Leadbeater's Possum Recommendations: Report to the Minister for Environment and Climate Change and the Minister for Agriculture and Food Security

Leadbeater's Possum Advisory Group

20 January 2014

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Foreword

The Leadbeater's Possum Advisory Group was established at the request of Ryan Smith, the Minister for Environment and Climate Change, and Peter Walsh, the Minister for Agriculture and Food Security, to develop recommendations to support the recovery of Leadbeater's Possum while maintaining a sustainable timber industry.

Leadbeater's Possum is endemic to the State and is highly valued by Victorians as a Victorian faunal emblem. The species is listed as a threatened species at both the State and Commonwealth levels. The majority of the population of Leadbeater's Possum is in an area of approximately 70 x 80 kilometers within the Central Highlands north-east of Melbourne.

Concern for Leadbeater's Possum increased significantly after the 2009 bushfires, which burnt around 45 per cent of the area reserved specifically for the species. This fire has intensified ongoing habitat decline caused by the collapse of dead nesting trees left standing after the 1939 bushfires. This loss of hollow-bearing trees is predicted to lead to a bottleneck in suitable habitat over the next 70 years. Modelling predicts the population of Leadbeater's Possum will fall to low levels during this time, increasing the risk of extinction, with future bushfires further exacerbating this situation.

Approximately one third of the Leadbeater's Possum range is managed for timber production, which can impact the species. The ash forests of the Central Highlands are highly valued for timber harvesting, with VicForests drawing up to 80 per cent of its ash timber from this area to supply Victorian wood and paper processors. This highlights the importance of ensuring that the management of these forests is undertaken in a way that supports habitat for Leadbeater's Possum into the future.

Our focus, therefore, was to recommend actions aimed at slowing the projected decline in population numbers in the Central Highlands within the broader context of the timber industry to help ensure there are sufficient individuals for the species to recover once it passes through the habitat bottleneck. This approach was considered to provide the best chance of long-term recovery for the species.

We have completed an extensive consultative process and acknowledge the scientific advice and views provided by individuals and peak organisations.

This input ensured we had access to world-class science and diverse perspectives on potential actions, their viability, the expected improvements they would provide for Leadbeater's Possum, and their expected impact on the timber industry. Conservation, feasibility and economic criteria were used to iteratively test potential actions, individually and in combination, for their value and cost.

We have recommended a single integrated package of complementary actions, consisting of on-ground, supporting and enabling actions, which should be viewed as a five-year intervention.

Implementing this package would:

- provide protection to Leadbeater's Possum colonies;
- protect current high quality habitat;
- protect existing old growth forest and expand future old growth forest;
- enhance the extent and quality of Leadbeater's Possum habitat in the future;
- proactively provide additional nesting resources;

- support improving knowledge to more effectively implement management actions; and
- support community engagement.

In developing this package we have carefully considered the implications for the Victorian timber industry. We believe the package of actions is viable, can be practically implemented, and is cost effective. Our consultation also identified some actions that, because of the expected resultant profound effect on the timber industry, were beyond our terms of reference.

We have recommended that the implementation of the package of actions be reviewed in four years. We have also recommended an interim review of Action 1 presented in this report (establishing a timber harvest exclusion zone of a 200 metre radius around colonies), to occur within two years or once 200 new colonies have been located, whichever comes first.

We have prepared two reports: this Recommendations Report, which provides the package of recommendations and a high level summary of the process we used to formulate it, and a separate Technical Report providing detail on the processes and findings we used to inform our deliberations.

In closing, we appreciated the generosity of participants in providing their time and willingness to frankly discuss with us and each other the current arrangements and future options. We acknowledge the professionalism and commitment of the individuals and organisations who provided their time and information and of our Secretariat.

Co Convenor
Jenny Gray
CEO Zoos Victoria

Co Convenor
Lisa Marty
CEO Victorian Association of Forest Industries

1 The Leadbeater's Possum Advisory Group

The Leadbeater's Possum Advisory Group (the Advisory Group) was established in June 2013 at the request of the Minister for Environment and Climate Change, Ryan Smith, and the Minister for Agriculture and Food Security, Peter Walsh.

The Advisory Group consisted of:

- Jenny Gray (co-Convenor), CEO Zoos Victoria
- Robert Green, CEO VicForests
- Bill Jackson, CEO Parks Victoria
- Lisa Marty (co-Convenor), CEO Victorian Association of Forest Industries
- Bram Mason, Chair Leadbeater's Possum Recovery Team

A Secretariat from the Department of Environment and Primary Industries (DEPI) supported the Advisory Group.

The Terms of Reference for the Advisory Group[1] were to develop recommendations for government focused on supporting the recovery of the Leadbeater's Possum while maintaining a sustainable timber industry. The Terms of Reference specified that the Advisory Group's recommendations should reflect current government policy, the principles of sustainable forest management (as reflected in the *Sustainable Forests (Timber) Act 2004*) and good governance, and should consider relative costs and benefits.

The Advisory Group was based on a partnership approach. The Terms of Reference highlighted the need for the Advisory Group to work with a broad range of experts and stakeholders and utilise the most up-to-date science and data to inform the development of its recommendations. Recommendations were expected to include but not be limited to:

- immediate actions to manage the decline of the species; and
- medium and longer term actions to ensure the persistence of the species and its co-existence with a sustainable timber industry.

It is anticipated that the recommendations presented in this report will be used by government, industry and other stakeholders to inform future efforts and priorities. This includes the revision of the Victorian Action Statement (1995) for the Leadbeater's Possum under the *Flora and Fauna Guarantee Act 1988* (FFG Act) and the Commonwealth Recovery Plan (1998) under the *Environment Protection and Biodiversity Act 1999* (EPBC Act).

2 Issues Definition

2.1 The Leadbeater's Possum

Leadbeater's Possum, *Gymnobelideus leadbeateri,* is a small, charismatic marsupial and the Victorian faunal emblem. The Leadbeater's Possum was considered extinct in the early 1900s and rediscovered in 1961. There is concern that Leadbeater's Possum is again facing the threat of extinction, and it is currently listed as 'threatened' under the FFG Act[2] and as 'endangered' under the EPBC Act. Significant

[1] Appendix 1: Leadbeater's Possum Advisory Group Terms of Reference

[2] *Flora and Fauna Guarantee Action Statement No.62: Leadbeater's Possum,* Gymnobelideus leadbeateri

work on the life history and habitat requirements of Leadbeater's Possum has been carried out over the last thirty years, alongside considerable research into forest management. Habitat loss, primarily through bushfires and to a lesser extent timber harvesting, is considered to be the main driver for the decline in the conservation status of Leadbeater's Possum.

Leadbeater's Possums exist in three habitat types:

- ash type forests in the Victorian Central Highlands;
- sub-alpine woodlands in the Victorian Central Highlands; and
- lowland swamp forest at Yellingbo.

The largest population is in an area of approximately 70 x 80 kilometres within the ash forests and sub-alpine woodlands in the Central Highlands. This area is the focus of the Advisory Group's work.

To facilitate management of the species, 21 Leadbeater's Possum Management Units (LMUs) were established in the Victorian Central Highlands. Each LMU is composed of 6,000 - 10,000 hectares of ash forest. Special Protection Zones were established within each LMU in November 2008, reserving a total of 30,500 hectares as the Leadbeater's Possum Reserve. In total, 65 per cent of the area of potential habitat within the range of Leadbeater's Possum is located in formal parks and reserves, Special Protection Zones in State forest (including the Leadbeater's Possum Reserve) or areas excluded from harvesting due to biodiversity, regulatory and operational reasons.

Approximately 63,000 hectares of ash forest within the range of Leadbeater's Possum (31 per cent of potential habitat) is available for timber harvesting. To reduce the impact of timber harvesting on the species while addressing the challenges with detecting the Leadbeater's Possum, forest management practices based around protecting high-quality Leadbeater's Possum habitat (known as Leadbeater's Possum habitat zones) have been implemented. This includes identifying and protecting Leadbeater's Possum habitat zones prior to harvesting. Recent court cases and intensified legal challenges have shown the importance of clear definitions for these habitat zones. Although high quality habitat for Leadbeater's Possum is protected through prescriptions, there are currently no measures to protect colonies that occur outside of these areas, with Leadbeater's Possum known to occur in areas with fewer hollow-bearing trees than the number required to qualify for protection as Leadbeater's Possum habitat zones.

A leading scientist on the Leadbeater's Possum, Professor David Lindenmayer, has called for increased protection for Leadbeater's Possum, changes to forestry management practices, and the establishment of a Great Forest National Park (these measures are referred to later in the document as the Lindenmayer et al. prescriptions)[3].

2.1.1 A New Strategic Approach to Biodiversity Management – Research Component

The Victorian Government's *Timber Industry Action Plan* (TIAP) (2011) details how the government will implement its forest-related election commitments to provide long term certainty for the timber

[3] David B. Lindenmayer, David Blair, Lachlan McBurney and Sam Banks; *New Restoration Forest Management, Prescriptions to Conserve Leadbeater's Possum and Rebuild the Cover of Ecologically Mature Forest in the Central Highlands of Victoria*; July 2013. Fenner School of Environment and Society; ANU College of Medicine, Biology and Environment.

industry. It includes an action to develop a new strategic approach to biodiversity management. As part of the TIAP, in 2011 the Victorian Government commissioned DEPI's Arthur Rylah Institute (ARI) to undertake research on the distribution and habitat use of nine high priority species within the Central Highlands Regional Forest Agreement area, including Leadbeater's Possum[4]. Targeted surveys for Leadbeater's Possum across State forests, parks and reserves were undertaken using a new survey technique. Leadbeater's Possums were found at 16 per cent of sites, with none found on burnt sites, confirming the strong negative impact of fire on the species. Nineteen per cent of unburnt sites surveyed were found to have Leadbeater's Possums.

An occupancy model using a wide range of habitat and environmental variables was developed using this survey data. While not incorporating all habitat variables, it does enable predictions of where the species is most likely to currently occur across the Central Highlands.

The ARI project also developed a Population Viability Analysis (PVA) to investigate the current and predicted future status of Leadbeater's Possum. The PVA investigated the capacity of the Leadbeater's Possum Reserve to sustain a viable population under a number of future fire and habitat loss scenarios. The analysis predicted that the population within the Leadbeater's Possum Reserve will decline in the near term and that it has a high risk of extinction over the next 50 to 70 years due to habitat constraints caused by the loss of hollow-bearing trees. The PVA was extended to include the formal parks system, and concluded that the existing national parks and conservation reserves in conjunction with the Leadbeater's Possum Reserve are insufficient to ensure the long term survival of the species and that other interventions are necessary. This analysis considered just the formal reserve system and did not factor in the contribution of non-reserve management actions (e.g. Leadbeater's Possum habitat zones and other areas excluded from timber harvesting), which also contribute to the habitat available for the species.

An estimate of the number of Leadbeater's Possum colonies in the Central Highlands was extrapolated from the survey data collected during the ARI research project. This extrapolation estimated that the number of colonies is likely to be between 1,578 and 4,384[5]. There is uncertainty around the size of colonies; however, current research suggests that colonies are typically 2 to 3 individuals. Using 2.5 individuals as an average, this would equate to approximately 3,945 to 10,960 individuals in ash and Snow Gum areas. As there is a high level of uncertainty around these population estimates and since the PVA shows the population is in serious decline, it is appropriate that the trend in population numbers is the primary focus rather than estimated population numbers.

2.1.2 Bushfire and Leadbeater's Possum

Bushfire is an integral component of ash forests and has an important influence on the occurrence, extent and viability of Leadbeater's Possum and its habitat. The impact of bushfires can vary greatly depending on the frequency, intensity, location and extent of the fire. Frequent, extensive, high-intensity bushfires – which result in mortality, destruction of food resources, alteration of forest structure and loss of hollow-bearing trees (with dead hollow-bearing trees at particular risk) – are a

[4] L.F. Lumsden, and others; *A New Strategic Approach to Biodiversity Management – Research Component*; September 2013; Arthur Rylah Institute for Environmental Research, Department of Environment and Primary Industries.

[5] Appendix 2: Estimated number of Leadbeater's Possum colonies in the Central Highlands.

major threat to the survival of Leadbeater's Possum. Future climate changes are predicted to lead to an increase in the frequency of such bushfires, increasing the risk to Leadbeater's Possum.

Severe, high-intensity bushfires kill ash trees, resulting in regeneration of single-aged stands. Most recently, the 2009 bushfires had a significant impact on the Leadbeater's Possum's population and its habitat. In total, 34 per cent of the potential ash forests and sub-alpine woodlands habitat (68,000 hectares) within the range of the Leadbeater's Possum in the Central Highlands was burnt in February 2009, with 45 per cent of the Leadbeater's Possum Reserve burnt. Post-fire, Leadbeater's Possums have not been detected at burnt sites, irrespective of the bushfire intensity, including where the understorey was burnt but the canopy remained intact. This suggests that the species has been lost from these areas. The severe impact of this bushfire has led to increased calls for action to protect remaining populations and a strong desire from community groups to assist with the recovery of the species.

2.2 Timber Industry

The timber industry provides social and economic benefits to Victoria. Up to the level of primary processing, the Victorian native timber industry employs around 2,300 people, with 1222 people directly employed in the Central Highland ash forests[6]. Secondary processing supports a further 14,500 jobs across the Victorian timber industry and there is additional indirect employment.

The 2009 bushfires significantly impacted the native forestry industry in the Central Highlands, burning approximately 26 per cent of harvestable ash forests. In August 2013, VicForests announced that ash harvest volumes will be reduced by 25 per cent starting from 2017. Due to ongoing work with industry, VicForests is expecting to have made significant reductions prior to 2017. The ash harvest area within the Leadbeater's Possum range is projected to reduce to between 500 – 1000 hectares per year. Future fires are a significant risk to the local timber industry.

Approximately 62,600 ha (31 per cent) of the ash forests within the Leadbeater's Possum range are potentially available for timber harvesting over an 80 year rotation[7]. Of this, around 24,000 hectares is likely to be harvested over the next 30 years.

These ash forests are highly valued for timber harvesting, with VicForests drawing up to 80 per cent of its ash timber from this area to supply Victorian wood and paper processors.

2.3 A landscape management perspective

The ash forests of the Central Highlands are also important to Victorians for other (non-timber) uses and values, including biodiversity and environmental values, water management, recreation, cultural and heritage values and economic uses such as tourism and apiary. Managing native forests to support threatened species like Leadbeater's Possum is an important component of sustainable forest management, which includes the application of forest management plans, forest certification standards and Codes of Practice.

[6] Appendix 3: Timber Industry Baseline.
[7] Appendix 4: Public forests within the Leadbeater's Possum range.

Ensuring appropriate habitat is available for Leadbeater's Possum across parks, reserves and State forests over the coming decades will be an essential component of any plan to support the recovery of the species. Managing these forests for diverse values is a challenge. Failure to adequately protect the habitat required now and in the future will lead to an ongoing reduction in the Leadbeater's Possum population and a loss of the timber industry's social licence to operate.

3 Advisory Group Process

The Advisory Group approached its Terms of Reference by examining the latest research and science on the Leadbeater's Possum and information on the forestry sector[8]. Various stakeholders across a wide range of interest groups were engaged through workshops, written submissions and an online forum[9]. Through these engagements, and drawing on existing documents, the Advisory Group compiled a list of over 100 possible actions to assess their potential to support the recovery of the Leadbeater's Possum while maintaining a sustainable timber industry.[10] A range of ecological modelling and economic analysis was used to assist in assessing actions and possible combinations of actions to inform the development of recommendations.

Potential actions were classified as within or out of scope of the Advisory Group's Terms of Reference. Those within scope were further classified as 'on-ground actions', 'supporting actions' or 'enabling actions'[11]. Models were developed to test the proposed actions against their potential benefits to Leadbeater's Possum and their potential impact on available harvest area. The models were used to refine packages of actions.

The Advisory Group recognised the immediate threats to Leadbeater's Possum and the need for actions with direct impacts in terms of outcomes for the species. It focused its efforts on prioritising the evaluation of on-ground actions and sought advice from ARI and DEPI experts on complementary supporting and enabling actions. A high level assessment of the potential benefits to the Leadbeater's Possum was then undertaken by a group of technical experts and cross-checked by the Australian National University (ANU) and the Leadbeater's Possum Recovery Team. VicForests assessed the estimated impact on timber harvesting and the practicality of implementation.

Following the initial assessment, a Bayesian model[12] was developed with input from research staff from the ANU. This model aimed to refine the potential impacts of on-ground actions and estimate the relative impacts of actions acting together to benefit the Leadbeater's Possum.

VicForests built a model based on its Geographic Information System to evaluate the impact of on-ground actions on timber harvest areas. This model was verified by the independent consultancy URS Australia.

DEPI's Economics and Policy Integration Branch was commissioned to analyse the direct and indirect costs of implementing alternative packages of actions[13]. This work did not consider who would bear these costs, as this was considered beyond the scope of the Advisory Group's Terms of Reference.

[8] Appendix 5: Decision-making framework.
[9] Appendix 6: Summary of the workshops and online submissions.
[10] Appendix 7: Leadbeater's Possum Advisory Group Process Map.
[11] Appendix 8: Actions considered by the Leadbeater's Possum Advisory Group.
[12] Appendix 9: Bayesian Network Model of benefits of proposed actions.
[13] Appendix 10: Approach to measuring the cost of actions to the timber industry.

The DEPI Forestry Industry Policy Branch engaged *Econsearch* to independently assess employment and socioeconomic impacts of potential changes in timber harvest volume available to the timber industry at the primary processing level. The results of these analyses were considered in developing recommendations.

The final deliverable from the modelling and analysis work was a detailed table showing the impacts of each proposed action in terms of its relative improvement in the state of Leadbeater's Possum and impacts on the harvestable volume of timber. Individual actions were grouped into packages and their impact assessed. Eighteen different packages were considered, ranging from the current situation to the Lindenmayer et al. prescriptions (which includes establishment of a Great Forest National Park - an action that was supported by a number of stakeholders). Further detail on the Advisory Group's approach, methodology and the inputs used is included in the Technical Report.

The Bayesian model showed that under the current situation there is high probability of Leadbeater's Possum being in a poor state. The model also indicated that the proposed Great Forest National Park would improve the probability of the Leadbeater's Possum population being in a better state. However, the impact of this action on timber harvesting in the Central Highlands would be considerable and it was therefore considered to be outside the scope of the Terms of Reference.

4 Recommended Package of Actions

The Advisory Group recommends a package of actions focused on supporting recovery of Leadbeater's Possum while maintaining a sustainable timber industry. The recommended package of actions provides for positive change to the current situation in terms of outcomes for the species and includes a combination of measures to:

- protect and support Leadbeater's Possum colonies; and
- conserve and enhance current and future habitat.

Implementing the package will impact on the volume and cost of timber available to industry and result in significant changes to timber production planning, harvesting and regeneration practices.

It is anticipated that the Advisory Group's recommendations will be used by government, industry and other stakeholders to inform future efforts and priorities. This includes informing the revision of the Action Statement and Recovery Plan for Leadbeater's Possum. To support these subsequent processes as efficiently as possible, the Advisory Group has presented its recommendations in a form considered most conducive to assisting with these processes.

A key focus of the Advisory Group has been on agreeing to recommendations that all organisations represented on the Advisory Group are committed to, and which can feasibly be implemented provided funding is available to support them.

1.) Protect Leadbeater's Possum colonies

Intent: To allow the species to recover by providing protection to all known and newly discovered colonies of Leadbeater's Possums. In recognition of the recent fire events and ongoing habitat decline, which have led to a reduced population of Leadbeater's Possum, the remaining wild population is critical to the recovery of the species.

Current prescription: The current regulatory framework does not include any specific protection for identified colonies.

Actions:

- Establish timber harvest exclusion zones of a 200 metre radius centred on the detection site to protect each identified colony.
- Review the effectiveness of this action in supporting the recovery of Leadbeater's Possum while maintaining a sustainable timber industry after two years of surveying, or once 200 new colonies are located whose exclusion zones impact the General Management Zone or Special Management Zone, whichever comes first.

Supporting and enabling actions:

- Develop management prescriptions that can be unambiguously applied by practitioners in the field, to protect identified colonies from harvesting activities and other forest management activities (e.g. roads).
- Undertake targeted Leadbeater's Possum surveys focusing on predicted high occupancy areas, as identified through the ARI 2013 occupancy model and aligned with VicForests' harvest plan, to identify and map colonies and clusters of colonies within the known range (with surveys designed to maximise increasing records while also contributing to improving habitat models and the understanding of habitat requirements).
- Actively seek out Leadbeater's Possum records from groups and institutions that are known to have undertaken survey work.
- Undertake surveys where required to verify records generated by the community (using standards for verification outlined in an updated DEPI survey standard).
- Refine distribution and habitat models based on new data to improve predictions of areas most likely to contain colonies.
- Ensure that all records are published in the DEPI Victorian Biodiversity Atlas (VBA) in a timely manner.
- Ensure that all known Leadbeater's Possum records and timber harvesting exclusion zones are mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library and replicated in VicForests' information systems.
- Ensure this information is accessible to stakeholders to inform forest management planning, timber planning, compliance, enforcement and auditing, and fire planning and suppression.
- Improve survey techniques.

Responsible agency: DEPI / VicForests

Timing: Immediate benefits

Risks:

- Leadbeater's Possum colonies do not survive in isolation; clusters of colonies with adequate connectivity are important to allow for distribution and genetic transfer between colonies.
- It is unknown how effective a 200 metres buffer will be for the long-term persistence of colonies.
- The potential to find colonies in forests available for harvest activities will result in a reduction in available harvest area.

- The management and verification of reported third party sightings leads to significant costs to VicForests and DEPI.
- Coupes would need to be deferred from harvest while third party reported sightings are being verified. This may lead to inoperable harvest schedules if unverified claims are made in a high proportion of scheduled coupes and/or verification takes significant time.
- Impact leads to inability to meet long term supply commitments, specifically the legislated pulpwood supply agreement.
- Surveys focused solely on planned harvesting areas may not contribute significantly to improving understanding of Leadbeater's Possum populations across its range and across all land tenures.
- There are delays in the review, or confusion about the process for the review, that result in the ongoing implementation of the action and associated impacts on industry beyond those initially forecasted.

2.) Delay harvesting in areas of anticipated high probability of occupancy

Intent: To minimise the risk of harvesting in areas with a high probability of the occurrence of Leadbeater's Possum.

Current prescription: The Leadbeater's Possum Reserve system includes habitat reservation targets based on habitat quality within each Leadbeater's Possum Management Unit. A significant portion of current high probability habitat (based on the ARI 2013 occupancy model) is already within parks and reserves (83 per cent at the >0.65 probability level).

Action:

- Delay harvesting for two years in areas that the ARI 2013 occupancy model predicts has a greater than 0.65 probability of being occupied by Leadbeater's Possum to allow surveys to be undertaken as per Action 1.

Supporting and enabling actions:

- Ensure that these areas are mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library and replicated in VicForests' information systems to indicate the area in which harvesting is delayed for two years.
- Ensure this information is accessible to stakeholders to inform forest management planning, timber planning, compliance, enforcement and auditing, and fire planning and suppression.

Responsible agency: VicForests / DEPI

Timing: Immediate benefits

Risks:

- Colonies of Leadbeater's Possum occur in areas where lower probability of occupancy is predicted in the occupancy model.
- VicForests' operational schedule of harvesting is impacted due to broad scale exclusions from available forest.
- Ability to deliver against legislated supply agreement is compromised during harvest delay.

3.) Transition to retention harvesting

Intent: To transition away from widespread clear-felling to more environmentally sensitive retention harvesting in ash forests within the Leadbeater's Possum range. Retention forestry, of which retention harvesting is a component, is defined as an approach to forest management based on the long term retention of structures and organisms, such as live and dead trees and small areas of intact forest, at the time of harvest.

Current prescription: The current regulatory framework does not include any requirement to undertake retention harvesting. Clear-felling is standard practice on nearly all of ash harvesting coupes.

Actions:

- From July 2014, undertake retention harvesting in at least 50 per cent of the area of ash harvested within the Leadbeater's Possum range.
- Begin planning for retention harvesting immediately.
- Raise the target for retention harvesting towards 100 per cent if the system proves to be operationally achievable.
- Undertake research, planning and implementation of retention harvesting.

Responsible agency: VicForests

Timing: Long term benefits

Risks:

- The analysis of the potential impacts of retention harvesting has been undertaken at a strategic level and may underestimate resource impacts at an operational level.
- While retention harvesting trials have been undertaken, the implementation of retention harvesting has not been undertaken on a significant scale in Victoria. A greater understanding of site level resource and cost impacts can only be fully understood following broader implementation.
- Impact analysis has considered that the retention of a one hectare island would modify a harvesting system from clear-fall harvesting to retention harvesting. This is a broad assumption that may not be valid at an operational level.

4.) Revised regeneration practices

Intent: To reduce the risk of damage to habitat from high intensity regeneration burns.

Current prescription: High intensity regeneration burns are standard site practice on nearly all of ash harvesting coupes. This method is the most effective in achieving high levels of ash regeneration[14].

Action:

- Investigate alternatives to high intensity regeneration burns linked to post-burn retention harvest criteria.

[14] Mountain Ash in Victoria's State Forests: Silviculture reference manual no. 1, DSE 2007

Supporting and enabling action:

- Change regulatory requirements to enable regeneration practices to consider ecological objectives (as opposed to a sole focus on regeneration of over-storey eucalypt species) when planning, undertaking and assessing post-harvest regeneration.

Responsible agency: DEPI / VicForests

Timing: Long-term benefits

Risks:

- Poor regeneration rates for VicForests leading to open ended retreatment costs.
- Potential conflict with regulatory and other requirements.
- Reduced regeneration rates leading to decreased forest productivity.
- Potential for increased injuries due to increased hand-burning activities.

5.) Buffer old growth

Intent: To minimise risk to modelled old growth forests protected in the current prescriptions by establishing a buffer around these old growth forest stands.

Current prescription: All stands of old growth forests greater than five hectares in State forests in the Wet, Montane Wet, Damp, Montane Damp, Riparian Forests, Sub-Alpine Woodlands and non-eucalypt vegetation types are included in Special Protection Zones because of their current rarity across the Central Highlands.

Action:

- Exclude harvesting from within 100 metres of modelled old growth ash forests (from the DEPI spatial layer) within the Leadbeater's Possum range.

Supporting and enabling actions:

- Ensure that these areas are mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library and replicated in VicForests' information systems.
- Ensure that this information is accessible to stakeholders to inform forest management planning, timber planning, compliance, enforcement and auditing, and fire planning and suppression.

Timing: Immediate and ongoing benefits

Responsible agency: DEPI / VicForests

Risks:

- Un-modelled old growth is not buffered.
- The areas modelled as old growth in the DEPI spatial layer may not be old growth.

6.) Amend the definition of Leadbeater's Possum Habitat Zone 1A

Intent: To protect hollow-bearing trees to increase the chance of retaining suitable habitat for Leadbeater's Possums. The more hollow-bearing trees per hectare on a site, the higher the probability is that Leadbeater's Possum will occur on that site.

Current prescription: Zone 1A is currently defined as 12 live, mature hollow-bearing ash trees per three hectare patch, with hollow-bearing trees defined by the DEPI Survey Standards: Leadbeater's Possum Habitat Zones.[15]

Action:

- Amend the definition of Zone 1A to 10 live, mature or senescent hollow-bearing ash trees per three hectare patch. (The definitions of mature, senescent, hollow-bearing, patch and all other definitions included in the survey methodology are to remain as described within the current DEPI Survey Standard: Leadbeater's Possum Habitat Zones.)

Supporting and enabling actions:

- Ensure that these areas are mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library and replicated in VicForests' information systems.
- Ensure that this information is accessible to stakeholders to inform forest management planning, timber planning, compliance, enforcement, and auditing, and fire planning and suppression.
- Undertake an estate-wide inventory to improve the understanding of the extent of Zone 1A habitat, building upon ARI assessments.

Timing: Immediate benefits

Responsible agency: DEPI / VicForests

Risk:

- The current extent and distribution of mature, senescent or hollow-bearing ash trees across the Leadbeater's Possum range is largely unknown.

7.) Target future old growth ash forests for protection

Intent: To ensure that in the future at least 30 per cent of ash forests are able to reach their oldest growth stage, thereby significantly increasing the proportion of old-growth ash forests across the landscape.

Current prescription: There is no current prescription regarding future old growth targets.

Action:

- Introduce a target specifying that at least 30 per cent of the ash forest within each Leadbeater's Possum Management Unit be protected so that it can mature into old growth forest in the future.

Supporting and enabling actions:

- Determine the most appropriate areas of forest and approaches for their protection.
- Ensure that these areas are mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library and replicated in VicForests' information systems.

[15] This is the current applied definition following MyEnvironment Inc v VicForests 2012 and confirmed in the 2013 Supreme Court of Appeal decision.

- Ensure this information is accessible to stakeholders to inform forest management planning, timber planning, compliance, enforcement and auditing, and fire planning and suppression.
- Improve understanding of habitat survival to identify landscape features and habitats that are resilient to natural disturbance processes such as bushfires.

Responsible agency: DEPI / VicForests

Timing: Long term benefits

Risk:

- Bushfire prevents the achievement of this target.

8.) Fire management of known colonies and high quality habitat

Intent: To increase the protection of Leadbeater's Possum colonies and habitat through fire planning and management and to develop fire recovery protocols to assist with timely emergency management responses.

Current practice: Current fire operation planning includes checks of proposed burn units for biodiversity values, including Leadbeater's Possum records. Recorded locations are protected from fire using mitigation measures to exclude fire from the area containing the record. These actions are dependent upon records being available for cross checking (i.e. so that planning can be compared against Leadbeater's Possum records). The new DEPI Risk Landscapes program is underway, which includes identification of biodiversity values on a risk register. Leadbeater's Possum is included on this register and has recently been identified as a critical asset for protection. No fire recovery protocols for Leadbeater's Possum are currently available.

Actions:

- Identify known colonies and high quality habitat as critical assets on the Natural Values database (part of DEPI's fire system) to inform fire operations and risk landscapes planning.
- Investigate and implement, where possible and appropriate, active fire management activities to protect identified colonies and high-quality habitat from bushfire, taking into consideration other threatened species requirements. This includes suppression activities and fuel management in adjacent drier forest types.
- Develop approved fire recovery protocols that can be enacted without delay following fire or other disturbance events that affect known colonies.

Supporting and enabling action:

- Ensure that all recorded Leadbeater's Possum colonies and their associated timber exclusion zones and high-quality habitat, whether formally reserved or not, are mapped, consolidated and published as datasets in DEPI's Corporate Spatial Data Library. Ensure this information is accessible to DEPI's fire operations and planning divisions to assist with fire operations planning, suppression and management.

Responsible agency: DEPI / Parks Victoria

Timing: Immediate benefits

Risk:

- Inadvertent impacts on other threatened species.

9.) Install nest boxes

Intent: To install nest boxes to support existing colonies in areas of declining natural tree hollows.

Current activity: A nest box supplementation program, *Project Possum*, is currently underway.

Actions:

- Provide artificial nest boxes in a targeted manner at key locations to support existing populations by extending Project Possum.
- Maintain and monitor existing nest boxes in Snow Gum and selected ash forest sites through the Project Possum program in five areas throughout the Central Highlands. Project Possum sites are predominantly in national parks, catchment areas and other reserve areas.
- Install nest boxes to investigate the extent of other populations occurring in sub-alpine woodlands and ash forest, including the Baw Baw plateau and Mt Matlock.

Responsible agency: DEPI / Parks Victoria / Zoos Victoria

Timing: Immediate benefits

Risk:

- Uncertainty on the realisation of benefits.

10.) Accelerate hollow development

Intent: To explore practices to expedite hollow development.

Current practice: Not current practice.

Actions:

- Investigate accelerated hollow development through silvicultural or other forest management processes[16].
- Investigate accelerated hollow development through mechanical or other approaches that may provide hollows in the near future.

Responsible agency: DEPI / VicForests / Parks Victoria

Timing: Long term benefits

Risk:

- The time taken to develop hollows is too long to benefit existing colonies.

[16] The University of Melbourne, in partnership with DEPI and VicForests, is currently seeking $500,000 of Commonwealth funding to pursue this research. DEPI and VicForests have agreed to match this with $600,000 of their own funding and in-kind support should the application be successful.

11.) Translocation

Intent: To assess the desirability and feasibility of translocating Leadbeater's Possums to establish new colonies in suitable but unoccupied habitat within the known range of the species. This is especially important in areas burnt during 2009 where sufficient hollow-bearing trees will be available once the habitat has recovered adequately to provide suitable foraging areas.

Current practice: Not current practice.

Action:

- Examine the feasibility of translocating Leadbeater's Possums from wild to wild.

Responsible agency: DEPI / Parks Victoria / Zoos Victoria

Timing: Dependent on outcome of the feasibility study.

Risk:

- None known

12.) Community engagement

Intent: To engage more closely with industry, environmental groups and the community on activities that would lead directly to improved outcomes for Leadbeater's Possum.

Current practice: Community participation in monitoring activities through *Project Possum*, ANU monitoring and other community groups.

Actions:

- Implement ongoing community engagement, including with environment and industry groups.
- Involve community stakeholders in monitoring activities.
- Continue to implement and enhance education programs to improve understanding of Leadbeater's Possums and their management.

Responsible agency: DEPI, Leadbeater's Possum Recovery Team, Parks Victoria, VAFI, VicForests, Zoos Victoria

13.) Monitoring and review

Intent: That the implementation of the recommended package of actions, which should be viewed as a five-year intervention, be subject to on-going monitoring and review to assess progress and inform adaptive management to ensure the package of actions is achieving its intended outcomes.

Current practice: Not current practice.

Actions:

- Review the implementation of the recommended package of actions in four years, with a view to assessing progress, capturing learnings and maximising benefits.
- With respect to Action 1 (establishing a timber harvest exclusion zone around colonies), review its effectiveness after two years of surveying or once 200 new colonies are located

(whichever comes first) in order to assess the effectiveness of this action in supporting the recovery of Leadbeater's Possum while maintaining a sustainable timber industry.
- Report on implementation progress periodically (e.g. every six months).

Responsible agency: DEPI, Leadbeater's Possum Recovery Team, Parks Victoria, VAFI, VicForests, Zoos Victoria

Risk:

- None

5 Impact of the Recommended Package of Actions

The recommended package of actions seeks to:

- provide protection to Leadbeater's Possum colonies (Actions 1,2, and 8);
- protect current high quality habitat (Actions 2, 3, 5, 6, and 8);
- protect existing old growth forest and expand future old growth (Actions 5 and 7);
- enhance the extent and quality of Leadbeater's Possum habitat in the future (Actions 3, 4, 5, 7 and 8);
- proactively provide additional nesting resources (Actions 9 and 10);
- support improving knowledge to more effectively implement management actions (all Actions); and
- support community engagement (Action 12).

The Advisory Group undertook an assessment of the recommended package of actions in terms of the estimated benefit to the conservation of Leadbeater's Possum and the estimated impacts on timber supply costs.

Benefit to the possum focused on changes in the number and distribution of clusters (groups of colonies) and changes in the quality, extent and distribution of habitat. The benefit is reported as the likelihood of Leadbeater's Possum being in a 'good', 'fair' or 'poor' state. While the states good, fair and poor do not strictly relate to the probability of persistence or eventual recovery of Leadbeater's Possum, the greater the likelihood of Leadbeater's Possum being in 'good' condition, the more likely it is to persist and potentially to recover.

To assist with interpretation, benefit to Leadbeater's Possum of the recommended package was assessed against the current situation and the implementation of the Lindenmayer et al. prescriptions. Although the Lindenmayer et al. prescriptions option was deemed to be outside the Advisory Group's Terms of Reference due to its estimated profound impact on industry, this was the option that was considered most likely to have the greatest benefit to the species (Table 1). The model suggests that the Lindenmayer et al. prescriptions option (which includes establishment of a Great Forest National Park), offers the best chance of recovery for the species. However, the model suggests that even this option does not guarantee recovery of the species, particularly when future fire is taken into consideration.

To provide information on the estimated impacts on the timber industry of undertaking various options, two measures were used: supply cost to the timber industry and percentage reduction in annual ash sawlog harvested. Both measures are annualised and were similarly measured relative to

the current situation and the implementation of the Lindenmayer et al. prescriptions. The estimated impacts on the timber industry developed during this process were used to assist in strategically assessing the relative costs and benefits associated with different options.

In order to reality-test the cost of giving effect to the recommended package of actions, indicative implementation costs were then assessed. These are summarised in Table 2, which includes estimated cost impacts on VicForests' operations.

Consequently, the costs in Tables 1 and 2 are not immediately comparable, as these tables were developed to assist the Advisory Group's strategic decision making process (Table 1) and to reality-test the recommended package (Table 2). It is anticipated that Table 2 will be refined for implementation purposes.

Table 1 Relative benefits to the conservation of Leadbeater's Possum[17]and expected costs on industry[18]

Option	**Good***	**Fair***	**Poor***	**Estimated impact on available volume****	**Estimated annual timber supply cost**
Current situation	19%	31%	50%	0	0
Package of recommended actions	26%	34%	40%	5%	$1.7 million
Lindenmayer et al. prescriptions (including the Great Forest National Park)	38%	35%	27%	96%	$20 million

* These figures represent the relative probability that the species is in either a good, fair or poor condition. Percentage figures are indicative and should not be viewed as absolute measures.

** The impact is in addition to the 25 per cent decrease in volume by 2017 in response to the impacts of the 2009 bushfires.

[17] Appendix 9: Bayesian Network Model of the benefit of proposed actions.

[18] Appendix 10: Approach to measuring the cost of actions to the timber industry.

Table 2: Indicative implementation costs for recommended package of actions (the cost of actions that were considered to be 'core business' are not included) (in $'000s)

No.	Action	Year 1	Year 2	Year 3	Year 4	Year 5	Total
1	Protect Leadbeater's Possum colonies						
	Undertake targeted surveys in predicted high occupancy areas	750	750	500	250	250	2,500
	Undertake surveys to verify records generated by the community	150	150	150	150	150	750
	Refine distribution and habitat models		50				50
	Improve survey techniques	50					50
3	Transition to retention harvesting						
	Research, planning and implementation	400 - 2,000	400 - 2,000	400 - 2,000	400 - 2,000	400 - 2,000	2,000 - 10,000
4	Revised regeneration practices						
	Investigate alternatives to high intensity regeneration burns	100					100
6	Amend definition of Leadbeater's Possum Habitat Zone 1A						
	Undertake inventory to improve the understanding of the extent of Zone 1A habitat	100					100
9	Install nest boxes						
	Extend *Project Possum* nest box program	10	10	10	10	10	50
	Targeted installation of nest boxes in other areas	10	10	10	10	10	50
10	Accelerate hollow development						
	Investigate alternate methods for hollow creation	100	100				200
11	Translocation						
	Examine the feasibility of translocating Leadbeater's Possums	50					50
	Total	**$1,720-$3,320**	**$1,470-$3,070**	**$1,070-$2,670**	**$820-$2,420**	**$820-$2,420**	**$5,900-$13,900**

6 Conclusions

The Leadbeater's Possum Advisory Group developed a package of actions that focus on:

- providing protection to Leadbeater's Possum colonies;
- protecting current high quality habitat;
- protecting existing old growth forest and expanding future old growth forests;
- enhancing the extent and quality of Leadbeater's Possum habitat in the future;
- proactively providing additional nesting resources;
- supporting improved knowledge to more effectively implement management actions; and
- supporting community engagement.

This package represents a multi-pronged approach to support the ongoing survival of Leadbeater's Possum across the landscape in the Central Highlands. It addresses the key threats to Leadbeater's Possum and includes recommendations to facilitate improvement in future habitat.

Based on the impacts of the 2009 bushfires and the lack of hollow-bearing trees, modelling predicts that the population of Leadbeater's Possum will continue to decline, albeit at a slower rate. Depending on the pattern and extent of future fires, the modelling predicts the population may increase again after approximately 70 years, when 1939 regrowth has commenced developing hollows. However, it is not possible to accurately predict the medium and long-term outcome. Risks from extensive bushfires in particular remain a challenge.

The Advisory Group believes that the recommended package of actions will make an important positive contribution to outcomes for Leadbeater's Possum, and that benefits arising from the actions will be directly linked to a clear focus on implementation, monitoring and review.

The Leadbeater's Possum exists within an area of approximately 70 x 80 kilometres within the ash forests and sub-alpine woodlands in the Central Highlands. Sixty-nine per cent of the area of potential habitat within the range of Leadbeater's Possum is located in formal parks and reserves, Special Protection Zones in State forest or areas excluded from harvesting due to biodiversity and regulatory reasons. The remaining 31 per cent is available for timber production, although not all of this area is suitable for harvesting within the next 20-30 years.

The recommended actions will reduce the supply available to industry by a further 5 per cent. This will be in addition to VicForests' 25 per cent reduction in yield announced in 2013, which was a direct result of the significant impacts of the 2009 bushfires. The actions are expected to impose additional timber supply costs and will fundamentally alter how harvesting is undertaken within the range of Leadbeater's Possum, a critical supply area for the local timber industry.

Both the Leadbeater's Possum and native timber harvesting in the Central Highlands are very sensitive to any future major fire event. The Advisory Group recommends DEPI continue to develop and implement its risk-based bushfire management approach, with consideration given to developing strategies that identify and protect natural fire refugia within the Leadbeater's Possum range and seek to maximise the number of viable populations in order to spread risk. It is recommended that a mitigation strategy for native forestry be developed in conjunction with plantation and private forest planning to secure Victorian processing jobs and mills into the future.

7 Acknowledgments

The Advisory Group would like to thank the Secretariat and key personnel who made significant contributions to the deliberations and processes as part of this review. The timeline required an extraordinary amount of work to be done in a relatively short time. The scientific support staff have developed sophisticated models which allowed the Advisory Group to test proposed actions both individually and in packages.

Stakeholder engagement drew on the support of the three leading scientists on the Leadbeater's Possum: Professor David Lindenmayer, Dr Lindy Lumsden and Dr Dan Harley. Their generosity in sharing their knowledge and passion for the Leadbeater's Possum was key to engaging with a wide range of stakeholders. Many stakeholders submitted detailed comments and proposed actions, which

have been considered in this process. The submissions indicate a high level of concern for the Leadbeater's Possum and strong engagement with the process.

Appendix 1: Leadbeater's Possum Advisory Group's Terms of Reference

Introduction

The Leadbeater's Possum Advisory Group will provide recommendations to the Minister for Environment and Climate Change, the Hon Ryan Smith, and the Minister for Agriculture and Food Security, the Hon Peter Walsh, focused on supporting the recovery of the Leadbeater's Possum while maintaining a sustainable timber industry.

It is anticipated that these recommendation will be used by government, industry and other stakeholders to inform future efforts and priorities. This includes feeding into the revision of the existing Victorian Action Statement and Commonwealth Recovery Plan for the Leadbeater's Possum.

The recommendations prepared by the Advisory Group should include, but not be limited to:

- immediate actions to manage the near-term risks of decline of the species; and
- medium and longer-term actions focused on ensuring the persistence of the species and its co-existence with a sustainable timber industry.

Terms of Reference

The Advisory Group will work with a broad range of experts and stakeholders and will rely on the most up-to-date science and data to undertake the following actions and inform the development of its recommendations:

- Canvass a diverse portfolio of options to better address the risk of extinction of the species.
- The portfolio should be benchmarked against acknowledged world's best practice and could include, for example:
    - review of the appropriateness of existing habitat assessment post 2009 fires
    - short-term habitat initiatives to enhance existing and potential habitat
    - consideration of the contribution that post fire reserves and harvest levels can make to the ongoing maintenance of suitable habitat
    - harvesting practices that complement the recruitment of long-term suitable habitat for the Leadbeater's Possum
    - potential for captive breeding programs to support wild population management
    - effective monitoring programs to confirm achievement of outcomes
    - consideration of the hectares available for habitat
    - consideration of the hectares available for timber harvesting
    - direct funding of recovery actions

Other considerations

The Department of Environmental and Primary Industries and VicForests will provide access to underlying data, science and modelling results for the purpose of facilitating robust analysis and supporting open and transparent consultation.

Regular progress reports to the Minister for Environment and Climate Change and the Minister for Agriculture and Food Security in relation to the Advisory Group's work are welcome.

The Advisory Group should provide a report to the Minister for Environment and Climate Change and the Minister for Agriculture and Food Security.

The recommendations developed by the Advisory Group should reflect current Government policy, the principles of sustainable forest management (as reflected in the Sustainable Forests (Timber) Act 2004) and good governance, and should consider relative costs and benefits.

Appendix 2: Estimated number of Leadbeater's Possum colonies in the Central Highlands

Broad-scale surveys for Leadbeater's Possum were conducted across the species' currently known range in 2012 during the Forest Biodiversity Project, to determine status and distribution and identify population strongholds (Lumsden et al. 2013). The Forest Biodiversity Project is part of 'A New Strategic Approach to Biodiversity Management' arising from the Victorian Government's Timber Industry Action Plan, which involved undertaking research providing data on the status, distribution and habitat use of ten priority threatened fauna species in the forests of Eastern Victoria.

Sampling was undertaken in forest blocks within the range of Leadbeater's Possum containing records and/or mapped vegetation classes known to be used by the species (primarily ash forests and snow gum woodlands). Within these vegetation classes, four survey strata were defined, based on two public land management categories (state forest, and parks and reserves), and 2009 fire status (burnt or not burnt in the 2009 fires). Overall, 180 sites were randomly selected for survey within these four strata, with the allocation of sites to state forest and parks and reserves in proportion to the availability of these land management categories.

Sites were surveyed using call playback in conjunction with thermal imaging cameras. This method involved broadcasting recorded calls of Leadbeater's Possums, and calls of a predator (Boobook Owl), to attract any possums present on survey sites. Thermal imaging cameras, which detect the heat signatures of animals (including those that may be obscured by dense vegetation), were used during the call playback to increase the likelihood of locating and identifying any Leadbeater's Possums investigating the broadcast calls. Provided each site was surveyed at least twice and in suitable weather conditions (i.e. little wind) this method was found to reliably detect Leadbeater's Possum with a probability of detection (i.e. the likelihood of detecting a possum during surveys of sites where they actually occur) of around 80% (Lumsden et al. 2013).

Leadbeater's Possum was detected at 29 of the 150 (19%) unburnt sites surveyed during the Forest Biodiversity Project. Although estimating population numbers was not the primary purpose of these surveys (because the sites were selected randomly) it is possible to extrapolate from these data. It is an oversimplification, however, to assume that the species occurs at 19% of all unburnt sites across the Central Highlands to estimate the potential number of animals present. Several factors need to be considered in estimating population numbers:

1. Population estimates were considered separately for the four strata sampled during the surveys (i.e. the two land management categories (state forest/parks and reserves) and 2009 fire status (burnt/not burnt)). As Leadbeater's Possums were not detected in any of the sites in the 'burnt' category during the surveys, it is considered that no animals are present in habitat burnt in 2009, regardless of its land management status.

2. Accounting for imperfect detectability. Specifically, as there is not 100% probability of detecting Leadbeater's Possum in all areas where they occur, a correction factor has been applied, whereby approximately 20% of the sites sampled were likely to have Leadbeater's Possum but none were not detected.

3. Bias associated with surveying on roads. For safety and logistical reasons, all sites surveyed during the Forest Biodiversity Project were along forestry roads/tracks. It is unknown whether the presence of roads effects the likelihood of that site being occupied by Leadbeater's Possum. In addition, it is possible that the presence of roads introduces a bias in the sampling, as roads may not randomly reflect the available habitat and Leadbeater's Possums may be more or less likely to occur in habitat near roads. As there is no data on occupancy rates away from roads, this uncertainty could not be factored into these calculations.

4. The area effectively sampled during each survey will influence the estimate of the number of potential colonies; however, there is uncertainty in the area sampled using the call playback technique. The broadcast calls transmit extensive distances (humans can hear these calls more than 450 m away). Therefore it is likely that the call projects into all parts of a colony's home range (typically up to 3 hectares in size). It is assumed that individuals will respond from anywhere within their territory. As all surveys were conducted along roads, which are likely to form the edge of territories where there is a lack of connectivity over the road, the typical effective survey area is likely to be within a 200 m radius of the sampling point, representing a total area of 12.6 hectares. This distance may be somewhat larger or smaller and so population sizes have also been calculated on 150 m and 250 m radius areas (Table A2-1). Figure A2-1 illustrates this point. The dark blue circle shows a 3 hectares area (based on a circle with a radius of 100 m) from a sampling point (black dot) along a road and hence likely to be at the edge of a home range. Sampling is likely to be effective anywhere within an approximately 200 m radius (light blue circle). Anything outside of this area is likely to be more than a territory width away and hence animals are not likely to cross over the intervening territory to be detected at the sampling point. Territories, however, are unlikely to be circular, so the additional area based on a 250 m radius is also included.

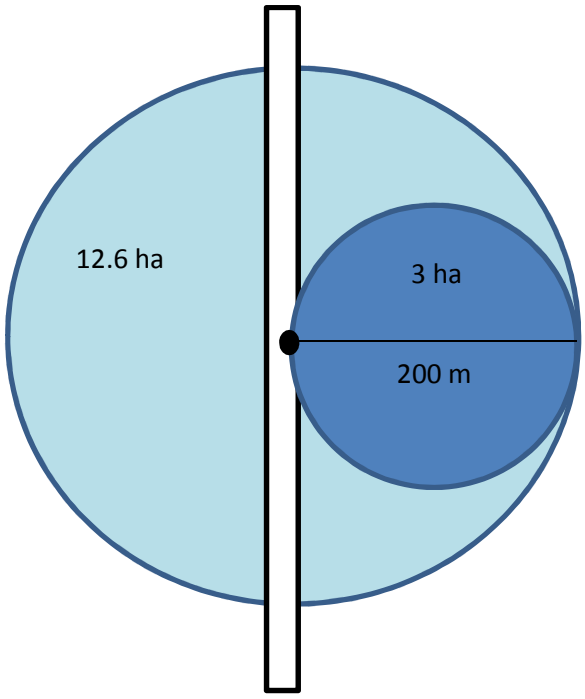


Fig. A2-1. An illustration of the potential effective survey area. The black dot represents a survey site located along a road, with the dark blue area a 3 ha effective survey area (100 m radius) and the light blue area a 12.6 ha area (200 m radius).

There are a number of assumptions leading to uncertainties in these figures:

- While females are unlikely to move outside of their own defended territory (i.e. home range of approximately 3 hectares), it is possible that males may be less territorial and may move between territories and hence further distances.
- If the adjacent area is not occupied by another colony, animals may move further in response to the call.
- Juveniles may behave differently to adults.
- There may be seasonal or nightly variation in how often the possums respond to the calls.
- There is the potential to sample separate colonies on each side of the road.

5. Number of individuals in a colony. The survey method used in the Forest Biodiversity Project does not enable the determination of the number of individuals present on a survey site, only whether Leadbeater's Possums were present and detected, or not. In addition, the number of animals present in each colony can vary substantially, and the current average colony size in different environments is unknown. Equating a positive record with one colony, regardless of the number of animals in the colony, is therefore less likely to lead to spurious results. However, although it adds another level of uncertainty, a conservative, average colony size of 2.5 individuals has been used (based on recent stag watching data from ANU surveys) in Table 1 to estimate the potential number of individuals in the Central Highlands.

Table A2-1: The predicted number of colonies and individuals of Leadbeater's Possum across the Central Highlands, factoring in the different reporting rates in state forest compared to parks and reserves and imperfect detectability, within different effective survey areas

Effective survey area	Area (ha)	Number of colonies	Number of individuals
150 m radius	7.1	4,384	10,960
200 m radius	12.6	2,466	6,165
250 m radius	19.6	1,578	3,945

Implications

- To ensure decisions are robust, the focus should be on population trends rather than absolute numbers.

Appendix 3: Timber industry baseline

The table shows the baseline employment, and annual revenue and household income, associated with the activity of the mills and contractors directly dependent on ash species timber from the Central Highlands region, including the area identified as the range of the Leadbeater's Possum. The data also shows the main local government areas dependent on the Central Highlands ash timber.

This data does not reflect the employment or economic activity undertaken by secondary processing businesses dependent on ash timber from the area or any other measures of indirect employment or economic activity.

Table: Timber industry baseline (2012)

	Revenue ($'000)			Employment (persons)			Household Income ($'000)		
	Mills	Contractors	Total	Mills	Contractors	Total	Mills	Contractors	Total
Local Government:									
Baw Baw			16,289			118			5,063
Benalla			9,301			29			1,515
East Gippsland			11,740			59			2,525
Latrobe			197,785			527			32,638
Dandenong			14,106			45			2,278
Mitchell			2,107			37			1,371
Murrindindi			9,004			66			2,414
Towong			3,543			18			677
Wellington			56,217			201			9,140
Yarra Ranges			18,101			78			3,583
Other LGA			1,067			45			2,522
Total			339,260			1,222			63,726

Appendix 4: Public forests within the Leadbeater's Possum range

Table 1

	Range of Leadbeater's Possum											
	Forest within Leadbeater's Possum Management Units within the Central, Dandenong and Central Gippsland FMAs											
	High and Very High Severity Fire since 2000			Moderate and Low Severity Fire since 2000			Unburnt since 2000			Total		
	State Forest	Parks and Reserve*	Total	State Forest	Parks and Reserve*	Total	State Forest	Parks and Reserve*	Total	State Forests	Parks and Reserve*	**Total**
Suitable Forest Types+	20,000	8,400	28,400	15,400	11,500	26,900	99,800	49,300	149,100	135,200	69,200	**204,400**
Unsuitable Forest Types	36,400	8,500	44,900	24,800	5,000	29,800	100,700	23,400	124,100	161,900	36,900	**198,800**
Total Public Forest	**56,400**	**16,900**	**73,300**	**40,200**	**16,500**	**56,700**	**200,500**	**72,700**	**273,200**	**297,100**	**106,100**	**403,200**
Suitable Forests Types+	20,000	8,400	28,400	15,400	11,500	26,900	99,800	49,300	149,100	135,200	69,200	**204,400**
Parks and Reserve*	NA	8,400	8,400	NA	11,500	11,500	NA	49,300	49,300	NA	69,200	**69,200**
Suitable Forests in mapped SPZ	3,400	NA	3,400	3,500	NA	3,500	22,400	NA	22,400	29,300	NA	**29,300**
Modelled code exclusions to be excluded from harvesting**	3,800++	NA	3,800++	3,300++	NA	3,300++	23,700	NA	23,700	30,800	NA	**30,800**
Estimated Additional Harvesting Exclusions***	2,000++	NA	2,000++	1,500++	NA	1,500++	9,000	NA	9,000	12,500	NA	**12,500**
Total Suitable Forest Never to be Harvested.	**9,200**	**8,400**	**17,600**	**8,300**	**11,500**	**19,800**	**55,100**	**49,300**	**104,400**	**72,600**	**69,200**	**141,800**
Total Ash Forest Available for Harvest	10,800	NA	10,800	7,100	NA	7,100	44,700	NA	44,700	62,580	NA	**62,580**

Note: Production of above numbers required combining datasets, which may have led to some variance in output accuracy. Area figures should therefore be read as indicative.

*Parks includes Parks and Reserves, Other Parks and Reserves and Other Public Land.

** Modelled code exclusions include variable width stream buffers and steep slopes. These modelled exclusions are mapped.

*** Additional exclusions include VicForests' operational exclusions and non-mapped prescriptive exclusions. This is an estimate only as these exclusions are identified on the group prior to harvest and are not available within resource datasets.

+ Suitable Forest types include: ash and snow gum forest types.

++ Area burnt is an estimate based on general exclusion percentage.

Table 2

	Range of Leadbeater's Possum											
	Forest within Leadbeater's Possum Management Units within the Central, Dandenong and Central Gippsland FMAs											
	High and Very High Severity Fire since 2000			Moderate and Low Severity Fire since 2000			Unburnt since 2000			Total		
	State Forest	Parks and Reserve*	Total	State Forest	Parks and Reserve*	Total	State Forest	Parks and Reserve*	Total	State Forests	Parks and Reserve*	**Total**
Suitable Forest Types+	20,000	8,400	28,400	15,400	11,500	26,900	99,800	49,300	149,100	135,200	69,200	**204,400**
Total Ash Forest Available for Harvest	10,800	NA	10,800	7,100	NA	7,100	44,700	NA	44,700	62,580	NA	**62,580**
Decade of Origin												
1900s	0			3			389			393		
1920s	0			1			124			125		
1930s	2,747			4,319			20,943			28,027		
1940s	0			9			638			648		
1950s	22			7			258			287		
1960s	24			45			409			479		
1970s	669			120			1,921			2,708		
1980s	480			436			5,432			6,354		
1990s	537			598			6,592			7,734		
2000s	5,071			928			5,729			11,699		
2010s	1,079			518			1,350			2,940		
Undefined	191			98			917			1,206		
Total	**10,820**			**7,080**			**44,700**			**62,600**		

Decade of Origin is an estimation of when the majority of the stand originated. In ash forest types this is generally from fire events.

Note[1]: Areas above are estimates only that provide an appreciation of relativities of age classes. Actual harvesting exclusions may vary from modelled.

Note[2]: The majority of forest within areas burnt since 2000 (especially if burnt by high and very high severity fire) will now have a decade of origin as 2000s. The year of origin prior to these fires has been only to indicate what was burnt, not what is present today.

Note[3]: Impact analysis was undertaken through consideration of the proportional impact on approximately 36,000 available and currently suitable (origin between 1901 and 1960) forest, minus modelled exclusions. This included areas that were unburnt since 2000 and some areas of moderate and low burnt forest. The 36,000 hectares used in analysis is greater than the table above, which considers operational exclusions in addition to modelled exclusions.

Appendix 5: Decision-making Framework

1. Objectives

The Leadbeater's Possum Advisory Group was charged with making recommendations to the Minister for Environment and Climate Change and the Minister for Agriculture and Food Security focused on supporting recovery of Leadbeater's Possum while maintaining a sustainable timber industry.

1.1 Primary considerations

As part of its Terms of Reference, the Advisory Group considered:

- Immediate actions to manage the near-term risk of the species declining, and
- Medium and longer-term actions to ensure the persistence of the species and its co-existence with a sustainable timber industry.

In developing its recommendations, the Advisory Group focused on actions expected to maximise benefits to the Leadbeater's Possum while minimising the costs to the timber industry.
The Advisory Group's primary considerations are reflected in the performance measures articulated later in this document for both Leadbeater's Possum and the timber industry.

1.2 Secondary considerations

Once the analysis of potential actions in terms of primary considerations was completed, in order to inform the development of its final recommendations the Advisory Group considered broader factors that were considered likely to be material. Initially the following secondary considerations were flagged as being most relevant:

- implementation methods and costs;
- costs and benefits to biodiversity and conservation values beyond the Leadbeater's Possum; and
- impacts on regional communities and jobs.

2. Summary of Process

The process for prioritising potential actions to inform the development of the Advisory Group's recommendations is summarised in Figure 1 below and described in further detail in the following sections.

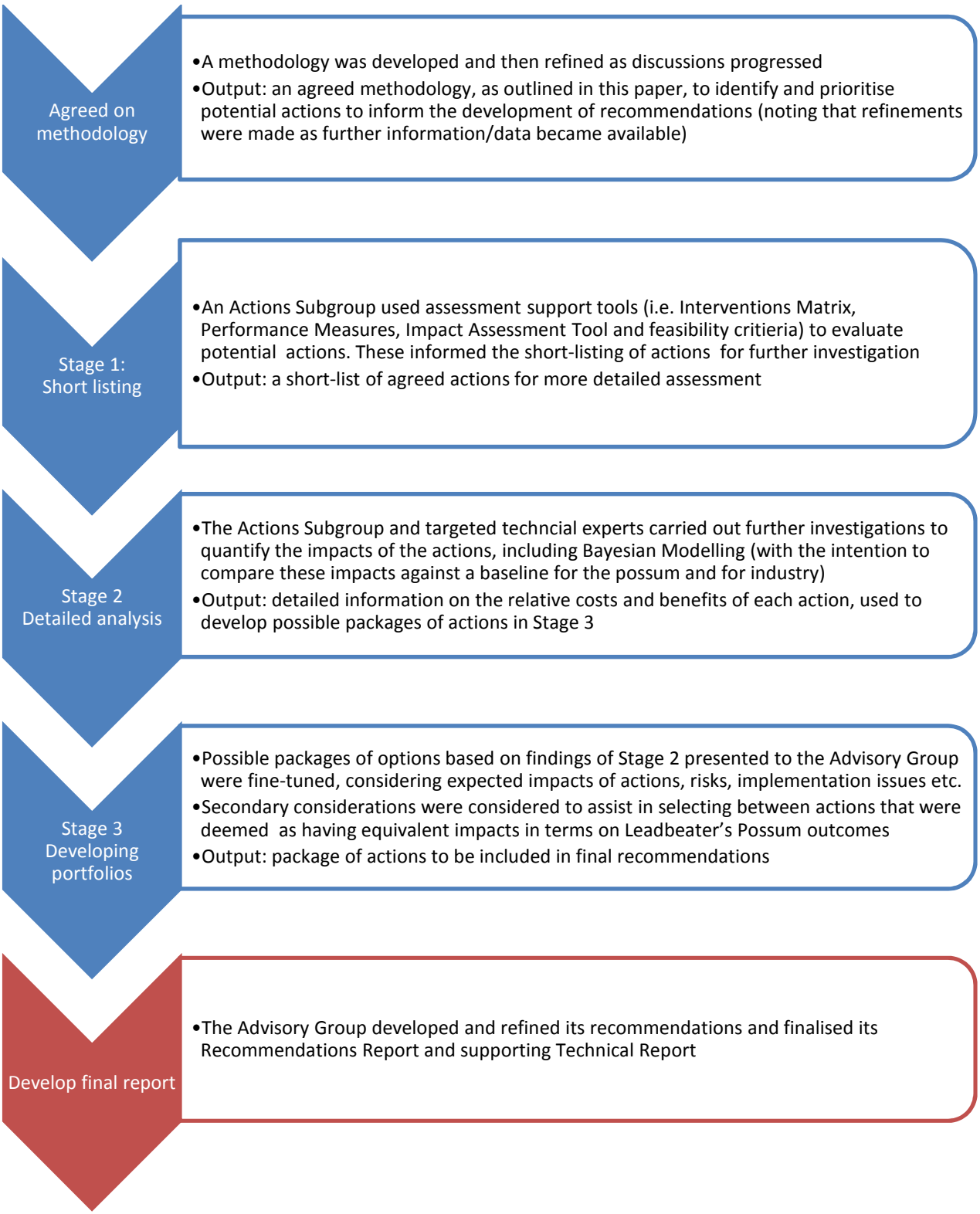


Figure 1 Process

3. Performance measures

The Advisory Group used specific performance measures to support the development of its recommendations. Through all stages of the process, actions and packages of actions were considered and assessed using the agreed Performance Measures articulated below. These aimed to capture the likely impact of the action on outcomes for the Leadbeater's Possum and the timber industry, consistent with the Advisory Group's terms of reference.

Performance Measures

Leadbeater's Possum	
Risk of extinction of the species	Measured as 'high', 'moderate-high', 'moderate', 'low to moderate', and 'low' based on expert opinion
Number of individual Leadbeater's Possums	
The quality of habitat for the possum	
The extent of habitat	
The distribution of habitat to spread risk	
Timber Industry	
Cost to timber industry informed by changes to: ▪ The volume of timber harvested ▪ The quality of timber harvested ▪ The cost of harvesting timber	Undertaken by DEPI secretariat using volume reductions from VicForests as an input. Note that this analysis is limited to cost to VicForests and does not consider flow on impacts to secondary processes.
Percentage reduction in annual ash sawlog harvested.	Annualised percentage reduction in ash sawlog harvested over the next 30 years relative to post 2017 baseline.

3.1 Applying the performance measures

The five categories of performance measures for Leadbeater's Possum were assessed separately for each action. The performance of the action was then considered collectively under the banner of 'benefits to Leadbeater's Possum' as High, Medium or Low, based on an 'average' of performance across the five measures of benefit (e.g. if rated low for most but medium for one, the action was rated as low).

The annualised cost and volume performance measures for the timber industry were considered in five broad ranges.

Full details of each performance measure, methodology and its application are detailed in the accompanying technical document to the Advisory Group's final report.

4. Stakeholder and expert contributions into decision-making

To inform the development of its recommendations, the Advisory Group consulted with stakeholders and obtained expert input. This is summarised below, and is fully detailed in the technical document.

Three avenues of stakeholder engagement were used:

- Targeted stakeholder forums

- Written submissions
- On-line forum

These stakeholder contributions were considered and informed the refinement of the list of actions considered by the Advisory Group as part of its staged approach to developing its final recommendations.

The views on the effectiveness of the actions in terms of impacts on the possum and the estimates of volume and costs impacts on the timber industry were sought from external sources, including:

- ANU team led by Prof David Lindenmayer;
- the Leadbeater's Possum Recovery Team; and
- commissioned timber industry economist and an expert working group.

5. Detail on the three-staged approach to support decision-making

5.1 Stage 1 – Qualitative assessment of actions

This stage sought to:

- Assess all actions identified from existing documents and submissions to the Advisory Group against performance criteria.
- Test this assessment with external experts (ANU team and Recovery Team).
- Present relative impacts of actions, in terms of expected benefits to the possum and expected costs to industry to assist in identifying a short-list of actions to feed into Stage 2.

This stage produced a short-list of actions to be fed into Stage 2 based on the above work and reflecting the following guiding principles, which were based on the directions and findings of previous work of the Advisory Group, as well as its Terms of Reference.

The Guiding Principles:

a) Ensuring there is a spread of actions that are effective in the short term and long term.
b) Ensuring there is a spread of actions that cover protecting known colonies, protecting known existing habitat and key habitat elements, predicted high quality habitat, and reducing the risk of future habitat declining further.
c) Spreading the risk both geographically and temporally.
d) Ensuring that all major threats are addressed, with the actions relating to the highest threats given priority in relation to the extent/scale of the action (e.g. if threats to colonies are considered a high risk, larger sized buffers may be considered around known colonies, with potentially a smaller buffer around other less threatened features).
e) Delivering maximum benefit to Leadbeater's Possum while minimising the direct costs to industry.
f) Excluding actions considered to have a low benefit to the possum, while including all actions considered capable of having a material positive benefit to the possum for further analysis in Stage 2.

The full list of actions assessed by the Advisory Group actions subgroup was 'tested' by external experts (the ANU team and the Recovery Team). This exercise generally affirmed that the actions considered to have greater benefit to Leadbeater's Possum should proceed to Stage 2, and also highlighted some key issues that require further discussion in Stage 2.

5.2 Stage 2 – Quantitative assessment of actions

Stage 2 involved two streams: the environment/Leadbeater's Possum stream (which focused specifically on outcomes for the possum) and the economics stream (which focused on the estimated costs to the timber industry and estimated implementation costs associated with individual actions). As such, the environment stream was undertaken by experts on the possum using models, and the economics stream used an approach developed by DEPI in consultation with VicForests.

- Environment/Leadbeater's Possum stream quantitatively assessed (where possible) the agreed actions from Stage 1 using:
  - Bayesian modelling (to assess expected outcomes for the Leadbeater's Possum). This modelling provided a relative comparison between each action in terms of reducing the risk of extinction while factoring in uncertainties. It also provided the capability to consider combinations of actions as required for Stage 3 below.
  - Economic analysis (to articulate costs of actions compared to an agreed baseline).
- Until each action was analysed individually it was not possible to determine packages of options expected to provide the most benefit at the least cost.
- GIS analyses was undertaken to determine the area of ash forest (within land use categories – e.g. GMZ, reserves etc.) that would be impacted by each action individually. This indicated the relative area impacted by implementing each action at selected spatial scales (e.g. different sized buffers around colonies) as well as the relative area impacted by different types of actions (e.g. buffering colonies versus protecting all hollow-bearing trees). The GIS analyses also provided the base information to assess the degree of overlap between different actions for use in Stage 3.

Stage 2 produced detailed information on the relative benefit and cost of each action, which was used to develop possible packages of actions in Stage 3.

5.3 Stage 3 – Development of packages of actions

The stage sought to develop possible packages of actions for further consideration, noting:

- the principles used in Stage 1 to short list actions, except for (f) (which is only relevant to Stage 1), were used to guide the development of the packages of actions once the analysis in Stage 2 was complete;
- once each action was evaluated in full during Stage 2 for both the costs and benefits, actions were considered in different combinations to test which combinations provide the highest benefit to the possum at the lowest cost;
- GIS analyses from Stage 2 was used to determine the overlap between actions (e.g. what proportion of buffering known colonies at various scales would be covered by buffers around other features of varying scales) and the Bayesian models were used to quantify the relative impact of various combinations; and

- this process resulted in a number of combinations of actions providing differing expected levels of costs and benefits to inform development of the Advisory Group's final recommendations.

The developed packages of actions were considered by the Advisory Group alongside the two outside positions of: (i) do nothing; and (ii) a new national park. The Advisory Group's recommendations aim to maximise expected outcomes for Leadbeater's Possum while minimising direct and/or implementation costs.

6. Final recommendations

The Advisory Group final recommendations to government clearly articulate the rationale for each action. For each recommended action, they also include a description of the intent of each action, current activity underway, responsible agencies, timing and risks.

Appendix 6: Summary of workshops and online submissions

The Advisory Group sought the input of stakeholders with significant knowledge and investment in the management of the Leadbeater's Possum, particularly within the Central Highlands. This input informed the development of recommendations aimed at achieving the most positive outcomes for the Leadbeater's Possum while minimising costs to industry.

The consultation process was designed to identify actions that stakeholders believed would address its Terms of Reference and make acceptable trade-offs between the needs of the Leadbeater's Possum and the impacts of actions, including on the sustainability of the timber industry. Actions put forward through this consultation process were assessed to estimate the benefit they offered to the possum and the estimated cost they imposed on the timber industry.

The consultation process

The consultation process included workshops with key stakeholders, the opportunity for interested members of the public to make written submissions and an on-line forum that provided an opportunity for participants to ask questions.

To ensure stakeholders were provided with a common understanding of the factors threatening the Leadbeater's Possum, three key scientists, Dr Dan Harley (Zoos Victoria), Professor David Lindenmayer (Australian National University), and Dr Lindy Lumsden (Arthur Rylah Institute) contributed presentations on the latest Leadbeater's Possum science. These presentations were made to stakeholder workshops and were made publicly available through the Advisory Group's webpage.

Workshops

The workshops provided an opportunity for participants to input directly into the process. Key stakeholders were identified, with the intent to include all known active stakeholders in the workshops.

Four stakeholder workshops were held on 30 September and 1 October 2013 in Melbourne. Four thematic workshops allowed participants to contribute in terms of their major interest or specialization:

- Science
- Environment
- Industry
- Community

The workshops provided collaborative and productive engagements that yielded valuable inputs to the recommendations process.

In total, 145 stakeholders were invited to participate in the workshops, with 56 stakeholders accepting the invitation to participate.

Each workshop was chaired by the DEPI Chief Scientist, Dr Graham Mitchell, and facilitated by pollinate, an independent research consultancy. Members of the Advisory Group attended each workshop, with Advisory Group members providing an overview of the Advisory Group process to each workshop.

Prior to the workshops, factsheets on Leadbeater's Possum, the timber industry, regulatory arrangements and fire management were provided to participants as background. These factsheets were also made publicly available through the Advisory Group's webpage.

Each workshop commenced with Dr Harley, Professor Lindenmayer and Dr Lumsden presenting their latest research on the Leadbeater's Possum. Collectively these presentations provided a current evidence base for status of the possum and the challenges to its recovery. Following the presentations, participants were invited to question the scientists and Advisory Group members. These discussions were valuable, as they allowed stakeholders to engage closely with the science and key experts, and provided an opportunity to bring key concerns to the Advisory Group's attention.

Workshop participants worked in small groups to identify actions they believed would have the greatest benefit to Leadbeater's Possum while also minimising impacts on the timber industry. The results were presented, discussed and submitted in full to the Advisory Group for consideration. All stakeholders were invited to submit further comments if desired through the written submissions process.

High level themes

Several high-level themes were evident in stakeholder commentary and in the actions put forward to the Advisory Group.

There was broad recognition that securing high-value habitat for the possum, both now and into the future, was critical to its survival. Retention harvesting was discussed in all workshops as a means of allowing continued timber harvesting while encouraging a multi-age forest. Altering harvest regimes to allow longer rotation times and facilitate the development of older forests, providing better habitat succession for the possum and reducing the risks of fire was suggested in this context.

Fire was recognised as a key factor in both limiting and creating Leadbeater's Possum habitat. It was noted that, no matter what measures were taken to protect Leadbeater's Possum, these could be over-ridden by a single large fire incident. Fire protection of critical habitat was therefore seen as an important measure to ensuring the persistence of the species.

It was also acknowledged that the species' chances of persistence would be increased if it was more broadly distributed, to minimise the risk that a single event could wipe out the entire population.

The value of nest boxes and other means of engineering hollows in live trees in order to provide alternative den sites were raised. There were calls for nest box design to be improved to more closely mimic the properties of a natural hollow; however, there was recognition that these options were often economically unviable, technically challenging and might be likely to encourage the proliferation of generalist species through Leadbeater's Possum habitat. The scientific community in particular recognized that - while there was potential to improve nest boxes - they were likely to be a distraction from the goal of providing Leadbeater's Possum with natural den sites in suitable habitat.

While there were also calls for further investigation of translocation, captive breeding and release options, it was recognized that these were all inferior options for ensuring the persistence of the species.

It was acknowledged that clearly articulating what a sustainable timber industry might be was complex and contentious. While the environment groups were keen that the Advisory Group makes recommendations to ensure an 'ecologically sustainable timber industry', the timber industry consultations indicated that the industry is of the view that it is already taking significant measures to ensure its long-term ecological viability, even though this has resulted in tightening operating margins.

The option of allowing for 'land-swaps' under the Regional Forestry Agreement (RFA) was raised, with industry stakeholders in particular suggesting that any increase in the Leadbeater's Possum reserve should be matched by a commensurate release of land for timber harvest from other reserve areas.

All stakeholders agreed that management of Leadbeater's Possum and the timber industry should be driven by a 'whole of landscape' vision that allowed a greater level of integrated and cooperative planning to support diverse outcomes.

Written submissions

The Advisory Group also invited interested members of the public to provide written submissions through its web page. Media coverage was designed to ensure that any party wishing to make a contribution to the process was afforded an opportunity.

In total, 41 submissions were received, 13 of which were from participants had attended the stakeholder workshops. Of those submission received from workshop attendees:

- 4 attended the Industry workshop;
- 3 attended the Science workshop;
- 2 attended the Community workshop; and
- 4 attended the Environment workshop.

High level themes

Written submissions identified the following high-level themes:

- The need to secure habitat for Leadbeater's Possum now and into the future, ensuring this habitat has connectivity and distribution of age classes. The strongest call was for the creation of a Great Forest National Park in line with David Lindenmayer's recommendations.
- A call for the end of clearfall timber harvest. Submissions did not equate the establishment of the Great Forest National Park as equivalent to ceasing native timber harvest. There is an opinion that timber harvest should be migrated to plantations.
- Protection of Leadbeater's Possum colonies is a strong theme throughout the submissions. In the light of the recommendations of the leading scientist on the species, David Lindenmayer, many submissions adopt either all his recommendations or variations on those recommendations.

- Address forestry prescriptions to secure environmental benefits – particularly the protection of old growth forest and the need to ensure the recruitment of the next generation of old growth.
- Lack of information and transparency – a call for an end to the perceived subsidization of VicForests, clarity on the sustainability of native timber harvest and the economic impacts/benefits of native timber harvest. Many submissions indicated a lack of trust that the full situation has been disclosed.
- Call for better information on the location and extent of the Leadbeater's Possum and for this to be linked better to the planning of allowable harvests.
- Fire management, including an acknowledgement of the impact of fire and recommendations to address the management of fire and its impacts on the species.
- Innovative solutions such as nest boxes, captive breeding, artificial hollow development and translocation.
- The importance of the timber industry and concern about potential impacts on resource availability.
- Criticisms of the process and the Advisory Group's Terms of Reference (i.e. they are too restrictive).
- Questioning whether Victoria needs to retain the native timber industry.

On-line forum

The Advisory Group also invited all members of the community to share ideas and ask questions through an online forum hosted on the DEPI website. The online forum used the IdeaScale tool to enable users to post questions or comments and to vote on the ideas/questions of other participants.

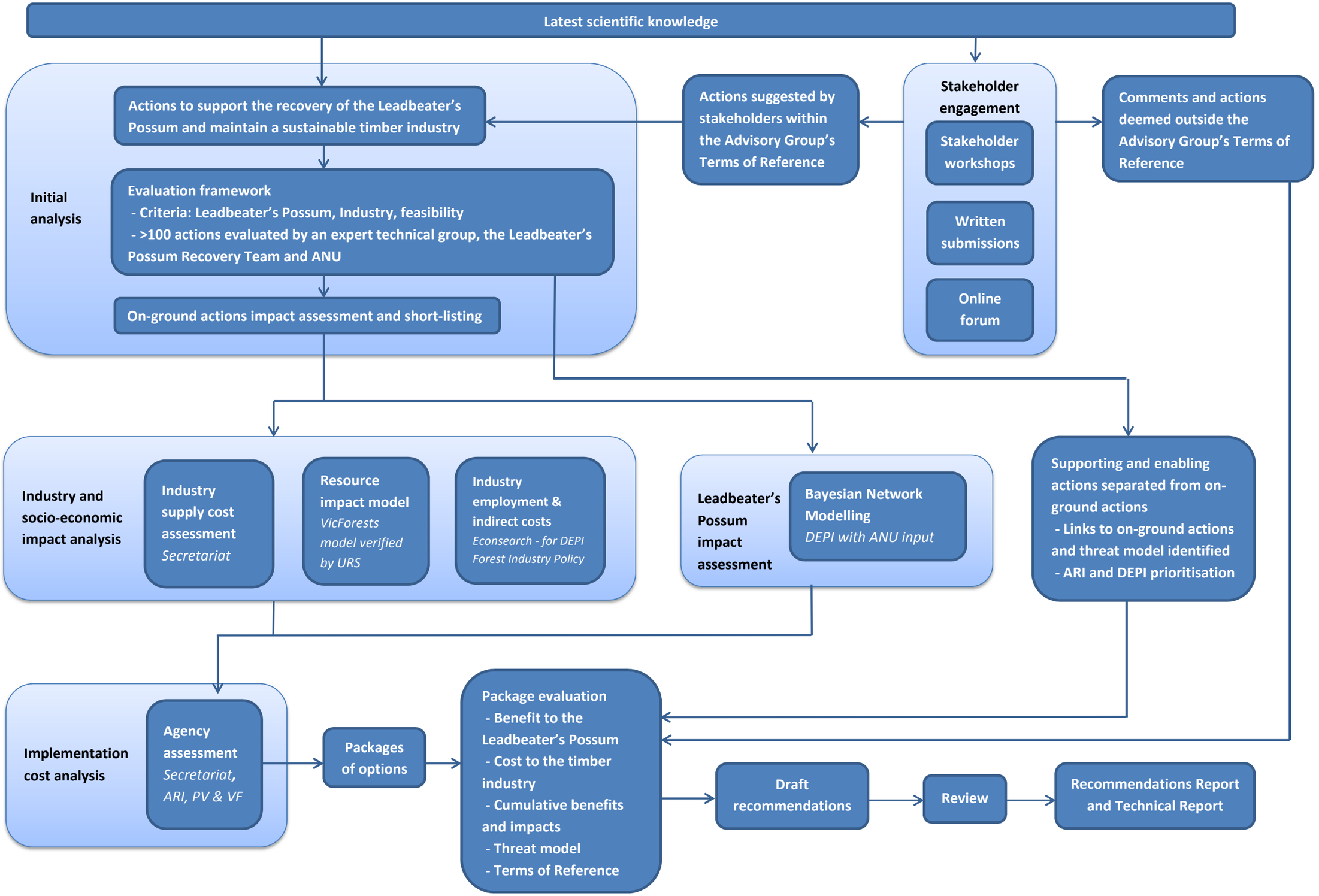
The online forum was conducted over 10 days and promoted through Zoos Victoria, VAFI and DEPI social media and the DEPI website.

In all, 17 posts were made by members of the public. In most cases, the posts provided comments rather than ideas or questions. The Advisory Group had advised participants that answers would be provided to the five ideas/questions which were rated most highly and this was done after the forum closed.

Some of the suggestions and themes arising from the on-line forum were:

- manage national parks in accordance with forest management certification practices;
- introduce a reserve possum population and/or controlled habitat zone;
- ban logging from old growth forest/known habitat;
- establish a Great Forests National Park to protect forest for a number of endangered species, including the LBP;
- shut down the industry (end logging);
- build better nest boxes;
- improve management of existing national parks; and
- a film and/or field trip for members of the public to gain a better appreciation of the issue.

Appendix 7: Leadbeater's Possum Advisory Group Process Map



Appendix 8: Actions considered

A large number of potential actions to develop its recommended package of actions. These potential actions were compiled using existing documents (the existing Leadbeater's Possum Action Statement and Recovery Plan, the Department of Environment and Primary Industries (DEPI) Actions for Biodiversity Conservation database, ANU papers and reports, etc.), additions by VicForests and DEPI, and suggestions from the stakeholder workshops and on-line submissions.

An initial assessment of the potential actions was carried out and those deemed outside the Advisory Group's Terms of Reference were not considered in detail. These actions were, however, considered to inform commentary on the issues and were used to frame the Advisory Group's understanding of stakeholder concerns.

Those actions assessed as being within the Advisory Group's Terms of Reference were further divided into the following categories: on-ground actions; enabling actions (actions that are mostly core business for DEPI, VicForests and other organisations); supporting actions (actions that will provide information required to implement on-ground actions, including research and surveys); and stakeholder engagement.

On-ground actions

Improve protection of existing colonies

- Protect all known colonies of Leadbeater's Possum with a buffer, based on records within the past 15 years (i.e. since 1998):
    a) Buffer all known records by 100 m radius;
    b) Buffer all known records by 200 m radius;
    c) Buffer all known records by 500 m radius;
    d) Buffer all known records by 1 km radius;
    e) Buffer the most appropriate 4 hectares around the record with a site specific plan.
- Undertake active fire management activities (including fuel management in adjacent forests or fire break creation) to protect identified colonies from fire.
- Undertake predator control in areas where colonies are vulnerable to introduced predators (most relevant to Snow Gum habitats).
- Supplement (hollows or food, if needed) to enable colonies surviving in 2009 fire refuges to continue until surrounding habitat becomes suitable.
- Exclude timber harvesting from fire refuge areas (from the 2009 fires and subsequent fires) - i.e. areas where both the understorey and canopy remained unburnt, surrounded by burnt area, irrespective of whether it meets Zone 1 habitat or have known colonies present. Areas to be greater than 10 hectares or 20 hectares in size with an upper size limit.
- Buffer and exclude timber harvesting from unburnt refuges.
- Exclude fire refuges from planned burning and protect where possible during bushfire.

Improve protection of existing suitable habitat

- Revise management prescriptions for the protection of currently suitable habitat from harvesting activities and other forest management activities (i.e. roads), including a revision of the existing Leadbeater's Possum habitat zone definitions, and associated survey standards:
    a) Maintain Zone 1A as > 12 trees/ 3 ha, but redefine trees as any HBT > 1.5 m DBH live or dead;
    b) Maintain Zone 1A as > 12 trees/ 3 ha, but redefine trees as any HBT > 1.0 m DBH live or dead;
    c) Maintain Zone 1A as > 12 trees/ 3 ha, but redefine trees as any HBT > 80 cm DBH live or dead;
    d) Redefine Zone 1A as > 8 trees/ 3 ha, while retaining current tree age definition;
    e) Redefine Zone 1A as > 8 trees/ 3 ha, and redefine trees as any HBT > 1.0 m DBH live or dead;
    f) Redefine Zone 1A as > 8 trees/ 3 ha, and redefine trees as any HBT > 80 cm DBH live or dead;
    g) Redefine Zone 1A as > 6 trees/ 3 ha, while retaining current tree age definition.
- Buffer all Zone 1A habitat by 100 m, to improve protection from disturbance, especially during timber harvesting.
- Buffer all areas of old growth ash forest to improve protection from disturbance, especially during timber harvesting.
- Based on current improved knowledge of where colonies and habitat occur, incorporate into Special Protection Zones (SPZs) the most important areas:
    a) Within the existing cap of SPZs;
    b) Increasing the area reserved above the cap:
        b1) Move areas from General Management Zone (GMZ) to SPZ where the ARI Occupancy Model predicts a greater than 65% probability of the species being present;
        b2) Move areas from GMZ to SPZ where the ARI Occupancy Model predicts a greater than 50% probability of the species being present;
        b3) Move areas from GMZ to SPZ where the ARI Occupancy Model predicts a greater than 30% probability of the species being present.
- Buffer areas in occupancy model represented by 0.65-0.90 probability, by 50m.
- New formal reserve system based on the proposal for a Great Forest National Park in the Central Highlands.
- Implement revised regeneration practices (regeneration burns) to minimise risk to retained habitat.
- Exclude thinning in GMZ from areas within 200 m of all known colonies.
- Exclude thinning in GMZ from areas within 200 m of areas reserved specifically for Leadbeater's Possum (Zone 1A&B or Leadbeater's Possum reserve).
- Expand riparian buffers:
    a) Increase riparian buffers to 20 m either side of all permanent and temporary streams;
    b) Increase riparian buffers to 50 m either side of all permanent and temporary streams;
    c) Increase riparian buffers to 100 m either side of all permanent and temporary streams;
    d) Variable width riparian buffers based on the suitability of the habitat, with width to be between 20 and 100 m.

- Undertake active fire management activities (including but not limited to fuel management in adjacent forests or fire break creation and suppression activities) to protect identified suitable habitat from fire.

Improve future habitat availability and quality

- Implement retention harvesting systems so that post-harvest forest maintains high levels of structural heterogeneity:
    a) Retention harvesting on 30% of coupes;
    b) Retention harvesting on 50% of coupes;
    c) Retention harvesting on all coupes.
- Active management of suitable stands (typically old growth forest) to encourage the regeneration of understorey wattle at suitable density.
- Develop active fire management techniques which will encourage the development of suitable forest structure.
- Actively promote natural accelerated development of hollows in areas with insufficient hollow bearing tree densities, using selective thinning or other silvicultural processes.
- Artificially accelerate the development of hollows.

Increase future old growth

- Identify future old growth areas such as those areas least likely to be affected by fire and other disturbance to be considered for active management to enable stands to grow on to ecological maturity. Set targets as part of a landscape planning system for the development of old growth ash forests across the landscape. Implement this system to meet specified targets.
    a) Expand reserves within each LMU to 30% (any forest types);
    b) Expand reserves within each Leadbeater's Possum Management Unit to 30% ash forest type to enable the development of old growth ash;
    c) Expand reserves within each Leadbeater's Possum Management Unit to 50% (any forest type) to enable the development of old growth forest;
    d) Expand reserves within each Leadbeater's Possum Management Unit to 50% ash forest type to enable the development of old growth ash.
- Buffer all mature live ash trees to improve protection from disturbance, especially timber harvesting:
    a) Buffer live mature trees by 100 m;
    b) Buffer live mature trees by 800 m;
    c) Buffer live senescent trees by 100 m;
    d) Buffer all live or dead hollow bearing trees by 100m;
    e) Exclude any trees>1.5m diameter from harvesting;
    f) Buffer any trees>1.5m diameter from harvesting.
- Totally protect by law all hollow-bearing trees.

Active habitat management

- Install nest boxes to supplement declining natural hollow densities at occupied sites:
    a) In ash forest at varying densities and scales:
        a1) low densities or just at restricted sites;

a2) moderate density or spread;
a3) high density and spread.

b) In Snow Gum woodland at varying densities and scales:
b1) low densities or just at restricted sites;
b2) moderate density or spread;
b3) high density and spread.

- Construct artificial stags using 3D printing technology.

Active species management

- Translocation of wild animals into suitable unoccupied habitat within the known range of the species, especially areas regenerating after the 2009 fires.
- Captive breeding program to breed possums that can be released to increase the number, distribution and genetic diversity of the wild population.
- Release animals (wild or captive bred) to potentially suitable habitat outside the known range.
- Capture animals from the wild and hold at zoo as an insurance population, with sufficient individuals to ensure genetic diversity.

Enabling actions

Improve protection of existing colonies

- Identify known colonies as critical assets in fire planning systems to prevent known colony areas being impacted during planned burning or fire suppression activities.
- Develop management prescriptions for the appropriate protection of identified colonies from harvesting activities and other forest management activities (i.e. roads).

Improve protection of existing suitable habitat

- Identify known suitable habitat as critical assets in fire planning systems to prevent areas of high quality or strategically important habitat, so that these areas do not get impacted during planned burning or fire suppression activities.
- Revise Zone 1 habitat survey standards.
- Increase size of retained habitat between coupes so that they are large enough to support colonies and facilitate dispersal.
- Improve coupe placement and landscape planning to reduce habitat fragmentation.

Improve future habitat availability and quality

- Review and formalise salvage timber harvesting prescriptions requirements within legal framework prior to next large fire.

Active colony management

- Develop approved fire recovery protocols that can be enacted without delay following fire (or other) disturbance events that affect known Leadbeater's colonies, to improve decision making about emergency responses with clear accountabilities (e.g. interventions such as supplementary feeding, predator control, translocation, bringing into captivity).

Improve information recording and access

- Actively seek out Leadbeater's Possum records from groups and institutions that are known to have undertaken survey work.
- Ensure that all records are published in the DEPI Victorian Biodiversity Atlas (VBA) in a timely manner.
- Ensure effective and timely integration between the VBA and DEPI Corporate Spatial Data Library (CSDL).
- Ensure that all areas of current suitable habitat identified through field surveys are mapped, consolidated and published. This includes suitable habitat identified through research, landscape surveys or during pre-harvest surveys undertaken by VicForests.
- Ensure effective feedback loop between VicForests and DEPI (on-ground LBP and suitable habitat identification) and integration of VF information and data sets with DEPI data sets.
- Where additional reserves are created their location and purpose is to be mapped, consolidated and published within the Forest Management Zoning scheme.
- Following a significant change to the forest management zoning VicForests to revise and release an updated Timber Resource Outlook.

Implementation, monitoring and reporting

- Confirm ongoing role and accountabilities of the Leadbeater's Possum Advisory Group and the Leadbeater's Possum Recovery Team regarding monitoring and reporting against actions.
- Define how, when and by whom recovery actions will be monitored and reported, then ensure delivery on this program.
- Ensure that adequate resources are available to deliver the actions identified within any plan.

Improve quality assurance

- Review to improve the operational auditing of compliance with Leadbeater's Possum regulations and implement findings of this review.
- Ensure that all requirements developed for the Leadbeater's Possum are clearly articulated in a manner that can be unambiguously applied by those practitioners who undertake implementation in the field.
- Ensure that all people involved in the implementation of Leadbeater's Possum habitat identification are adequately trained.

Supporting actions

Improve knowledge of Leadbeater's Possum populations and their habitat

- Undertake targeted surveys to identify and map colonies and clusters of colonies within known range.
- Undertake a landscape-wide, broad scale survey program to locate additional colonies and improve models of suitable habitat.
- Improve survey techniques and detection probability estimates.
- Conduct pre-harvesting surveys by independent biologists on all coupes to provide information on species and populations.
- Survey private land.

- Targeted surveys of areas outside known range or habitat types to investigate if located in other areas.
- In conjunction with species surveys assess habitat characteristics to improve the description of the range of habitats suitable for the possum across the distribution.
- Analyse data collected to continue to develop distribution and population models.
- Undertake a landscape wide survey program to identify areas of suitable habitat.
- Continue the ANU long term monitoring.
- Continue variable retention harvesting study.
- Investigate potential to accelerate hollow creation.
- Investigate potential to improve persistence within refuge areas.
- Improve understanding of species ecology.
- Improve understanding of habitat requirements.
- Determine dispersal and recolonisation capabilities.
- Investigate options for translocation, establishing protocols, procedures and trialling technique.
- Investigate the most effective way to optimise for Leadbeater's Possum outcomes within an area cap using a bespoke reserve design that considers habitat (now and future), colonies, dispersal / connectivity and fire refugia.
- Improve understanding of habitat survival.
- Investigate potential to improve resilience within Snow Gum areas.
- Determine structure of Leadbeater's Possum populations.
- Investigate population genetics.
- Investigate potential climate change impacts.
- Investigate landscape disturbance patterns.
- Investigate a range of environmental economics of ash forests.
- Research nest box designs to mimic natural hollows (and discourage non-target species).
- Investigate the impact of bees and other pests using of natural hollows.
- Investigate predators and predation impacts.

Stakeholder engagement

- Implement ongoing community engagement.
- Involve community stakeholders in monitoring activities.
- Instigate Leadbeater's Possum education programs to improve understanding of management.
- Provide viewing opportunities at selected colonies to enlist public support.

Broader actions

- Develop definitions for an ecologically sustainable forest and an economically sustainable timber industry.
- Stop timber harvesting in the Central Highlands until ecologically sustainable forestry can be achieved.

- Immediate cessation of clear-fell logging in Australia and a complete end to harvesting of native forests.
- Move to immediately place a moratorium on logging of known areas of LBP habitat, to prevent unnecessary habitat loss while the Advisory Group process is underway, during subsequent deliberations on recommendations, and beyond.
- Transition native forestry into mixed species plantations and expand the plantation estate, including using the plantations in the south west part of the state.
- Leverage Commonwealth Direct Action funding for local government to create carbon plantations through VicForests.
- Remove government subsidies to VicForests and apply funding to Leadbeater's Possums and the Great Forest National Park.
- Shut down VicForests.
- Revise estimates of the area available for logging, the allocation order and sustained timber and pulpwood yield.
- Reduce pulp and sawmill targets.
- Assist transition of forest industry workers to restoration forestry and plantation forestry or to exit the industry altogether.
- Exit packages should be offered to loggers who can be retrained as forest managers and tourist operators.
- Release areas from national parks and reserves to compensate for any changes in access due to actions to protect Leadbeater's Possums.
- More flexibility in harvest area and longer rotations i.e. 200 years.
- Address the inequality of environmental groups not being held accountable under consumer law for undermining the environmental credibility of well managed forest practice.
- Less minority input, more liaison with contractors, harvest and haulage and VicForests.
- Expand the scope of the corridor plantation resource to secure jobs at Maryvale.
- Invest in greater value-adding and new products out of a reduced timber supply from ash forests.
- Encourage the industry to process logs that would be currently be chipped into more valuable and useful products.
- Research the economic uses of other wood species.
- Leadbeater's Possum awareness campaign targeting the industry, community and environmental groups
- Actions Statements under the Flora and Fauna Guarantee Act 1988 (FFG Act) to be made legally binding.
- The DEPI be resourced to ensure that the FFG Act is properly implemented and that monitoring, compliance and enforcement in relation to the Act is thorough and effective.
- Develop tools and mechanisms for long term planning and thinking.
- Facilitate a program whereby people can contribute directly to conservation and establishment of a new national park.
- Proclaim the area as a National Park and manage it for natural history protection and tourism/recreational benefits to the growing Melbourne and regional population.
- Expand and develop ecotourism around the Central Highlands to produce more jobs.

- Carry out forest age class stratification mapping in parks and reserves in conjunction with additional population survey work for Leadbeater's Possum in parks and reserves so that the reserve system for Leadbeater's Possum can be proactively managed in future. Recovery of the very small isolated lowland population of Leadbeater's Possum, and a long term plan to establish more colonies in the lowlands.
- Buying back land around Yellingbo State Faunal Reserve along with independent study into effects of agricultural run off on die back of Leadbeater's Possum habitat.
- Consideration should be made for supporting restoration of suitable habitat, through improved forest management practices and revegetation programs.
- Consideration should be given to the economic and social values of water, carbon and tourism from the Central Highlands forests.
- Consideration of the very high probability that within the 50-100 year timeframe of the Resource Outlook, productivity of these forests is highly likely to decline significantly due to climate change.
- New governance model to develop a shared, holistic landscape vision adaptive with strong stakeholder participation to bring together all interests to support effective land use whilst protecting and restoring habitat.
- Clarify the values of the community.
- Public awareness of the facts – channel resources currently spent on legal/media by industry/government/NGO's to Leadbeater's Possum solutions.
- Australia has the highest rate of extinction of mammals in the world and the LBP continues to be under serious threat. We must all play a committed role to fighting extinction of this unique and ecologically important species. Do it for your children, your grandchildren and their grandchildren.
- Change government - vote Green.

Appendix 9: Bayesian Network Model of the benefit of proposed actions

A Bayesian Network model was developed to assist in comparing the likely benefit to Leadbeater's Possum arising from the individual proposed actions (Stage 2), and then the likely benefit to the species from different combinations of actions (i.e. packages; Stage 3). The Bayesian Network model is a conceptual model of the causal relationships between the most significant factors influencing the status of Leadbeater's Possum in the Central Highlands, encompassing all ash forest and sub-alpine woodland habitat and populations.

The value of the model is in its ability to combine empirical data and expert opinion to represent our understanding of system function, including reflecting levels of uncertainty about the status of particular variables and the relationships between different variables.

The Bayesian Network model outputs allowed the conservation status of Leadbeater's Possum to be estimated, based on the probability (as a percentage) that Leadbeater's Possum is in 'good', 'fair' or 'poor' condition, given the various combinations of actions and the states of other factors in the model. While the states 'good', 'fair' and 'poor' do not strictly relate to the probability of persistence or eventual recovery of Leadbeater's Possum, the greater the likelihood of Leadbeater's Possum being in 'good' condition, the more likely it is to persist and potentially to recover. In general, these states can be described as:

- 'good' – the distribution and abundance of Leadbeater's Possum and the condition of its habitat is such that it is likely to persist beyond 2100;
- 'fair' – the distribution and abundance of Leadbeater's Possum and the condition of its habitat is such that it is marginally likely to persist beyond 2100; and
- 'poor' – the distribution and abundance of Leadbeater's Possum and the condition of its habitat is such that it is unlikely to persist beyond 2100.

The focus of the analysis was on the degree to which the likelihood of the status of Leadbeater's Possum being 'good' was increased by the proposed actions and packages of actions. In developing the Leadbeater's Possum model, management actions, threats and population and habitat factors that impact Leadbeater's Possum population status were identified. The outcome of the model depends on which management actions, or combination of management actions, are implemented; the degree to which these actions mitigate the identified threats; and the likely response in the population and habitat variables for the species and, hence, the status of the population. Modelling different scenarios allows a comparison of the relative value of the management actions to Leadbeater's Possum.

The model is focused on the 30 year period to 2044. The management of Leadbeater's Possum habitat and the occurrence of bushfire and other environmental threats over this period will play a critical role in determining the likelihood that Leadbeater's Possum will emerge from the 50-70 year population bottleneck, resulting from a predicted shortage of hollow-bearing trees, and persist beyond 2100. The values generated from the Bayesian Network model are not to be used in an absolute sense – they reflect the relative benefit likely to be derived from the different portfolios, compared to the current situation.

Appendix 10: Approach to measuring the cost of actions to the timber industry

Performance indicators were used to measure the cost to the timber industry of individual actions, and clusters of actions, to support the recovery of the Leadbeater's Possum while maintaining a sustainable timber industry. The indicators were:

1. Estimated impact on available volume – derived as annualised estimates of the percentage reduction in foregone ash sawlog resulting from actions; and
2. Estimated annual timber supply cost – derived as annualised estimates of the direct and opportunity cost to the timber industry resulting from actions.

To estimate the percentage reduction in foregone ash sawlog from the Leadbeater's Possum range from proposed individual actions the following steps were undertaken:

- Geographic Information System (GIS) analysis were used by VicForests to create a spatial data layer identifying the area of ash forest available for harvest from within the Leadbeater's Possum range within the next 30 years.
- A projected baseline of the annual volume of ash sawlog and pulp log harvested from within the Leadbeater's Possum range was established. The baseline was derived from VicForests' resource outlook which assumes that 30-35% of the area available for harvest will not actually be harvested based on historic data (due to factors such as triggers based prescriptions, slope, and proximity to unmapped waterways).
- The areas excluded from harvesting for each on-ground action were mapped by VicForests to determine the reduction in area of ash forest available. These area calculations were verified by GIS analysis conducted independently by DEPI.
- The reductions in area for each on-ground action were translated into annual percentage reductions in the volume of ash sawlog and pulp log. This was done by applying the percentage of the area excluded as a proportion of the total area (identified through the spatial layers above) to the projected baseline annual timber volumes. The derivation assumes that the area to volume relationships are distributed uniformly (i.e. productivity is constant) across the harvested area based on historic data. Areas available for harvest that will not actually be harvested are also assumed to be uniformly distributed.

The supply costs to the timber industry were developed based on the estimated reductions in the volume of ash sawlog and pulp log for each on-ground action. The estimates comprise direct costs and opportunity costs, defined as:

- Direct costs: additional costs that will be directly incurred as a result of the reduction in harvesting from the on-ground action. These are based on estimated increases in transport and harvest costs per m^3 for VicForests to source alternative timber supplies, or increased operational costs per m^3 for VicForests where on-ground actions result in smaller coupes.
- Opportunity costs: foregone revenue resulting from the reduction in harvesting with each on-ground action. This comprises the net value of timber foregone where an action is likely to reduce the volume of timber harvested in Victoria. The net value is calculated as average revenues per cubic metre less average harvest and haulage cost per cubic metre for ash sawlog and pulp log based on VicForests current price/cost schedules.

The analysis derives costs separately prior to 2017 when existing contracts end, and costs post 2017. This is because VicForests is expected to source additional timber from outside of Victoria to meet contractual obligations within the duration of existing contracts. An annualised cost was derived over the next 20 years using a discount rate of 3.5 per cent (recommended by the Department of Treasury and Finance for assessing regulatory impacts).

URS Australia conducted an independent assessment of the approach used to estimate the costs to the timber industry to assist in finalising these estimates.