Planning and Development Engineering Action Plan – June 2014

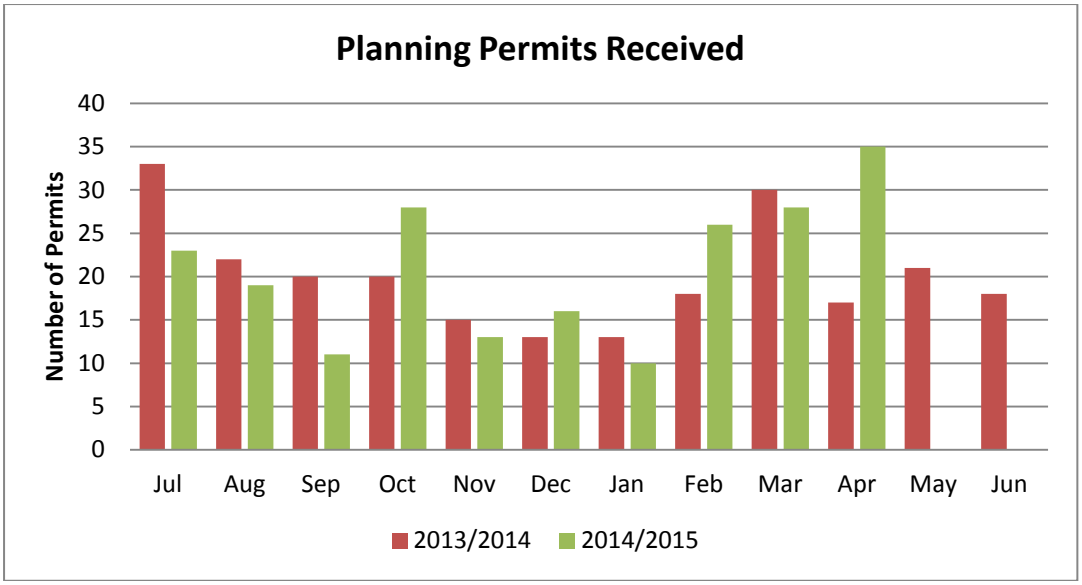
Activity	Description	Action	Timing	Responsible Officers	Status
1. Media Releases	Use of website, local papers and local radio to promote planning, building and infrastructure development, eg publishing monthly planning data, promoting pre-application meetings and development of planning fact sheets.	Develop media/Comms plan with Communications Manager	To be completed by December 2014 Note: The timeline for this item has been revised from mid July.	Manager Development & Environmental Services (MDES) Coordinator Statutory Planning	Completed New fact sheets have been published on Council's website. Promotional activities are being forecast in the department quarterly activity report for the next quarter
2. Customer Feedback	Random call backs to individuals who have contacted Council to discuss their level of satisfaction with the service received or opportunities to improve.	At least 3 call backs to customers per month.	Monthly	MDES Manager Infrastructure & Development Services (MIDS)	Superceded– new customer feedback forms implemented
3. Promotion of Building Department	Promote the building department and its services to the wider community through media releases and Councils website and local radio.	Develop media/Comms plan with Communication Manager.	To be completed by December 2014	MDES Municipal Building Surveyor (MBS)	Completed Promotional activities are being forecast in the department quarterly activity report for the next quarter UGFM scheduled presentation
4. Development Forums	Conduct development forums on various planning, building and infrastructure issues.	Four forums to be held in 2014/2015	Quarterly	MDES MIA	Completed Ongoing schedule of promotional activities and participation at forums

Planning and Development Engineering Action Plan – June 2014

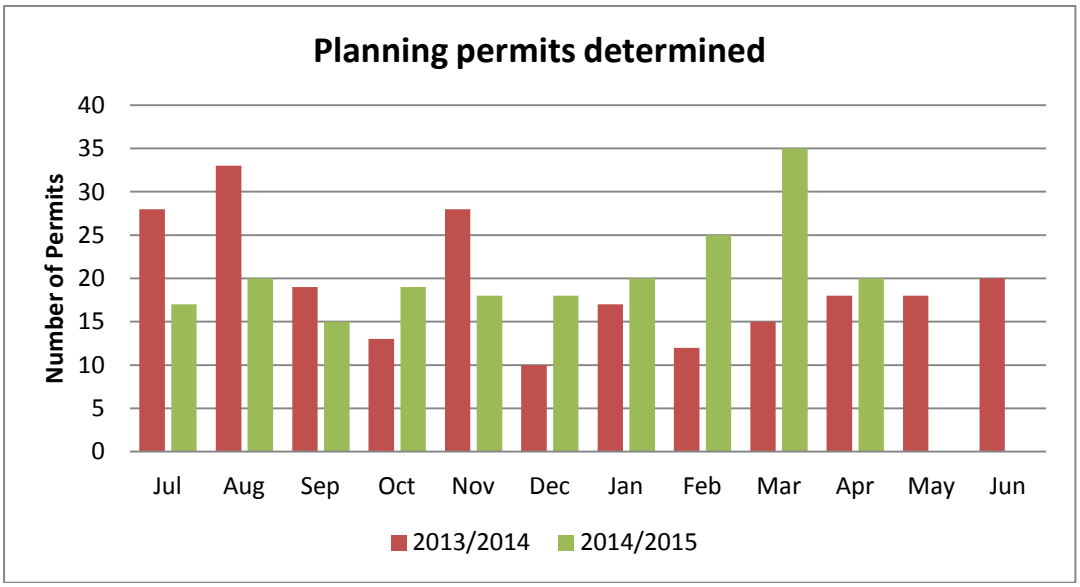
Activity	Description	Action	Timing	Responsible Officers	Status
5. Growing the Rate Base Plan	Presentation of the growing the Rate Base Plan to all staff within the Division	Presentation of growing rate base plan to IDS Division.	Presentation in February 2015.	General Manager Corporate and Community Services (GMCCS) MIA MDES	Completed in part. A further update on progress in relation to this item will occur in June 2015.
6. Performance Reporting to Council	Quarterly report to Council on development services and infrastructure actions	Template to be developed by GMIDS.	For reporting in 2014/2015	General Manager Infrastructure & Development Services (GMIDS)	Completed Development & Environmental Services Department Quarterly Activity Report
7. Investigate cost of infrastructure development	Evaluate infrastructure cost to fund new infrastructure and promote growth	1. Cost modelling to be undertaken with briefing of Council on costs. 2. Council briefing on Infrastructure Design Manual.	To be completed by March 15 Deferred until September 2015 Briefing 5/11/2014	Coordinator Assets & Development Manager Business Services MIDS	1. Not complete but is under development. This item will form the basis of a separate briefing note. 2.Completed
8. Training and Development	Customer service training	Develop training plan with Managers and HR Manager for: 1.Customer service training. 2.Communication in a regulatory environment.	Target mid July revised. 1.August 2014 2. February 2015	GMIDS	1.Completed 2. Customer feedback will inform future training needs in relation to customer service.

Attachment 2 – Performance Charts and Graphs

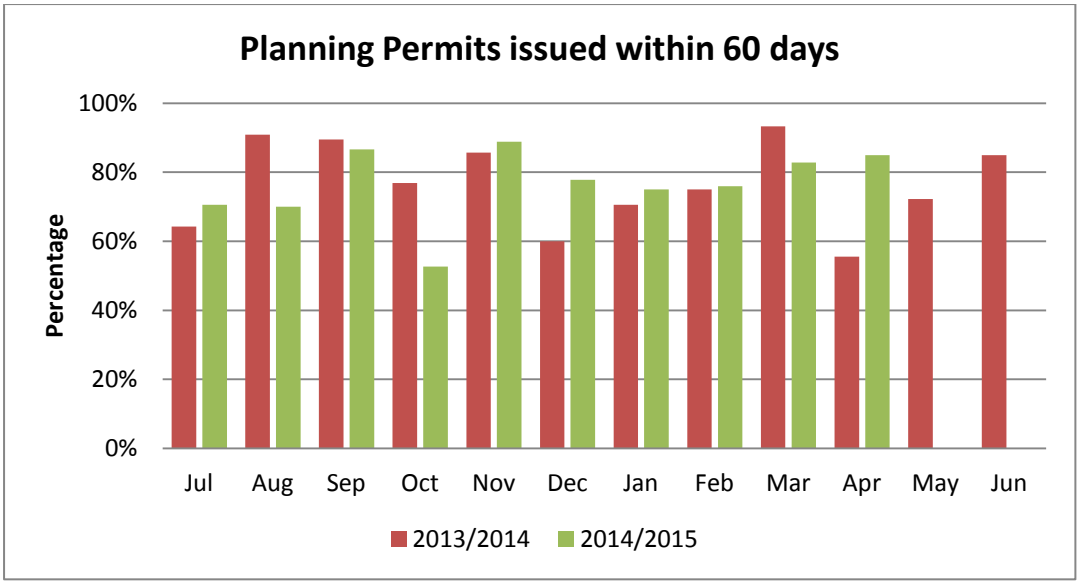
Planning Unit



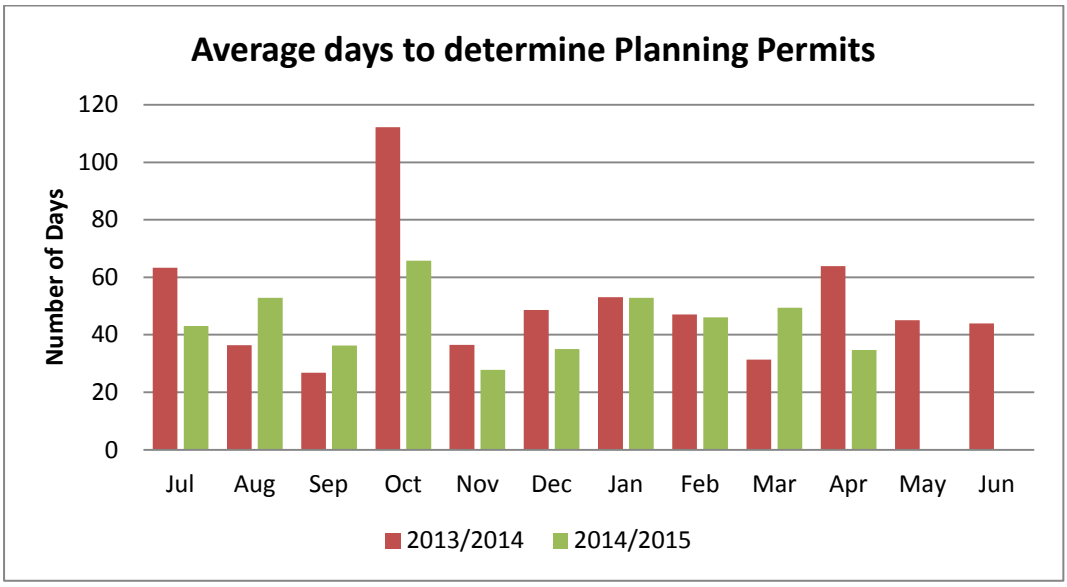
The above chart details the number of applications received by month, compared with the previous financial year. The number of applications received includes new planning applications, requests to amend existing planning permits and planning consents. For the 2013/2014 financial year the number of applications received overall was 240. This was 10 less than the previous financial year. For the 2014/2015 year to date 209 applications have been received.



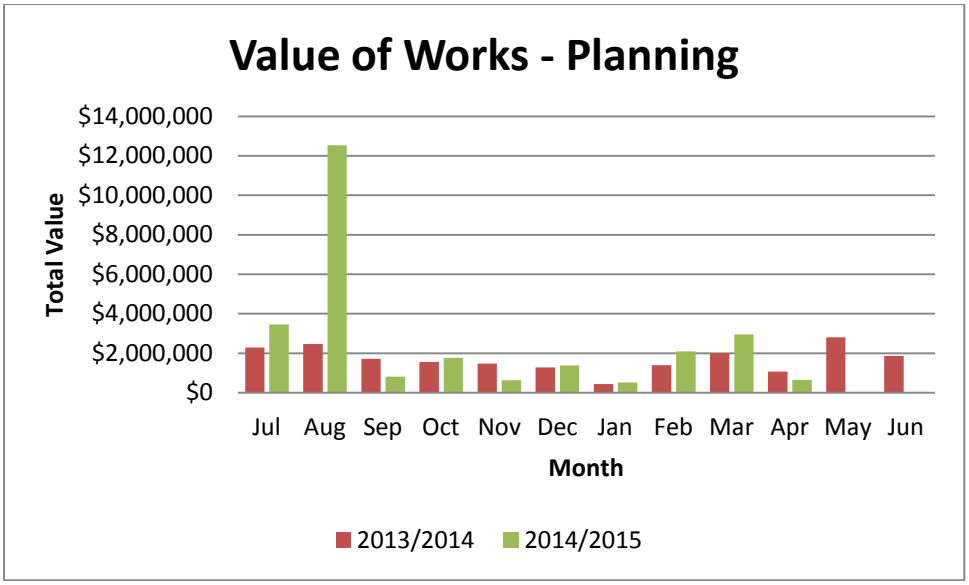
The number of applications determined for 2013/2014 was 231. This was 32 less than the previous financial year. For the 2014/2015 year to date, 207 applications have been determined.



The above chart details the percentage of planning permits issued within 60 days. The statutory time frame to issue permits under the *Planning and Environment Act 1987* is 60 days. In 2013/2014, 78 per cent of permits were issued within the statutory time frame. For the 2014/2015 year to date77% of permits have been issued within the statutory time frame.



The above planning chart details the average number of days taken to determine planning permits, on a month by month basis. This includes officer delegated decisions and decisions of Council. The average number of days to determine planning permits in 2013/2014 was 44 days. For the 2014/2015 financial year to day, the average number of days to determine permits is 44 days.



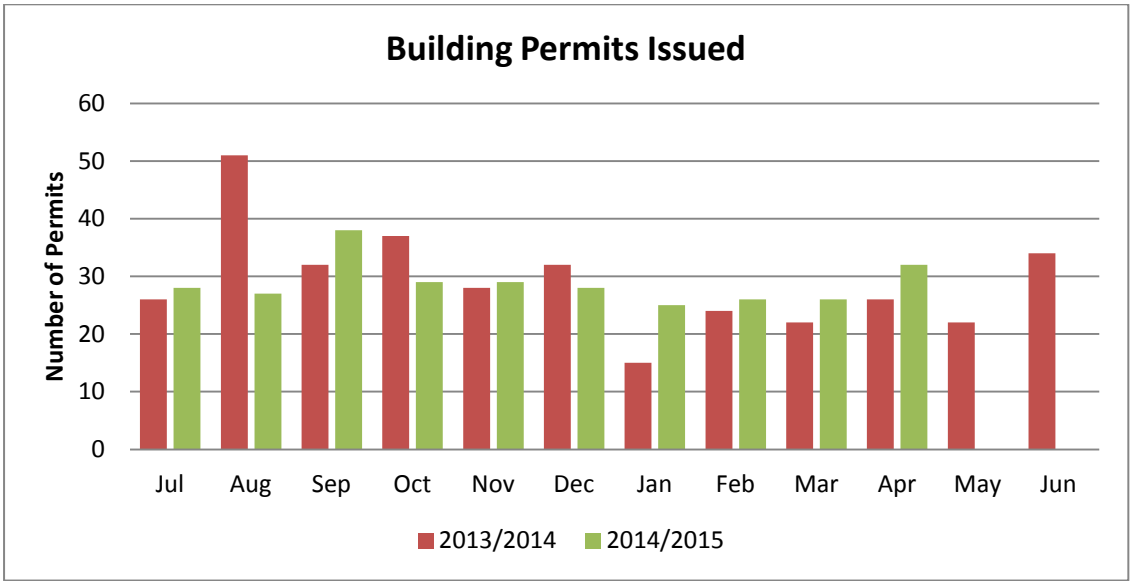
The final planning chart details the value of works for planning permits, on a month by month basis. For the 2014/2015 financial year to date the total value of works is $26,765,662, compare to the total value of works for 2013/2015 which was $20,315,982.

Benchmarking Comparative Data – Planning Permits

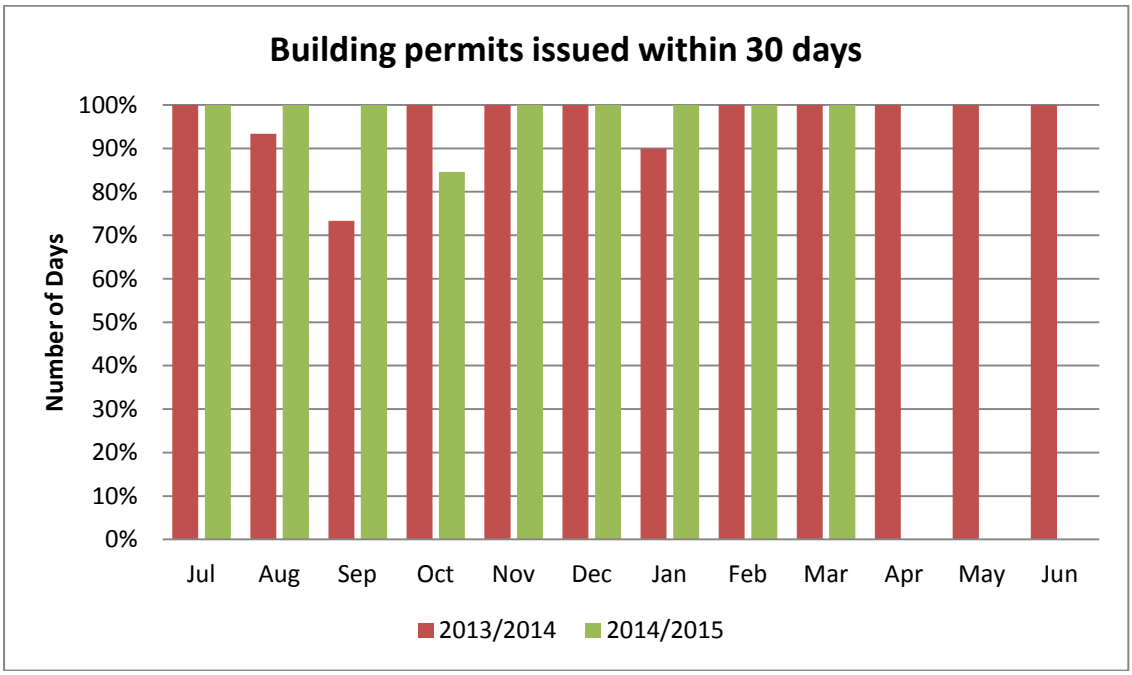
Council is required to report planning permit activity on a monthly basis to the state government, which is then compared against various regions and groups of municipalities within the whole of Victoria. The following table provides a brief outline of how Murrindindi is performing this financial year to date.

Benchmark	MSC	Peri Urban Region	Rural Municipalities	State Wide
Planning permits determined within 60 days (YTD)	78%	69%	71%	65%
Average days to determination (YTD)	56	91	61	77

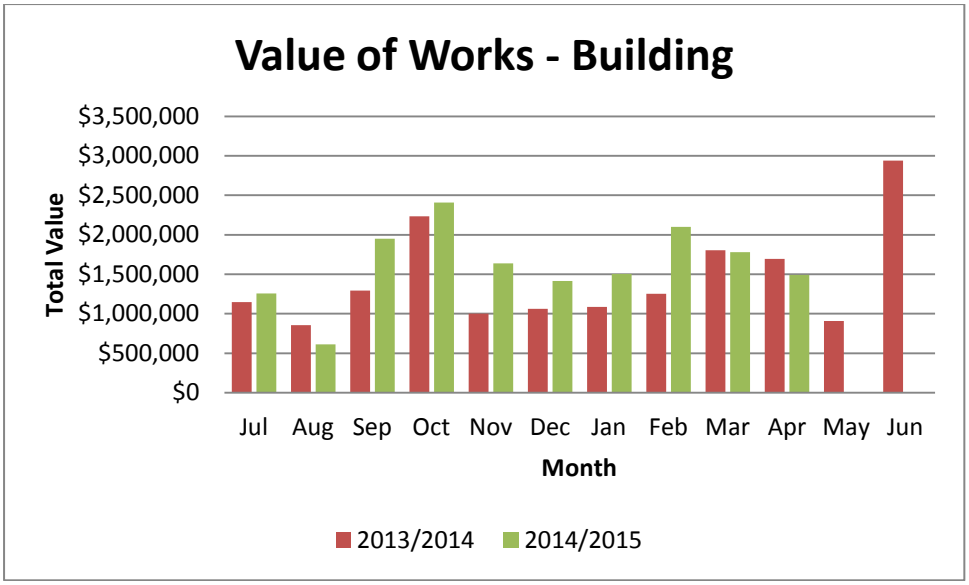
Building Unit



The above chart details the number of building permits issued within Murrindindi Shire, including both municipal and private building surveyor permits. The total for 2013/2014 is 349, which is one more than the previous financial year. For the 2014/2015 year to date, 282 permits have been issued.



The above chart details the percentage of building permits issue by the municipal building surveyor within the units 30 day Key Performance Indicator (KPI) timeframe. The overall percentage of permits issued within 30 days for the 2013/2014 financial year was 97%. For the 2014/2015 year to day, 99% of permits have been issued within 30 days.



The final building chart details the value of works for planning permits, on a month by month basis. For the 2014/2015 financial year to date the total value of works is $16,157,848, compare to the total value of works for 2013/2015 which was $17,275,027.

Current planning projects, Murrindindi Shire:

Planning studies:

- Gaming Policy:
  - Gaming policy being prepared for inclusion in the Murrindindi Planning Scheme to guide any future proposals for gaming machines.
  - Consultant Rob Milner, 10 Consulting, appointed, with work now commenced.
  - Public meetings to be held on 21 May 2015, with project completion by July 2015.

  Contact: Grant Scale (5772 0317)

- Eildon Structure Plan:
  - Council commenced a structure plan for the Eildon township and environs in early 2015, reviewing both land use planning and economic assessment aspects.
  - Although consultants Macroplan were appointed to the project, work on the land use planning part of the project has been delayed due to state government funding not being forthcoming at this stage.
  - The project was due to be completed in 2015, although the land use planning component will now be delayed, dependent on funding.

  Contact: Matt Parsons or Grant Scale (5772 0317)

- Kinglake Ranges, Flowerdale and Toolangi Streetscape Design Framework:
  - Framework will outline designs and recommendations for works in streetscape and public places in Kinglake, Kinglake West / Pheasant Creek, Flowerdale and Toolangi.
  - Consultants Aecom were appointed 2014 to undertake the framework, which has involved public meetings and exhibition and will be completed mid 2015.

  Contact: Melissa Crane, Matt Parsons or Grant Scale (5772 0317)

- Regional Landscape Assessment project:
  - The Department of Environment, Land, Water and Planning (DELWP) is preparing 6 regional landscape assessment projects across Victoria. Murrindindi Shire lies within the proposed Lower Hume and High Country Landscape Assessment Study.
  - The draft for the Lower Hume and High Country indicates potentially state significant landscape areas in the Lake Eildon area, Cathedral Ranges area, east of Kinglake and east of Marysville; a regionally significant landscape area in the Murchison Hill / Trawool Valley area; a regionally significant view point at Eglinton Cutting, west of Alexandra.
  - Feedback on the draft Lower Hume and High Country is now sought until 19 April 2015. The draft study and an online feedback forms are available at: http://www.dtpli.vic.gov.au/planning/policy-and-strategy/rural-and-regional-planning/landscapestudies

  Contact: Grant Scale (5772 0317)

Planning scheme amendments:

- C46:
  - C46 proposes to implement a 2013 review of the Development Plan Overlay (DPO) by rezoning land in Alexandra from General Residential to Low Density Residential, removing the Development Plan Overlay from land in Alexandra, Marysville and Yea when it is no longer required and revising all DPO schedules.
  - On exhibition from 7 May – 8 June 2015

  Contact: Grant Scale (5772 0317)

- C53:
  - Implementation of the Kinglake Flowerdale Toolangi Plan (adopted March 2014).
  - Draft C53 has been prepared using funding from the state government. Discussions are being held with state planning department representatives (DELWP) to determine the most appropriate mechanism for exhibition and / or approval of the amendment.

  Contact: Matt Parsons or Grant Scale (5772 0317)

- C54:
  - Implements a 2013 review of the Murrindindi Planning Scheme through a revised local planning policy framework to revise all local planning strategies / policies. C54 does not propose any changes to zoning or planning controls.
  - 12 submissions received through exhibition; a panel has been requested to hear submissions.
  - The Directions Hearing for the panel was held at Council's Yea offices, 10 am, Thursday 9 April 2015.
  - A Panel Hearing is scheduled for 12 May 2015, Planning Panels Victoria, Melbourne at 11 am.

  Contact: Grant Scale (5772 0317)

- C55:
  - C55 proposes to implement the *Yea Structure Plan* 2014 by amending strategic directions for the Yea township and environs, rezoning various parcels of land and amending subdivision provisions and applying the Development Plan Overlay for defined areas of land zoned Rural Living.
  - Exhibited 14 May – 15 June 2015

  Contact: Grant Scale (5772 0317)

Encl 6.9c

Title:	**Portfolio Councillor Policy**
Type:	**Council**
Adopted:	27 May 2015
Review:	27 May 2017
File No:	SF/491
Attachments:	Nil

1. Purpose

Murrindindi Shire Council has established the Portfolio Councillor system. The purpose of this Policy is to articulate the role and support to be provided to Portfolio Councillors.

2. Rationale

With the appointment of Portfolio Councillors, it is desirable that the objectives of establishing these roles and the support that will be provided to Councillors is articulated.

3. Scope

This policy applies to Portfolio Councillors and Council officers who have a responsibility in ensuring that the Portfolio Councillor is kept informed on key matters relating to their area of portfolio responsibility.

Currently there are six portfolios covering the following areas:

- Land Use Planning
- Economic Development
- Corporate and Customer Services
- Community Services
- Natural Environment and Climate Change
- Infrastructure and Waste

Portfolio Councillors are appointed at the Special Meeting held each year. In order to enable Councillors to gain a broader experience of Portfolio roles, Councillors will generally not represent a portfolio for more than two years.

The role of the Portfolio Councillor recognises that the day to day management and direction of staff in implementing Council policy and strategy remains the responsibility of the relevant General Manager. Good governance identifies that the authority of councillors can only be exercised when they meet formally as Council at a properly constituted Council meeting. Outside the Council meeting, individual councillors have no authority.

4. Definitions

N/A

Encl 6.10

5. Policy

5.1 Objectives of the Portfolio Councillor system

The objectives of establishing a Portfolio Councillor system are:

- To enable Councillors to have a greater understanding and input to strategic and policy development on portfolio issues. This facilitates the active and regular engagement of Councillors in major planning, projects and services related to the portfolio.
- To enable Councillors to advocate and "Champion" on strategic and policy issues to Council and the community.
- To enable the briefing of other Councillors on specialist areas by the Portfolio Councillor.
- To assist Councillors develop the fullest possible understanding of matters being put to the Council, through the Portfolio Councillor leading discussion of relevant items.

5.2 Portfolio Councillor's duties

The role of the Portfolio Councillor will include:

- Advocating on strategic and policy issues to Council and the community.
- Briefing of other Councillors on specialist areas through specific workshops or presentation of reports.
- Represent Council on local, regional or state bodies of relevance to the portfolio.
- Act as the spokesperson of Council on matters relating to the Portfolio, including, quotes in Media Releases and speaking on Radio and Television as required.
- Where there is a relevant Council Committee to be the nominated chair for that committee, unless legislative provisions provide otherwise.

Encl 6.10

5.3 Support provided to Portfolio Councillors

Support to Portfolio Councillors to enable them to fulfil this role will be provided through:

- A designated General Manager being appointed as the primary contact for the Portfolio Councillor.
- Induction by the General Manager, and other relevant staff or organisations, in relation to the key issues affecting the portfolio.
- The designated General Manager will initiate regular meetings with the Portfolio Councillor, and other officers where relevant, to keep them briefed on issues (not less than bi monthly) and at other times necessary for the Portfolio Councillor to fulfil their role.
- Facilitating the participation of the Portfolio Councillor in relevant committees
- The provision of memberships, publications, training and/or conference attendance where appropriate to enable to Portfolio Councillor to be informed on issues relevant to their portfolio.

5.4 Reporting of Portfolio Councillors

Council will enable the Portfolio Councillor to report on matters that are relevant to their portfolio by:

- Presentation of minutes and recommendations of Committees that are related to their portfolio at the Ordinary Meeting of Council.
- Presenting a written report on their portfolio issues at the Ordinary Meeting of Council.
- Leading discussion at Councillor Briefing Sessions on matters relevant to their portfolio.
- Leading discussion in the development and annual review of the Council Plan.

6. Related Policies, Strategies and Legislation

Local Government Act, 1989
Governance Local Law No. 2, 2014
Councillor Code of Conduct

7. Council Plan

There is a Strategy in the Council Plan 2013-2017 under the Our Council Goal to communicate key Council decisions and strategies to the community in a variety of ways.

8. Management and Review

This Policy will be implemented by members of the Executive Management Team and monitored by the Chief Executive Officer.

This Policy will be reviewed by Council in February 2017.

9. Consultation

Review of this Policy has been conducted by the Executive Management Team and Councillors.

10. Human Rights Charter

This policy has been developed with consideration of the requirements under the Charter of Human Rights and Responsibilities.

The Hon. Greg Hunt MP
Minister for the Environment

MEDIA RELEASE

22 April 2015

Government moves to save Victoria's iconic Leadbeater's possum

After carefully considering advice from the independent Threatened Species Scientific Committee and submissions from experts, interested organisations and the wider community, I have decided to list the Leadbeater's possum as a 'critically endangered' species.

The Threatened Species Scientific Committee's recommendation was clear and unequivocal regarding the need to transfer the species from endangered to critically endangered.

This means Victoria's faunal emblem will now receive the highest level of protection under national environment law.

Leadbeater's possums have very specific habitat requirements in order for them to survive and flourish. Sadly, almost half of the possum's ideal habitat – the old-growth mountain ash forest in the Central Highlands of Victoria – was burnt in the 2009 bushfires.

The challenges facing this iconic species are significant. It has undergone very severe population declines in recent decades with numbers having decreased by more than 80 per cent since the mid 1980s.

That is why we will be working closely with the Victorian Government to find a solution which will help save the possum for future generations.

First and foremost, I have already asked my Department to work with Victorian Government officials and commence a review and update of the Leadbeater's possum draft Recovery Plan. This Plan must be finalised and acted upon.

The Australian Government is already taking significant action to protect threatened species. In 2014, we initiated a new national approach to saving our threatened species with the appointment of Australia's first Threatened Species Commissioner. Since then, we have invested more than $76 million for practical science-based actions, to turn around species declines.

As an example, the Australian Government is supporting Zoos Victoria to grow habitat for lowland Leadbeater's possum and helmeted honeyeater populations. Through funding under the 20 Million Tree Programme, the Government will help Zoos Victoria to plant 112,000 trees at Coranderrk Bushland Reserve which will provide breeding populations of these species with suitable habitat to help their recovery.

In addition, the Australian Government's National Environment Science Programme Threatened Species Recovery Hub will be investing $30 million over the next six years in practical science and field work to test and explore options to tackle the threats to our native animals and plants.

(ENDS)

Conservation Advice

Gymnobelideus leadbeateri

Leadbeater's possum

Taxonomy

Conventionally accepted as *Gymnobelideus leadbeateri* McCoy, 1867 (Leadbeater's possum).

Conservation status – Critically Endangered (Criterion 1:A2(c), A3(c))

Leadbeater's possum has been found to be eligible for listing under the following categories:
Criterion 1: A2 (c), A3(c): Critically Endangered
Criterion 2: B2 (a)(b)(iii)(iv)(v); Endangered
Criterion 3: B (a)(b)(iii)(iv)(v); Endangered
Criterion 5: (c); Vulnerable

The highest category for which Leadbeater's possum is eligible to be listed is Critically Endangered.

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Reason for conservation assessment by the Threatened Species Scientific Committee

This is a revised listing assessment for Leadbeater's possum. The species was listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2000.

This advice follows assessment of new information provided by public nomination to up-list Leadbeater's possum to the **critically endangered** category.

Description

Leadbeater's possum is a small, nocturnal, arboreal possum. It has a prominent dark brown stripe along its back and is pale underneath. Its ears are thin, large and rounded and it grows up to 17 cm in length. Its thick tail grows to 18 cm in length (Cronin, 1991; Strahan, 1998).

Cultural Significance

Leadbeater's possum is the faunal emblem of the state of Victoria.

Distribution

Leadbeater's possum is endemic to Victoria.

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' is located at Cockatoo Swamp near Yellingbo (Smales, 1994) within 181 ha of lowland floodplain forest where less than 20 hectares provides suitable habitat (D. Harley 2014, pers. comm., cited in DEPI, 2014). The small subpopulation is a surviving remnant of a lowland subpopulation that has historically been, and remains, isolated from others (Hansen, 2008). The Yellingbo population occurs at 110 m elevation (Harley, 2004a).

The core location of the species is an area of approximately 70 x 80 km in the Central Highlands of Victoria 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 alpine forest and subalpine woodland comprising *Eucalyptus regnans* (mountain ash), *Eucalyptus delegatensis* (alpine ash), *Eucalyptus nitens* (shining gum) and *Eucalyptus camphora* (snow gum). Prior to the 2009 fires, the greatest numbers were considered to occur in montane ash forests, and subalpine woodlands including at Lake Mountain, Mt Bullfight, and Mt Baw Baw.

Fossils and historical records indicate that the species was more widely distributed in the past than the present (Lindenmayer et al., 1993c; Bilney et al., 2010). It was once distributed from Mt Willis in north-eastern Victoria to the Yarra Valley near Melbourne, and south to the Westernport region (DEPI, 2014). Leadbeater's possum has always been considered a rare species (Smith, 1984) and the scarcity of specimens, together with the clearing in the late 1800s of areas thought to be its only habitat, led to the belief that the species was extinct (Rawlinson and Brown, 1977; Smith 1984). Specimens were collected after the 1960s in new localities in the Central Highlands (Wilkinson, 1961; Rawlinson and Brown, 1977).

Occupancy modelling following the 2009 fires predicts current strongholds mainly in the south of the Central Highlands, including the Baw Baw Plateau and its southern slopes, the Toorongo Plateau south of the Upper Yalla Catchment and state forest in the vicinity of Powelltown, parts of Toolangi State Forest and southern parts of the Upper Yarra National Park (Lumsden et al., 2013).

Relevant Biology/Ecology

Leadbeater's possums live in small groups of between two to twelve individuals containing one breeding pair, and shelter in tree hollows during the day (Lindenmayer, 1996a). Colonies live in territories that contain multiple den sites (Lindenmayer and Meggs, 1996). Female dispersal is greater than male dispersal (Smith, 1984) and females are subject to higher rates of mortality. Among young adults, males outnumber females by three to one (Lindenmayer, 1996a) and the general adult population is thought to have a sex ratio approaching 3:1 (Smith, 1984).

Breeding is limited by the number of mature females (Lindenmayer, 1996a). Observations of mating behaviour in captivity suggest that Leadbeater's possum is strictly monogamous, that only one adult male per colony is reproductively active (Smith, 1984) and colonies typically contain only a single adult female (Smith, 1984; Harley and Lill, 2007), although other studies have found colonies with two breeding females (Lindenmayer and Meggs, 1996). Breeding females reproduce twice per year and mean litter size is approximately 1.5 (Smith, 1984; Harley and Lill, 2007). Adult longevity is approximately ten years and age at first breeding is typically two years (Lindenmayer and Possingham, 1995b; Lindenmayer et al., 1993b). Generation length ([longevity + age at maturity]/2) for Leadbeater's possum is six years.

Leadbeater's possum habitat is usually defined as montane ash forest dominated by mountain ash, alpine ash and shining gum with a dense understorey of *Acacia* and an abundance of large hollow-bearing trees. The species also inhabits sub-alpine woodland dominated by snow gum containing a dense midstory of mountain tea tree (*Leptospermum grandiflorum*) along drainage lines (Jelinek et al., 1995) or forest dominated by mountain swamp gum (*Eucalyptus camphora*) with a dense midstory of *Melaleuca* and *Leptospermum* species (Smales, 1994).

Colonies live in territories of 1–3 ha that contain multiple den sites and are actively defended from neighbouring colonies (Lindenmayer and Meggs, 1996). Leadbeater's possum is typically sedentary and territorial, with resident animals travelling between den trees and feeding areas, or between alternative den trees (Lindenmayer and Meggs, 1996; Smith, 1984) with the distance between a set of nest sites used by a colony possibly exceeding 100 m (Lindenmayer and Meggs, 1996). The species appears to have long-term site fidelity (Lindenmayer et al., 2013a).

Leadbeater's possum may be a central place forager. Nest trees are spaced close to the centre of a relative exclusive home range (Smith, 1984), and linear strips of habitat (e.g., 80 m) may be insufficient for their social and dietary requirements (Lindenmayer et al., 1993d).

Leadbeater's possums feed on carbohydrate-rich plant and insect secretions (e.g. sap, manna, honeydew) and invertebrates (Smith, 1980; 1984). In montane ash forest, the species has been recorded incising acacias and feeding on the gum that exudes into the wound (Smith, 1980). Smith (1980) also highlights the dietary importance of an undescribed species of tree cricket. Paperbarks and tea trees may also be incised in lowland swamp forest.

Tree hollows are a critical resource for Leadbeater's possum and the species' abundance is positively correlated with hollow availability (Lindenmayer et al., 1991b). The majority of trees occupied by Leadbeater's possum are dead hollow-bearing trees. Living hollow-bearing trees are also used and become the next cohort of dead hollow-bearing trees in the future (Lindenmayer et al., 2013a). Leadbeater's possum rarely descends to the ground and is highly reliant upon dense, continuous vegetation with interconnecting lateral branches and/or high stem density (Lindenmayer, 1996a).

The key attributes of Leadbeater's possum across all forest types (LPAG, 2013) are:

- Hollow-bearing trees (for nest sites and refuge) with large internal dimensions in the order of 30 cm in diameter are a critical habitat feature for Leadbeater's possums (LPAG, 2013), particularly and almost exclusively large old trees (Lindenmayer et al., 2013a; Lindenmayer et al., pers. comm., 2014a).
- Density of hollow-bearing trees is recognised as a critical habitat feature (e.g., DEPI, 2014). There are strong and quantified links between the abundance of hollow-bearing trees and the occurrence of Leadbeater's possum (e.g., Lindenmayer et al., 1991b; Lindenmayer et al., 2013b; Lindenmayer et al., pers. comm., 2014a), with nest hollow availability the limiting factor to population size. Density of less than one hollow-bearing tree per hectare is considered to represent ecosystem collapse for the Mountain Ash Forest ecosystem (Burns et al., 2014).
- predominance of smooth-barked eucalypts (with loose bark hanging in strips providing shelter for insect prey and material for nests) or gum-barked eucalypts (related to foraging behaviour) (Lindenmayer, 1996a; Harley, 2004a;b;c). Forest types of Leadbeater's possum are most commonly ash forest typically dominated by mountain ash, alpine ash and shining gum but it is also known to occur in subalpine woodlands and lowland swamp forest dominated by snow gum or mountain swamp gum (Smith and Hartley, 2008)
- a structurally dense interlocking canopy or secondary tree layer of continuous interconnecting structure (to facilitate movement) (Lindenmayer, 1996a; Harley, 2004a;b;c), and
- a wattle understory (providing food) (Smith and Lindenmayer, 1988; Menkhorst and Lumsden, 1995; DSE, 2013).

Habitat considered most likely to be currently occupied by Leadbeater's possums is characterised by lush, unburnt vegetation in gullies, located in areas that have relatively low summer temperatures and high summer rainfall (Lumsden et al., 2013). An optimum habitat is an uneven-aged ash forest with a dense understory of wattle trees and a supply of hollow-bearing trees of between 4.2 – 10 per 3 ha (Smith and Lindenmayer, 1988). Leadbeater's possums appear to have critical minimum habitat size of around 12 ha (Lindenmayer et al., pers. comm., 2014b).

Leadbeater's possums do not occur on burned sites, including those subject to low and moderate severity fire, clearfell logged, or regenerated montane ash forest where hollow-bearing trees are largely absent (Lindenmayer et al., pers. comm., 2014a) until required conditions have returned.

Habitat of the lowland population is different to that throughout the possum's core range of montane ash forest (Harley et al., 2005). The lowland population occupies lowland swamp forest of varied densities of mountain swamp gum with *Melaleuca* spp or *Leptospermum* spp in the

middle-story. Densities of Leadbeater's possum are highest in young (e.g., 20–40 years old) stands of forest supporting high stem density. Like the montane population, the lowland population habitat has a predominance of smooth-barked eucalypts (that provide exudates from the trunks), hollow-bearing trees (that provide den sites) and highly-connected in the middle-story or canopy (Harley et al., 2005). Given the genetic distinction of this population, its gene pool may include genes involved in adaptation to a lowland swamp environment, adding to the conservation importance of this population.

Threats

The primary threats to Leadbeater's possum are habitat loss and ongoing deterioration of habitat quality including loss of vegetation type and structure. These threats result in a loss in the species' ability to shelter, breed, disperse, and feed. This situation has resulted in immediate population decline as well as ongoing decline in reproduction rates. Loss of habitat quality has resulted in complete abandonment of habitat in some instances, or reduction in population size and reproduction rate (e.g., at Yellingbo during the past nine years).

The loss of habitat and loss in habitat quality have occurred and continue to occur through a number of causes:

<u>Loss through fire</u>
Fire results in:

- direct mortality of Leadbeater's possums
- loss of habitat (extent and fragmentation). Leadbeater's possum is absent from sites burnt in the 2009 fires regardless of fire severity (Lindenmayer et al., 2013a, b) with 36 per cent of the potential ash forest habitat burnt in 2009 (Lumsden et al., 2013) (or 35 per cent (LPAG, 2013), and
- loss of habitat quality.

Fire is the primary form of natural disturbance in mountain ash forest. Prior to European settlement the fire regime was less frequent than at present, and occurred in late summer (Lindenmayer et al., 2013b). Many major fires have occurred in the Central Highlands over the past 400 years, the largest and most extensive known are the 1939 'Black Friday' fires which burnt over 1.5 million hectares state-wide, including much of the area of Leadbeater's possum habitat (Lindenmayer and Ough, 2006; DSE, 2008).

Lumsden et al. (2013) and LPAG (2013) note that over the last century, bushfires have occurred in the Central Highlands on average every ten years, and that the frequency and intensity of wildfires are likely to increase under climate change scenarios, which predict increased rates of extreme climatic events (Lumsden et al., 2013). The last decade has seen a significant and measurable increase in the number, intensity and area burnt by bushfires and projections suggest that this will continue to escalate (DSE, 2008).

Of the 195,000 ha of ash forest and snow gum woodlands considered to be potential habitat of Leadbeater's possum at 2009, 68,000 ha (35 per cent) was burnt in 2009 (LPAG, 2013) and 45 per cent of the best Leadbeater's possum habitat within montane ash forest (Lumsden et al., 2013). Of the three sub-alpine sites where Leadbeater's possum have been monitored – Lake Mountain, Mt Bullfight and Mt Baw Baw; Lake Mountain and Mt Bullfight were burnt in 2009. The Lake Mountain site was thought to contain up to 300 individual Leadbeater's possums prior to the 2009 fires, with only four individuals recorded since (Harley and Antrobus, unpublished data cited in Harley and Lindenmayer pers. comm., 2013). Surveys at Mt Bullfight indicate that the population supports fewer than 50 individuals following the 2009 fires (Harley and Lindenmayer pers. comm., 2013)

Low intensity fire can stimulate some regeneration but may not kill all over-story trees, resulting in multi-aged stands. In severe, high intensity wildfires, almost all the over-story trees may be

killed, but seeds are released that germinate as a uniform regenerating cohort. Fire in an old growth forest will produce a pulse of large dead trees and fire scarred living old trees that can provide nesting habitat for cavity-dependent species such as Leadbeater's possum (Lindenmayer et al., 2013b).

Wattle in the understory provides food for Leadbeater's possums. Wattles age and decline over more than 50 years after fire. Bushfire usually kills wattle, but promotes regeneration of this foraging habitat, which forms suitable substrate within 20 years of fire (LPAG, 2013).

While fire may promote the capacity for older trees to form hollows from fire scarring, young trees do not stand long after they are burned and are not able to form cavities for nesting (Lindenmayer et al., 2013b). It is estimated that old-growth or multi-aged mountain ash forest comprised 30–60 per cent of the current ash forest estate in the Central Highlands of Victoria prior to European settlement. Old grown ash forest now comprises 1.15 per cent of this mountain ash forest estate (Lindenmayer et al., 2011; Lindenmayer et al., 2013a). Large areas of the forest estate are regrowth forest with small areas of old forest embedded within them (Lindenmayer et al., 2011).

When the interval between fires is less than that required for stands to reach reproductive maturity (approximately 20 years), mountain ash will be replaced with other species with shorter reproductive periods such as wattle (Lindenmayer et al., 2011).

The 'Black Saturday' fires in 2009 fires burnt 45 per cent of the best Leadbeater's possum habitat within montane ash forest (Lumsden et al., 2013). Post-fire, the species has not been detected at burned sites regardless of fire severity (Lumsden et al., 2013). The threat of another wildfire, even if it is small in scale, is a threat to this species' persistence (VicForests pers. comm., 2014).

Leadbeaters' possum are less abundant on unburned sites where the surrounding landscape has been burned, and suggest a greater level of decline after fire than previously recognised (Lindenmayer et al., 2013c).

Young forest burns at higher severity than mature forest (Lindenmayer et al., 2011). Lindenmayer et al. (2011) outline a number of reasons for this, including increased density of regrowth saplings, lower canopies and therefore lower fuel height for flames, closely spaced tree crowns, the potential for reduced soil and moisture holding capacity of undergrowth, and propose that a landscape fire-trap develops because of the interacting effects of wildfire, logging and the combination of these. Taylor et al. (2014) also found a strong relationship between the age of mountain ash forest and the severity of fire damage, with a higher frequency of high-severity impacts occurring in stands of trees less than seven or greater than 40 years. Attiwill et al. (2013), however, found no support for increased fire severity in younger age class forests from the 2009 fires in the Central Highlands. They note that the largest of these fires (at East Kilmore–Murrindindi, which burnt 100,000 ha) was not consistently greater or lesser in older regeneration than in the most recent regeneration, and that greatest fire severity (measured by crown burn) occurred in the intermediate age classes.

Burned forests are subject to post-fire salvage logging. Salvage logging resembles clearfelling but in the reverse order: the forest is initially burned by unplanned fires and fire damaged stands are then clearfelled with merchantable timber removed. In some cases regeneration burns or mechanical site-preparation methods are used to re-establish eucalypt stands (Lindenmayer and Ough, 2006). The impact of this process is similar to clearfelling, because it involves clearfelling (Lindenmayer and Ough, 2006). Burned hollow-bearing trees in stands subject to salvage logging are exempt from cutting, however their collapse rates are higher because they are subject to increased exposure (Lindenmayer and Ough, 2006).

Fire is also involved in the process of clearfell harvesting. Following clear cutting, logging debris is burned to create a bed of ashes in which the regeneration of a new eucalypt stand takes place (Lindenmayer et al., 2011; Lindenmayer et al., 2013a).

Loss through harvesting and lack of habitat quality in regrowth forest

In the past 40 years, the usual method of logging has been clear-felling (Lindenmayer et al., 2011) and is currently the conventional form of logging in Victorian mountain ash forests (DSE, 2006). Clear-felling is a method of harvesting a coupe in which all merchantable trees, apart from those to be retained for wildlife habitat, are removed in a single operation. In the Central Highlands, harvesting predominantly involves clearfelling in coupes averaging 16.5 hectares (Attiwell et al., 2013). A 'regeneration' or 'slash burn' fire is then usually undertaken of the debris (logging slash) before sowing takes place (DSE, 2006; Attiwell et al., 2013). Hollow-bearing trees retained for 'wildlife habitat' are of little immediate habitat value to Leadbeater's possum when there is no surrounding foraging habitat, but may be used when surrounding foraging habitat vegetation and structure is regrown (i.e. 20 years (LPAG, 2013)).

Vegetation clearance results in an expected direct mortality of Leadbeater's possums and loss of habitat (extent and fragmentation). Leadbeater's possum does not occur in clearfell logged and regenerated montane ash forest where hollow-bearing trees are largely absent (Lindenmayer et al., pers. comm., 2014a). 42,685 hectares of montane ash forest in the Central Highlands has been logged in the past 40 years, including approximately 19,338 hectares since late 1997 Lindenmayer et al. (pers. comm., 2014a).

Old-growth ash forest is prime habitat for Leadbeater's possum. It is estimated that old-growth or multi-aged mountain ash forest comprised 30–60 per cent of the current ash forest estate in the Central Highlands of Victoria prior to European settlement. Old growth ash forest now comprises 1.15 per cent of this mountain ash forest estate (Lindenmayer et al., 2013a).

The dominant eucalypts in montane ash forest do not begin to form hollows until trees are 120 years old (Lindenmayer et al., 2013b) and do not develop hollows suitable for Leadbeater's possum until trees attain 190 years of age (Smith and Lindenmayer, 1988). In many areas, standing dead trees have provided the majority of dens for Leadbeater's possums (Lindenmayer et al., 1991b). However, these trees are subject to a high rate of collapse resulting from natural decay (Lindenmayer et al., 1997; 2012). While loss of hollows due to decay is a natural process, hollows have been and are currently being lost at a greater rate than they are formed due to a reduction in equivalent replacement as a result of clearfelling, fire, and in some cases, altered succession (e.g., Yellingbo). Short-term intervals between fire events and timber harvesting on short rotation cycles do not provide for formation of replacement hollows (Lindenmayer and Possingham, 1995a; 1995b; 1996). As a consequence, the availability of suitable hollows for denning is a limiting factor across much of the range of Leadbeater's possum (Lindenmayer et al., 1997; 2012). In areas of regrowth, for instance in areas burnt during fires in 1930s, trees may not develop hollows suitable for Leadbeater's possums for more than a century (Lindenmayer et al., 1993a,b).

Clearfell logging on 80–120 year rotations means that large old trees never develop on logged and regenerated sites. Selective clearfelling removes targeted existing large trees (including nest hollows), but also accelerates the decay and collapse of non-targeted hollow bearing trees, (Lindenmayer et al., 2013b). The rate of tree fall exceeds recruitment of new hollow-bearing trees within montane ash forests (Lindenmayer et al., 1997).

The impacts of fire go beyond the areas directly burned. Hollow-bearing trees adjacent to areas of logged forest have been found to suffer from accelerated rates of collapse (Lindenmayer et al., 1997).

In existing forests, the quality of Leadbeater's possum habitat may be reduced by:

- loss of hollow bearing trees without equivalent replacement hollows as a result of earlier harvesting;
- habitat fragmentation as a result of timber harvesting or fire,
- altered habitat structure due to altered fire regimes, harvesting regimes or altered hydrology.

Loss of habitat quality – other causes

Loss of habitat quality has resulted in complete abandonment of habitat in some instances, or reduction in population size and reproduction rate (e.g., at Yellingbo during the past nine years).

The Yellingbo Nature Conservation Reserve population of Leadbeater's possum is genetically distinct from the remaining Leadbeater's possums (Hansen, 2008). It occurs in mountain swamp gum dominated forest with a dense midstory of *Melaleuca* and *Leptospermum* species (Smales, 1994). This habitat is subject to ongoing quality decline of eucalypt dieback and reduced regeneration, resulting in an altered, more open forest structure. The major cause of this change is thought to be a result of altered hydrology of the Cockatoo Creek floodplain (Harley and Antrobus, 2007). There is currently estimated to be less than 20 ha of high quality habitat available at Yellingbo. In 2007, an assessment across the reserve indicated that vegetation dieback was present at more than 40 per cent of sites (Harley and Lindenmayer, pers. comm., 2013). Habitat deterioration has resulted in the abandonment of 46 per cent of active territories at Yellingbo during the past nine years (Harley and Antrobus, unpublished data cited in Harley and Lindenmayer pers. comm., 2013). Molecular analyses also indicate that the habitat decline has resulted in population fragmentation within the reserve (Hansen, 2008).

Population monitoring of the lowland population of Leadbeater' possum has been conducted at Yellingbo Nature Conservation Reserve since 1996. Data collected between 1995 and 2004 indicated that the size of the population was stable at 80–100 individuals (Harley et al., 2005). The number of individuals recorded peaked to 112 at 2003. At 2012 the number had dropped to 60 individuals (Harley and Lindenmayer, pers. comm., 2013). Recent reports are that the population has declined to only 42 individuals in 2013 (Arup and Smith, 2013) and in 2014 only 40 individuals (Smith, 2014).

How judged by the Committee in relation to the EPBC Act Criteria and Regulations

The Committee notes it is not necessary to identify a quantitative risk of extinction, but it is important to ensure that judgements about the criteria (for example, whether a reduction in numbers represents a severe decline) are made in the context of risk of extinction. When assessing a species' eligibility against the listing criteria, the Committee exercises its judgement to give practical meaning to the subjective terms of the criteria, by considering information in the context of the species' biology and relevant ecological factors, and having regard to the degree of complexity and uncertainty associated with that context and the information provided. The Committee is informed, but not bound by, indicative thresholds.

Criterion 1: Reduction in numbers (based on any of A1 – A4)

A1. An observed, estimated, inferred or suspected population very severe ≥90%, severe ≥70% substantial ≥50% size reduction over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
 (a) direct observation
 (b) an index of abundance appropriate to the taxon
 (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
 (d) actual or potential levels of exploitation
 (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

A2. An observed, estimated, inferred or suspected population very severe ≥80%, severe ≥50% substantial ≥30% size reduction over the last 10 years or three generations, whichever is the longer**,** where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible**,** based on (and specifying) any of (a) to (e) under A1.

A3. A population size reduction very severe ≥80%, severe ≥50% substantial ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

A4. An observed, estimated, inferred, projected or suspected population size reduction very severe ≥80%, severe ≥50% substantial ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

Criterion 1 establishes trend through estimates of quantitative change by comparing a baseline of a variable to the same variable over the period of time of three generations lengths. The comparison provides for an estimated decline over time. The time of comparison varies among the four options of this criterion with A1 and A2 including the past, A3 the future, and A4 the past to the future. Within each of these, decline may be observed, estimated, inferred or suspected for population size based on any one variable described in (a) – (e).

Eligible for listing as Critically Endangered (based on A2(c), A3(c))

Evidence:

The period of time over which decline is considered (three generation lengths) for Leadbeater's possum is 18 years.

Application of A1–A4 for Leadbeater's possum:
Causes of population reduction in Leadbeater's possum have not ceased and may not be reversible. Therefore A1 is not applicable and the Committee will consider has therefore considered declines only within the options described under A2, A3 and A4. Under these, thresholds for population size reduction of very severe ≥80%, severe ≥50% or substantial ≥30% are applicable and these thresholds equate to listing categories of critically endangered, endangered and vulnerable respectively.

Application of (a)–(e) for Leadbeater's possum:
The variables that can be considered in Criterion 1 for population size reduction include direct observation (a) (not applicable for A3) and index of abundance (b); area of occupancy, extent of occurrence and/or quality of habitat (c); levels of exploitation (d); or effects of an introduced biological threat (e).

While there are estimates of current numbers of individuals of Leadbeater's possum for the whole species (e.g., LPAG, 2013; Lindenmayer et al., pers comm., 2014a, see also Criterion 3), the methodology used for these estimates cannot be applied to the past to provide baseline numbers for comparison of change resulting in a quantitative threshold. While there are instances of numbers of individuals in specific locations declining over time (e.g., Yellingbo, Mt Bullfight, Lake Mountain) and these indicate decline in the species at these locations, they do not provide for quantitative estimates of decline for the whole species. There are therefore inadequate data to provide for quantitative levels of declines over time for the whole species using 'direct observation' (a) and 'index of abundance' (b) for population size for this criterion.

There are no data to provide for quantitative declines for Leadbeater's possum based on (d) levels of exploitation, or (e) effects of an introduced threat.

Analyses for Leadbeater's possum under Criterion 1 therefore focus on decline in Leadbeater's possum based on decline in area of occupancy, extent of occurrence and/or quality of habitat (c). Analyses based on (c) – decline in area of occupancy, extent of occurrence and/or quality of habitat have be undertaken for A2 and A3. There are not adequate baseline data to provide for additional further analyses under A4. Details of these analyses are provided in Appendix 1 and are summarised below.

Information sources for analyses under Criterion 1
Decline in area of occupancy, extent of occurrence and/or quality of habitat for Leadbeater's possum under Criterion 1 is primarily focused on three causes:

- decline as a result of fire,
- decline as a result of harvesting, primarily as clearfelling but also including thinning, and
- decline in habitat quality due to loss, without equivalent replacement, of hollow-bearing trees.

Leadbeater's possum is a habitat specialist, with one of the most restricted distributions of any Australian mammal (Lindenmayer, 2013). While alpine forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum have been termed 'potential habitat' and 'suitable forest' (e.g., LPAG 2013; 2014a, b) for Leadbeater's possum, not all of this forest is suitable habitat. Lindenmayer et al. have undertaken large scale vegetation surveys in the central highlands of Victoria since 1987 (e.g., Lindenmayer, 1989; Lindenmayer et al., 1990; 1991a, b; 2000). Their data layers indicate that at 1987 and 1989 montane ash forest was represented by 171,200 ha, but of this only 6.7 per cent was predicted to support suitable habitat for Leadbeater's possum. Lumsden et al. (2013) also note that while there are 43,501 ha of unburnt ash forest protected in parks and reserves within the Central Highlands at 2013, not all this area is likely to be suitable and occupied by Leadbeater's possum, with modelling based on post-2009 fire surveys estimating that the possum is likely to only occupy 15,000 ha.

Loss due to future fire
The last decade has seen a significant and measurable increase in the number, intensity and area burnt by bushfires. Projections suggest that this situation will continue to escalate (DSE, 2008). Wetter forests, including the Central Highlands and the Otway Ranges burn less frequently and often only following periods of extended drought. Over the last century, major fire events in the state of Victoria, including 1939 Black Friday, 1983 Ash Wednesday, 2003 Alpine Fires and the 2006/07 Great Divide Fires have occurred during extended periods of drought (DSE, 2008). Each of these fires burnt over 1 million hectares state-wide (DSE, 2008).

DEPI (2013) note that bushfire risk is difficult to quantify, and where and when they will occur is largely unknown. Modelling to quantify bushfire risk across Victoria was undertaken by DEPI (2013) to develop bushfire risk mitigation strategies. The model could not incorporate risk to ecological values because sub-models that quantify bushfire effects on ecological values were not sufficiently advanced to be incorporated. As a result, estimation of risk was limited to risk to property. Results noted that bushfire risk to property varies considerably between regions. East Central, the region that includes the Central Highlands, has a significant proportion of the state's bushfire risk to property (31 per cent). This region had a residual risk near the maximum level (100 per cent) for many years (20) prior to the 2009 bushfires, and after the 2009 fires the residual risk dropped to near 40-50 per cent as a result of the reduction in fuel loads. Residual risk, however, has rapidly increased since 2009 (modelled to be at between 70–75 per cent by 2015) even after planned burning on public land (DEPI, 2013).

Lumsden et al. (2013) and LPAG (2013; 2014b) note that over the last century, bushfires have occurred in the Central Highlands on average once every ten years. As Leadbeater's possum is confined to a relative small area, a single large fire can impact on a significant proportion of the population (LPAG, 2014b). This frequency and intensity of wildfires is likely to increase under climate change scenarios, which predict increased rates of extreme climatic events (Lumsden et al., 2013) and thereby increasing the risk to Leadbeater's possum (LPAG, 2014b).

Of the 195,000 ha of ash forest and snow gum woodlands considered to be 'suitable forest' for Leadbeater's possum, 68,000 ha (35 per cent) was burnt in 2009 (LPAG, 2013), and 45 per cent of the best Leadbeater's possum habitat within montane ash forest (Lumsden et al., 2013). A single large fire can impact on a significant proportion of the population of Leadbeater's possum (DEPI, 2014). VicForests (pers. comm., 2014) note that the threat of another wildfire, even if it is small in scale, is a threat to this species' persistence. Lumsden et al., (2013) note that the 2013 Aberfieldy fire could have severely affected the remaining strongholds for Leadbeater's possum in the Baw Baw region if it had started on the western side of Thompson Dam instead of the eastern side, noting that a single fire could have had a significant impact on one of the remaining strongholds for the species. The Baw Baw Plateau was not affected by 2006/7 or 2009 fires, but is a continuous forested area and an area less than a quarter in size of that burned in the 2009 fires. This smaller size and its continuity makes it susceptible to extreme damage should a fire reach this location.

A fire to the Yellingbo population would significantly reduce the genetic diversity of the species.

Noting this likelihood and potential damage, Lumsden et al. (2013) incorporate future fire scenarios of 25 and 50 per cent of Leadbeater's possum reserve system burnt by bushfire by 2020 into their modelling of population viability. They noted that if the fire was larger, for example equivalent to the 1939 fires, the impact would be even greater, and if there was more than one fire, the risks would be compounded.

If we assume the prediction of one fire every ten years (following Lumsden et al., 2013; LPAG, 2013; 2014b), and these are independent events across an area, the probability of <u>at least</u> one fire occurring over the period 2013 to 2031 is around 85 per cent, with the potential to further reduce ash or snow gum woodland in the range of Leadbeater's possum. The chance of more than one fire occurring is 55 per cent. The magnitude of any future fire occurring between now and 2031 and its impact on existing ash forest and Leadbeater's possum habitat, however, is unable to be quantified.

Given the likelihood of fire, but the unknown and unquantified area likely to be impacted, the Committee has considered a range of potential scenarios to determine possible impacts to area of occupancy/extent of occurrence. Scenarios include no fire, low to medium likelihood of fire impact (e.g., of 12.5 and 20 per cent), and a 50 per cent likelihood of fire impact. A 35 per cent loss from fire scenario is also included, because this is equivalent to the area lost to ash forest and snow gum woodland 'suitable forest' in the 2009 fires. This range of potential losses are

applied to the area estimates (to 'predicted habitat' and 'suitable forest') that remain following loss from harvest and loss of habitat quality.

The Committee notes that the fire damage scenarios included in its analyses are relatively conservative, given:

- 34–36 per cent of potential ash forest habitat / suitable forest ash was lost in the 2009 fires (Lumsden et al., 2013; LPAG 2013; 2014a),
- 45 per cent of the 'best habitat' in the reserve system was lost during the 2009 fires (Lumsden et al., 2013; LPAG 2013),
- modelling of future loss to the reserve system from fire by Lumsden et al. (2013) included:
    - fire scenarios of 25 and 50 per cent loss
    - within a timeframe of 7 years (to 2020).

The analyses of future loss from fire scenarios explored here in Criterion 1, estimate losses to the maximum of 2031 i.e., within 18 years. This approach is more conservative in terms of likelihood.

The Committee notes that risk of fire occurring within an area often drops immediately following fire (e.g., as demonstrated in DEPI, 2013) and that fires are not independent events, but notes also that the impacts of fire can be cumulative within an area. The analyses provide for one fire of various magnitudes within the time periods considered, but as occurrences of fires reduce the likelihood of subsequent future occurrence (at least in the short-term), the consequence of any subsequent fire to the remaining reduced habitat is much greater. The analyses, like those of Lumsden et al. (2013), assume future fire is independent of previous fires, but the Committee notes that any subsequent fire would have compounding impact.

Details of these analyses are provided in Appendix 1. This Appendix provides the detail for options considered most appropriate for the data available for Leadbeater's possum. The analyses in Appendix 1 for Criterion 1 are limited to the subpopulation within the Central Highlands and do not include data or analysis of the remaining lowland subpopulation of Leadbeater's possum in Yellingbo (which are currently thought to occupy as little as 50 ha (LPAG, 2013)).

Analysis A2 (past 18 years from 1995)

Analysis A2a provides estimates of loss of the predicted occupied habitat from 1989 to 2013 (Lindenmayer et al., pers. comm., 2014a). Suitable habitat at the baseline at 1989 is estimated to be 11,470 ha, which declines to only 2,225 ha by 2013 as a result of loss from fire, harvesting and loss in habitat quality from loss of hollow-bearing trees. This is a decline of over 80 per cent decline, which is considered to be very severe (Table 1).

In this estimation of remaining suitable habitat, Lindenmayer et al. (pers. comm., 2014a) have noted previously suitable habitat has been lost and become unsuitable through the loss of hollow-bearing trees. Where 6.7 per cent of montane ash forest was suitable in 1989, the loss of hollow-bearing trees has resulted in only 3.1 per cent being currently suitable (independent of other losses from fire and harvesting). This represents a 53.7 per cent loss of habitat from this cause, and is a complete loss of habitat use by Leadbeater's possum (rather than a habitat quality decline where habitat may still be used but at a lower capacity than high quality habitat). It is presumed that in the remaining habitat that is used by Leadbeater's possum, there is an additional decline in quality of a lower density of hollows. Such decline has not been included within this assessment and may, therefore, provide for an underestimation of decline. These losses are also conservative because they do not include the loss of potentially suitable habitat that occurs as narrow strips, edge effects, or the fragmentation of habitat by roads and tracks that the possum cannot cross. The Committee is uncertain about any over-estimation of loss from potential double counting (e.g., habitat lost from hollow-decline and subsequent burn). This analysis uses data from 1989 (rather than 1995) and therefore may include a degree of over estimation of loss.

The Committee notes that the analysis of predicted suitable habitat overestimates loss because it considers loss over a larger time period (the baseline begins at 1989 rather than 1995), but as it does not include reduced habitat quality from loss of hollow-bearing trees, habitat lost as a result of edge effects and, loss of habitat as strips and fragmentation by roads it also underestimates loss.

Analysis A2b provides estimates of loss for the much larger area of 'suitable forest' (from data provided by VicForests pers. comm., 2014; LPAG, 2014a) for all ash forest (comprising mountain ash, alpine ash, shining gum and snow gum forests) within the home range of Leadbeater's possum and within the Central, Dandenong and Central Gippsland Forest Management Areas. 'Suitable forest' at the baseline 'since 2000' is 204,400 ha. Two options of loss from the decline of hollow-bearing trees have been provided in the analysis, along with quantitative data on losses (in hectares) from fire and harvesting. The first option is a 22 per cent loss based on abundance at 1997 being 5.1 hollow-bearing trees per hectare to 4 per hectare in 2013 (Lindenmayer et al., pers. comm., 2014a). Using this decline of 22 per cent, the overall decline in 'suitable forest' from this, fire and harvesting is 44 per cent, which is considered to be substantial. The second option is a 53.7 per cent loss following that found by Lindenmayer in A2a. Using this decline, the overall loss from fire, harvesting and loss of habitat from loss of hollows is 67 per cent, which is considered to be severe (Table 1). The data for losses from harvesting and fire provided by VicForests (pers. comm., 2014) are provided 'from 2000'. This time period is shorter than that considered for A2a and is therefore an underestimate for the 18 year time period considered for this assessment. This analysis uses data from 'since 2000' (rather than 1995) and therefore may include a degree of underestimation of loss.

Results of A2 are shown in Table 1.

Table 1. Summary outcome of assessment under A2

A2	Type	Assessment period	Baseline area	Total estimated area of occupancy, extent of occurrence and/or quality of habitat decline by 2013
(a)	Predicted 'suitable habitat'	1989 to 2013	11,470 ha	81–83%
(b)	'suitable forest'	'since 2000' to 2013	204,000 ha	44–67%

The Committee notes that both analyses incorporate inaccuracies. Analysis (a) appears to have unknown degrees of overestimation (longer time period than 18 years) and underestimation (it does not include all expected losses). Analysis (b) similarly has unknown underestimation of loss as it does not include loss for the entire 18 year period.

The Committee considers that predicted suitable habitat is more closely aligned with the possum's area of occupancy. Decline in this area is a more accurate measure of likely decline in Leadbeater's possum. The IUCN (2014) note that area of occupancy is included in the criteria in addition to extent of occurrence because it helps to identify those species that are habitat specialists (such as Leadbeater's possum) and these species are considered to have an increased risk of extinction. It also notes that area of occupancy can be a useful proxy for population size because there is generally a positive correlation between area of occupancy and population size. Given this, the Committee considers that decline in the predicted suitable habitat is a closer approximation to decline in population size than is 'suitable forest' or extent of occurrence.

In this instance, where there are different decline rates for these two measures, the Committee considers predicted suitable habitat to be a closer representation to decline in Leadbeater's

possum over this time period. The Committee therefore considers that the decline of 81–83 per cent is a closer representation to decline in population size of Leadbeater's possum over this time period, which it considers to be very severe.

A3 (future 18 years to 2031)
Analysis under A3 allows for the use of current estimates of 'suitable habitat/predicted occupied habitat' or 'suitable forest', and predicts into the future.

Analysis A3a and A3b provide estimates of loss from 2013 to 2031 using baselines of the predicted occupied habitat at 2013 of 2,225 ha (Lindenmayer et al., pers. comm., 2014a) and 15,000 ha (of Lumsden et al., 2013). Analysis A3c provides the same analysis but on 'suitable forest' (rather than predicted occupied habitat). Losses from predicted harvesting (with different harvesting rates) and a 63 per cent loss of quality to the remaining unharvested habitat /forest, as a result of a decline from 4 hollow-bearing trees per hectare to 1.5 hollow-bearing trees per hectare in 2035 (Lindenmayer et al., pers. comm., 2014a), are deducted sequentially (to prevent double counting of loss). This area also has the potential to be lost to fire in the 18 year period to 2031, although the quantities of loss are speculative. Given fire history of the region, various potential losses from fire have been included, noting these include loss scenarios less than those of Lumsden et al. (2013) and over a longer time period, and are therefore relatively conservative. As the analysis provides for outcomes from a range of scenarios, including no fire, they do not include the quantitative probability of fire occurring within this time period. The results indicate that should fire damage 50 per cent of area by 2031, overall loss will be greater than 80 per cent, regardless of the various predicted harvest rates or the original baselines used (predicted occupied habitat or 'suitable forest'). This loss is considered to be very substantial. Under the maximum predicted harvest rates the loss is very substantial if fire only damages 35 per cent of habitat to 2031. These results are summarised in Table 2 (with detail provided in Appendix 1).

A revised Action Statement under the Victorian *Flora and Fauna Guarantee Act 1988* for Leadbeater's possum was approved and released in August 2014 (DEPI, 2014). This Action Statement sets out what is intended to be done by the Victorian Government to conserve and manage the species. Action Statements are designed to apply for three to five years, after which time they will be reviewed and updated. The Action Statement (DEPI, 2014) for Leadbeater's possum notes further specific reductions in harvesting activities relative to Leadbeater's possum 'potential habitat' ('potential habitat = 'suitable forest'). These include:

- that all future harvesting activities, including thinning and the construction of new roads, are to be excluded from the timber harvesting exclusion zone around *[verified]* colonies* *[i.e. 200m radius]*,
- harvesting activities will be excluded from within 100 m of modelled old growth ash forests,
- protection from harvesting activities for at least 30 per cent of ash forest (approximately 274 ha) to develop old growth forest,
- additional exclusions with a 200 metre radius (Special Protection Zones) will be established around all verified records of colony sites from the 15 years prior to February 2014, and all new records once the record is verified.
- harvesting will be delayed for two years in areas where modelling (Lumsden et al., 2013) predicts a greater than 0.65 probability of being occupied by Leadbeater's possum. Should Leadbeater's possums be confirmed to occur following surveys *[presumably undertaken across these areas within the two year timeframe?]*, these sites will be confirmed sites and zoned as Special Protection Zones.

* colonies are required to be verified to a standard developed by DEPI.

These reductions in harvesting activities are expected to reduce the impact of harvesting beyond 2014, however estimates of the level of reduction relative to the baselines of the above analyses are not quantifiable.

Table 2. Summary outcome of assessment under A3

	type	Assessment period	baseline area	Estimated total decline – no future fire[1]	Estimated total decline – 35% fire[2]	Estimated total decline – 50% fire[1]
A3(a)	Predicted suitable habitat	2013 to 2031	15,000 ha	65	77–83	87
A3(b)	Predicted suitable habitat	2013 to 2031	2,225 ha	63	77–83	87
A3(c)	'suitable forest'	2013 to 2031	146,660 ha	65	77–83	87

[1]= under all harvest scenarios assessed
[2]= range of total loss under all harvest scenarios assessed

The Committee considers that it is unlikely that no fire will occur by 2031 and, although included here in Table 2 to demonstrate the lower bound of decline under A3, scenarios of no fire will not be considered further for this assessment to 2031.

Given that:

- the Committee's assessments of fire scenarios are relatively conservative to models predicting outcomes based on fire history for the area,
- a 35 per cent impact of fire is similar to the 2009 fires,
- Lumsden et al. (2013) and LPAG (2013) note that over the last century, bushfires have occurred in the Central Highlands on average every ten years
- this assessment is over an 18 year period, and therefore fire has a even greater likelihood of occurring,
- the 18 year period provides for the likelihood of more than one fire occurring within this time period,
- that the intensity and frequency of fire is expected to increase (e.g., DSE, 2008; Lumsden et al., 2013),
- the smaller the area considered, the lower the likelihood of fire impact to that area, however the greater the consequence should it occur,

on balance the Committee considers that decline in population size to 2031 under A3 is estimated, inferred, projected and suspected to be of over 80 per cent and very severe.

Long term projections beyond 2031

After the period under consideration for this criterion, Leadbeater's possum is confidently predicted to decline further.

Beyond 2031 (the limit of consideration for thresholds in this criterion) the rate of decline of hollow-bearing trees and therefore Leadbeater's possums will increase, noting that the rate of decline will increase further towards 2060, and recognising there is likely to be some degree of lagged response. Mountain ash typically do not start forming hollows until they are 120 years old, with the large cavities preferred by Leadbeater's possum typically taking 190–220 years to form (Smith and Lindenmayer, 1988).

The trend for projected abundance of hollow-bearing trees in montane ash forests is for a rapid decline over the coming 20 years, even without further logging and fire, with projections of more than 4 hollow-bearing trees per hectare habitat wide in 2013 to 1.5 per ha by 2035, followed by less than 0.9 per ha by 2060 (Lindenmayer et al., pers. comm., 2014a). Lindenmayer et al., pers. comm. (2014a) project that the amount of suitable habitat for Leadbeater's possum will decline by at least 75 per cent by 2035. This is considered to be an underestimate given that it does not include estimates of the impacts of edge effects on the degradation of habitat suitability created by clearfell logging (and harvesting infrastructure e.g., roads).

Following 2060, the largest cohort of old trees regenerating after the 1939 fires, will begin to develop cavities suitable for occupancy by Leadbeater's possum (Lindenmayer et al., pers. comm., 2014a) and therefore following this time, Leadbeater's possums may begin to rebuild in numbers.

The Leadbeater's possum reserve system was established as a key strategy for conservation of the species. Lumsden et al. (2013) recognise that areas will become increasingly unsuitable for Leadbeater's possum before 1939 regrowth trees mature sufficiently to produce suitable hollows during the next 50–120 years. Increased rates of tree fall and future fires will exacerbate this situation, with models predicting the population in the reserve to fall to critically low levels (Lumsden et al., 2013). Lumsden et al. (2013) undertook population viability modelling (see Criterion 5) to quantify the risk of extinction with risk of extinction defined as the probability of adult females falling below 500 within a 200 year time frame. Overall, the results of their modelled scenarios indicate that, even without further disturbances such as future wildfires and an accelerated loss of hollow-bearing trees, the reserve system does not provide the requisite minimum population requirements. The analysis predicts that the population of Leadbeater's possum within the reserve system has a high likelihood of being at a very low population size which imposes on the species a greater risk of extinction, and that the existing reserve is insufficient to ensure the long-term persistence of the species.

Woinarski et al. (2014) found Leadbeater's possum to be critically endangered based on this criterion (IUCN criterion A) for declines in population size (a) (b) as well as area of occupancy/extent of occurrence/habitat quality (c), in the past, future and past+future (A2, A3, A4), with a rate likely to exceed 80 per cent (thresholds of eligibility for critically endangered). This was based on the following information:

- absence of populations from sites burnt in 2009 suggesting a decline of greater than 40 per cent since 2009,
- monitoring of known subpopulations (e.g., Lake Mountain, Yellingbo) and modelling indicate that the current rate of decline is greater than 50 per cent and suspected to be greater than 80 per cent over the last 18 years,
- this rate is likely to increase over the next 18 years (due to loss of suitable den trees and other habitat deterioration, and the risk of fire).

Burns et al. (2014) undertook a quantitative assessment of the probability of ecosystem collapse of the Mountain Ash Forest ecosystem. They defined the Mountain Ash Forest ecosystem as forest dominated by mountain ash but which may also contain alpine ash, shining gum, or at lower elevations messmate stringybark (*Eucalyptus oblique*), mountain grey gum (*Eucalyptus cypelloarpa*) and red stringybark (*Eucalyptus macrorhyncha*), and differentiation from other ecosystems also dominated by mountain ash (e.g., in other parts of Victoria and Tasmania) by other features including its distinctive vertebrate fauna and fauna, such as Leadbeater's possum – which is unique to this Mountain Ash Forest ecosystem among other forests dominated by mountain ash and restricting it to 157,000 ha within the Central Highlands of Victoria. Burns et al. (2014) defined three potential thresholds for ecosystem collapse of the Mountain Ash Forest ecosystem. One was where the abundance of hollow-bearing trees dropped below one per hectare averaged across the entire Mountain Ash Forest ecosystem. Modelling to 2067 included 39 scenarios. These included no harvesting and no future fire as the best case scenario, and worst case scenario of harvesting and one fire equivalent in extent to that of the 1939 fires. The estimate of decline for the best case scenario (no fire, no harvesting) to 2067 was 78 per cent and the worst case 92 per cent.

The IUCN (2014) notes that an understanding of ataxon and its relationship to its habitat, and the threats facing the habitat, is central to making the most appropriate assumptions about habitat loss and subsequent population reductions. It notes that populations may have a lagged response to habitat loss. The predictions that Leadbeater's possum habitat loss will continue into the future to 2067 suggest that, on balance, a critically endangered listing of population

decline is most appropriate for A3 (loss to 2031). A summary of thresholds and listing categories for conclusions for assessments under Criterion a (A2 and A3) is provided at Table 3.

Table 3. Summary conclusions for thresholds assessed under Criterion 1

	Guidance threshold	Listing category
A2	very severe (≥80% decline)	Critically Endangered
A3	very severe (≥80% decline)	Critically Endangered

Conclusion for Criterion 1
The Committee finds that analyses of loss of population size under Criterion 1 (A2 and A3) are very severe under A2 and very severe under A3 and that the species is therefore eligible under this criterion as Critically Endangered.

Criterion 2:

Geographic distribution (based on either of B1 or B2)
B1. Extent of occurrence estimated to be very restricted <100 km^2, restricted <5,000 km^2 or limited < 20,000 km^2
B2. Area of occupancy estimated to be very restricted <10 km^2, restricted <500 km^2 or limited <2,000 km^2
AND
Geographic distribution is precarious for the survival of the species,
(based on at least two of a–c)
- a. Severely fragmented or known to exist at a limited location.
- b. Continuing decline, observed, inferred or projected, in any of the following:
  - (i) extent of occurrence
  - (ii) area of occupancy
  - (iii) area, extent and/or quality of habitat
  - (iv) number of locations or subpopulations
  - (v) number of mature individuals.
- c. Extreme fluctuations in any of the following:
  - (i) extent of occurrence
  - (ii) area of occupancy
  - (iii) number of locations or subpopulations
  - (iv) number of mature individuals

Eligible for listing as Endangered (based on B2 (a)+ (b)(iii)(iv)(v))

Evidence:

Geographic distribution - quantitative estimates
Leadbeater's possum is a habitat specialist, with one of the most restricted distributions of any Australian mammal (Lindenmayer, 2013). It occurs in two distinct subpopulations. The lowland subpopulation of Leadbeater's possum at Yellingbo is isolated from the remaining alpine and subalpine colonies The lowland forest habitat used by this subpopulation at Yellingbo covers approximately 181 ha, however, less than 20 hectares provides suitable habitat for Leadbeater's possum (D. Harley 2014, pers. comm. cited in DEPI, 2014).

The remaining possums are patchily distributed (Macfarlane et al., 1997) and occur within alpine forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum within a 70 x 80 km area (5,600 km^2) of the Central Highlands (LPAG, 2013; Lumsden et al., 2013) for which for extent of occurrence is considered to be **'limited'**.

Within this 70 x 80 km range, there are approximately 1,950 km^2 of 'potential habitat' (LPAG, 2013) or 204,000 hectares (LPAG, 2014b) of alpine forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum forests (LPAG, 2014b) which, if considered to be extent of occurrence, is considered to be to be **restricted**.

VicForests (pers. comm., 2014) provides that there is 4,032 km^2 of forest (ash and non-ash) within the home range of Leadbeater's possum and within the Central, Dandenong and Central Gippsland Forest Management Areas. Of this area, ash forest (including mountain ash, alpine ash, shining gum and snow gum forest as 'suitable forest' for Leadbeater's possum) totals 2,044 km^2.

In 2009, approximately 34 per cent (LPAG 2014a) or 35 per cent (LPAG, 2013) of alpine forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum within the 70 x 80 km range of Leadbeater's possum was burnt. 149,100 ha (1,491 km^2) remains unburnt since 2000 which, if considered to be extent of occurrence, is considered to be to be **restricted**.

Burns et al. (2014) applied the IUCN Red List Ecosystems criteria to assess the Mountain Ash Forest Ecosystem for potential listing as threatened. They defined the Mountain Ash Forest Ecosystem as including that dominated by mountain ash but also may contain alpine ash, shining gum, or at lower elevations messmate stringybark, mountain grey gum and red stringybark and differentiate this ecosystem from others also dominated by mountain ash (e.g., in other parts of Victoria and Tasmania) by other features including its distinctive vertebrate fauna, such as Leadbeater's possum, and flora. Burns et al. (2014) note that there are approximately 156,700 ha (1,567 km ^{2}) of this ecosystem. The area of minimum convex polygon enclosing all mapped occurrences of this ecosystem was 11,000 km^2, which for extent of occurrence for Leadbeater's possum is considered to be **'limited'**.

As discussed in Criterion 1, Leadbeater's possum is a habitat specialist and not all alpine forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum is suitable as habitat. While this forest has been termed 'potential habitat' (e.g., LPAG, 2013; 2014a, b), not all of this forest is suitable habitat for Leadbeater's possum.

Lindenmayer et al. (pers comm., 2014a) have undertaken large scale vegetation surveys in the central highlands of Victoria since 1987 (e.g., Lindenmayer, 1989; Lindenmayer et al., 1990; 1991a, b; 2000). Their data layers indicate that at 1987 and 1989 montane ash forest was represented by 171,200 ha. Of this available montane ash forest, only 6.7 per cent was predicted to support 'suitable habitat' for Leadbeater's possum at this time (i.e. approximately 11,470 ha). This estimate was based on measures of the abundance of hollow-bearing trees and the prevalence of an understorey of *Acacia* spp. Reduction in the number of hollow-bearing trees, fire effects and clearfell logging has reduced the amount of suitable habitat to 1.3 per cent of the montane ash forest estate. On this basis, Lindenmayer et al. (pers. comm., 2014a) provide a crude estimate that approximately 2,225 ha remaining ash forest is currently suitable as habitat for Leadbeater's possum. If this estimate of 'suitable habitat' is considered as area of occupancy, this is considered to be **restricted** (<500 km^2). Burns et al. (2014) note that by 2011, the estimated amount of unburnt (since 1903) and unlogged (since 1932) Mountain Ash Forest Ecosystem remaining was 1,700 ha.

Lumsden et al. (2013) undertook a broad scale survey to determine where the species currently occurs, identify population strongholds, and to investigate relationships between environmental variables and probability of occurrence to allow prediction of distribution across the species' range. The survey sampled across all of the species' range but only within forest blocks known to contain records of Leadbeater's possum and/or potentially suitable habitat (containing ecological vegetation classes known to be used by Leadbeater's possum), to determine where the species currently occurs and identify population strongholds. It investigated relationships

between environmental variables and probability of occurrence to allow prediction of distribution across the entire species' geographic range. It was not possible to include forest age class (e.g., old growth forest) within the modelling, as this classification has only been comprehensively mapped in state forest with comparable data not available for most parks and reserves (Lumsden et al., 2013).

Modelling of predicted current strongholds for Leadbeater's possum is provided in Figure 4 of Lumsden et al. (2013). The areas include unburnt habitat mainly in the south of the Central Highlands including the Baw Baw Plateau and its southern slopes, the Toorongo Plateau south of the Upper Yarra Catchment and state forest in the vicinity of Powelltown, parts of Toolangi State Forest, and southern parts of the Upper Yarra National Park. Occupancy by Leadbeater's possum across sampled sites (which included burnt sites) was approximately 16 per cent. Unburnt sites considered as potentially suitable habitat for Leadbeater's possum were selected based on Ecological Vegetation Classes known to be used by Leadbeater's possum (i.e., Montane Damp Forest, Montane Riparian Thicket, Montane Wet Forest, Wet Forest, Cool Temperate Rainforest and Sub-alpine Woodland). Of these, Leadbeater's possum was recorded from 17.4 per cent of the ash sites and half of the snowgum sites (noting there were few snowgum sites sampled). Occupied sites were generally structurally complex. Based on areas that are predicted to have at least a 50 per cent likelihood of the species being present now, Lumsden et al. (2013) estimate that there is approximately 150 km^2 (15,000 ha) of currently occupied habitat, which for area of occupancy is considered to be **restricted** (<500 km^2). There are no indications, however, that these areas of predicted occupation have been tested by subsequent surveys to detect the species and verify these predictions.

Table 4. Summary of estimates for extent of occurrence and area of occupancy for Leadbeater's possum (alpine and subalpine subpopulation).

Data source	Extent of occurrence termed 'suitable forest', 'potential habitat', 'ash forest' or as otherwise specified very restricted <100 km^2 restricted <5,000 km^2 limited < 20,000 km^2	Area of occupancy (as predicted to be occupied, or 'suitable habitat' within ash forest) very restricted <10 km^2 restricted <500 km^2 limited <2,000 km^2
Lumsden et al. (2013)	5,600 km^2	predicted to be occupied 150 km^2
LPAG (2013)	5,600 km^2 and 'potential habitat' 1,950 km^2	
LPAG (2014 b)	5,600 km^2 and 'potential habitat' 2,040 km^2 unburnt ash forest 1,491 km^2	
VicForests (pers. comm., 2014)	'suitable' ash forest 2,044 km^2	
(VicForests pers. comm., 2014 + LPAG, 2014a) and following Criterion 1A2	Maximum available suitable unburnt and unharvested ash forest at 2013 1,466 km^2	
Lindenmeyer et al. pers. comm. (2014a)		suitable habitat 22 km^2
Burns et al. (2014)	11,000 km^2 1,567 km^2	

Table 4 summarises estimates of extent of occurrence and area of occupancy for Leadbeater's possum. All estimates of current extent of occurrence of Leadbeater's possum are over 100 km^2 and less than 20,000 km^2 which the Committee considers are restricted to limited.
The area of occupancy of a taxon is defined as the area within its extent of occurrence occupied by the taxon, reflecting the fact that a taxon will not usually occur throughout the area of its

extent of occurrence, which may contain unsuitable or unoccupied habitats (IUCN, 2014). Given that Leadbeater's possum is a habitat specialist, the Committee considers that among these estimates, the best estimate for current area of occupancy of Leadbeater's possum is the area within unburnt ash forest that is considered likely to be occupied by the possum based on habitat conditions and known habitat preference. Two estimates are available: (1) that 'crudely' estimated by Lindenmayer et al. (pers. comm., 2014a) at 22 km^2 and (2) Lumsden et al.'s, (2013) estimate of 150 km^2. Both of these estimates range between the Committee's guideline thresholds (of between 10 km^2 and 500 km^2) for restricted. In addition, the Committee notes that data are not available to provide for more accurate estimates of area of occupancy using the methodology of 2 x 2 km^2 grid as recommended by IUCN (2014), and that these estimates are, therefore, likely to be underestimates.

Geographic distribution - precariousness

The species is considered to have a geographic distribution that is precarious for its survival for the following reasons:

a) Severely fragmented

Increased extinction risks to Leadbeater's possum result from the fact that most individuals are found in small and relatively isolated subpopulations. Macfarlane et al. (1997) described the distribution of Leadbeater's possum in 1997 as occurring in scattered patches. The species is not uniformly distributed, but occurs in patches of suitable habitat influenced by past wildfires and selective timber harvesting operations (DSE, 2003).

Genetic work indicates that Leadbeater's possum consists of two genetically-distinct subpopulations that have historically occupied different habitats (Hansen, 2008). The small subpopulation at Yellingbo is a surviving remnant of a lowland subpopulation that has historically been, and remains, isolated from others. The remaining possums occupy alpine forest and subalpine woodland comprising mountain ash, alpine ash, shining gum and snow gum. Throughout these areas the species is distributed in scattered patches (Macfarlane et al., 1997).

The Leadbeater's Possum Advisory Group (LPAG, 2013) notes that fire and timber harvesting result in unsuitable habitat, leading to isolation of colonies and further fragmentation of the populations, and a reduced genetic diversity at a landscape scale. The Advisory Group identifies the subpopulation at Toolangi as an example of isolation from other populations due to fire having burnt surrounding areas.

The Leadbeater's Possum Advisory Group (LPAG, 2013) notes that old-growth stands of mountain ash contain the highest densities of hollow-bearing trees, which are a critical habitat feature for Leadbeater's possum. The combination of landscape-wide fires and 30 years of salvage harvesting after the 1939 fires has led to there being very little of this old growth forest remaining in the Central Highlands. Lindenmayer et al. (e.g., Lindenmayer et al., 2011; Lindenmayer et al., 2012; Lindenmayer et al., 2013a) estimate that old growth forest comprises around 1.1–1.2 per cent of the mountain ash forest estate, estimated to total 1,887 ha (Lindenmayer et al., pers comm., 2014a), but is confined to small remnant patches embedded within regrowth forest across 147 different patches, giving a mean patch size of 12.8 ha.

Fire causes habitat fragmentation. Leadbeater's possums in 2013 do not occupy sites burnt in 2009 (Lumsden et al., 2013). Lumsden et al. (2013) aimed to determine the extent to which Leadbeater's possum may have persisted in unburnt habitat islands refuges following the 2009 fires. Thirty-seven potential fire refuges were found with intact canopy and understory, and Leadbeater's possum was detected at six of these sites. Lumsden et al. (2013) found that there are likely to be only small numbers of individuals in any occupied unburnt refuges, with doubt about their capacity to persist.

Lindenmayer et al. (1993d) found that linear strips set aside and excluded from wood production include areas on steep slopes and adjacent to streams, or stands of unmerchantable timber set

aside for wildlife conservation. These supported fewer species and had a lower probability of containing an animal than sites of similar habitat quality within areas of continuous forest. The number of trees with hollows in contiguous forest occupied by an arboreal marsupial was approximately twice that of trees in retained linear strips. Habitat fragmentation has occurred as a result of:

- division by narrow, approximately 20–100m wide strips between logging coupes which do not support colonies of Leadbeater's habitat (indicated by empirical field data), and
- logging roads and tracks that Leadbeater's possums do not cross (as indicated by radio-tracking work) Lindenmayer et al. (pers. comm., 2014a).

b) Continuing decline is observed, inferred and projected:
A decline in area of suitable habitat relative to the present is outlined in Criterion 1, and threats are continuing. Continuing decline is:

- observed, inferred and projected in (iii) area, extent and/quality of habitat;
- inferred and projected in the (iv) number of locations or subpopulations; and
- inferred and projected in (v) the number of mature individuals.

Decline in area and extent of habitat through loss to harvesting
Areas of 44,700 ha of unburnt ash forest are currently identified as available for harvesting (VicForests, pers. comm., 2014). These do not include areas excluded from harvesting as Special Protection Zones, modelled code exclusions and estimated additional harvesting exclusions. Leadbeater's possums are recorded on harvestable land outside of these exclusion areas. Leadbeater's possum does not inhabit logged and regenerated forest where no hollow-bearing trees have been retained (Lindenmayer et al., 2013b). While some habitat trees may remain in clearfelled areas, it is unlikely that these areas are suitable for long term viability (Lindenmayer et al., 1993a) and therefore areas identified for future clearfell harvesting are likely to represent a level of projected and inferred future Leadbeater's possum habitat decline.

Decline in area and extent of habitat and number of locations or subpopulations due to likelihood of fire
Over the last century, bushfires have occurred in the Central Highlands on average every ten years (LPAG, 2013; Lumsden et al., 2013). An additional bushfire occurring in the Central Highlands within the next ten years is likely, with the potential to further reduce ash or snow gum woodland in the range of Leadbeater's possum and therefore contribute to Leadbeater's possum population decline. While the magnitude of any future fire and its impact on existing ash forest is unable to be quantified, further decline is considered to be projected and inferred.

Decline in area and extent of habitat due to prescribed burning
The Victorian Government has committed to implement all recommendations from the 2009 Victorian Bushfires Royal Commission, which include an annual state-wide target of burning a minimum of five per cent of public land in Victoria. This target includes National Parks and Reserves and other public land. Fire operational plans for the years 2013/14 to 2015/16 have been made available detailing plans to undertake approved burns of 276,295, 312,886 and 425,038 hectares (respectively) across Victoria over this three year period. A small proportion of these burns may be planned within habitat areas of Leadbeater's possum excluded from harvesting (http://www.depi.vic.gov.au/fire-and-emergencies/planned-burns/fire-operations-plans/current-approved-fop).

Decline in habitat quality due to decline of abundance of hollow-bearing trees
There are strong and quantified links between the abundance of hollow-bearing trees and the occurrence of Leadbeater's possum (e.g., Lindenmayer at al., 1991b; Lindenmayer et al., 2013c; Lindenmayer et al., pers. comm., 2014a). A decline in the number of hollow-bearing trees therefore corresponds to a decline in the number of mature individuals of Leadbeater's possum.

Lumsden et al. (2013) find that, in contrast to the 1939 fires, it is predicted that there will be limited rebound in population numbers after the 2009 fires. While there were extensive areas of

old growth forest prior to the 1939 fires, the large living trees that survived the fire and the large fire-killed dead trees were of sufficient size to provide suitable hollows. The 1939 regrowth areas that were burnt in 2009 lost the majority of dead stags. The live trees that were killed are considered unlikely to be large enough to provide suitable hollows. Any that do provide hollows, are predicted will remain standing for only a short period of time (Lindenmayer et al., 2012; Lumsden et al., 2013). The population is predicted to continue to decline until areas of 1939 regrowth forest become sufficiently mature to provide adequate tree hollows (Lumsden et al., 2013), i.e. until at least 2067 (Lindenmayer et al., 2012).

Based on long-term monitoring (e.g., Lindenmayer et al., 1990; 1993a; 1997; 2011; 2012) Lindenmayer et al. (pers. comm., 2014a) estimate the abundance of hollow-bearing trees will decline in the future from more than four per ha ecosystem wide in 2013 to 1.5 per ha by 2035. This estimate represents more than a 63 per cent decline in habitat quality to 2035. The rate of decline then increases, with less than 0.9 per ha ecosystem wide by 2060. The largest cohort of old trees regenerating after the 2039 fires will not begin to develop cavities suitable for occupancy by Leadbeater's possum until after 2060 (Lindenmayer et al., pers. comm., 2014a). Burns et al. (2014) modelled future abundance of hollow-bearing trees using thirty-nine scenarios of 'no fire', and 'small, medium, and large fire regimes' as well as projections of clearfell logging under the 2011–2016 Timber Release Plan (DSE, 2011). They found a projected severe decline in the average number of large old hollow-bearing trees across the mountain ash forest of approximately 3.77 ha^{-1} in 2011, to 0.29–0.82 ha^{-1} by 2067. The best case scenario of no fire or logging was 78 per cent decline relative to 2011, and worst case (with fire equal in extent to the 1939 fire) of 92 per cent decline. Burns et al. (2014) find a greater than 92 per cent chance that the Mountain Ash Forest ecosystem will reach a collapsed state (defined as below 1 hollow-bearing tree per hectare averaged across the ecosystem), by 2067.

A consequential decline in the number of mature individuals of Leadbeater's possum is therefore projected, noting that the rate of decline increases towards 2060, and recognising there is likely to be some degree of lagged response.

Decline in habitat quality - Yellingbo subpopulation
Of the 50 ha of lowland floodplain forest at Yellingbo (LPAG, 2013), less than 20 ha of high quality habitat is estimated to be currently available (Harley and Lindenmayer, pers. comm., 2013). There are three main causes for this decline in habitat condition: (i) eucalypt dieback related to altered hydrology, (ii) habitat succession towards an older age-class that is more open in structure, and (iii) a lack of eucalypt regeneration (Harley and Antrobus, 2007).

Dieback of the tree canopy of mountain swamp gum was first noted in the 1970s. In 2003 dieback was estimated to affect more than 40 per cent of mountain swamp gum forest along Cockatoo Creek (Turner, 2003). It has been estimated that around 90 per cent of the swamp habitat is currently in poor condition (VEAC, 2012).

Fifty-six per cent of active territories at Yellingbo have been abandoned during the past ten years as a result of habitat deterioration. Vegetation dieback is present at more than 52 per cent of sites across the reserve (Harley pers. comm., 2014). Mid-story species necessary for movement of Leadbeater's possum are declining in stem density and do not form a continuous canopy. Some are heavily grazed (by deer) and are not regenerating to a density desirable as Leadbeater's possum habitat. There is a low abundance of denning hollows in the reserve (Harley et al., 2005).

Molecular analyses indicate that population fragmentation within the reserve has already occurred (Hansen, 2008). Reproductive rates have also declined at Yellingbo. The mean percentage of colonies (denning groups) where the dominant adult female had pouch young or was lactating has declined from 65 ± 9 per cent during 2001 – 2007 to 47 ± 24 per cent during 2008 – 2012 (Harley and Antrobus, unpublished data cited in Harley and Lindenmayer pers comm., 2013

Population monitoring of the lowland population of Leadbeater' possum at has been conducted at Yellingbo Nature Conservation Reserve since 1996. Data collected between 1995 and 2004 indicated that the size of the population was stable at 80–100 individuals (Harley et al., 2005). The number of individuals recorded peaked to 112 at 2003. At 2012 the number had dropped to 60 individuals (Harley and Lindenmayer, pers. comm., 2013). Recent reports are that the population has declined to only 42 individuals in 2013 (Arup and Smith, 2013) and in 2014 only 40 individuals with concerns expressed about the population's genetic health (Smith, 2014).

Reversal in the decline of these conditions will be difficult and may not be achievable, and therefore there is an expected continuing decline inferred and projected in (iii) area, extent and/quality of habitat; inferred and projected in the (iv) number of locations or subpopulations; and inferred and projected in (v) the number of mature individuals at Yellingbo.

The Yellingbo Nature Conservation Reserve population of Leadbeater's possum is genetically distinct from the remaining Leadbeater's possums (Hansen, 2008). Loss of this subpopulation would be a significant loss to genetic diversity of the species.

Decline in numbers of mature individuals
Some Leadbeater's possums have been found to occur in a small number of unburnt fire refuges (16 per cent of sites surveyed with intact canopy and understory) (LPAG, 2013). These animals have been suggested as possible sources of recolonisation of burnt areas once regenerated habitat becomes suitable. Previous population viability analyses suggest that single, isolated populations exceeding 200 animals are needed to have a high probability of long term persistence (Lindenmayer et al., 1993b). As there are likely to be only small numbers of individuals in these occupied unburnt refuges, there is doubt about the capacity of these isolated colonies to persist (Lumsden et al., 2013).

Population viability analysis was undertaken by Lumsden et al. (2013) to evaluate if the reserve system, established as one of the key strategies for the conservation of Leadbeater's possum, was sufficient to support the long-term conservation of the species. The results of this modelling found that all scenarios had more than a five per cent chance of the number of adult females falling below 500 individuals in the future. In the best case modelled scenario i.e., without further future fires or further loss of hollow-bearing trees, there was a 73 per cent probability of the population falling below 500 adult females within the reserve system. All other modelled scenarios with habitat loss and/or future fires, had an even higher probability that the population would fall below 500 adult females in the future, thereby providing a high degree of certainty of future decline. This population viability analysis predicts that the population of Leadbeater's possums in the reserve system will steadily decline until later this century, even in areas not burnt during the 2009 fires, as dead nest trees will continue to collapse without replacement, in contrast to the 1939 fires.

The long term viability of the lowland population at Yellingbo is doubtful, given its current population size of only 40 individuals (Smith, 2014) and that population viability analyses indicate populations of 50 individuals or fewer were predicted to be highly vulnerable to extinction within the next 100 years (Lindenmayer et al., 1993b).

Decline in numbers of mature individuals - Loss of genetic diversity
Population genetic analyses have been undertaken on the two largest populations of Leadbeater's possums prior to the 2009 fires: the Lake Mountain (159 individuals for which genetic material was available for testing) and Yellingbo (198 individuals). Effective population size[1] (N_e) for each of these subpopulations was found to be 57 and 7 respectively (Hansen et

[1] N_e, 'effective population size' is defined by Frankham et al. (2004). It can be likened to the number of animals that successfully contribute genetic material to the next generation, providing a proxy of the number of breeding animals in a stable population. It is rarely as large as the census population size.

al., 2009). Hansen (Hansen, 2008; Hansen and Taylor, 2008; Hansen et al., 2009) found that the Lake Mountain population was likely to represent a single genetic unit with other nearby populations (Cambarville, Marysville and Mt Margaret) and also found a strong signal of historical decline (most likely coinciding with climatic changes at the end of the Pleistocene). These past range contractions may exacerbate current population processes (Hansen pers. comm., 2014).

c) Extreme fluctuations.

Extreme fluctuations can be said to occur in a number of taxa where population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude. Population trajectories must show a recurring pattern of increases and decreases representing changes in total population size. Populations that undergo extreme fluctuations are likely to have highly variable growth rates, and therefore likely to be exposed to higher extinction risks than populations with lower levels of variability (IUCN, 2014). While Leadbeater's possums appear to have rebuilt following the extensive fires of 1939, and have again suffered a reduction in numbers following the 2009 fires, there is no indication that Leadbeater's possum has undergone 'extreme fluctuations'. Modelling indicates that, in contrast to the 1939 fires, hollow-bearing trees on which Leadbeater's possum depend, will continue to decline in abundance and not rebuild until after 2067 (Lindenmayer et al., 2012; Lumsden et al., 2013), with future bushfires in the species' range further exacerbating this situation (LPAG, 2014b). Leadbeater's possum therefore does not meet this subcriterion.

Conclusion for Criterion 2

As the species has a restricted area of occupancy and the species is considered to have a geographic distribution that is precarious for its survival based on (a) and (b), the species is considered to be eligible for listing as Endangered.

Criterion 3:

The estimated total number of mature individuals is very low <250, low <2,500 or limited<10,000; **and** either of (A) or (B) is true

(A) evidence suggests that the number will continue to decline at a very high rate (25% in 3 years or 1 generation, whichever is longer, up to 100 years), high rate (20% in 5 years or 2 generations, whichever is longer, up to 100 years) or substantial rate (10% in 10 years or 3 generations, whichever is longer, up to 100 years); or

(B) the number is likely to continue to decline and its geographic distribution is precarious for its survival (based on at least two of a – c):
   a. Severely fragmented or known to exist at a limited location.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals

Eligible for listing as Endangered (based on limited and B(a)+(b)(iii)(iv)(v))

Evidence:

Numbers of individuals

Leadbeater's possum is cryptic, being nocturnal, fast moving and inhabiting forest canopy and sub-canopy (Smith and Hartley, 2008). Accurately estimating population size is therefore difficult. Survey techniques require intensive resourcing (e.g., Lindenmayer, 1996a).
Initial estimates of the total number of mature individuals of Leadbeater's possum were provided by Menkhorst (2008) who estimated 2000 individuals for the montane populations and 200 individuals at Yellingbo.

Leadbeater's possums in montane ash forest have been monitored as part of a long term monitoring program since the 1980s (e.g., Lindenmayer et al., 1997, 2011, 2012). Monitoring has also been ongoing at targeted strongholds such as Mt Bullfight, Lake Mountain, Mt Baw Baw and Yellingbo (Harley, 2005, Harley and Antrobus, unpublished data via Harley and Lindenmayer pers. comm., 2013). Lindenmayer (1996b) notes that while others had estimated the montane population at between 1000 and 5000 individuals, his estimation at that time was 4000 individuals based on the extent of suitable habitat, the mean abundance of possums on such sites, and the fact that the species is absent from 40 per cent of apparently suitable areas (Lindenmayer, 1996b).

Leadbeater's possum have been monitored at three sub-alpine targeted sites – Lake Mountain, Mt Bullfight and Mt Baw Baw; Lake Mountain and Mt Bullfight were burnt in 2009. The Lake Mountain site was thought to contain up to 300 individual Leadbeater's possums prior to the 2009 fires, with only six individuals found following extensive surveys after the 2009 fires (Harley and Antrobus, unpublished data, cited in Harley and Lindenmayer pers comm., 2013). Surveys at Mt Bullfight suggested that the population comprised fewer than 50 individuals following the 2009 fires (Harley and Antrobus, unpublished data, cited in Harley and Lindenmayer pers comm., 2013).

Subsequent surveys (Lumsden et al., 2013) included the use of call playback and thermal imaging cameras to detect presence, with a probability of detecting the species' presence on occupied sites of up to 80 per cent when there was no wind (Lumsden et al., 2013). Findings from these surveys were consistent with earlier post fire findings (e.g., Lindenmayer et al., 2013), with no possums detected in any area burnt during the 2009 fires irrespective of fire intensity, including those sites where the understory was burnt but the canopy remained intact.

Based on the post-2009 fire surveys of occurrence, Lumsden et al. (2013) undertook occupancy modelling to identify population strongholds and investigate relationships between environmental variables and probability of occurrence. Modelling was designed to account for the possibility of non-detection during surveys. Lumsden et al. (2013) do not attempt to provide estimates of numbers of colonies or individuals in their report, the purpose of these surveys was not to estimate population numbers (LPAG, 2014a). However, the Leadbeater's Possum Advisory Group extrapolated population numbers from these data. It doing so it notes (LPAG, 2014a) a number of levels of uncertainty and assumptions, including bias associated with surveying on roads from where all surveys were conducted, uncertainty in the call playback survey technique, and that the survey method does not enable determination of the number of individuals. The Committee notes that these assumptions and the technique have yet to be independently tested for accuracy and therefore has a high level of uncertainty. LPAG (2014a) notes that the focus for robust decisions should be on population trends rather than absolute numbers, given these uncertainties. Nonetheless, they estimate there may be 1,500–4,500 (LPAG, 2013) or 1,578–4,384 (LPAG, 2014b; DEPI, 2014) colonies present in the Central Highlands 'based on the number of adult breeding females'. LPAG (2014a) notes that that this survey method only detected presence or absence, that the number of animals present in each

colony of Leadbeater's possums can vary substantially, and the current average colony size in different environments is unknown. If applying a conservative average colony size of 2.5 individuals to estimate 'a potential number of individuals' in the Central Highlands, the 'predicted number of individuals' range from 3,945–10,960 (LPAG, 2014 a, b; DEPI, 2014) (or approximately 3,750–11,250 in LPAG, 2013).

Lindenmayer et al. (pers. comm., 2014a) notes that direct estimation of numbers of individuals is problematic and notes the potential for overestimation using the survey methods of Lumsden et al. (2013) by as much as 3–5 times. Lindenmayer et al. (pers. comm., 2014a) note that using playback calls may have a larger sound catchment than estimated by others who have previously used this technique and is likely to have drawn in animals from distances of as much as 400–500m, especially because the lack of continuous habitat in these forests means that colonies are unlikely to have territory boundaries with neighbouring colonies. Patten (pers. comm., 2014) notes the use of thermal imaging for population surveys of arboreal mammals has not been undertaken previously and its accuracy requires further investigation.

In the use of this criterion for number of remaining individuals, the IUCN (2014) notes: '*mature individuals that will never produce new recruits should not be counted*'. Leadbeater's possums live in small groups of between two to twelve individuals containing one breeding pair (Lindenmayer, 1996a). A snap shot of colony composition of nine colonies in 1978 (Smith, 1984) found one of each colony size of 2, 3, and 6, three colonies of 4 individuals and three of 5 individuals (median= colony size of 4). The mating system typically results in a 3:1 (m:f) sex ratio across the species (Smith, 1980; Lindenmayer and Possingham, 1995a). If this represents a monogamous pair in each colony and two non-reproductive animals – the percentage of mature breeding individuals is up to 50 per cent of total estimated population (50% is likely to represent a maximum).

Lindenmayer et al. (pers. comm., 2014a) provide 'a crude' estimate of maximum total numbers of individuals as 3,125. This estimate is based on availability of suitable habitat, which is estimated by Lindenmayer et al. (pers. comm., 2014a) to be 2,225 ha at the end of 2013, and based on field survey data (e.g., Smith and Lindenmayer, 1988), the long-term mean abundance of animals per ha of suitable forest is 1.4 animals. Given that the species is colonial and colonies include non-breeding individuals, the number of breeding individuals is likely to be less that any estimate of total number of individuals. However, because population structure within the current population of Leadbeater's possum is unknown, the estimated number of mature individuals relative to a total population size of 3,125 is unable to be estimated. If using the rationale of mature breeding individuals are up to 50 per cent of total population, as outlined above; the percentage of mature breeding individuals is 1,563.

Population genetic analyses have been undertaken on the two largest populations of Leadbeater's possums prior to the 2009 fires: the Lake Mountain and Yellingbo. Effective population size (N_e) provides a proxy of the number of breeding individuals in a stable population. Using microsatellite genetic markers, which provide a measure of recent population processes, N_e for these subpopulations was found to be 57 for Lake Mountain and 7 for Yellingbo (Hansen et al., 2009), which translates to 36 per cent of the known population at Lake Mountain and 4 per cent of the population at Yellingbo.

Because genetic similarities cluster the Lake Mountain population with nearby populations of Cambarville, Marysville and Mt Margaret, the patterns from the genetic sample at Lake Mountain might be inferred for the broader region. If 36 per cent of the broader population are breeding individuals, this equates to approximately:

- 1,350 breeding individuals, if based on the lower estimate of 3,750 total individuals of LPAG (2013), or
- 1,125 breeding individuals, if based on the estimate of 3,125 total of Lindenmayer et al. (pers. comm., 2014a).

Hansen pers. comm. (2014) notes caveats around extrapolating beyond the study area, as population processes may differ between habitats, and N_e is sensitive to rates of population growth and decline. It is therefore likely that the estimated total number of mature individuals is at least limited (<10,000) with population genetics suggesting that within these estimates breeding individuals may be low (<2500).

Table 5. Summary of estimated numbers of individuals and numbers of breeding individuals

	Estimated numbers	If 3:1 sex ratio = 50% mature breeding individuals**	If 36% of the broader population are breeding individuals
Menkhorst (2008)	2000 + 200	1,100	
Lindenmayer (1996b)	4000	2,000	
LPAG (2013)	3,750–11,250	3,000–9,000*	1,350–4,050
LPAG (2014 a, b), DEPI (2014)	3,945–10,960	3,156–8,768*	1,420–3,946
Lindenmayer et al. (pers. comm., 2014a)	3,125	1,563	1,125

* estimated as two breeding individuals in a colony, from the estimated number of colonies provided.
** 50% of the population being breeding individuals is likely to represent a maximum

Table 5 summarises the estimates of individuals and breeding individuals. The number of mature breeding individuals of Leadbeater's possums in the Central Highlands is at least limited (<10,000) and is very likely to be restricted (<2,500).

Population monitoring of the lowland population of Leadbeater's possum at has been conducted at Yellingbo Nature Conservation Reserve since 1996. Data collected between 1995 and 2004 indicated that the size of the population was stable at 80–100 individuals (Harley et al., 2005). The number of individuals recorded peaked to 112 at 2003. At 2012 the number had dropped to 60 individuals (Harley and Lindenmayer, pers. comm., 2013). Recent reports are that the population has declined to only 42 individuals in 2013 (Arup and Smith, 2013) and in 2014 only 40 individuals (Smith, 2014).

(A) Rate of decline

Generation length for Leadbeater's possum is six years. To meet part A of this criterion, evidence needs to suggest that the number of Leadbeater's possums will continue to decline at:

- a very high rate (25% in 3 years),
- a high rate (20% in 12 years), or
- a substantial rate (10% in 18 years).

While the population has been predicted to continue to decline in the future (see Criterion 5), the Committee does not have access to quantitative data to determine the rate of decline in the population over the periods required by part A of this criterion.

Or (B) Continuing decline and precariousness

To meet part B of this criterion, evidence needs to suggest that the number of Leadbeater's possums is likely to continue to decline and its geographic distribution is precarious for its survival (based on a variety of options outlined in the criterion). The Committee has assessed this already in Criterion 2, and found that the species is likely to (B) continue to decline and that its geographic distribution is precarious for its survival (see Criterion 2) based on severe fragmentation (a) and continuing decline (b) observed, inferred and projected in (iii) area, extent and/or quality of habitat, (iv) number of locations or subpopulations, and (v) number of mature individuals).

Conclusion for Criterion 3

Based on this evidence, the Committee considers that the number of mature breeding individuals of Leadbeater's possums is likely to be at least limited and is very likely to be

restricted, the number is likely to continue to decline and the species' geographic distribution is precarious for its survival and is therefore eligible for listing under this criterion as Endangered.

Criterion 4:

Estimated total number of mature individuals:
(a) Extremely low < 50
(b) Very low < 250
(c) Low < 1000

Not found to be eligible for listing in this category

Evidence:

If using the IUCN (2014) guidelines for defining mature individuals for the criteria, '*mature individuals that will never produce new recruits should not be counted*' and '*in the case of biased adult or breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals'*.

As discussed in Criterion 3, the mating system of Leadbeater's possum typically results in a 3:1 sex ratio across the species (Smith, 1980; Lindenmayer and Possingham, 1995a). As described in Criterion 3, the estimates of the number of mature individuals are provided in Table 5. The highest threshold for eligibility under this criterion is 1000 mature individuals. All estimates of number of mature individuals are greater than 1000 (Table 5). These estimates are not considered to be low, very low or extremely low under this criterion.

Criterion 5:

Probability of extinction in the wild based on quantitative analysis is at least:
(a) 50% in the immediate future (i.e. 10 years or three generations, whichever is longer, up to a maximum of 100 years); or

(b) 20% in the near future (i.e. 20 year or five generations, whichever is longer, up to a maximum of 100 years); or

(c) 10% in the medium-term future (i.e. within 100 years).

Eligible for listing as Vulnerable (5c)

Evidence:

Leadbeater's possum has been the focus of a number of studies using Population Viability Analysis over the past two decades demonstrating the vulnerability of the species to extinction (Lindenmayer et al., 1993b; Lindenmayer and Possingham, 1995 a,b, 1996; Lindenmayer and Lacy, 1995). Analyses have been used to predict trends in populations of Leadbeater's possum by patch size, connectivity (Lindenmayer and Lacey, 1995; Lindenmayer and Possingham, 1995a) and other factors such as spatial scale, wildfire (Lindenmayer and Possingham, 1995b) and logging (Lindenmayer and Possingham, 1996). As the general rate of annual loss of trees with hollows is more than 3–5 per cent annually, Leadbeater's possum could be lost from large

areas by 2040s. In areas of old-growth forest, where rate of hollow loss is lower, populations of 200 animals or more experienced a less than 10 per cent decline in predicted genetic variability and therefore, where suitable habitat can be maintained, may persist in the long term (e.g., 100 year projection). Lindenmayer et al., (1993b) note that old-growth forest patches of 600 ha should support a 'population' of 200 animals (old-growth forest being dominant overstory trees >120 years old, Lindenmayer et al., 2013a). Lindenmayer and Lacy (1995) however, note that while these populations may be demographically stable, more than this number of individuals might be required to avoid significant decline in genetic variability over 100 years, as demographic and genetic stability occur at different 'population' sizes. Small, isolated populations are vulnerable to inbreeding depression (Lindenmayer et al., 1993b). 'Populations' within isolated patches of 20 ha or less are very susceptible to extinction, even in the absence of wildfires, but the probability of persistence approached 100 per cent in patches of 250 ha (Lindenmayer and Possingham, 1995b). 'Populations' of 20 or fewer animals were characterised by very rapid rates of extinction and most failed to persist for longer than 50 years (Lindenmayer and Lacey, 1995). The probability of extinction of isolated populations remained above 60 per cent even for a single patch size of 1,200 ha once wildfire was included in the modelling. Predicted values for the probability of extinction were sensitive to inter-relationships between the frequency of fires and the proportion of habitat patches that were burnt during a given fire event (Lindenmayer and Possingham, 1995b).

The timeframe over which these analyses are assessed is 100 years (Lindenmayer and Lacy, 1995; Lindenmayer et al., 1993b) or greater. Quantitative probability of extinction is included, however the populations modelled are based on small subpopulations that examine minimum population size viability under differing scenarios e.g., with founding populations of 25, 50, 100 individuals and differing environmental variability (with values raging from minimal (1) to moderate (20)). There are scenarios modelled that indicate that an examined 'population' will have a greater than 100 per cent probability of extinction with 100 years or less, however, these analyses do not attempt to examine the probability of extinction for the whole species, as is the intent of Criterion 5. These analyses do not provide the specific quantitative probabilities required for meeting the thresholds of Criterion 5.

Some previous population strongholds have been found to have significantly declined to the point at which they are unlikely to be viable. For instance, the population at Lake Mountain has been reduced to less than 10 individuals following the 2009 fires (Harley and Lindenmayer, pers. comm., 2013; DEPI, 2014). Mount Bullfight supported Leadbeater's possums in sub-alpine woodland habitat, but surveys since the 2009 fires indicate that approximately 30–50 individuals survive in three distinct areas (Harley and Antrobus unpublished data cited in DEPI, 2014). The long term viability of the lowland population at Yellingbo is doubtful, given its current population size of only 40 individuals (Smith, 2014). Lindenmayer et al. (1993b) found that populations of fewer than 50 individuals were predicted to be highly vulnerable to extinction within a 100 year timeframe, while populations of 200 animals or more were considered to be genetically and demographically stable over a 100 year period.

Lindenmayer et al. (2012) undertook transition probability matrices of large trees with cavities through increasingly decayed condition states. They project severe decline in large trees with cavities by 2039, with decline continuing until at least 2067. These projections were noted as being highly optimistic due to the number of assumptions included in the analysis (e.g., paucity of future fire and logging) and the lack of cavity bearing trees is likely to be more severe than indicated in the projections. Lindenmayer et al. (2012) suggest that similar severe declines are expected for cavity-dependent species such as Leadbeater's possum.

Population viability analysis of Leadbeater's possum was undertaken by Lumsden et al. (2013) to evaluate if the reserve system established as one of the key strategies for the conservation of Leadbeater's possum was sufficient to support the long-term conservation of the species.

Lumsden et al. (2013) used survival and fecundity rates from models previously developed by Lindenmayer et al. (1993b), Lindenmayer and Possingham (1995a, b; 1996), and Lindenmayer and Lacy (1995) and the impact of fire to Leadbeater's possum by fire models of Lindenmayer and Possingham (1995a, b). The modelling examined the impact of historic and more recent wildfires (i.e., fires in 1939, 1983, 1990, 2007 and 2009) on Leadbeater's possum populations, the increased rate of loss of hollow-bearing trees reported by Lindenmayer et al. (2012), and potential impacts of future fires. The model predicts changes in the size of the Leadbeater's possum reserve population over time based on the number of adult females from prior to the 1939 fires into the future. The reserve was established to incorporate priority areas for Leadbeater's possum by including the highest quality habitat of old growth forest (compared to 1939 regrowth where dead hollow-bearing trees were collapsing) (Lumsden et al., 2013). There are no data that provide the number of females possums prior to 1939. The model therefore includes a variety of initial numbers of adult females, with the average being the adult carrying capacity as prescribed by the fire models of Lindenmayer and Possingham (1995a, b).

Lumsden et al. (2013) assessed the probability that the number of adult females would fall below 500 individuals within a 200 year time frame. A 200 year time frame was selected because this related to the time it takes to develop hollows suitable to Leadbeater's possum, and 200 years is equivalent to 40 generations of Leadbeater's possum – a key time frame for assessing threatened species (Schaffer, 1981; Reed et al., 2003 cited in Lumsden et al., 2013). 500 individuals is a population size at which, declines below this level are considered to be more susceptible to loss of genetic variation and population changes due to unfavourable environmental conditions and catastrophic events (Lacy, 2000 cited in Lumsden et al., 2013). Scenarios were modelled with various combinations of habitat loss and future fires. All modelled scenarios resulted in a high probability that the population would fall below the critical 500 individual population size within the 200 year timeframe. While the reserve system was established to protect priority areas of Leadbeater's possum habitat, the probability analysis of Lumsden et al. (2013) indicate that the reserves system is insufficient to provide for long-term persistence of Leadbeater's possum.

To be eligible for listing under this criterion, the species needs to have a quantitative probability of risk of extinction within set timeframes (e.g., 50 per cent probability). Generation length for Leadbeater's possum is six years. Probability of extinction in the wild based on quantitative analysis for Leadbeater's possum must be at least:

(a) 50% in 18 years (critically endangered);
(b) 20% in 30 years (endangered); or
(c) 10% within 100 years (vulnerable).

The modelling of Lumsden et al. (2013) finds a high probability of extinction (based on a critical population size of 500 individuals) in 200 years. The probability is quantified: There is a 75 per cent chance of the population falling below 500 individuals within a 200 year timeframe when there is no further loss of habitat. Future habitat loss scenarios of 12.5, 25, and 50 per cent (e.g., from loss of hollow-bearing trees) and further additional loss of habitat of 25 and 50 per cent from fires in 2020 are modelled, all indicate a 90 per cent chance or more of extinction (based on a critical population size of 500 individuals) in 200 years. The timeframe over which these analyses are assessed is 200 years, and not within the timeframes considered for this criterion. While it is likely that the data are available, these analyses under the timeframe of 200 years do not provide the specific quantitative probabilities required for meeting the thresholds of this criterion.

Burns et al. (2014) undertook a quantitative assessment of the probability of ecosystem collapse of the Mountain Ash Forest ecosystem. They defined the Mountain Ash Forest ecosystem as forest dominated by mountain ash but which may also contain alpine ash, shining gum, or at lower elevations messmate stringybark, mountain grey gum and red stringybark, and differentiation from other ecosystems also dominated by mountain ash (e.g., in other parts of Victoria and Tasmania) by other features including its distinctive vertebrate fauna and fauna,

such as Leadbeater's possum – which is unique to this Mountain Ash Forest ecosystem among other forests dominated by mountain ash and restricting it to 157,000 ha within the Central Highlands of Victoria. Burns et al. (2014) defined three potential thresholds for ecosystem collapse of the Mountain Ash Forest ecosystem. One was where the abundance of hollow-bearing trees dropped below one per hectare averaged across the entire Mountain Ash Forest ecosystem. Burns et al. (2014) found that there was more than a 92 per cent chance of ecosystem collapse/ less than one hollow-bearing tree per hectare ecosystem-wide by 2067 (within 100 years). If less than one hollow-bearing tree per hectare equates to an unviable habitat for Leadbeater's possum, and given that the Mountain Ash Forest is the core habitat of this species, this may be considered to equate to probability of extinction of Leadbeater's possum, and thus meeting at least the 10 per cent likelihood of extinction within the 100 year timeframe for vulnerable under this criterion.

As population viability analyses also indicate a high likelihood of populations less than 50 individuals (such as the remaining Leadbeater's possums in the lowland habitats of Yellingbo), going extinct in the next 100 years (probabilities ranging from 10–100 per cent depending on the environmental variation) (Lindenmayer et al., 1993b), this accounts for all known Leadbeater's possums.

Conclusion for Criterion 5
Given the Mountain Ash Forest ecosystem on which the montane populations of Leadbeater's possum depend, have been estimated to become extinct within the next 100 years with at least a 10 per cent likelihood, and that the only known population of the species outside of this habitat is also predicted to become extinct in the next 100 years, with a greater than 10 per cent likelihood, the Committee considers that Leadbeater's possum meets the eligibility for listing as vulnerable under this criterion.

Public Consultation

Notice of the proposed amendment was made available for public comment for more than 30 business days between from 3 December 2013 to 24 January 2014. Comments received relevant to the survival of the species have been taken into account by the Committee.

Recovery Plan

There is a recovery plan in place for the species: Macfarlane et al. (1997) '*Leadbeater's Possum (Gymnobelideus leadbeateri) Recovery Plan*'. 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.

This plan was transferred as an adopted recovery plan under the *Endangered Species Protection Act 1992* to an adopted plan under the *Environment Protection and Biodiversity Conservation Act 1999* at the commencement of the Act on 16 July 2000.

The Committee recommends that this plan (Macfarlane et al., 1997) should be retained and updated.

Recovery and Impact avoidance guidance

Primary Conservation Objectives

Increase the total population size and number of locations of subpopulations of Leadbeater's possums.

1. Maintain, protect, restore and enhance existing habitat, especially key habitat attributes
2. Establish habitat links that include key habitat attributes between known population sites
3. Enable recovery of additional sites to increase habitat and population size
4. Provide for the establishment of additional populations.

Important populations

All populations of Leadbeater's possum are important.

The smaller sized Yellingbo lowland population is genetically distinct from the montane population and represents an important source of genetic diversity for the species, and is therefore important for the species as a whole.

Important habitat for the survival of the species

The key habitat attributes of Leadbeater's possum across all forest types (LPAG, 2013), and therefore important habitat for the survival of the species, are:

- Hollow-bearing trees (for nest sites and refuge) with large internal dimensions in the order of 30 cm in diameter are a critical habitat feature for Leadbeater's possums (LPAG, 2013), particularly and almost exclusively large old trees (Lindenmayer et al., 2013a; Lindenmayer et al., pers. comm., 2014a).
- Density of hollow-bearing trees is recognised as a critical habitat feature (e.g., DEPI, 2014). There are strong and quantified links between the abundance of hollow-bearing trees and the occurrence of Leadbeater's possum (e.g., Lindenmayer at al., 1991c; Lindenmayer et al., 2013c; Lindenmayer et al., pers. comm., 2014a), with nest hollow availability the limiting factor to population size. Density of less than one hollow-bearing tree per hectare is considered to represent ecosystem collapse for the Mountain Ash Forest ecosystem (Burn et al., 2014).
- Predominance of smooth-barked eucalypts (with loose bark hanging in strips providing shelter for insect prey and material for nests) or gum-barked eucalypts (related to foraging behaviour) (Lindenmayer, 1996a; Harley, 2004a;b;c).
- Forest types of Leadbeater's possum are most commonly ash forest typically dominated by mountain ash, alpine ash and shining gum.
- The species is also known to occur in subalpine woodlands and lowland swamp forest dominated by snow gum or mountain swamp gum (Smith and Hartley, 2008) with *Melaleuca* spp or *Leptospermum* spp in the middlestory (Harley et al., 2005).
- A structurally dense interlocking canopy or secondary tree layer of continuous interconnecting structure (to facilitate movement) (Lindenmayer, 1996a; Harley, 2004a;b;c), and
- A wattle understory (providing food) (Smith and Lindenmayer, 1988; Menkhorst and Lumsden, 1995; DSE, 2013).

Leadbeater's possum colonies are territorial, defending areas of 1–3 hectares (Smith, 1984). Leadbeater's possums appear to have critical minimum habitat size of around 12 ha (Lindenmayer et al., pers comm., 2014b). As the species indicates long-term site fidelity (Lindenmayer et al., 2013a), habitat where the species currently occurs is important habitat to maintain.

Habitats considered most likely to be currently occupied by Leadbeater's possums are characterised by lush, unburnt vegetation in gullies, located in areas that have relatively low summer temperatures and high summer rainfall (Lumsden et al., 2013). An optimum habitat is an uneven-aged ash forest with a dense understory of wattle trees and a supply of hollow-bearing trees of between 4.2 – 10 per 3 ha (Smith and Lindenmayer, 1988).

Information required, research and monitoring priorities-

All populations

- Investigate options to establish an effective means of detection, including further independent testing of the call-back survey technique and its assumptions for estimating population numbers of Leadbeater's possums, to understand and reduce uncertainty.
- Undertake surveys and consolidate this data with existing data, and undertake an integrated monitoring program to provide increased understanding of:
    - abundance of the whole species
    - location of strongholds
    - occupied habitat across all habitat types
    - areas of key habitat attributes
    - population statistics and trends
    - threats and threat trends
- Identify and map habitat (including areas with key habitat attributes and occupied habitat)
- Improve understanding of habitat survival to identify landscape features and habitats that are resilient to natural disturbance processes such as bushfires.
- Evaluate the effectiveness of actions to support the recovery of Leadbeater's possum through an adaptive management process
- Investigate population structure and genetic diversity and the potential effects of fragmentation between colonies
- Investigate the feasibility of insurance populations and translocations including:
    - Genetic viability of the captive breeding program for the lowland subpopulation
    - Feasibility of maintaining genetic distinction of the lowland subpopulation
    - Wild to wild and captive to wild translocation options (should suitable habitat be available).

Lowland subpopulation:

- Identify requirements for a planning regime that provides for appropriate suite of habitat structure (i.e., that simulates nature regeneration).
- Research appropriate regeneration techniques to simulate natural regeneration of mountain swamp gum and mid-story species in the floodplain of Yellingbo (including manipulative research trials), and the identification of quantitative vegetation condition targets.
- Identify former hydrological regime(s) (e.g., complete investigation through groundwater bores, track surface flow) to identify ideal conditions for future potential application, and
- Investigate techniques/applications to provide for restoration of former hydrological regime (e.g., manipulate water flow on the floodplain by weirs, earthworks).
- Explore/investigate the potential to provide for expansion of suitable lowland habitat to a network including other lowland patches, to reduce the risk to the population at this single isolated site, including identifying other sites that may be suitable for use by lowland colonies (or modified to become so).

Management actions required

All subpopulations

- Protect occupied habitat and areas with key habitat attributes from incompatible development activities such as road and track construction or maintenance in or adjacent to habitat, and recreational development in parks.

- Prepare fire management plans to inform fire operations, planning, suppression and management.
- Implement fire management measures to protect Leadbeater's possum colonies and habitat (particularly those that appropriately minimise the risks of high intensity fires)
- Develop fire recovery protocols to be enacted during and following fire or other disturbance that affect known colonies
- Maintain, protect, restore and enhance habitat (known occupied habitat, predicted occupied habitat, and potential future habitat)

Montane populations:

- Provide for protected habitat linkages between known or modelled-predicted occupied habitat and colonies.
- Prevent further decline and rebuild the population through protecting all current and future Leadbeater's possum habitat.

Lowland population:

- Undertake management planning to provide for long term priority planning with targets (e.g., 10 year, 20 year plan) for application of management actions for habitat restoration and to address key threats to the lowland subpopulations
- Apply targeted vegetation management planning that provides for appropriate habitat structure and restoration, such as regimes for patch clearance / opening up of patches or other disturbance for regeneration.
- Control and minimise feral grazers that destroy saplings and prevent revegetation and habitat succession.
- Control and minimise weed species (e.g., phragmites) that compete and prevent revegetation and habitat succession.
- Apply / restore the former or most appropriate hydrological regime along Cockatoo Creek and Macclesfield Creek (e.g., manipulate water flow on the floodplain by weirs, earthworks).
- Provide for additional and/or insurance populations as determined appropriate following investigations under 'Information required, research and monitoring priorities'.

Recommendations

(i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **transferring** from the endangered category to the **critically endangered** category:

Gymnobelideus leadbeateri

AND

(ii) The Committee recommends that the current recovery plan should be retained and updated.

The Committee considers the most effective way to prevent further decline and rebuild the population of Leadbeater's possum is to cease timber harvesting within montane ash forests of the Central Highlands.

Threatened Species Scientific Committee

2/12/2014

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Appendix 1
Assessment under Criterion 1

All data and analyses for Criterion 1 have a degree of uncertainty and the available data have different sources and assumptions that provide for some degree of over or under estimation that cannot be quantified. These are described within for each as comprehensively as possible and as understood by the Committee from the information available at the time of this assessment.

The assessments that follow have attempted to ensure, where possible, that losses due to different causes, in this case fire, harvesting and loss of hollow-bearing trees have not been multiple-counted and consequently overestimate loss. Any potential multiple counting of loss has been indicated where suspected or known.

This is an unavoidable consequence of the limitations of Criterion 1(c) that combines features of area (quantitative area of occupancy/extent of occurrence) and a less quantifiable/measurable 'quality of habitat' – that may overlap, as they do in this case.

Similarly, where harvesting is considered, it is limited (where known) to unburnt harvest rather than post-burn salvage harvest, unless indicated otherwise.

Primary sources of information used for this assessment include:

Lindenmayer et al. pers. comm., (2014a): Lindenmayer and colleagues have used extensive site data over a number of years (e.g., Lindenmayer, 1989; Lindenmayer et al., 1990; 1991a, b; 2000) to model and estimate the amount of suitable habitat for Leadbeater's possum available at 1989. Declines in 'suitable habitat' to 2013 caused by fire, logging, and loss of hollow-bearing trees are provided as percentage loss relative to this habitat. They use this loss to provide what they term to be a 'crude estimate' of current suitable habitat based on this modelling. Lindenmayer et al. (pers. comm., 2014a) also provide data on trend in decline of hollow-bearing trees over the periods 1989–2013, 2013–2035, and 2035–2060. They note that these estimates are underestimates as they do not account for edge effects, the loss of habitat to wide strips between logging coupes, and subdivision causing habitat fragmentation.

VicForests pers. comm. (2014) provide data for area (hectares) within the range of Leadbeater's possum of public forest suitable for Leadbeater's possum (ash forest including mountain ash, alpine ash, shining gum and snow gum). Most of these data are also provided in Appendix 4 of LPAG (2014a). For these forests, data are provided for the quantity burnt and not burnt since 2000. The information on ash forest is further categorised into 'available for harvest' and areas 'never to be harvested'. The non-harvestable areas are divided into those managed as 'parks and reserves', areas of Special Protection Zones, and exclusions.

VicForests pers. comm. (2014) also provide estimates of the area (ha) per annum harvested since 2009, and 'projected are to be harvested pa post 2013'. LPAG (2014a) clarify that the 'projected' harvest is from 2017, following the transition to lower harvest levels outlined in 'VicForests' 2013 Resource Outlook'.

LPAG (2014a, b) provide the table of data sourced from VicForests (as described above, but also provide information previously provided at LPAG (2013) and elsewhere such as that of Lumsden et al. (2014). Where these data differ to that of VicForests, it is assumed here to be due to the baseline being 2009, rather than that of 'since 2000' for VicForests.

These data do not include lowland floodplain forest habitat used by Leadbeater's possum, of which only 20 hectares provides suitable habitat conditions for the possum (D. Harley 2014 pers. comm., cited in DEPI, 2014).

Assumptions and data limitations

Data available to the Committee for its use in assessment under Criterion 1 have come from different sources. Given that the criterion is a comparison of variables over time, it requires data from different years, or predictions into the future. In many cases data is available for a single point in time but is not comparable to data in the past. For Leadbeater's possum, estimates of (c) area of occupancy, extent of occurrence and/or quality of habitat for the present time are difficult to determine and highly variable. The species is difficult to detect and estimates of occupancy and habitat may incorporate biases based on statistical assumptions (e.g., from sampling) as well as bias from sampling errors. These are exacerbated when projecting from these into the past or future.

Data for future circumstances are invariably speculative and uncertain, and relies on a number of assumptions. Data from different sources are rarely comparable, particularly if there are assumptions or biases built into their collection. Much of the data or estimates are not in the public domain and/or not independently verified or peer reviewed.

Area of occupancy, extent of occurrence, habitat quality

Criterion 1 provides for reduction in population size based on a decline in area of occupancy, extent of occurrence, and/or quality of habitat. The relationship between these and population size may be linear (and used as a direct proxy for population decline), but there may also be lagged response of the population to a decline in its habitat (IUCN, 2014). The relationship between loss of habitat quality and either occupation or population density may not be able to be estimated into the past or future. Combining estimates of decline in area of occupancy and extent of occurrence (where data may be spatial and quantifiable), with estimates of habitat quality (not spatial, less quantifiable) to provide for a single quantitative estimate of decline relative to the thresholds of the criterion is also difficult.

Some declines from threats may overlap spatially over time. For example, fire and harvesting may occur on areas where decline in habitat quality has occurred, harvesting may occur in areas affected by fire. Efforts in the analysis have also been made to reduce the occurrence of double counting these losses where possible.

The analyses undertaken for Criterion 1 for area of occupancy and extent of occurrence use data described as 'estimates of occupied habitat' or 'suitable habitat' within the Central Highlands (e.g., Lindenmayer and collegues; Lumsden et al., 2013), which differ significantly from estimates of 'suitable forest' within the Central Highlands (VicForests pers. comm., 2014; LPAG 2013, 2014a,b).

Efforts have been made whenever possible to separate assessments using these different source estimates of area of occupancy and extent of occurrence in analyses for Criterion 1, given they are not compatible data.

Assessment based on A2 (past)

The period of time over which decline is considered for A2 is within a past 18 years (three generation lengths). In this instance, the 18 year period 1995–2013 is chosen to provide for inclusion of best available Leadbeater's possum data from the 'present' (2013). This period includes declines observed, estimated, and inferred as a result of fire, harvesting and loss of habitat quality.

There are different sources of data that provide different and incompatible information on which this assessment can be based. Given this, assessments will be presented separately. These are outlined as (a) and (b) below and undertaken as differing assessments. There are two sources of information which provide comprehensive estimates of current /potential area of occupancy or

extent of occurrence and comparable estimates from the past close to, or within, the 18 year time frame considered (3 generation lengths) for this criterion:

a) Lindenmayer et al., pers. comm. (2014a). Comparisons of declines here are provided as percentage declines relative to forest at the year 1989. Lindenmayer et al., pers. comm. (2014a) provide data on decline in quality of habitat due to loss of hollow-bearing trees. The period 1989 to 2013 is 24 years used in this assessment rather than the 18 period required for this assessment, will therefore potentially provide an overestimate of decline for the whole 18 year period.

b) VicForests pers. comm. (2014) and LPAG (2014a) use a different baseline to that of Lindenmayer et al., pers. comm., (2014a). These provide data on area lost to fire and fire disturbance (in hectares) 'from 2000' to the present (2013) and include change due to the 2006/07 and 2009 fires (combined). This source also provides past harvest rates for some of these years. Assessment under A2 using this data will consider the 18 year period from 2013 to 1995, but data is only provided 'from 2000'. This shortened timeframe will therefore potentially provide an underestimate of decline for the whole 18 year period.

These data sources will be used for the following two assessments under A2. Additional or alternative information is included within these analyses where comparable.

LPAG (2013; 2014a) provide different estimates of the percentage of forest lost to fire. The estimates of LPAG (2013; 2014a) are instead based only on the 2009 fires, rather than fires 'since 2000' [of VicForests pers. comm., (2014); LPAG (2014a)]. In addition, these have a 'pre 2009' baseline of 195 000 ha, with a loss of 68,000 ha to fire of 34% (LPAG, 2014a) or 35% (LPAG, 2013). The timeframe for this change is only four years, and will be an underestimate of decline relative to the similar alternative data provided by VicForests. This data will therefore not be used for this A2 assessment (but will be included within subsequent assessments with more relevant timeframes).

a) Using data of Lindenmayer et al. (pers. comm., 2014a)

'Suitable habitat' available at 1995

Hollow-bearing trees with large internal dimensions in the order of 30 cm in diameter are a critical habitat feature for Leadbeater's possums (LPAG, 2013) and are required within ash forest to support colonies of the possum. There are strong and quantified links between the abundance of hollow-bearing trees and the occurrence of Leadbeater's possum (e.g., Lindenmayer at al., 1991c; Lindenmayer et al., 2013c; Lindenmayer et al., pers. comm., 2014a), with nest hollow availability limiting population size. An understory of wattle is also a required component of Leadbeater's possum habitat (Smith and Lindenmayer, 1988; Menkhorst and Lumsden, 1995; DSE, 2013).

Lindenmayer et al. (pers. comm., 2014a) have undertaken large scale vegetation surveys in the central highlands of Victoria since 1987 (e.g., Lindenmayer, 1989; Lindenmayer et al., 1990; 1991a, b; 2000). Their data layers indicate that in1987 and 1989 montane ash forest was represented by 171,200 ha. Of this available montane ash forest, only 6.7% was predicted to support 'suitable habitat' for Leadbeater's possum at this time (i.e. approximately 11,470 ha). This estimate was based on measures of the abundance of hollow-bearing trees and the prevalence of an understorey of *Acacia* spp.

This data, based on 'suitable habitat', is therefore likely to represent area of occupancy for Leadbeater's possum.

Loss from habitat decline (loss of hollows) 1989 to 2013
In 1997, the abundance of hollow-bearing trees was estimated to have occurred as 5.1 hollow-bearing trees per hectare and by 2013 had declined to 4 per hectare ecosystem-wide (Lindenmayer et al., 2012; Lindenmayer et al., pers. comm., 2014a). From repeated studies of the rate and spatial extent of decay and collapse of hollow-bearing trees throughout montane ash forest, Lindenmayer et al. (e.g., Lindenmayer, 1989; Lindenmayer et al., 1990; 1991a, b; 2000) estimate that of 6.7% of ash forest predicted to support potentially suitable habitat in 1989, by 2014 this will decline to 3.1% (= loss of 3.6% (absolute loss)).

Loss from fire 1989 to 2013
Lindenmayer et al. (pers. comm., 2014a) estimate that of the 6.7% possum-suitable habitat in montane ash forest, around 1.4% has been lost to fire or fire disturbance since 1989.

Loss from harvesting 1989 to 2013
Lindenmayer et al., (pers. comm., 2014a) estimate that 19,338 ha of montane ash forest in the Central Highlands has been lost to harvesting since late 1997, including areas predicted to support suitable Leadbeater's possum habitat. This estimated loss from harvest does not include post burn salvage harvest.

They also estimate that clearfell logging since 1989 has lead to 0.6% of the montane ash forest predicted to support suitable habitat being lost. They note that this is a conservative estimate because this does not also include the loss of other areas that have been rendered uninhabitable by harvesting – i.e. areas left as narrow strips (of approximately 20–100 m wide) that are unlikely to support Leadbeater's possum (Lindenmayer et al., 1993) and areas fragmented by logging roads and tracks that may have rendered areas too small for Leadbeater's possums.

Table 1 summarises the decline in 'suitable habitat' for Leadbeater's possum from fire, harvesting and loss of quality from 1989 to the present following Lindenmayer et al. (pers. comm., 2014a).

Table 1. Declines in 'suitable habitat' from 1989–2013 based on data from Lindenmayer et al. (pers. comm., 2014a).

'Suitable habitat' at 1989 is 6.7% of 171,200 ha =11,470 ha (baseline)	Of 11,470 ha		'Suitable habitat' remaining at 2013 (1.1% of 171,200 ha)	loss (relative to 11,470 ha baseline)
Estimated loss by 2013:	Loss			
-habitat quality from loss of hollows*	3.6%	6,163 ha		53.7%
-fire and fire disturbance*	1.4%	2,397 ha		20.9%
-harvesting*	0.6%	1,027 ha		9.0%
Total loss by 2013	5.6%	9,587 ha		
Total			1,883 ha*	83%
Lindenmayer et al. (pers. comm., 2014a) calculates:	5.4%		2,225 ha	81%

[*these % estimates attempt to allocate a % loss to each threat independent of each other, and may include some small degree of multiple counting]

The decline of 'suitable habitat' for Leadbeater's possum over the past 18 years through fire, harvesting, and a reduction in availability in hollow-bearing trees estimated primarily by data collected over a number of years (since 1987) and modelled and tested Lindenmayer et al. (e.g., Lindenmayer, 1989; Lindenmayer et al., 1990; 1991a, b; 2000) is therefore over 80%. This is considered by the Committee to be very severe.

b) Using baseline data of VicForests pers. comm. (2014) and LPAG (2014a)

Suitable forest available at 1995

While the assessment above at (a) uses data that focuses on 'suitable habitat' for Leadbeater's possum, data of VicForests pers. comm. (2014) and LPAG (2014a) includes all ash forest, including mountain ash, alpine ash, shining gum and snow gum forest within the home range of Leadbeater's possum within the Central, Dandenong and Central Gippsland Forest Management Areas. This data is provided noting that this forest type is 'suitable forest' for Leadbeater's possum. However, 'suitable forest' is an overestimate of suitable habitat for Leadbeater's possum, because not all ash forest is suitable for use by Leadbeater's possum (e.g., Lindenmayer et al., 1990; 1991a, b; 2000; Lumsden et al., 2013) with Lindenmayer et al. (pers. comm., 2014a) estimating that in 1987 and 1989 only 6.7% of montane ash forest in the Central Highlands was 'suitable habitat' for Leadbeater's possum.

There are no precise data available to the Committee that provide the baseline amount of montane ash forest available to Leadbeater's possum at 1995 (i.e. 18 years prior to the 'present' 2013). 'Since 2000', there was 204,400 ha ash forest (including mountain ash, alpine ash, shining gum and snow gum forest) considered to be suitable forest types for Leadbeater's possum within the home range of Leadbeater's possum and within the Central, Dandenong and Central Gippsland Forest Management Areas (VicForests pers. comm., 2014).

Decline from fire:

Leadbeater's possums do not occupy burnt sites regardless of fire intensity (Lindenmayer et al., 2013a; LPAG, 2013; Lumsden et al., 2013). Of the 204,400 ha 'available forest' for Leadbeater's possum 'since 2000', 55,300 ha (27%) has been burnt since 2000 (VicForests pers. comm., 2014). A total area of 149,100 ha ash forest remains unburnt at 2013 (Table 2).

Table 2. Loss of 'suitable forest' from fire 1995 to 2013 (area data from VicForests pers. comm. (2014) 'since 2000')

		Loss at 2013 from burn 'since 2000'
Ash forest total	204 400 ha	
Burnt since 2000	55 300 ha	27%
Remaining (unburnt) since 2000	149 100 ha	

Loss to harvesting

Of this unburnt 149,100 ha remaining ash forest/'suitable forest':

- 44,700 ha are available for harvesting (VicForests pers. comm., 2014). Ash or snow gum woodland available for harvesting excludes parks and reserves, Special Protection Zones, stream buffers and steep slopes and non-mapped exclusions.
- 104,400 ha are excluded from harvesting (VicForests pers. comm., 2014) (Table 3).

Table 3. Remaining unburnt 'suitable forest'/ash forest available for harvest (area data from VicForests pers. comm. (2014) 'since 2000')

Total unburnt ash forest at 2013	149,100 ha
Unburnt ash forest excluded from harvesting total	104,400 ha
Unburnt ash forest available for harvest	44,700 ha

VicForests (pers. comm., 2014) estimated that of the 44,700 ha area of harvestable ash forest 'since 2000', 610 ha has been harvested or thinned per annum since 2009 i.e., approximately 2,440 ha over 4 years to 2013, representing a further decline of 1.2% in 'suitable forest' since fires due to harvesting. 42,260 ha unharvested forest within the 'harvestable' areas is therefore 'suitable forest' at 2013 in addition to that of the ash forest excluded from harvesting (104,400 ha) (Table 4).

Table 4. Unburnt 'suitable forest' at 2013.

excluded from harvesting total	104,400 ha
available for harvest minus harvested area (i.e. 2,440 ha) at 2013	44,700 ha – 2,440 ha = 42,260 ha
'suitable forest' at 2013	= 146,660 ha

Table 5 provides the loss to 2013 from fire and harvest relative to the 204,400 ha baseline (VicForests pers. comm., 2014) which is 28%.

The Committee notes that Lindenmayer et al. (pers. comm., 2014a) estimate that 19,338 ha of 'montane ash forest in the Central Highlands' has been lost to harvesting since late 1997, including areas predicted to support suitable Leadbeater's possum habitat. If this amount is compared to the 204,400 ha ash forest available 'after 2000' of VicForests (pers. comm., 2014), this would represent a decline of 9.5%. These data are not comparable, for instance, this harvest estimate is since 1997 rather than since 2000, and may include areas subsequently lost to 206/7 and 2009 fires, but this provides an upper extreme potential of harvest and is included in Table 5.

Table 5. Loss from fire and harvest (relative to baseline of 204,400 ha)

	Harvested by 2013	% loss due to harvest relative to original 204,400 ha ash forest	% loss relative to original 204,400 ha ash forest
Harvest per annum since 2009 (over 4 years) (VicForests pers. comm., 2014) 610 ha	2,440 ha	1.2%	28%
Harvest since 1997* Lindenmayer et al. (pers. comm., 2014a)	19,338 ha	9.5%	36%

* noting the harvest estimated here is not directly comparable to the baseline of VicForests (pers. comm., 2014).

Decline due to loss of habitat quality (loss of hollow-bearing trees):
The abundance of hollow-bearing trees in 1997 is estimated to have been 5.1 hollow-bearing trees per hectare ecosystem-wide. By 2013 the abundance is estimated to be 4 per hectare (Lindenmayer et al., 2012; Lindenmayer et al., pers. comm., 2014a). This represents a decline in quality of habitat (of 22%) for Leadbeater's possum over this period of time. This loss is applied to the remaining 'suitable forest' following loss from fire and harvesting. Table 6 provides the total estimated loss from fires, harvesting and loss of quality if a 22% decline from loss of hollow-bearing trees is added to the declines estimated at Table 5. Lindenmeyer et al., (pers. comm., 2014a) also note a complete loss of habitat through loss of hollow-bearing trees from 1989 to 2013 of 55.7% (i.e. see Table 1). This loss is also included in Table 6.

Table 6. Estimated declines from fire, harvest and loss in habitat quality to from 1995 to 2013 (from 204,400ha).

Harvest per annum since 2009 (VicForests pers comm., 2014)	Loss from fire	Harvested by 2013	% loss from fire and harvest relative to original 204,400 ha ash forest	Remaining	Total loss following an additional 22% loss in quality of the remaining 'suitable forest'	Total loss
610 ha	55,300 ha (27%)	2,440 ha (1.2%)	28%	146,660 ha	Loss of 22% in quality (loss of 32,265 ha) =114,395 ha	44%
					Loss of 53.7% (loss of 78,756 ha) =67,904 ha	67%

Decline from 1995 to 2013

Using 204,400 ha of ash forest as a baseline, decline by fire, habitat quality, and harvesting results in an overall decline in 'suitable forest' for Leadbeater's possum of 44% or 67% (depending on the loss used for decline in hollow-bearing trees (Table 6)). The Committee considers this decline to be substantial to severe.

Assessment based on A3 (future)

The period of time over which decline is considered for A3 is a future 18 years. Data on change in area of occupancy, extent of occurrence and/or quality of habitat from a future period to a period further into the future is speculative and therefore to reduce the level of uncertainty, the period chosen includes the present (as 2013 with data provided for this assessment) to enable inclusion of known information about the present time (rather than some other future time). The period from 2013 to 2031 therefore includes the future, with declines projected and suspected due to:

- projected harvesting
- projected decline in tree hollows
- inferred/suspected extent of occurrence due to likelihood of future fire damage.

Like the assessment at A2, there are various sources of information which are not necessarily compatible, that can be used to inform the assessment under A3.

There are three sources of information which provide area estimates to estimate area of occupancy, extent of occurrence of Leadbeater's possum at 2013:

- Lindenmayer et al., pers. comm., (2014a)
- VicForests pers. comm., (2014) and LPAG (2014a)
- Lumsden et al. (2013)

Each of these is included in the following assessment.

There is one source of information on projected harvest rates: with three potential projected declines from harvesting provided by VicForests pers. comm. (2014) + LPAG (2014a).

There is one source of information on projected decline in tree hollows (Lindenmayer and colleagues) which is considered to be decline in habitat quality. There are no data available that can provide quantitative estimates of future decline as a result of fire. A range of potential

declines due to likelihood of loss in area of occupancy and/or extent of occurrence due to fire are therefore considered.

These are all included within the following analyses, where able, to estimate decline in area of occupancy, extent of occurrence and/or quality of habitat from 2013 to 2031.

Estimates of area of occupancy and/or extent of occurrence of Leadbeater's possum at 2013
a) Using occupancy modelling, Lumsden et al. (2013) predict that within the 'ash forests of the Central Highlands', there are only approximately 15,000 ha of forest currently occupied by Leadbeater's possum.

b) In 1989, a total of 25 of 370 field sites (6.7%) surveyed as part of a large-scale vegetation survey were predicted to support suitable habitat for Leadbeater's possum (Lindenmayer, 1989). Reduction in the number of hollow-bearing trees, fire effects and clearfell logging has reduced the amount of suitable habitat to 1.3 per cent of the montane ash forest estate. On this basis, Lindenmayer et al. (pers. comm., 2014a) provide a crude estimate that approximately 2,225 ha remaining ash forest is currently suitable as habitat for Leadbeater's possum.

c) Following the rationale provided at A2 based on data from VicForests pers. comm. (2014): there are 104,400 ha of unburnt ash forest within the range of Leadbeater's possum that are protected through parks and reserves, Special Protection Zones, and harvest exclusions (VicForests pers. comm., 2014). Within the unburnt 44,700 ha available for harvesting, an estimated minimum of 2,440 ha is estimated to have been harvested or thinned since 2009 leaving less than 42,260 ha unharvested ash forest at present. Therefore, there are currently approximately 146,660 ha of ash forest within the range of Leadbeater's possum that could be considered to be 'suitable forest' for Leadbeater's possum.

There are therefore three estimates of the area of occupancy or extent of occurrence of Leadbeater's possum at 2013, as provided in Table 7.

Table 7. Estimated available area of occupancy, extent of occurrence (ha) available for Leadbeater's possum at 2013.

Source and type of estimation	Estimated available area of occupancy, extent of occurrence
a) Estimated occupied forest at 2013 (Lumsden et al., 2013)	15,000 ha
b) Predicted available 'suitable habitat' (Lindenmayer et al., pers. comm., 2014a)	2,225 ha
c) Maximum available 'suitable forest' (unburnt and unharvested ash forest) (VicForests pers. comm., 2014 + LPAG, 2014a) and following A2	146,660 ha

Estimated loss of area of occupancy, extent of occurrence from 2013 to 2031 due to harvesting
At 2013, it is estimated that there are 42,260 ha of unburnt ash forest available for harvesting (following data presented at A2). This is the maximum possible harvest by 2031 and is used for assessment under (c).

The average rate of harvest and thinning of both burnt and unburnt ash forest from 2009 to 2013 was around 1,265 ha per annum (VicForests pers. comm., 2014; LPAG, 2014b). The amount harvested and thinned within unburnt ash forest between 2009 to 2013 was 610 ha per annum (and 655 per annum in burnt forest).

VicForests (pers. comm., 2014) estimates that 500–1000 ha ash forest is projected to be harvested per annum after 2013. LPAG (2014b) notes that this is a reduction in harvest rate implemented in ash forests within the range of Leadbeater's possum in response to the 2009 fire, and will be from 2017 as outlined in VicForests' 2013 Resource Outlook. Neither of these

sources provide a distinction between harvest rates in burnt and unburnt forest for this future harvest.

Given the uncertainty from when this rate will commence (i.e., either 'post 2013', or 'from 2017') it is assumed here that the former rate (of 610 ha pa) will continue to 2017 within unburnt ash forest. The following assessment will provide the loss due to harvest and thinning in unburnt ash forest (containing potential Leadbeater's possum habitat) using this rate to 2017. From 2017 to 2031 the rate of harvest will use the predicted reduced rate of 500 ha and 1000 ha pa. The Committee notes, however, that this rate is assumed to be across all ash forest within the range of Leadbeater's possum, and unlike the former rate of 610 ha pa, includes burnt and unburnt ash forest. This will therefore provide for an overestimation of harvest, and loss of 'suitable forest' over the years 2017 to 2031.

Three harvest rates are therefore included:

- 3050 ha (harvested at 610 ha per annum from 2013 to 2017) + 6,500 ha (when harvested at the lower rate of 500 ha/annum from 2017 to 2031) =9,550 ha
- 3050 ha (harvested at 610 ha per annum from 2013 to 2017) + 13,000 ha (when harvested at the higher rate of 1000 ha/annum from 2017 to 2031) =16,050 ha
- All harvestable forest (i.e. 42,260 ha) might be harvested between 2013 and 2031.

The three scenarios of loss from harvesting equate to 6.5%, 10.9% and 28.8% loss respectively relative to the 146,660 ha available at 2013. Table 8 provides the remaining extent of occurrence/area of occupancy to the original baselines at 2013 of (a) Lumsden et al. (2013) and (b) Lindenmayer et al (pers. comm., 2014a) following the application of the declines (%) under the three scenarios relative to the baseline of (c) (VicForests pers. comm., 2014 + LPAG, 2014a).

(a) Of the 15,000 ha of habitat estimated by Lumsden et al. (2013) to be occupied at 2013 using occupancy modelling, current strongholds include habitat mainly in the south of the Central Highlands including the Baw Baw Plateau and its southern slopes, the Toorongo Plateau south of the Upper Yarra Catchment and state forest in the vicinity of Powelltown, parts of Toolangi State Forest, and southern parts of the Upper Yarra National Park (Lumsden et al., 2013). Lumsden et al. (2013) note that these areas occur both within the reserve system and outside of these protected areas, however the proportions of these are not described by Lumsden et al. (2013). As some areas occur outside of the protected areas, it is likely that some will be subject to loss due to future harvesting. Of the three harvest loss scenarios of 6.5%, 10.9% and 28.8% are applied to the area estimates of Lumsden et al. (2013), it assumes that this forest is harvested at the same rates as applied generally, with these areas neither avoided or targeted for harvesting. The Committee notes that under future management this is unlikely to be the case, but the result of these theoretical harvests are provided in Table 8 for consideration of the potential loss without the application of future proposed management change.

(b) Similarly, of the 2,225 ha remaining suitable habitat for Leadbeater's possum estimated by Lindenmayer et al. (pers. comm., 2014a), some is expected to occur within areas projected for harvesting. The Committee is unaware of the quantity of harvestable forest that could be harvested by 2031 within these areas estimated to be occupied or estimated as 'suitable habitat' for Leadbeater's possum at 2013 indicated by Lumsden et al. (2014) and Lindenmayer et al. (pers. comm., 2014a).

Table 8. Extent of occurrence /area of occupancy Possible lost to harvest from 2013 to 2031

	area estimation at 2013	Loss to harvest from 2013 to 2017	Loss to harvest from 2017 to 2031	Total possible loss to harvest (ha) from 2013 to 2031	lost from harvest since 2013	Area remaining at 2031
a) Lumsden et al. (2013)[1]	15,000 ha				6.5%	14,025 ha
					10.9%	13,365 ha
					28.8%	10,680 ha
b) Lindenmayer et al. (pers. comm., 2014a)[1]	2,225 ha				6.5%	2080 ha
					10.9%	1982 ha
					28.8%	1584 ha
(c) Maximum available unburnt and unharvested ash forest (ha) (VicForests pers. comm., 2014)	146,660 ha					
(c) When harvested at 610 ha to 2013 (610 x 5)		3,050 ha				
c)* If harvested at min projected rate from 2017 (500 ha x 13 years)			+6,500 ha	=9,550 ha	6.5%	137,110 ha
c)* If harvested at high projected rate from 2017 (1000ha x 13 years)			+13,000 ha	=16,050 ha	10.9%	130,610 ha
c) If all harvestable unburnt ash forest is harvested				=42,260 ha	28.8%	104,400 ha

[1] loss from harvesting is applied to baseline areas of (a) and (b) at the three percentage declines found for harvest rates relative to baseline area of (c). This assumes the application of harvesting is neither avoiding or concentrating on these areas considered to be Leadbeater's possum habitat by these authors.
* harvest rate provided does not distinguish between burnt and unburnt forest harvesting. Thus this loss may include some double counting of loss from harvest and fire, and therefore be a slight over-estimation.

Estimated decline in habitat quality from 2013 to 2031 due to loss of hollows

There have been significant losses of hollow-bearing trees in past decades (LPAG, 2013). The combination of the loss of existing hollow-bearing trees and a lack of formation of new hollows is predicted to lead to a severe shortage of hollows in the next 30–70 years (LPAG, 2013).

Hollow-bearing trees with large internal dimensions in the order of 30 cm in diameter are a critical habitat feature for Leadbeater's possums (LPAG, 2013). Leadbeater's possums are more likely to occur in areas with higher densities of hollow-bearing trees, such as areas with more than two or three hollow-bearing trees per hectare (LPAG, 2013). There are strong and quantified links between the abundance of hollow-bearing trees and the occurrence of Leadbeater's possum (e.g., Lindenmayer at al., 1991c; Lindenmayer et al., 2013c; Lindenmayer et al., pers. comm., 2014a), with nest hollow availability limiting population size. A decline in the number of hollow-bearing trees therefore corresponds to a decline in the number of mature individuals of Leadbeater's possum, noting there may be a lagged response.

Lindenmayer and colleagues have undertaken extensive vegetation surveys since the 1980s to study the rate and spatial extent of decay and collapse of hollow-bearing trees throughout the montane ash forests of the Central Highlands of Victoria. Based on empirical data and modelling of the ongoing collapse of hollow-bearing trees between 1983 and 2012 in unburned areas (see Lindenmayer et al., 1990, 1997; Lindenmayer and Wood, 2010; Lindenmayer et al., 2012), Lindenmayer et al. (pers. comm., 2014a) estimate the decline of hollow-bearing trees will be from more than four per ha ecosystem wide in 2013 to 1.5 per ha by 2035. Because Leadbeater's possums are less likely to occur in areas with less than two or three hollow-bearing trees per hectare (LPAG, 2013), this represents a significant decline in habitat quality. A decline from 4 to 1.5 hollow-bearing trees per hectare from 2013 to 2035 represents a decline in habitat quality of 63% ecosystem-wide over this time. A further decline of 63% relative to that remaining following harvest from each of the original habitat estimates at 2013 are provided at Table 9. These percentage declines are applied to remaining area after harvesting (so as not to double count).

Table 9 provides the estimated remaining area after these combined losses, and a combined percentage loss.

Table 9. Estimated loss of habitat quality due to loss of hollow-bearing trees 2013–2031

Source of estimate	After harvest/ unharvested area remaining at 2013	63% loss of habitat quality (from remaining area)	Loss (from harvest and quality)
(a) following Lumsden et al. (2013) baseline of15,000 ha			
If harvested at min. projected rate	14,025 ha =6.5% loss	5,189 ha	65%
If harvested at max. projected rate	13,365 ha =10.9%	4,945 ha	67%
If all available harvestable forest is harvested	10,680 ha =28.8%	3,952 ha	74%
(b) following Lindenmayer et al. (pers. comm., 2014a) baseline of 2,225 ha			
If harvested at min. projected rate	2,080 ha =6.5% loss	770 ha	65%
If harvested at max. projected rate	1,982 ha =10.9%	733 ha	67%
If all available harvestable forest is harvested	1,584 ha =28.8%	586 ha	74%
(c) following VicForests (pers. comm., 2014) baseline of 146,660 ha			
*If harvested at min. projected rate	137,110 ha =6.5% loss	50,731 ha	65%
*If harvested at max. projected rate	130,610 ha =10.9% loss	48,326 ha	71%
If all available harvestable forest is harvested	104,400 ha =28.8%loss	38,628 ha	74%

* harvest rate provided does not distinguish between burnt and unburnt forest harvesting. Thus, this loss may include some double counting of loss from harvest and fire, and therefore be a slight over-estimation.

Loss due to fire 2013–2031

Scenarios include no fire, low to medium likelihood of fire impact (e.g., of 12.5% and 20%), and a 50% likelihood of fire impact. A 35% loss from fire scenario is also included, because 35% loss was that lost to ash forest and snow gum woodlands 'suitable forest' from the 2009 fires. These potential reductions are applied to the estimated areas remaining following loss from harvest and quality loss (i.e. if fire occurs at the end of the 18 year period). These are included in Table 10. The range of decline from these causes range from 63% to 87%.

Table 10. Loss to remaining area of occupancy/extent of occurrence after harvesting, loss of hollow-bearing trees (loss of quality) and from a range of potential fire scenarios from 2013 to 2031 (fire impacts to the area already harvested and loss of quality).

	Area remaining at 2031 after harvest	Area remaining at 2031 after harvest and 63% loss of quality	Area remaining at 2031 after further loss from fire (% loss to post harvest, post quality area)	% total loss
a) Estimated occupied habitat at 2013 (ha): 15,000 ha[1] (following Lumsden et al. , 2013)	14,025 ha	5,189 ha		
If 0% lost through fire by 2031			5,189 ha	65%
If 12.5% lost through fire by 2031			4,540 ha	70%
If 20% lost through fire by 2031			4,151 ha	72%
If 35% lost through fire by 2031			3,373 ha	77%
If 50% lost through fire by 2031			2,594 ha	83%
a) Estimated occupied habitat at 2013 (ha): 15,000 ha[2] (following Lumsden et al. , 2013)	13,365 ha	4,945 ha		
If 0% lost through fire by 2031			4,945 ha	67%
If 12.5% lost through fire by 2031			4,327 ha	71%
If 20% lost through fire by 2031			3,956 ha	74%
If 35% lost through fire by 2031			3,214 ha	79%
If 50% lost through fire by 2031			2,472 ha	83%
a) Estimated occupied habitat at 2013 (ha): 15,000 ha[3] (following Lumsden et al. , 2013)	10,680 ha	3,952 ha		
If 0% lost through fire by 2031			3,952 ha	74%
If 12.5% lost through fire by 2031			3,458 ha	77%
If 20% lost through fire by 2031			3,162 ha	79%
If 35% lost through fire by 2031			2,569 ha	83%
If 50% lost through fire by 2031			1,976 ha	87%
b) Estimated 'suitable habitat' at 2013 (ha): 2,225 ha[1] (following Lindenmayer et al. pers. comm., 2014a)	2,080 ha	770 ha		
If 0% lost through fire by 2031			820 ha	63%
If 12.5% lost through fire by 2031			674 ha	70%
If 20% lost through fire by 2031			616 ha	72%
If 35% lost through fire by 2031			500 ha	77%
If 50% lost through fire by 2031			385 ha	83%
b) Estimated 'suitable habitat' at 2013 (ha): 2,225 ha[2] (following Lindenmayer et al. pers. comm., 2014a)	1,982 ha	733 ha		
If 0% lost through fire by 2031			733 ha	67%
If 12.5% lost through fire by 2031			641 ha	71%
If 20% lost through fire by 2031			586 ha	74%
If 35% lost through fire by 2031			476 ha	79%
If 50% lost through fire by 2031			367 ha	83%
b) Estimated 'suitable habitat' at 2013 (ha): 2,225 ha[3] (following Lindenmayer et al. pers. comm., 2014a)	1,584 ha	586 ha		
If 0% lost through fire by 2031			586 ha	74%
If 12.5% lost through fire by 2031			513 ha	78%
If 20% lost through fire by 2031			469 ha	79%
If 35% lost through fire by 2031			381 ha	83%
If 50% lost through fire by 2031			293 ha	87%
c)* Estimated 'suitable forest' at 2013 (ha): 146,660 ha[1]	137,110 ha	50,731 ha		
If 0% post harvest and quality lost though fire by 2031			50,731 ha	65%
If 12.5% lost through fire by 2031			44,390 ha	70%

If 20% lost through fire by 2031			40,585 ha	72%
If 35% lost through fire by 2031			32,975 ha	77%
If 50% lost through fire by 2031			25,365 ha	83%
c)* Estimated 'suitable forest' at 2013 (ha): 146,660 ha[2]	130,610 ha	48,326 ha		
If 0% lost through fire by 2031			48,326 ha	67%
If 12.5% lost through fire by 2031			42,285 ha	71%
If 20% lost through fire by 2031			38,661 ha	74%
If 35% lost through fire by 2031			31,412 ha	79%
If 50% lost through fire by 2031			24,263 ha	83%
c) Estimated 'suitable forest' at 2013 (ha): 146,660 ha[3]	104,400 ha	38,628 ha		
If 0% lost through fire by 2031			38,628 ha	73%
If 12.5% lost through fire by 2031			37,997 ha	74%
If 20% lost through fire by 2031			30,902 ha	79%
If 35% lost through fire by 2031			25,108 ha	83%
If 50% lost through fire by 2031			19,314 ha	87%

[1] at minimum harvest rate (6.5% loss)
[2] at maximum harvest rate (10.1% loss)
[3] at maximum possible harvest (28.8% loss)
* the harvest rate provided post 2013/ after 2017 does not distinguish between burnt and unburnt forest harvesting. This loss may, therefore, include some double counting of loss from harvest and fire, and therefore be a slight over-estimation.
Areas burnt would include areas already included to have lost habitat quality, and therefore the total loss is slightly overestimated.
As the analysis provides for outcomes from a range of scenarios, including no fire, these results do not include the quantitative probability of fire occurring within this time period.

Assessment based on A4 (past and future)

The period of time considered for A4 is a three generation length period (18 years) including both the past and the future. Because most data on change in area of occupancy/extent of occurrence and quality is available from the periods that include the 2006/7 and 2009 bushfires, this assessment under A4 incorporate times that include these events.

LPAG (2013; 2014a) provide data for hectares of forest lost during the 2009 fires relative to 'area of potential habitat'. The 'area of potential habitat' as 100% range of Leadbeater's possum is provided by LPAG (2013) as 195,000 ha. However, there is no indication of whether this 'potential habitat' is unburnt and prior to 2009 (in which case a proportion would be unsuitable) or current post 2009 'potential habitat' excluding burnt areas.

As Lindenmayer et al. (pers. comm., 2014a) data uses a baseline of 1987 and 1989, and their estimations of harvest lost relative to this baseline is from late 1997, the 18 year period potentially for consideration here under A4 would only extend to 2015. Because the result from assessment over this time period would be very similar to that provided under A2 (to 2013), analysis using this 1997 baseline data will not be considered further for A4. Analyses for this subcriterion using data 'since 2000' of VicForests (pers. comm., 2014) similarly, do not provide data that would be different from analyses under A2, with the 18 year period under consideration extending to 2018. There are no additional known baseline data for just prior to 2006 or 2009 to provide for consideration of change in area of occupancy/extent of occurrence and quality for A4.

There are therefore inadequate data to provide for baselines alternative to those already considered under A2 and A3. Assessment under A4 is therefore not evaluated here.

Encl 6.11c

AGENDA - Murrindindi Environment Advisory Committee				**File: 58/03/16**	
Date	**28 April 2015**	**Time**	**1:30pm**	**Location**	**Yea Y Water Centre**
Attendance		Mark Leitinger, Sue McNair(minutes), Rita Seethaler, John Coyne, Nigel Waterhouse, Peter McKernan, Christine Glassford, Steve Meacher (Chair), Roger Cook, Judy Watts, Ron Litjens		**Apologies**	Ann Jelinek, Robert Chaffe, Cr. John Kennedy, Cr. Andrew Derwent

Item	**Description of Issue**	**Action**	**Who**	**When**
1.	**Minutes of Meeting held**: 10 February 2015	Accepted minutes as true and correct	Moved: Rita Seethaler Seconded: Roger Cook	
2.	**Matters Arising Previous Minutes**	Determined to be discussed at round table agenda item		
3.	**Election of Chairperson for coming year.** .	By agreement Mark Leitinger assumed the role as temporary chair and called for nominations for the position of Chair of the MEAC. Only one nomination was received with Steve Meacher nominated by Roger Cook. Steve accepted the nomination and was therefore elected as chair of MEAC for the next 12 months.		

4.	**Manager Update** Mark gave an update on a number of programs including: Coordinator Environmental Programs-Zoe Blakeney has delivered a little girl Josephine Rose and will be on maternity leave for 12 months. Curtis Thornton, who was appointed the Coordinator of Environmental Programs for 12 months whilst Zoe on maternity leave, has resigned. Currently in the process of appointing another candidate. Submission to Vic Forests- Council officer provided the Councils Vic Forests submission to the MEAC members on the 27/04/2015 via email. This submission indicated that council did not support logging unless there were certain criteria met by Vic Forests which include environmental and sustainable management practices. 2015-16 Business Plan-Zoe had prepared a draft before her departure Historic Offsets-Mark indicated that the Environmental Programs	To arrange appointment of Coordinator Environmental Programs SM commented that the Council's submission was of a high quality	ML	

	Unit has been working on this and Sue gave an update on the progress. A review of council assets determined that there was only one possibly suitable site. Partnering with either the GBCMA or the local office of DEDJTR would provide the best outcome however need to work through the administrative, legal and associated issues before resuming with the steering committee set up to help assist with the historical offsets project. Council approval would be required to then proceed to the delivery of the project.		Coordinator Environmental Programs	
	Rail Trail Style Guide- Judy Watts and the Upper Goulburn Landcare Network had inquired as to the branding of signage for the Rail Trail. A style guide was provided to Judy. Approval of signage contact at Council is John Canny, Manager Infrastructure Assets. Rita suggested that the style guide be put on the Council's website.	Send a copy style guide to MEAC members. Discuss upload of document to website with Communications Team.	SM SM	
	Energy Efficiency Program- In the draft 15-16 budget Mark indicated an amount of $180,000 is being proposed for the installation of solar panels to 5 sites. The following sites have been identified for consideration the Alexandra Library, the Alexandra Shire Offices, the UGFM/Council chambers, the Alexandra depot and the Webster St offices.	Implement subject to budget approval & allocation	Coordinator Environmental Programs	
	Peter indicated that 2 energy consumption monitoring devices were available for installation in Council buildings. After some discussion it was agreed to keep one device for use in checking locations where further investigation is required to understand consumption patterns and detect any errors with billing with the other being installed at the Marysville VIC/RAC subject to approvals.	Discussion required with VIC & subsequent training if approval given by VIC	PM	
	Rita suggested a training workshop for staff to be able to read the energy efficient technology to determine and analyse where problems lie. Watts Working Better-Replacement of street lighting from mercury vapour to T5 in Alexandra and Yarck. There is a community meeting to be held on the 27th May at the Alexandra RSL Hall at 6.30pm to explain the process to the community on energy cost reduction.	Circulate details to members as required	ML	

	Climate Smart Agriculture Program-Mark advised that the program falls under the Goulburn Broken Greenhouse Alliance and is auspiced by Moira Shire Council. A meeting for stakeholders is scheduled for early May. Deakin University have been appointed to undertake the study with 7 councils	Continued participation with working group	Coordinator Environmental Programs (other staff as required)	
5.	**Environment Policy Review-**This policy is an overarching document whereby all departments within Council consider environmental and sustainability principles in delivery of programs. Mark indicated the need for an additional point/clause within the policy to include an understanding that whilst every effort is required to adhere to policy, it will be done so under the constraints imposed with finances and resources available. Nigel also indicated the need for inclusion of a statement indicating that Council needs to meet Environmental Legislative responsibilities. This point could be put under Protect what we have.	Edit current Policy Document to reflect these changes and circulate for feedback then seek Council adoption	Coordinator Environmental Programs	
6.	**Environment Strategy-** Mark explained Zoe had reviewed Environment Strategy activities with the Council Plan. Curtis is coordinating the 1st review of the Environment Strategy which incorporates what has been completed and what actions will be abandoned. Curtis will submit to Mark by the end of the week. Whilst a graphic representation of what actions had been completed and what actions still needed to be undertaken there was discussion as to the method of representation not being realistically reflective of the true state of achievements.	Distribute draft to members for feedback.	Coordinator Environmental Programs	

7.	**Additional Business-** Cr Derwent Email- The email sought the MEAC thoughts on asking the Council to lobby the Federal government to invoke action to compel the State government to cease logging in areas identified in the recent Threatened Species Scientific Committee's report on the Leadbeater's possum. It was pointed out that MEAC may be in favour but ultimately Council would need to make the final decision on whether to send such correspondence to the Minister.	Moved: RS Seconded: PM MEAC recommends that Council write to the Federal Environment Minister, the Hon. Greg Hunt MP, to commend him on his decision to recognise Leadbeater's possum as 'Critically Endangered' under federal legislation. As Murrindindi Shire includes a significant part of the critical habitat of Leadbeater's Possum, much of which was burnt in the February	ML	

		2009 bushfires, Council seek assurance that a high priority be given to, 1) Increased protection and management of Leadbeater's Possum in our area, particularly in the context of the Central Highlands Forest Management Plan and continued logging operations in Mountain Ash forests, and 2) Initiatives that provide advice and support to any affected communities.		
	<u>UT Creek Alexandra-</u>Mark explained there had been a complaint about the fuel loads along the UT creek in Alexandra. Sue indicated that this has been a common theme over a number of years and that there could be a possibility of Council collaborating with the Upper Goulburn Landcare Network (UGLN) and the UT Creek Maintongoon Landcare Group and also the Goulburn Broken Catchment Management Authority (GBCMA) to tackle woody weeds and fuel loads on the creek. Funding would be integral to any program.	Follow up with UT Creek/Maintongoon Landcare Group, GBCMA and UGLN and report by next meeting.	SM	
	<u>Yea Wetlands Fire Management Plan-</u>A draft fire management plan has been developed by the CFA in collaboration with stakeholders involved in the Yea Wetlands. Due to the sensitive nature of the site the fuel reduction is based on a schedule of slashing and mulching. The Yea Wetlands Committee who were consulted in the development of the plan are concerned however as to the ongoing financial costs, and whether they can meet the costs associated	Forward a copy of the Yea Wetlands Fire Management Plan to members. Comments need to be forwarded to Sue by Friday 1 May 2015. Sue to coordinate any responses.	MEAC SM	

	Attachments- Cr Derwent's email Yea Wetlands Fire Management Plan Rail Trail Style Guide Minister Hunts Media release – Lead Beater's possum (22 April 2015)			
	Next Meeting: 9th June Alexandra Offices			
	The meeting closed at: 3.45pm			