific Committee judged that the population of the species (explicitly based on information on its area of occupancy, extent of occurrence and/or quality of habitat) had declined by more than 80% over its last three generations (18 years) and, further, that it was projected to decline by more than 80% over its next three generations: collectively, an estimated population decline of more than 96% over a 36 year period. Ongoing action is required to facilitate the longer term viability of this species.

4.0: RECOMMENDATIONS

An updated recovery plan is required, providing for the research and management actions necessary to stop the decline of, and support the recovery of Leadbeater's Possum.




Review methods: The Department of the Environment and the Victorian Department of Environment, Land, Water and Planning have collaborated on undertaking this review.



Date: February 2016

1.0: PROGRESS OF RECOVERY ACTIONS

1.1: Progress in implementing actions

Status progress

 No/little progress
  Some progress
  Action completed

Actions	Action description from 1997 Recovery Plan	Implementation details	
		Activities/achievements/outcomes in meeting Action	Status
1 The Leadbeater's Possum Management Team (LMT) to continue to monitor and review recovery program and recommend further management actions. (Re objective 1)	The Leadbeater's Possum Management Team (LMT) includes representation from academia, the community, Australian Nature Conservation Agency (ANCA) and staff from the relevant NRE areas and policy divisions. It reports on actions being implemented and provides a forum for discussing problems and recommending modification. The LMT provides an annual written report to the Leadbeater's Possum Steering Committee (LPSC), which will include an evaluation of progress towards achieving objectives of this Recovery Plan.	<p>A collaborative management approach was established to implement the Recovery Plan through the Leadbeater's Possum Management Team which incorporated the biodiversity and forestry sections within the state government department. Regular reports were provided on the progress of actions (especially the establishment of the Leadbeater's Possum reserve and Zone 1 habitat).</p> <p>The Management Team (which was later called the Recovery Team) was operational most of the time up to 2014, with a few periods of inactivity. With the establishment in 2013 of Leadbeater's Possum Advisory Group (LPAG) and the implementation of their recommendations which applied to the Central Highland population, the Recovery Team largely focussed on the Yellingbo population. LPAG recommendations to support the recovery of the Leadbeater's Possum while maintaining a sustainable timber industry were accepted by the Victorian Government and implementation commenced in early 2014. Implementation of the recommendations is overseen by a cross agency implementation committee. There was no information made publicly available on the monitoring and reviewing of actions by the early Management Team. There have been two reports on the progress in implementing the LPAG recommendations published in October 2014 and 2015.</p>	
2 Apply conservation strategies in each of the 21 Leadbeater's Possum Management Units (LMUs) (Re objective 1)	For the management of Leadbeater's Possum public forests within the Central Highlands have been divided into geographic units based on the extent and spatial distribution of ash-type forest. These are referred to as Leadbeater's Possum Management Units (LMUs). Each LMU generally contains between 6,000 and 10,000 ha of ash-type forest; the LMUs are composed of one or more forest management blocks containing contiguous patches of ash-type forest. Twenty-one LMUs have been delineated, covering the known distribution of Leadbeater's	<p>The 21 LMUs had been established by the time the Recovery Plan was released and these have been subsequently used to assist with management decisions, especially for designing the Leadbeater's Possum reserve - see Action 5.</p> <p>More recently the LMUs have been used for one of the LPAG recommendations to protect at least 30 percent of ash forest within each LMU which is a new standard introduced with the release of the <i>Code of Practice for Timber Production 2014</i>.</p>	

	Possum in the Central Highlands. The target for the conservation of Leadbeater's Possum is to maintain viable populations of the species in all LMUs.		
3 Complete habitat resource assessment across known range of the species. (Re objective 1)	Habitat resource assessment is being undertaken to determine the extent and distribution of current optimum and potentially optimum habitat for Leadbeater's Possum (as defined in this document). The methodology uses aerial photo interpretation to map a vegetation mosaic of the dominant canopy species and age-class or growth-form and the location of individual old ash trees (where they occur outside patches of old ash-type forest) and emergent stags. The habitat resource assessment is complete for 75% of the ash forest throughout the range of Leadbeater's Possum. In addition, proposed logging coupes as set out in 3 year wood utilisation plans are checked by either helicopter survey or ground survey, or both for areas of Zone 1B habitat that cannot be identified by air photo interpretation.	<p>Air photo interpretation (API) to assess habitat resources was undertaken during the 1990s based on the mapping of emergent mature or senescent trees and dead stags. This mapping and a simple model was subsequently used to identify areas that met Zone 1 habitat criteria. These patches were then incorporated into SPZs enacted through the Central Highlands Forest Management Plan in 1998. Patches containing large old trees that did not meet the criteria for Zone 1A habitat remained within the General Management Zone and managed through prescriptions (Action 4).</p> <p>There has been a severe decline in the abundance of large old trees since this time due to bushfires and collapse of stags remaining from the 1939 fires, and a loss of live hollow-bearing trees (Lindenmayer et al. 2012). As a result the earlier API mapping is no longer representative of the current situation and checking for Zone 1 habitat has been undertaken using ground assessments on proposed timber harvesting coupes, and there is currently not a map showing where all the large old trees are across the whole of the Central Highlands.</p> <p>As part of the LPAG recommendations, methods to identify potential Zone 1A habitat at a landscape level using information derived from existing aerial photography and remote sensing technology have been explored. This has been developed further in 2015 with an aerial survey commissioned to collect new data using remote sensing technology, including LiDAR to better enable identification of mature and senescent trees, which can then be used to identify Zone 1A habitat.</p> <p>Habitat distribution models and occupancy models for the Leadbeater's Possum have been developed by ARI (DELWP) to predict the areas most likely to be occupied by Leadbeater's possum. These models will be updated based on new data on the distribution of the species and will incorporate the spatial mapping of mature and senescent trees as well as understorey density.</p>	●
4 Zone all areas of forest within known	The management zoning system for Leadbeater's Possum in State forest has been revised to reflect the relative long-term stability of	This action was implemented at the time of the recovery plan and enacted through the Central Highlands Forest Management Plan in 1998. The review of the	●


<p>range of Leadbeater's Possum according to habitat suitability. (Re objective 1)</p>	<p>some good habitat with live old trees (Zone 1A) and the impermanence of habitat where most existing nest-trees are dead and likely to collapse in the near future (Zone 1B).</p> <p>Zone 1A: Leadbeater's Possum (and other wildlife) conservation as the major priority.</p> <ul style="list-style-type: none"> • mature ash forest (> 120 years old) and mixed-aged ash forest where the oldest age class is mature (> 120 years old) • regrowth ash forests with > 12 live hollow-bearing trees per 3 ha. • the minimum area for assessment and establishment of Zone 1A type forest shall be 3 hectares. <p>Zone 1B: Leadbeater's Possum conservation and timber production as joint priorities.</p> <ul style="list-style-type: none"> • regrowth ash forest with > 12 live or dead hollow-bearing trees per 3 ha. combined with a basal area > 5m² of <i>Acacia dealbata</i>, <i>A. obliquinervia</i> or <i>A. frigescens</i>. • the minimum area for assessment and establishment of Zone 1B type forest shall be 10 hectares. <p>Zones 1A and 1B, regardless of minimum size criteria, have the highest priority in the reserve selection process detailed in Action 5. Areas of Zone 1B, identified and mapped as priority for inclusion in the reserve system, will be protected from timber harvesting. If these areas become unsuitable or offer little potential as habitat for Leadbeater's Possum through successional or other change, (which is likely for Zone 1B during the next 50 years), they will become available for timber harvesting. Conversely, areas that develop the essential components for Zone 1 classification through time, or circumstance will attain Zone 1 status. Zone 1A forest will not be included in sustainable yield calculations whilst Zone 1B will be included. The role of Zone 1B, including the minimum area of assessment, will be reviewed following completed habitat resource assessment, reserve establishment and subsequent population viability analysis (PVA), to determine its effectiveness in contributing to the major conservation objectives.</p>	<p>effectiveness of Zone 1B in contributing to the major conservation objectives including the minimum area requirements, however, was not undertaken. No specific action in relation to Leadbeater's Possum was applied to Zone 2 habitat.</p> <p>Amendment of the definition of Zone 1A habitat to >10 live mature or senescent hollow bearing ash trees per three hectares in patches greater than three hectares was recommended by LPAG in 2014. The revised definition which reduced the requirement from 12 to 10 trees was implemented with the release of the <i>Code of Practice for Timber Production 2014</i>.</p> <p>The definitions of Zone 1A and 1B have varied subtly between the various documents in which they are defined (i.e. Recovery Plan, Action Statement, Forest Management Plan), and have been further interpreted in the Leadbeater's Possum survey standard released in April 2015 (available on DELWP website), which introduced additional definitions and requirements for trees and areas to meet the criteria for Zone 1A and 1B habitat.</p>	
--	--	---	--

	<p>Zone 2: Timber production as the major priority, but including the conservation of existing components of habitat.</p> <p>This zone will consist of remaining forest, where the prescriptions outlined in Action 7 will be applied to protect existing habitat components for their on-site value and to enhance the value of adjacent habitat.</p> <p>GIS based analysis will continue to be used to identify the Leadbeater's Possum management zones, generate maps, examine management options and assess impact on other forest values and uses.</p>		
<p>5 Establish a reserve system across the range of the species based on habitat suitability. (Re objective 2)</p>	<p>NRE will establish a permanent reserve system in each LMU based on the extent and spatial distribution of Zone 1 classified forest, combined with strategic areas of regrowth forest (Zone 2). The intention of the permanent reserve will be to identify, and maintain in the long-term, sufficient areas in the forest that will sustain viable populations of Leadbeater's Possum. The permanent reserve will exist in two forms; large, aggregated patches of ash-type eucalypt forest (>50 ha) and smaller (3-50 ha) patches of Zone 1A habitat that are dispersed throughout the forest.</p> <p>Large patches will be 50 to 100 hectares in size to minimise the impact of threatening processes and be linked by wildlife corridors, streamside reserves, buffer strips and areas of State forest not suitable or available for timber harvesting. The total area of large patches in each LMU will be a target of at least 600 hectares of ash forest, but will vary depending on the extent and spatial distribution of potential and existing habitat, both within and adjacent to each LMU.</p> <p>The reserve system will be implemented through the Central Highlands Forest Management Plan and reflected in the Regional Forest Agreement.</p>	<p>The Leadbeater's Possum reserve system was established in the Central Highlands to protect priority areas of Leadbeater's Possum habitat. When this reserve was established in 2008, it comprised 30,500 ha of high-quality Leadbeater's Possum habitat, distributed throughout the species' range from Toolangi in the north-west to Erica in the south-east. A total of 127 patches, greater than 50 ha in size, and containing predominantly old growth ash forest were selected (Smith and Morey 2001). Areas of old growth were primarily selected as 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 bushfire. Areas to be included in the reserve system were assessed tenure blind. The majority of the reserves (85%) were located in areas that were 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 excluded timber harvesting.</p> <p>The Recovery Plan recommended linking these patches with wildlife corridors, streamside reserves etc, however, this was not universally implemented.</p> <p>In 2009, 45% of the Leadbeater's Possum reserve was burnt during the bushfires, and hence these areas no longer contain live old growth forests, however as the area regenerates they will provide suitable habitat based on the dead standing hollow-bearing trees and dense regeneration. They are therefore still important</p>	

		<p>areas for the species.</p> <p>Within the Central Highlands there are over 200,000 hectares of potential habitat for Leadbeater's Possum, with 34% of this reserved within national parks and conservation reserves and a further 14% is protected within SPZs, i.e. 48% of the species range is formally reserved (LPAG 2014b). Additional areas have recently been protected as part of implementing the LPAG recommendations through the release of the <i>Code of Practice for Timber Production 2014</i> as follows:</p> <ul style="list-style-type: none"> • Establishment of Special Protection Zones in State forests for 200 metre radius centred on each verified Leadbeater's Possum colony found since 1998 excluding forest areas severely impacted by the 2009 bushfire; • Exclusion of timber harvesting in State forest from within 100 meters of modelled old growth ash forest in the Leadbeater's Possum range. 	
6 Implement population monitoring throughout known range (Re objective 3)	Implement monitoring of Leadbeater's Possum populations throughout its range, using rigorous experimental design to assess its conservation status and to assess the effectiveness of the reserve system for Leadbeater's Possum conservation.	<p>Largely complete as there has been extensively monitoring throughout the species range, and this has provided critical information on population trends in various areas and conservation status.</p> <p>Long-term monitoring of 161 one-hectare sites within the ash forests has been undertaken since 1997 that includes count data of arboreal marsupials including Leadbeater's possum (Lindenmayer 2009). Monitoring of populations in snow gum woodland at Lake Mountain, Mt Bullfight and Mt Baw Baw, some of which commenced in 2003, is also ongoing (Harley 2016). Detailed annual population monitoring of the lowland population at Yellingbo has been underway since the mid-1990s, assessing total population size and colony persistence through time (Harley 2016).</p> <p>A recent Population Viability Assessment has assessed the effectiveness of the reserve system for Leadbeater's possum, post the 2009 fires (Lumsden et al. 2013), building on earlier PVAs.</p>	●
7 Apply guidelines during logging coupe planning and harvesting and adopt modified or alternative silvicultural	Assessment: Assessment of proposed logging coupes and roading to validate zoning classification will continue to be undertaken using resource information held on GIS and elsewhere in NRE, aerial photographs, helicopter reconnaissance and ground inspection.	The <i>Code of Practice for Timber Production 2014</i> contains regulatory standards for timber harvesting for the Leadbeater's Possum and its habitat in line with government policy. This policy is outlined in the Leadbeater's Possum Action Statement, last revised in 2014. The Leadbeater's Possum Survey Standard was last revised in 2015. These documents are current.	●

<p>systems (Re objective 4)</p>	<p>Buffer Strips: Consideration will be given to retaining buffer strips of unlogged forest to avoid creating large areas of continuously logged forest (e.g. > 40 ha coupe conglomerates). These will be most applicable where streamside or other reserves do not form coupe boundaries. These buffer strips will be allowed to grow to ecological maturity (at least 250 years old) and thereby provide hollow trees for Leadbeater's Possum and other hollow-dependent wildlife. Where possible logging operations should be staggered so that a retained buffer strip is not simultaneously exposed on both sides.</p> <p>Coupe Shape: The practice of logging variably sized and shaped coupes, interspersed with areas of undisturbed forest, ensures a scattering of different age classes and hence habitat niches throughout the forest.</p> <p>Protection of Hollow Trees: Protective measures to aid the continued survival of nest-trees on logging coupes will be used, including the use of fire retardants and the bulldozing of fire breaks around such trees. Special attention will be given to the protection of currently living nest-trees regardless of zoning classification. Hollow-bearing trees will not be felled for seed collection purposes. Consideration will be given to the protection of groups of >10 retained trees from regeneration burning to minimise windthrow effects.</p> <p>Salvage Logging: Special plans for salvage logging, required under the Code of Forest Practices for Timber Production (1996), should consider both the number and spatial distribution of hollow-bearing trees and zoned accordingly, especially in areas of Zone 1B. Zone 1A forest will not be salvage logged. Prescriptions developed for normal logging operations will be adhered to in all areas where salvage logging is undertaken.</p> <p>Adoption and refinement of alternative silvicultural systems Continue to undertake operational trials of retained overwood silvicultural systems with a view to their adoption as an alternative to the current system of clearfelling in selected areas of ash forest within the Central Highlands. Such areas will be selected considering existing</p>	<p>In addition to the obligatory regulatory standards, VicForests undertakes coupe planning and harvesting methods to manage risks associated with potential impact to the Leadbeater's Possum. These are implemented in line with government policy.</p> <p>Some protection of hollow-bearing trees occurs with pre-1900 live trees not harvested, however they are frequently impacted by regeneration burns. Less protection is provided to dead hollow-bearing trees.</p> <p>Salvage logging prescriptions consider Leadbeater's Possum habitat and treat a burnt area of Zone 1A habitat as if it was unburnt, and hence harvesting does not occur.</p> <p>Alternative silvicultural systems have been adopted and from 2014 onwards, 50% of the ash forest within the range of Leadbeater's Possum will be harvested using retention harvesting approaches and alternatives to high intensity regeneration burns are being investigated.</p>	
-------------------------------------	---	--	--





	and potential habitat within each Leadbeater's Possum Management Unit (LMU).		
8.1 Assess development proposals which could affect Leadbeater's Possum for areas outside State forest. (Re objective 4)	Assessment of all areas within the known range of Leadbeater's Possum need to be carried out as part of any development proposals which could affect the species, including roading, recreation facilities, fire management.	Referral of forestry operations (within State Forest) is not required under the EPBC Act (covered by RFA). Other actions that may have a significant impact on Leadbeater's possum are required to be referred under EPBC Act to the Australian Government Minister for the Environment. The East Central Bushfire Management Plan identifies known Leadbeater's Possum colonies and the location of high quality habitat and factors this information into bushfire risk planning and risk reduction activities. Assessments are undertaken to examine the risk of other developments.	●
8.2 Determine management objectives for the populations of Leadbeater's Possum in the Yellingbo State Nature Reserve and snow gum forests at Lake Mountain and Mt. Baw Baw (Re objective 4)	Investigate the status and determine the necessary management objectives for the recently discovered populations of Leadbeater's Possum in the Yellingbo State Nature Reserve and snow gum forests at Lake Mountain and Mt Baw Baw.	Detailed annual population monitoring of the Leadbeater's Possum population at Yellingbo Nature Conservation Reserve is undertaken, with >80% of the total population sampled each year via nest boxes. Several measures of population condition are evaluated annually, including total population size, colony sizes, colony persistence through time, reproductive rates, and annual recruitment, as well as data on survivorship, longevity and dispersal (Harley 2016). Nest boxes have also been used to monitor populations in snow gum woodlands to investigate distribution and abundance both before and after the 2009 fires (Harley 2016). Management objectives have been developed and are being implemented.	●
9 Implement training programs to ensure quality application of, and implementation of, management guidelines. (Re objective 5)	Implement training for all relevant field and planning staff involved with Leadbeater's Possum management and/or timber production within its range, in relation to understanding the ecology of Leadbeater's Possum, habitat assessment and recording, the recovery plan process, and progress towards implementation of Leadbeater's Possum management guidelines.	VicForests has undertaken training of field staff as operational procedures are introduced or revised, most recently following publication of a new Regrowth Retention Harvesting instruction applied in the Central Highlands to implement a LPAG recommendation. Although there are no formalised training programs for DELWP operational field staff, staff have access to a range of up to date Leadbeater's Possum information and are provided with on the job training appropriate to their role in relation to threatened species management issues, including for the Leadbeater's Possum.	●
10.1 Research on dispersal and recolonisation capacities (Re objective 6)	Determine the dispersal and recolonisation capacities of Leadbeater's Possum Examine the results of genetic analysis to explore aspects of dispersal behaviour and population genetic variability in several wild sub-populations of Leadbeater's Possum.	Genetic analysis has been undertaken using samples from some subpopulations: mainly from Yellingbo and snow gum woodlands, with less sampling from ash forests (Hansen and Taylor, 2008; Hansen et al, 2009). This provides information on dispersal and genetic isolation, however, detailed information on recolonisation capacities for management purposes and arrangement of reserves is lacking. Nest	●

	Design, scope and implement a research project to determine the extent and limitations of dispersal and recolonisation capacities utilising artificial nest boxes as a trapping and recapture methodology. A major outcome of the project would be to determine the best spatial arrangement of reserved areas for the species.	boxes have been used successfully as a trapping and recapture methodology, especially in Yellingbo and in snow gum woodlands (Harley 2016). Annual monitoring of areas of subalpine woodland burnt during the 2009 fires is investigating recolonization rates (Harley 2016).	
10.2 Research response to edge effects (Re objective 6)	Investigate the response of Leadbeater's Possum to edges of habitat.	<p>Information on the impact of edge effects has been investigated in a number of studies.</p> <p>Lindenmayer et al. (1993) found that linear strips set aside and excluded from timber production (e.g., on steep slopes and adjacent to streams, stands of unmerchantable timber and strips set aside for wildlife conservation) supported fewer species and had a lower probability of containing an animal than sites of similar habitat quality within areas of continuous forest. In addition, the number of trees with hollows in contiguous forest that were occupied by an arboreal marsupial was approximately twice that of trees in retained linear strips.</p> <p>Small patches of forest are unlikely to support populations of Leadbeater's possum. Population Viability Analysis suggest that single isolated populations of greater than 200 Leadbeater's possums are required for a high probability of long term persistence (Lindenmayer et al., 1993). Edge effects from additional logging roads and tracks may similarly render these remnants less viable, as possums are reluctant to cross these.</p> <p>Once harvested areas have regenerated however, ecotones between different aged habitat can be used by colonies and many of the sites where Leadbeater's Possums are currently being found during the DELWP targeted surveys are located on or near ecotones such that both foraging and nesting habitat is available (Nelson et al. 2015). Ecotones between some different vegetation types can also be productive, such as where rainforest or montane riparian thickets adjoin ash forest.</p>	
10.3 Research on fire modelling (Re objective 6)	Improve the precision of modelling fire in the ash forests of the Central Highlands, particularly as it relates to the risks of reducing populations of Leadbeater's Possum.	The East Central Bushfire Risk Landscape project uses Phoenix RapidFire, a fire simulation tool, to study how under different weather conditions, a fire is predicted to spread over the landscape and impact on different assets, which in this case is Leadbeater's Possum habitat. The use of this tool can predict where the worst fires will spread and how fuel management actions can be used to reduce the spread and intensity of a fire and potentially protect the species habitat. Currently the East Central Bushfire Risk Landscape Team have modelled and assessed bushfire risk to known colonies and high-quality habitat of Leadbeater's Possum, and chosen some	

		<p>adjacent areas for priority fuel management to reduce the risk.</p> <p>The published Strategic Bushfire Management Strategy (2014) shows the extent to which the strategy will reduce residual risk to Leadbeater's Possum and high-value native timber in the Central Highlands, benefiting the recovery of the possum and the timber industry. Further risk analysis work is being undertaken to refine the model inputs and improve the strategy to define the best fuel management approach to reducing the risk of bushfire to the Leadbeater's Possum</p>	
--	--	--	--

2.0: EVALUATION AGAINST OBJECTIVES

2.1: Summary evaluation of achievement against objectives

Overall objective	Comments	Status
To downlist Leadbeater's Possum from endangered to vulnerable within 10 years based on the IUCN (1994) criteria of population trend and size, extent of occurrence, probability of extinction, and the management of habitat towards a target of no more than a 1% probability of extinction over 250 years throughout the forest within its current range.	Not achieved. Species has been uplisted to critically endangered.	
Specific objectives/recovery criteria	Comments	Status
<p>SO1: Identify and implement protection of optimum and potentially optimum habitat including the establishment of a permanent reserve system, using the CAR reserve system consistent with the JANIS criteria.</p> <p>RC1: Identify all optimum and potentially optimum habitat within the known range of the species by 1997 and have this data scanned and entered onto NRE's Geographic Information System (GIS).</p>	Criterion met. See Action 2-5	
<p>SO2: Apply strategies that address the development and continued availability of habitat in each Leadbeater's Possum Management Unit (LMU).</p> <p>RC2: Establish a permanent reserve system in 10 Leadbeater's Possum Management Units (LMU) by June 1997 and the remaining LMU's by June 1998. The reserve system will include strategic areas of both existing optimum and potentially optimum habitat with a target of at least 600 ha of ash forest in each designated LMU.</p>	Criterion met although full implementation of reserve system delayed until 2008. See Action 5	
SO3: Implement population monitoring of Leadbeater's Possum throughout its range and assess the effectiveness of the reserve system for the species conservation, using rigorous experimental	<p>See Action 6</p> <p>Long-term monitoring of arboreal marsupials including Leadbeater's possum has</p>	

<p>design.</p> <p>RC3: Develop and implement a monitoring program based on rigorous experimental design to assess population status of Leadbeater's Possum throughout its range and the effectiveness of the reserve system for the conservation of the species.</p>	<p>been conducted since the early 1980s' focusing on known localities and population strongholds in ash forests to investigate trends. Detailed monitoring has occurred in snow gum woodlands (e.g. Mt Baw Baw, Lake Mountain, Mount Bullfight) and at Yellingbo.</p> <p>Lumsden et al. (2013) undertook new surveys, sampling across the species' range to determine occurrence and population strongholds, and predict areas where they might occur, with current targeted surveys (Nelson et al. 2015) sampling these areas to locate colonies for protection. This is providing additional information on where the species is located but longer term monitoring will be required to investigate persistence at these sites.</p>	
<p>SO4: Develop management guidelines for Leadbeater's Possum throughout its range. Apply modified and alternative silvicultural systems that result in high quality habitat, while providing for commercial timber production.</p> <p>RC4: Existence of management guidelines that address the conservation of Leadbeater's Possum throughout its range. Including the application of modified or alternative silvicultural prescriptions to protect and promote the availability of hollow-bearing trees, specifically in the Special Management Zone (SMZ) implemented through the Central Highlands Forest Management Plan.</p>	<p>Management guidelines and prescriptions developed. See Action 7. The effectiveness of these prescriptions in protecting and promoting the availability of hollow-bearing trees, however, is debated, particularly in the context of the range of threats operating.</p>	●
<p>SO5: Implement training for all relevant field and planning staff.</p> <p>RC5: Implement training for all relevant field and planning staff, and monitor and report annually on progress towards implementation of Leadbeater's Possum management guidelines as contained in the Central Highlands Forest Management Plan.</p>	<p>Some training has been undertaken by biodiversity staff in DELWP and VicForests. See Action 9. Limited monitoring or annual reporting the implementation of Leadbeater's Possum management guidelines (i.e. the prescriptions).</p>	●
<p>SO6: Undertake research on biology and ecology with a particular emphasis on the risk of wildfire reducing populations, the dispersal and recolonisation capacities of the species and response to edge effects.</p> <p>RC6: Establish research projects by 1997 addressing the dispersal and recolonisation capacities of the species, modelling of fire as it relates to the risks of reducing populations of Leadbeater's Possum and response to edge effects.</p>	<p>Extensive research has been undertaken on Leadbeater's possum since the Recovery Plan was published in 1997, including the impact of wildfires and response to edge effects. Dispersal and recolonization capacities have been investigated for the Yellingbo population but less has been studied on these aspects for the Central Highlands populations. See Actions 10.1-10.3.</p>	●

Status progress

- Objective not achieved No progress towards meeting criteria/Insufficient action to meet criteria
- Objective partly achieved Criteria not fully met but some progress/Action underway, most elements of criteria met
- Objective achieved Criteria met, further actions may or may not be required

3.0: CHANGES IN KNOWLEDGE AND CONSERVATION TRAJECTORY

3.1: Evaluation of the current status and conservation trajectory of the species

Previously known status at the time the recovery plan was published	
Habitat/distribution	The possum is mainly confined to montane ash forests dominated by <i>Eucalyptus regnans</i> , <i>E. delegatensis</i> or <i>E. nitens</i> in the Central Highlands of Victoria, is not uniformly distributed throughout this area – occurring in patches, and is most likely to occur on sites with numerous trees with hollows and dense <i>Acacia</i> spp. understory. The species has recently been recorded in snow gum <i>E. pauciflora</i> woodland, and lowland swamp forest <i>E. camphora</i> and <i>E. ovata</i> .
Abundance	No abundance data provided in the plan.
Threats	Reduction of nest trees as a result of logging and natural decay (see below re trajectory for timing). Bushfires
Trajectory predicted	Modelling predicted a reduction in the availability of suitable habitat (nest trees) between the time of writing and the year 2020 followed by a population bottleneck until the year 2075.
Current known status	
Habitat/distribution	No significant change in the overall distribution, however within this area the range has constricted due to loss of suitable habitat following the 2009 bushfires. Detailed knowledge of the distribution has increased significantly in recent years based on surveys at long term monitoring sites (e.g. Lindenmayer 2009), detailed nest box and camera trap surveys at Yellingbo, snow gum woodlands and parts of the ash forest (Harley 2016) and DELWP surveys throughout the ash forests (Lumsden et al. 2013, Nelson et al. 2015). This new information is readily available through the DELWP interactive map (http://lbp.cerdi.edu.au/possum_map.php). Genetic information (Hansen et al., 2009) indicates that the Yellingbo subpopulation in the lowland swamp forest is a distinct evolutionary unit and the last representative of what was a broader distributed population that has suffered from habitat loss. There is now also a greater understanding of habitat requirements in all three main habitat types.
Abundance	A number of rough estimates of current total population size have been made based on extrapolations from survey data, with wide ranging population numbers presented depending on assumptions made. Irrespective of this range in estimates, the true abundance is expected to be significantly less than at time of publication of RP in 1997, due to impact of 2009 fires.
Threats	Same threats. +Habitat decline for lowland populations.
Trajectory predicted	Negative trajectory remains, however a significant proportion of habitat, and therefore the associated populations, have declined since the plan's publication. PVA modelling suggests a continuing decline of population numbers over the next several decades due to changes in forest structure and hollow-bearing trees abundance (Lumsden et al. 2013).
Evaluation of change in conservation trajectory	

The negative change trajectory has continued, and the population has undergone a significant decline, estimated based on significant decline in available suitable habitat as a result of continued loss from fire (especially the 2009 bushfires), timber harvesting and natural decay. The species was considered to be endangered at publication of the plan (1997) and is now listed as critically endangered (2015).

4.0: RECOMMENDATIONS

4.1: Potential recovery objectives

Long-term recovery objective:

Increase the extent, quality and connectivity of currently and prospectively suitable habitat, and its occupancy by Leadbeater's possum in order to maximise the probability of persistence of the species

While acknowledging that the long-term recovery objective is unlikely to be achieved over the ten year period of a new plan, the following interim recovery objectives are recommended for discussion.

Interim Objective	Existing, Modified, New	Link to any existing or new objectives	Comments
All relevant existing and future planning and policy settings are refined, interpreted and implemented in a manner that contributes appropriately to maximising the chances of long-term survival of Leadbeater's possum in nature	Modified	Specific Objectives 1 & 2 in the 1997 Recovery Plan	Management actions alone will not be sufficient to recover the Leadbeater's possum: that objective also needs harmonisation of existing and future planning and policy settings such that they collectively and coherently contribute appropriately to maximising the chances of long-term survival of Leadbeater's possum in nature.
A whole of landscape management regime is in place ensuring that all currently suitable and prospective habitat across the species' known range is maintained, enhanced and effectively managed to maximise its suitability for Leadbeater's possum	Modified	Specific Objectives 1, 2 & 4 in the 1997 Recovery Plan	The key conservation concern for Leadbeater's possum is ongoing decline in the extent, quality and connectivity of suitable habitat, now and into the future. This objective seeks to focus explicitly on the maintenance and management of currently suitable habitat, and to ensure that future habitat is maintained and effectively managed
Where there is a net long-term benefit, translocate individuals or colonies within and adjacent to the known range	New		Strategic translocations within the known range may decrease population fragmentation, and increase subpopulation viability and occupancy of suitable habitat.
Seek to locate, or establish, additional populations outside the core range of the Central Highlands.	New		The conservation future of Leadbeater's possum within its known range in the Central Highlands is precarious. Its overall conservation outlook may be improved by seeking to spread extinction risks by establishing additional populations outside this known range, while the current population size may still allow for such translocation.
Targeted research addresses key knowledge gaps that currently impede effective management.	Modified	Specific objective 6 in the 1997 Recovery Plan	This interim objective aligns closely with the 1 st and 2 nd interim objective to enhance our knowledge on the current biology, and ecology of this species following on from the original recovery plan prescriptions, new and ongoing research and the 2009 bushfires.
An integrated monitoring program is effectively implemented that publicly reports	Modified	Specific objective 3 in the 1997	Ongoing implementation of a monitoring program to indicate the status of the species to

in a timely manner on possum status, existing and prospective habitat extent, quality and connectivity, and effectiveness of management actions.		Recovery Plan	inform management decisions.
All stakeholders support and where relevant are involved in the implementation of the plan	Modified	Action 1 in the 1997 Recovery Plan	Development of a recovery team or similar governance model to oversee the implementation of this plan, and to facilitate stakeholder engagement and involvement.
Ensure effective and adaptive implementation of the plan including adequate reporting	New		A framework is implemented such that positive or negative recovery aspects are reported upon, and the recovery actions can be adapted (if necessary) to support the overall ongoing recovery of the species.

4.2 Discussion and recommendation for future recovery effort

Based on this review, all key previous threats to this species remain, the species conservation trajectory is declining, and the objective of the original plan has not been achieved. The species has been uplisted under the EPBC Act from Endangered to Critically Endangered.

A range of measures have and currently are being implemented by Victoria resulting from the publishing of the Leadbeater's Possum Action Statement in 2014.

An updated recovery plan is required, providing for the management and research actions necessary to stop the decline of, and support the recovery of Leadbeater's possum, and build upon the work which is already being undertaken to protect the Leadbeater's possum and its habitat over the longer term.

4.3 Recommendation

It is recommended that an updated recovery plan be developed

5.0: INFORMATION SOURCES, REFERENCE MATERIAL, ACKNOWLEDGEMENTS:

Commonwealth of Australian and State Government of Victoria (1998) Central Highlands Regional Forest Agreement. www.agriculture.gov.au/SiteCollectionDocuments/rfa/regions/vic-central-highlands/rfa/vic_cent_rfa.pdf

Hansen BD (2008). Population genetic structure of Leadbeater's possum *Gymnobelideus leadbeateri* and its implications for species conservation. PhD Thesis, Monash University, Clayton, Australia.

Hansen BD, Harley DKP, Lindenmayer DB and Taylor AC (2009). Population genetic analysis reveals a long-term decline of a threatened endemic Australian marsupial. *Molecular Ecology* 18: 3346–3362.

Hansen BD and Taylor AC (2008). Isolated remnant or recent introduction? Estimating the provenance of Yellingbo Leadbeater's possums by genetic analysis and bottleneck simulation. *Molecular Ecology* 17: 4039–4052.

Harley, D (2016). An overview of actions to conserve Leadbeater's Possum (*Gymnobelideus leadbeateri*). *Victorian Naturalist* (in press).

Leadbeater's Possum Advisory Group (2014b) Leadbeater's Possum Technical Report: Report to the Minister for Environment and Climate Change and the Minister for Agriculture and Food Security. http://www.depi.vic.gov.au/_data/assets/pdf_file/0019/258220/Leadbeaters-Possum-Advisory-Group-Technical-Report.pdf.

Lindenmayer D (2009) 'Forest Pattern and Ecological Process: A Synthesis of 25 years of Research.' (CSIRO Publishing: Collingwood)

Lindenmayer DB, Blanchard W, McBurney L, Blair D, Banks S, Likens GE, Franklin JF, Laurance WF, Stein JAR and Gibbons P (2012). Interacting factors driving a major loss of large trees with cavities in a forest ecosystem. PLOS One 7, e41864.

Lindenmayer DB, Cunningham RB, Donnelly CF, Tanton MT and Nix HA (1993). The abundance and development of cavities in *Eucalyptus* trees: a case study in the montane forests of Victoria, southeastern Australia. Forest Ecology and Management 60: 77–104.

Lindenmayer DB, Smith AP, Craig SA and Lumsden LF (1989). A survey of the distribution of Leadbeater's possum, *Gymnobelideus leadbeateri* McCoy in the Central Highlands of Victoria. Victorian Naturalist 106: 174-178.

Lumsden LF, Nelson JL, Todd CR, Scroggie MP, McNabb EG, Raadic TA, Smith SJ, Acevedo S, Cheers G, Jemison ML, and Nicol MD (2013). A New Strategic Approach to Biodiversity Management–Research Component. Arthur Rylah Institute for Environmental Research.

Macfarlane M, Smith J, and Lowe K (1997). Leadbeater's Possum Recovery Plan. Department of Natural Resources and Environment, Victoria.

Nelson JL, Lumsden LF, Durkin LK, Bryant DB, Macak PV, Cripps JK, Smith SJ, Scroggie MP and Cashmore MP (2015) 'Targeted surveys for Leadbeater's possum in 2014-15 '. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning. Report for the Leadbeater's Possum Implementation Committee. (<http://www.delwp.vic.gov.au/environment-and-wildlife/conserving-threatened-species-and-communities/leadbeaters-possum>)

Smales IJ (1994). The discovery of Leadbeater's possum *Gymnobelideus leadbeateri* McCoy, resident in a lowland swamp woodland. Victorian Naturalist 111: 178-182.

Smith S and Morey J (2001) 'Options for a permanent reserve system for the conservation of Leadbeater's Possum. Central Highlands of Victoria.' Department of Natural Resources and Environment, East Melbourne.

State Government Victoria NRE (1998) Forest Management Plan for the Central Highlands. Department of Natural Resources and Environment, Victoria.

State Government Victoria DEPI (2014). Action Statement No 62 Leadbeater's Possum *Gymnobelideus leadbeateri* Flora and Fauna Guarantee Act 1988. Victorian Government Department of Environment and Primary Industries.

State Government Victoria DELWP (2015). Threatened Species Survey Standard Leadbeater's possum. Department of Environment, Land, Water and Planning, Victoria.

State Government Victoria (2014). Supporting the recovery of Leadbeater's possum – Report on Progress. Victorian Government.

TSSC (2014). Conservation advice *Gymnobelideus leadbeateri* Leadbeater's possum. Threatened Species Scientific Committee.

VicForests (2013 draft). Forest Management Plan. Victorian Government.

VicForest (2013 draft). VicForests Strategy. Victorian Government.