INQUIRY INTO ECOSYSTEM DECLINE IN VICTORIA

RESPONSE TO QUESTIONS ON NOTICE

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Ms Melina Bath: What funding do you receive from environmental groups that actively oppose native timber harvesting?

I am not funded by any environmental groups. I am not a member of any environmental group – other than Birds Australia – because my 85-year old father pays my subscription dues every year as my birthday present. Notably, I have written 114 peer-reviewed scientific articles on birds and in 2010, I won Birds Australia's prestigious Serventy Medal for contributions for Ornithology.

Please note that I have received funding from the Forests and Wood Products Research and Development Corporation for work on implementing the Variable Retention Harvesting Experiment. I have also received funding from industry bodies such as the Rural Industries Research and Development Corporation (for work on plantation establishment and management), Victorian Department of Primary Industries (for work on Variable Retention Harvesting), NSW Forestry Corporation (State Forests of NSW) (for work on plantation establishment), and Meat and Livestock Australia (for work on integrating agricultural production and on-farm biodiversity conservation). In national and international contexts, I have been funded to provide expert forest ecology advice to

companies such as CSR, Weyerhasuer, McMillan-Blodel and government forestry agencies in Sweden, Norway, Argentina and Chile (among others). In addition, I have received funding from the Australian Government (Department of Agriculture, Water and Environment), Victorian Government, and the Australian Research Council, to conduct extensive, field-based empirical studies over the past 37 years.

I have worked with other researchers in a collaborative way – often through providing datasets - whom I have been informed have received funding from sources such as environmental groups. Those grants were made to them directly and not to me.

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Ms Melina Bath: At the Hearing, VicForests revealed new analysis that shows that Leadbeater's Possums are predominantly found in regenerating forest areas. Do you still stand by your claim that the best habitat for the possums is 200 year old trees?

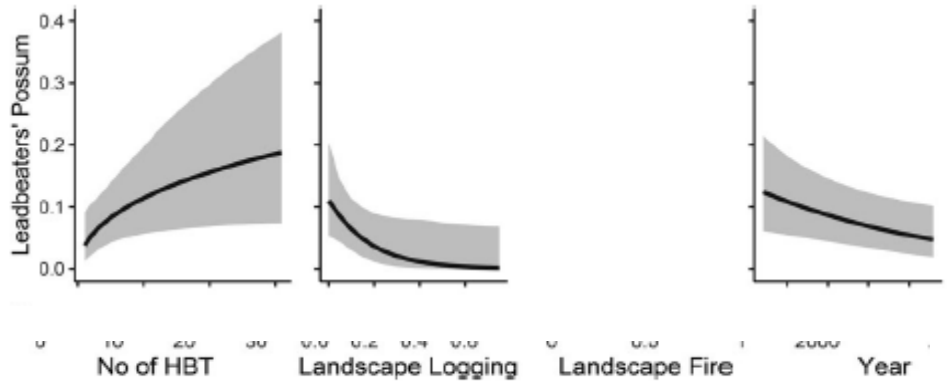
Thankyou for this question. I have not been privy to the work by VicForests – and they rarely submit their work for detailed peer-review – as I do as part of my professional standing as a forest ecologist.

For more than 35 years, I have been aware that the habitat requirements for Leadbeater's Possum is a combination of large old hollow-bearing trees and an understorey of *Acacia* spp. trees. This was first documented in a report I co-authored in 1985 and then quantified the habitat requirements of the species in peer-reviewed scientific papers in international journals written in 1992, 1991, 1994, 2014 (Lindenmayer et al. 1991a, Lindenmayer et al. 1994) (Lindenmayer et al. 2014a) (Smith and Lindenmayer 1992). Large old trees are critical nesting sites for animals, whereas the *Acacia* spp. understorey provides a foraging substrate and facilitates the movement of animals throughout the forest.

Importantly, Leadbeater's Possum spends 75% of its life living inside large old hollow-bearing trees (Smith et al. 1982). Work on the occupancy of trees, shows that these trees can exceed 170 years of age (Lindenmayer et al. 2017) and are often much older (Lindenmayer et al. 1991b). Animals do not occur on sites which lack hollow-bearing trees (Lindenmayer et al. 1991a) (Blair et al. 2017, Blair et al. 2018) (Lindenmayer et al. 2020a). Conversely, the probability of occurrence of animals on sites is strongly associated with the abundance of hollow-bearing trees

(Lindenmayer et al. 1991a, Lindenmayer et al. 1994) (Lindenmayer et al. 2014a) (Smith and Lindenmayer 1992). The latest empirical evidence of the relationship between hollow-bearing trees and animal occurrence is presented in (Lindenmayer et al. 2020a) and the shape of that relationship is shown in Figure 1. The key point is that Leadbeater's Possum cannot persist in a forest environment without access to large old hollow-bearing trees in which to nest and den.

Figure 1. Long-term changes in occurrence in Leadbeater's Possum in relation to key variables – hollow-bearing trees, levels of logging and year (from Lindenmayer et al. 2020).



The long-term data show that levels of site occupancy by Leadbeater's Possum have declined by 50% since 1997 (Lindenmayer et al. 2020a). The decline is linked to a decline in the abundance of hollow-bearing trees and the increasing amount of logging in the landscape (Lindenmayer et al. 2020a). Importantly, it is also indirectly linked to whether sites have been burnt both due to direct mortality (Lindenmayer et al. 2013) and the accelerated loss of hollow-bearing trees on sites following wildfire (Lindenmayer et al. 2012) (Lindenmayer et al. 2018a, Lindenmayer et al. 2018b). Therefore, many of the sites which used to support Leadbeater's Possum, no longer support the species – in part because of the loss of nesting and denning sites due to fire and the amount of logging in the surrounding landscape (Lindenmayer et al. 2020a).

A key issue is the state of the forest at the time it was burnt. Where fire burns in old growth forest, then there are more biological legacies such as large fire-scarred dead and living large old trees and these in turn may eventually provide nesting sites for animals (Lindenmayer et

al. 2019c). The key problem in the Central Highlands of Victoria is that just 1.16% of the landscape in Mountain Ash and Alpine Ash ecosystems is now old growth and therefore subsequent wildfires will NOT produce the pulses of large old trees needed to ensure the long-term persistence of animals (Lindenmayer et al. 2020b) (Lindenmayer and Taylor 2020). The solution to this problem is to protect existing regrowth forest and maximize its chances of growing through to become old growth forest (Blair et al. 2018) (Lindenmayer et al. 2019c). Indeed, old growth forest is where fire severity is lowest (Taylor et al. 2014, Lindenmayer et al. 2021b). Ongoing logging is not only concentrated in areas of high conservation value for animals such as Leadbeater's Possum (and other threatened species like the Greater Glider, see (Taylor and Lindenmayer 2019)), but also further fragments Mountain Ash and Alpine Ash ecosystems (Taylor and Lindenmayer 2020)) which has major negative impacts on biodiversity (including Leadbeater's Possum) (Lindenmayer et al. 2020a) – see Figure 1 above which shows the relationships between site occupancy and the amount of logging in the landscape.

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Ms Melina Bath: Randomness and the design of long-term monitoring program inthe Central Highlands of Victoria. Are your 164 monitoring sites randomly distributed across Mountain Ash and Alpine Ash forests and age classes?

Ms Melina Bath asked a question regarding the design of long-term monitoring program in the Central Highlands of Victoria. She inquired about whether the program was based on the random selection of sites.

The answer to this question is that site selection is not random. There are good statistical and ecological reasons for this. That is, approximately 98.8% of the forest cover in the Central Highlands is comprised of forest aged ~ 80 years or younger (Lindenmayer and Taylor 2020). A random selection of sites would in turn be heavily biased towards sites of this age (because that is the predominant age class in the Mountain Ash and Alpine Ash ecosystem) (Burns et al. 2015) (Lindenmayer and Taylor 2020). A biased focus on young forest would limit inference from the long-term data collection to young forests, with the results unable to then be extrapolated to other forest conditions such as old growth. On this basis, the statistical basis for

the design of the long-term monitoring program was to ensure that the full range of environmental and biophysical conditions in the landscape were encompassed in the array of site types that are targeted for sampling and resampling on a regular basis (Lindenmayer et al. 2003). Therefore, the suite of sites in the monitoring program includes young forest, old growth forest, forest on steep slopes and forest on flat terrain, burnt forest, unburnt forest, forest on north and other aspects, forests with a high value for topographic wetness and low values for this measure, forests at high, low and intermediate elevation, forests with numerous hollow-bearing trees versus forests where these keystone structure are rare (Lindenmayer et al. 2020a). Hence, as a result of the array of conditions sampled in the monitoring program, the basis for ecological and statistical inference is broad across the ash-type forests in the Central Highlands of Victoria. Notably, the sites span wood production forests and national parks/closed water catchments in equal measure – enabling inference across tenures.

This design for the monitoring program in the Central Highlands of Victoria has been published in the peer-reviewed scientific literature (Lindenmayer et al. 2003) and is widely recognized as best practice for monitoring design. Notably, the design was guided by three leading statistical scientists – Professor Ross Cunningham, Professor Alan Welsh (who [like me] is a member of the Australian Academy of Science), and the late Associate-Professor Jeff Wood. The monitoring work is now guided by expert statistical scientist Dr Wade Blanchard whom has more than 30 years of experience in experimental design and the analysis of high quality ecological and other datasets (e.g. see (Lindenmayer et al. 2013, Lindenmayer et al. 2014b) (Lindenmayer et al. 2018a, Lindenmayer et al. 2018b) (Lindenmayer et al. 2019b, Lindenmayer et al. 2020a)).

We have published extensively on the statistics underpinning large-scale experiments and quasi-experiments as well as observational studies (e.g. see (Cunningham and Lindenmayer 2016)) as well as produced several seminal papers and books on how best to design, implement and maintain high quality monitoring programs (Lindenmayer and Likens 2010a, b, c) (Legge et al. 2018) (Lindenmayer and Likens 2018, Lindenmayer et al. 2020c).

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Ms Melina Bath requested a map of the locations of field sites.

This map is shown in Figure 1 below which has been reproduced from a paper on temporal changes in site occupancy by arboreal marsupials (Lindenmayer et al. 2020a).

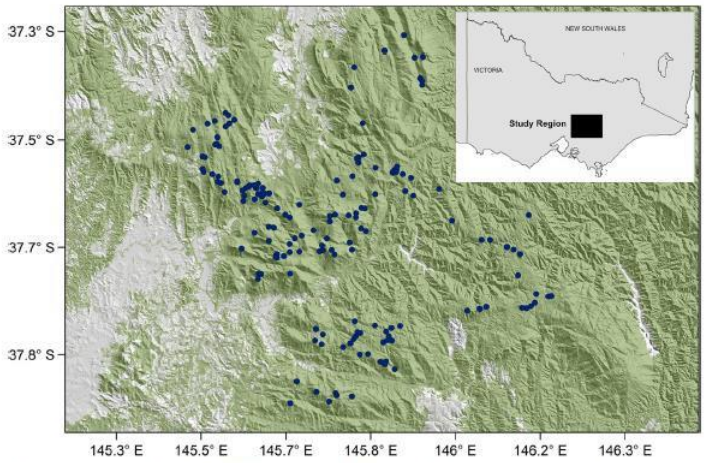

Figure 1 The location of the study area in the Central Highlands of Victoria, south-eastern Australia. The black dots show the location of field survey sites.

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Ms Melina Bath: As a follow up question, isn't it correct that LBP need foliage andmid story trees not only 200 year old trees?

Thankyou for this question. I have been aware that the habitat requirements for Leadbeater's Possum is a combination of large old hollow-bearing trees and a dense understorey of Acacia spp. trees. This was first documented in a report I co-authored in 1985 and then quantified the habitat requirements of the species in peer-reviewed scientific papers in international journals written in 1992, 1991, 1994, 2014 (Lindenmayer et al. 1991a, Lindenmayer et al. 1994) (Lindenmayer et al. 2014a) (Smith and Lindenmayer 1992). The large old trees are critical nesting sites for animals, where the *Acacia* spp. understorey provides a foraging substrate and facilitates the movement of animals throughout the forest.

Importantly, Leadbeater's Possum spends 75% of its life living inside large old hollow-bearing

trees (Smith et al. 1982). Work on the occupancy of trees, shows that these trees can exceed 170 years of age (Lindenmayer et al. 2017) and are often much older (Lindenmayer et al. 1991b). Animals do not occur on sites which lack hollow-bearing trees (Blair et al. 2017, Blair et al. 2018) (Lindenmayer et al. 2020a). Conversely, the probability of occurrence of animals on sites is strongly associated with the abundance of hollow-bearing trees. The latest empirical evidence of the relationship between hollow-bearing trees and animal occurrence is presented in (Lindenmayer et al. 2020a) and the shape of that relationship is shown in Figure 1. The key point is that Leadbeater's Possum cannot persist in a forest environment without access to large old hollow-bearing trees in which to nest and den.

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Ms Melina Bath: Do you agree that dense areas of tall Ash trees crowd out the understory needed by LBP? What do you think should be done toopen up these forests so that forage trees will grow?

With respect, this question indicates a lack of understanding of patterns of forest growth and development. Eucalypt trees and the overstorey of Mountain Ash and Alpine Ash forests. *Acacia* spp. trees are the understorey of the same forests. The amount of *Acacia* spp. trees in the udnerstorey vegetation has been subject to extensive study in the past few years and on our long-term sites (e.g. (Bowd et al. 2018, Bowd et al. 2021) (Lindenmayer et al. 2021a)). The data show there are extensive areas of dense wattle regrowth in the Central Highlands forests (Lindenmayer et al. 2021a). **There is no need to do management interventions in Mountain Ash and Alpine Ash forests to open them up to grow forage trees.**

Indeed, because 98.8% of the Mountain Ash and the Alpine Ash forest estate is 80 years or younger (including regrowth following fire and logging in the past 11-40 years), there is no shortage of *Acacia* spp. as foraging sites for animals such as Leadbeater's Possum. Rather, the key limiting factor for Leadbeater's Possum is the rapid decline in the abundance of hollow-bearing trees – as indicated by the decline in long-term site occupancy by the species in the past 20+ years (see (Lindenmayer et al. 2020a)).

Notably, although the basal area and percentage cover of *Acacia* spp. is often greatest in young

forest, these trees are also found in old growth forest (Lindenmayer et al. 2000).

I would be delighted to take Ms Melina Bath on a study tour of the Mountain Ash and the Alpine Ash forests and provide some tuition on the ecology and dynamics of forests.

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Ms Melina Bath: At the Hearing we heard from VicForests regarding their variable retention harvesting practices. As their approach is based on yourown research for the timber industry, have you sought to understand VicForests methodology?

Thankyou for your question. I am acutely aware of what constitutes Variable Retention Harvesting Systems, as I led the Forestry Roundtable meeting that underpinned the establishment of the approach in mainland Australia (Lindenmayer et al. 2004). Indeed, I invited leading silviculturalists from around the world to that meeting and a book on ecologically sustainable forest management was produced from that work (Lindenmayer and Franklin 2003). Importantly, the work from the initial establishment of Variable Retention Harvesting Systems led to an experiment that is still going to this day – and from which the data that we at ANU collect continue to be analysed (e.g. (Lindenmayer et al. 2010, Lindenmayer et al. 2015) (Lindenmayer et al. 2019a)). That is, my research team conduct the monitoring program for that experiment (Lindenmayer et al. 2019a). The design of the experiment is shown in Figure 3.

Figure 3. Schematic design of the Variable Retention Harvesting experiment that was designed, implemented and maintained by The Australian National University (see (Lindenmayer et al. 2019a)).

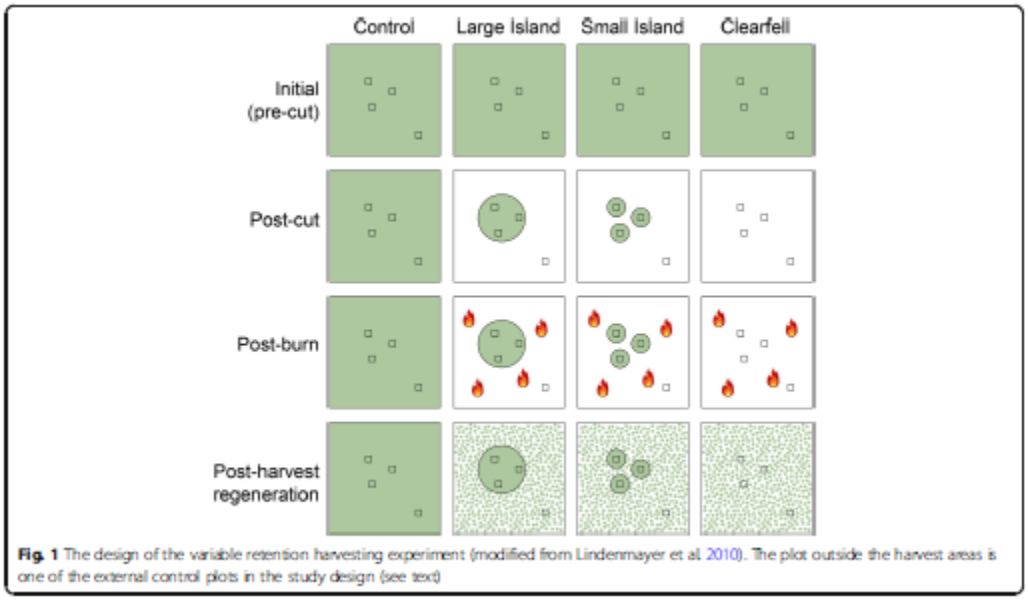

Fig. 1 The design of the variable retention harvesting experiment (modified from Lindenmayer et al. 2010). The plot outside the harvest areas is one of the external control plots in the study design (see text)

It is important to note what actually constitutes a Variable Retention Harvesting System. The Variable Retention Harvesting System is defined (after (Helms 1998)) as:

> *"….an approach to harvesting based on the retention of structural elements or biological legacies from the harvested stand for integration into the new stand to achieve various ecological objectives…..Major variables…..are types, densities and spatial arrangements of retained structures."*

A fundamental part of Variable Retention Harvesting System is that retained structures need to be within the boundary of the harvested area of a cut-block and not confined to the edges of a harvest unit (Lindenmayer and Franklin 2002) (Lindenmayer et al. 2019a).

However, it is clear from many of the logging coupes that we have observed over the past two years, that cutblocks claimed to be Variable Retention Harvesting areas do not in fact conform to what an informed forester or forest ecologist would consider to actually be Variable Retention Harvesting coupe. Figure 4 shows one of numerous examples.

Figure 4. A logging coupe near Matlock in Alpine Ash forest. This cutblock is listed as being a Retention Harvest coupe on the Victorian Government's logging history layer. The coupe does not have any of the characteristic levels of retention typical of a Variable Retention Harvesting system logging coupe (Gustafsson et al. 2012, Fedrowitz et al. 2014) and fails to meet the formal definition of that type of logging operations (see text). (Photo taken on 30 July 2019).

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