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RESEARCH CENTRE FOR  
FUTURE LANDSCAPES

**Submission to:**

## **Bushfire and Natural Hazard Cooperative Research Centre**

**Prepared by**

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The Research Centre for Future Landscapes is a multi-disciplinary environmental research centre based in the School of Life Sciences, College of Science, Health and Engineering at La Trobe University, Australia. The Centre is primarily concerned with the nature of landscape change, its drivers and management interventions that are necessary to sustain species, communities, ecosystems and society.

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# Summary

## Efficacy of past and current vegetation and land management policy in bushfire management –

The latest science underpinning estimates of the efficacy of hazard reduction burning indicates:

1. It reduces the intensity and spread of bushfires and enhances fire suppression activities.
2. It is most effective when carried out within 500m of the asset you are trying to protect.
3. Its effectiveness in altering fire behaviour is greatest in the first ~ 1-6 years in many forest types, but can diminish significantly after that.
4. It needs to be strategically targeted around assets, rather than haphazardly across broad landscapes.
5. Its effectiveness is lowest on days of extreme fire weather (when most loss of life and property occurs), but it can greatly assist suppression efforts on more benign days.
6. Its impact in reducing losses to life and property is modest (e.g. ~3-5% reduction in Victoria), even if all hazard reduction burning hectare targets are reached.
7. The public probably hold an unfounded, overly optimistic and potentially dangerous view of how much safer hazard reduction burning can make them.
8. It can do both ecological good and harm, depending on how, where and when it is applied.
9. It should not be equated with indigenous cultural burning, as the latter was primarily done to achieve other objectives, in a very different context; climatically and ecologically.
10. Hazard reduction burning is just one method of reducing risk to life and property. Other strategies may offer a better return on investment, when it comes to reducing risk.
11. Current conflation of the goals of protecting both life and property may be diminishing consideration of alternative strategies for saving lives

The folly of attempting to impose “national standards” in levels of hazard reduction burning:

1. Broad hectare targets for hazard reduction burning were attempted (e.g. 5% of Crown Land or 380,000 ha/yr in Victoria) but were found to be ‘unachievable, affordable or sustainable’ and “ineffective in achieving the primary intent of the Bushfires Royal Commission recommendations to ensure the protection of human life and community safety<sup>1</sup>.”
2. The application of a state-wide hectare target created a perverse incentive for agencies to treat large areas in remote locations (that represented low risk to life and property), rather than smaller, more costly and difficult burns in places where they were really needed.
3. A primary cause of failure to achieve targets has been the brief and shrinking fire-weather window in which agencies can safely conduct hazard reduction burning (~10 days per year), without causing collateral damage to human health and the very assets they are attempting to protect.
4. It is a myth that ‘environmentalists’ have constrained government agencies from achieving the hazard reduction targets on public land.
5. The move in Victoria from a crude hectare-based target to a more strategic risk-reduction based target is supported by both policy science and ecological science undertaken since Black Saturday 2009.
6. Given the diminishing window in which it will be safe to conduct hazard reduction burning, increased resourcing will be needed to ensure we capitalise on opportunities when they arise.

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<sup>1</sup> Bushfire Royal Commission Independent Monitor, Annual Report 2013, p. 64

# Justification of key points based on research published in the refereed scientific literature

The latest science underpinning estimates of the efficacy of hazard reduction burning indicates:

- 1. There is consistent evidence that hazard reduction burning can reduce the intensity and spread of bushfires, and can aid suppression activities**

Most practitioners argue its primary value is in assisting in control when fire weather conditions moderate below 'very severe' or 'extreme' (e.g. Boer et al. 2009, McCaw et al. 2013). It is of great value in reducing the rate of lateral spread of a fire and the establishment of control lines under more moderate conditions. Both strategies enhance firefighters' capacity to lessen the impact of the fire if more extreme conditions return.

- 2. It is most effective when carried out close (500 m) to the asset you are trying to protect.**

Analyses of the factors affecting house losses in past bushfires by Gibbons et al. (2012) showed that fuel reduction close to assets (within 40 m) was more effective at reducing house losses than the more typical broad-scale hazard reduction burning distant from the assets. They concluded that "a shift in emphasis away from broad-scale fuel-reduction to intensive fuel treatments close to property will more effectively mitigate impacts from wildfires on peri-urban communities." Similarly, Penman et al. (2014) found that planned burning at the interface between assets and the forest was the most cost effective means of reducing risk to those assets.

- 3. Its effectiveness in altering fire behaviour is greatest in the first ~ 1-6 years after burning in many forest types, but can diminish significantly after that.**

Numerous studies have documented that the capacity for hazard reduction burning to reduce fuels sufficiently to have a measurable impact on fire behaviour is limited to a short period of time (1-6 years) following treatment (e.g. Fernandes and Botelho 2003, Cary et al. 2009; Bradstock et al. 2010; AFAC 2015; Penman and Cirulis 2019).

- 4. To be most effective it needs to be strategically targeted around assets, rather than haphazardly across broad landscapes.**

Price et al. (2015) showed varying levels of effectiveness of hazard reduction burning across 25 years of fires examined in south-eastern Australia. They report that the "contention by Burrows and McCaw (2103) and Sneeuwjagt et al. (2013) that prescribed fire is universally effective is not supported by historical fire records in south-east Australia, even when restricted to forests.". Price et al. (2015) also concluded that "The most efficient use of prescribed fire is applying it to the immediate proximity of assets, where a resultant reduction in fire intensity can be of immediate benefit in terms of impacts on structures and ease of suppression (Price & Bradstock, 2010, 2012).". Furlaud et. al. (2017) has shown that realistic, implementable prescribed-burning plans to reduce fine fuel loads in fire prone Tasmanian grasslands, sedgeland and dry eucalypt forests have little potential to

substantially reduce the extent and intensity of wildfires at a state-wide scale. The study highlights that prescribed burning can theoretically mitigate wildfire, but that an unrealistically large area would need to be treated to affect fire behaviour at the statewide scale across Tasmania. It advocates for local-scale design solutions based on improved modelling of fire behaviour, empirical measurement of fuels and analysis of actual wildfires.

Florec et. al. (2019) also found that planned burning close to assets in the urban interface in WA was more effective at reducing damages (i.e. loss of built assets) than burning in the more distant landscape but on balance, less cost effective because burning remotely was much cheaper than burning close to assets. They did, however, acknowledge that their study did not consider any ecological costs associated with prescribed burning and that this was a limitation of their cost/benefit analysis.

**5. Its effectiveness is lowest on days of extreme fire weather (when most loss of life and property occurs), but it can assist suppression efforts on more benign days.**

The value of hazard reduction burning is primarily to assist with the safe suppression of fire under moderate to benign fire weather conditions. It increases the likelihood that indirect suppression (e.g. backburning) and containment methods (e.g. establishment of control lines) will be successful in reducing fire spread.

Wildfires on severe or extreme weather days account for the vast majority of area burnt, property losses and fatalities. A range of researchers (e.g. Morrison et al. 1996, Fernandes and Botelho 2003, Moritz et al. 2004, Carey et al. 2009, Penman et al. 2011, Gibbons et al. 2012, Penman et al. *in press*) and highly respected fire managers (e.g. Shane Fitzsimmons, NSW RFS Commissioner <https://www.abc.net.au/news/2020-01-08/nsw-fires-rfs-commissioner-weights-in-on-hazard-reduction-debate/11850862>), have noted that the ability of hazard reduction burning to aid in fire suppression efforts during such extreme conditions is negligible.

Bradstock (2008, p.811) discusses the correlation between extreme fire weather and high intensity fires and comments that ‘maximum severity [of wildfire] in each case is associated with severe fire weather – particularly high wind speeds in association with high temperatures plus low fuel moisture and relative humidity. Effects of weather on severity predominate over effects of terrain and vegetation type and condition [where Vegetation type and condition is a reference to fuel load], as found elsewhere in temperate vegetation (e.g. Moritz et al. 2004)’.

In their work in Californian shrublands, Moritz et al. (2004, p.70) argued that during extreme fire weather, in particular, “Santa Ana” wind conditions ‘fire may spread through all age classes of fuels, because the importance of age and spatial patterns of vegetation diminishes in the face of hot, dry winds (Bessie and Johnson 1995, Moritz 2003)’. Moritz et al (2004 p. 71) noted that ‘Rotational prescription burning to maintain a landscape mosaic of different age classes is thought to inhibit large fire development; however, the present study suggests that this strategy will be ineffective.’.

**6. Its likely impact in reducing losses to life and property is modest (e.g. ~3-5% in Victoria), even if all area-based targets for hazard reduction burning are reached.**

Some of the most sophisticated scenario modelling conducted anywhere in the world (using Phoenix Rapid Fire, Tolhurst and Chong 2011) has been used in Victoria by DELWP to predict the extent to which hazard reduction burning on public land can reduce the risk of property losses. This spatially explicit modelling has enabled the agency to estimate the magnitude of the potential reduction in property losses under extreme fire weather conditions compared to a scenario in which no hazard reduction burning on public land had taken place. Across all of Victoria the estimated total reduction in risk to property losses if DELWP is able to achieve its annual hazard reduction target for 2020 of 242,400 ha is predicted to be just 5% by June 2022 (Statewide 2019/20-2021/22 Joint Fuel Management Program [https://www.ffm.vic.gov.au/\\_data/assets/pdf\\_file/0028/448165/State-Summary-for-2019-2020-Year1.pdf](https://www.ffm.vic.gov.au/_data/assets/pdf_file/0028/448165/State-Summary-for-2019-2020-Year1.pdf)). Notably, in the Greater Melbourne Region the estimated reduction in risk to property losses that can be achieved under extreme fire weather conditions, even if all hazard reduction burning on both public and private land takes place, is just 3% by June 2022 (Greater Melbourne 2019/20-2021/22 Joint Fuel Management Program [https://www.ffm.vic.gov.au/\\_data/assets/pdf\\_file/0032/448169/Greater-Melbourne-Summary-for-2019-2020-Year1.pdf](https://www.ffm.vic.gov.au/_data/assets/pdf_file/0032/448169/Greater-Melbourne-Summary-for-2019-2020-Year1.pdf)).

**7. Many in the Australian community probably hold an unfounded, overly optimistic and potentially dangerous view of how much safer hazard reduction burning can make them.**

The call for additional hazard reduction burning by some media commentators and politicians creates an impression in the public mind that hazard reduction burning will substantially reduce the risk to their property on an extreme fire day, well beyond what the agencies' best estimates tell us is likely (see DELWP reports mentioned above). If this creates a false sense of security, tempting home-owners occupying vulnerable homes to stay and defend, rather than flee to a safe haven on extreme fire days, then these exaggerated claims about the benefits of hazard reduction burning could result in loss of life.

**8. Hazard-reduction burning can do both ecological good and harm, depending on how, where and when it is applied.**

Plant and animal communities in Australia have evolved to cope with fire regimes exhibiting different fire severity, frequency, extent, season, and configuration (patchiness). Fire can be a necessary component for the maintenance of some vegetation communities (e.g. heathlands, grasslands), but also cause the destruction of others (e.g. rainforests, alpine peat bogs). It is ecologically simplistic and inaccurate to generalise and claim that the Australian bush "craves" fire or has uniformly evolved to cope with fire. Too frequent, too intense or too extensive fires are recognised as posing a major threat of local extinction of native species (e.g. Bradstock et al. 1998; Connell et al. 2019) and this is why inappropriate fire regimes are formally listed as a major threatening process for flora and fauna in Victoria and NSW. Gross generalisations, like those of Gammage (2011) that "Most of Australia was burnt about every 1-5 years depending on local conditions and purposes", are neither accurate nor helpful when it comes to working out where and when to apply fire. Our own research has shown the likely ecological impact of both wildfire (e.g. Haslem et al. 2011, Robinson et al. 2016, Chia et al. 2016, Connell et al. 2017,2019) and hazard-reduction burning on a range of flora and fauna can be positive (Morgan et al. 2018) or negative (e.g. Holland et al. 2017, Flanagan-Moodie et al. 2018), depending on the attributes of the fire and the ecosystem. One size does not fit all.

Prescribed burning has been proposed as a means of creating a patch-mosaic of different fire age-classes, on the basis that a 'fire mosaic' is ecologically beneficial for flora and fauna. While it is clear that fire can be used to create ecologically suitable conditions for plants and animals, the application of fire for this purpose varies greatly depending on the species concerned and the type of ecosystem. Similarly, fire mosaics can enhance biodiversity in some ecosystems (e.g. Russell-Smith et al. 2009) but the same prescriptions do not necessarily hold in all ecosystems. A growing number of studies have questioned the assumptions underpinning the purported ecological value of patch mosaic burning in a number of different vegetation types (Parr and Andersen 2006; Giljohann et al. 2015; Taylor et al. 2012, 2013; Farnsworth et al. 2014).

**9. Hazard reduction burning should not be equated with indigenous cultural burning, as the latter was primarily done to achieve other objectives, in a very different landscape and climate context.**

Indigenous communities have different reasons for burning the bush from European settlers; not primarily for hazard reduction. They burn the bush:

- a. to promote the production of critical resources (e.g. plants and animals for food, fibre, medicine, shelter, tools and weapons)
- b. to enable ease of travel through dense vegetation
- c. for ceremonial reasons.

Indigenous communities did not burn everywhere and large tracts of land were intentionally not burnt by indigenous people in many ecosystems, such as rainforests, tall wet forests, mallee (e.g. Prober et al. 2016). This is contrary to Gammage's (2011) claim that "Most of Australia was burnt about every 1-5 years depending on local conditions and purposes." Indigenous burning was usually targeted and small scale and "characterised by its selectivity rather than its ubiquity." (Prober et al. 2016). There is limited (and strongly contested) evidence of indigenous burning in tall eucalypt forests of eastern Australia (Hateley 2010)

Given the huge challenges we face in managing fire under climate change, we need to harness the most relevant aspects of both traditional indigenous site-specific knowledge and western science to identify the best ways forward. There is an opportunity for indigenous practitioners and scientists to work together to better learn what works and why in a novel and much more challenging context, due to climate change.

The context in which to conduct burning has become much more complex than it was prior to European settlement. Indigenous people weren't operating in a continent in which:

- a. 25 million humans are scattered across the landscape, (compared with probably less than half a million at the time of the invasion by Europeans).
- b. there are complex networks of vulnerable infrastructure (powerlines, roads, pipelines, bridges, catchment reservoirs) crisscrossing the landscape.
- c. much of our precious remnant vegetation only exists in isolated fragments
- d. fuel layers have changed with the introduction of flammable weed species, like Buffel Grass, Lantana.
- e. landscapes and fuel layers are drying out and becoming more flammable due to increased frequency, extent and duration of droughts caused by climate change.

**10. Hazard reduction burning is just one method of reducing risk to life and property. Other strategies may offer a better return on investment, when it comes to reducing risk.**

Over-reliance on just one method of reducing risk to life and property from bushfires is poor stewardship of tax-payer dollars. Investment in early warning phone apps and educating the public to 'leave early' has contributed to a remarkable drop in fatalities associated with this season's fires (34 in 2020), compared to 173 deaths on Black Saturday, despite over 13 million hectares burnt this season compared to 450,000 in 2009.

Other complementary strategies that need to be considered include:

- a. Improved early detection of ignitions
- b. Reducing potential sources of ignitions (e.g. putting power lines underground)
- c. Enhanced and earlier rapid attack/suppression, especially on fires in remote locations, before they reach built assets (e.g. aerial suppression)
- d. Other methods of fuel removal (e.g. slashing, mulching, rolling)
- e. Tightening building and maintenance codes for types of dwellings approved in fire prone areas
- f. Planning regulation of building placements in fire prone locations
- g. Community shelters in defensible spaces, as is done for cyclone shelters in northern Australia
- h. Encouraging construction to an approved standard of private bushfire shelters/bunkers (could be compulsory at least for new buildings in fire prone areas). Lessons could be learnt from personal tornado shelters built below homes in vulnerable regions of the USA.
- i. Education and communication programs to encourage people to leave early
- j. Legislating for compulsory evacuation powers, including the development of strategies in advance for implementing them (learning from experiences in Canada and USA).
- k. Improved acceptance of the responsibility for fuel management on *private* land (e.g. in the East Central Region of Victoria where there is 35% public land, 65% private land).

**11. Current conflation of the goals of protecting both life and property may be diminishing consideration of alternative strategies for saving lives**

If, as the climatologists predict, more frequent, extensive and prolonged drought conditions, coupled with an increase in the frequency of days of extreme fire weather is more likely to become the norm, then the **nature of the fire threat has undergone a step change**. Approaches of the past in reducing risk need to be rethought. For example, we never talk about earthquake or cyclone "management". Perhaps many of our fires are now entering a similarly 'unmanageable' status and we should be more sanguine about how limited an impact our preparations can have in reducing the ferocity of a fire under these new conditions.

We need to re-evaluate the most effective ways to reduce the threat or risk to the three key things we value:

- a) People's lives
- b) Human assets (homes, farms, crops, infrastructure, water catchments, timber resources)
- c) Ecological assets (threatened species, communities, refugia, corridors)



Current bushfire risk management zoning systems (e.g. Department of Sustainability and Environment 2012) blur the distinctions between these three different values unhelpfully. When the values we are trying to protect become conflated some mitigation options are given greater emphasis (e.g. hazard reduction burning), under the assumption that applying that mitigation strategy is the best option for simultaneously reducing the risk to all three values. However, it can lead to the importance of other complementary strategies being undervalued (e.g. early ignition detection, better warning communication systems, rapid attack while the fire is small). Over reliance on just one mitigation option (e.g. hazard reduction burning or aerial water bombing), that we know have limited effectiveness under severe or extreme fire weather conditions, seems imprudent. Instead we should choose our mitigation strategies for each of the three different kinds of values we are trying to protect. Where different values are protected by the same mitigation option, great, but let's first be really clear about the objective we're hoping to achieve before we decide which tool is the best one to apply to protect that value in each different spatial context.

If we only have a hammer in the tool box, everything begins to look like a nail.

This is not to say we should give up and reduce the level of hazard reduction burning; in all likelihood we are going to need to increase it, but let's be scrupulously realistic about how much (or how little) we are able to reduce the fire's ferocity on bad days, given the climate has really changed as much as the climatologists tell us it has, and will.

If we treated the future threat of fire more like the threat of cyclones or tornados, we might prioritise our list of mitigation strategies to reduce the threat of fires differently. We might instead prioritise:

- a) Getting people out of harm's way before the cyclone/fire hits. This could involve strategies like:
  - Better early detection of ignitions and real time mapping of fire spread
  - Better communication infrastructure for remote communities (e.g. satellite phones), early warnings, clearer communications
  - Better evacuation planning (as we do for remote communities in the paths of cyclones) and better responsiveness (not have people waiting days on beaches)
  - Better construction of public fire shelters and safe places (as we do for cyclones)
- b) Enforcing building codes and requirements for construction of buildings and private fire bunkers in fire prone regions, as is done for cyclone, tornado or earthquake-rated buildings.
- c) Enforce zoning where buildings or assets can or cannot be located.

The folly of attempting to impose “national standards” in levels of hazard reduction burning:

1. **Broad hectare targets for hazard reduction burning were attempted (e.g. 380,000 ha/pa in Victoria) but were found to be ‘unachievable, affordable or sustainable’<sup>2</sup> and “ineffective in achieving the primary intent of the Bushfires Royal Commission recommendations to ensure the protection of human life and community safety”<sup>3</sup>.**

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<sup>2</sup> Review of performance targets for bushfire fuel management on public land April 2015- Inspector-General for Emergency Management, Victoria  
<sup>3</sup> Bushfire Royal Commission Independent Monitor, Annual Report 2013, p. 64



The 2009 Victorian Bushfire Royal Commissioners recognised that where you carried out hazard reduction was as, or more important, than just how much you burnt: *“The target must, however, take into consideration the fact that each hectare burnt is not of equal ‘value’ and the location of prescribed burns affects the effectiveness of risk reduction”* **VBRC 2010 Vol 2, p 294.**

Neil Comrie (2009 Bushfires Royal Commission Independent Monitor) concluded in his Annual Report in 2013 (p.64) that hectare targets for hazard reduction burning were *“ineffective in achieving the primary intent of the Bushfires Royal Commission recommendations to ensure the protection of human life and community safety.”*.

A review of performance targets for bushfire fuel management on public land April 2015- Inspector-General for Emergency Management, Victoria concluded that the broad hectare targets for hazard reduction burning were attempted (e.g. 385,000 ha/yr in Victoria) but were found to be *‘unachievable, affordable or sustainable’*.

## **2. The application of a state-wide hectare target created a perverse incentive for agencies to treat large areas of low risk, rather than smaller, more costly and difficult burns in places where they were really needed.**

Following the adoption in Victoria of the state-wide hectare-based target to burn a rolling average of 385,000 ha per annum there was a demonstrable mismatch between the location of the bulk of hazard reduction burning that took place and where properties were at greatest risk to fire. This left the government vulnerable to accusations that they had burnt where it was cheaper to conduct hazard reduction burning in order to meet the hectare target, rather than where it would achieve the most reduction in risk to life and property (which was the intent behind Recommendation 56 of the Bushfires Royal Commission).

A detailed analysis of the implementation of the hectare-based target by Handmer and Keating (2015) concluded the following:

*“On a per hectare basis, burning in the highest risk areas (for example the Dandenongs) is comparatively costly and more difficult than burning in low risk areas... A hectares treated objective creates a perverse incentive to treat large areas of low risk, rather than the smaller, more costly and difficult burns in high risk areas.”*

*“A hectares treated objective puts a significant constraint on the capacity for communities and stakeholders to have their views genuinely incorporated into decision-making because the directive to burn a certain number of hectares overrides all other considerations. Hence there is a disincentive {for DELWP} to genuinely engage communities and stakeholders.”*

*“A hectares treated objective places a non-negotiable fuel management responsibility in the hands of DELWP. This dis-incentivizes private action as stakeholders and communities perceive the problem to be outside their sphere of influence and responsibility.”*

*“Measuring and communicating compliance with the primary hectares burned objective is relatively easy. However, there is a lack of incentive to invest in measuring and communicating impact on risk to lives, assets, and ecosystems”* (Handmer and Keating 2015).

## **3. A primary cause of failure to achieve targets has been the brief (~10 days per year) and shrinking fire-weather window in which agencies can safely conduct hazard**

**reduction burning without causing collateral damage to the very assets they are attempting to protect.**

Several studies (e.g. Jolly et al. 2015; Quinn-Davidson and Varner 2012) have demonstrated, and senior fire managers from multiple states (<https://www.abc.net.au/news/2020-01-10/hazard-reduction-burns-bushfire-prevention-explainer/11853366>) have reiterated, that failure to achieve hazard reduction hectare targets is due to being constrained by ever decreasing windows of opportunity in which they can safely conduct prescribed burning.

Whether a fuel will burn, and how well it will burn, depends on its moisture content. In other words, on fuel dryness. *Live* plant material (green leaves etc) contains high moisture contents (e.g. 70% of dry weight). Mostly such fuels won't burn. They will burn if they are first dried out by heat from other fuels that are burning nearby or underneath. Long-term drought dramatically increases the flammability of fine and even heavy (> 6mm) fuels.

- a. At fuel moisture contents of 18% or higher, fires won't burn.
- b. At fuel moisture contents of 12%, planned burns behave in mild ways.
- c. As moisture content falls 5%, 4%, 3%, the effect on fire behaviour is exponential. Fires then become erratic and very difficult to control.

So, the range of moisture content in which fuels are safe to burn is very narrow: 5-17% and the number of days on which fuels fall within this range is small and getting smaller.

In addition, the public also often places very high expectations on agencies that our health (e.g. asthma sufferers), property (e.g. damage to Lancefield properties from escaped controlled burn in 2015) and businesses (e.g. smoke taint to grape crops) won't be impacted by prescribed burning in their vicinity. This can further constrain the number of days and locations in which burning can be conducted safely.

Given the diminishing window in which it will be safe to conduct hazard reduction burning, increased resourcing will be needed to ensure we capitalise on opportunities when they arise.

**4. It is a myth that 'environmentalists' have constrained government agencies from achieving the hazard reduction targets on public land.**

NSW RFS Commissioner, Shane Fitzsimmons has categorically rejected assertions that the capacity of the RFS to achieve their hazard reduction targets has been constrained by 'environmentalists or greenies' (<https://www.abc.net.au/news/2020-01-10/hazard-reduction-burns-bushfire-prevention-explainer/11853366>). Furthermore, no environmental-based political party holds the balance of power in any State or federal jurisdiction. Consequently, 'environmentalists' have no legislative power to impose constraints on hazard reduction targets by government agencies.

**5. The move in Victoria from a crude hectare-based target to a more strategic risk-reduction based target is supported by both policy science and ecological science undertaken since Black Saturday.**

The analysis by Handmer and Keating (2015) highlighted the fundamental flaws in a hectare-based target from a policy science perspective. Our own work has highlighted the perverse and detrimental ecological outcomes likely to result from the application of a hectare-based

based target in vegetation types that suffer from too frequent fire (e.g. tree mallee, Connell et al. 2019 and Box-Ironbark Woodlands, Flanagan-Moodie et al. 2018). It was these kinds of evidence that led the 2009 Bushfires Royal Commission Independent Monitor (Mr Neil Comrie), the Victorian Commissioner for the Environment (Prof Kate Auty), and the Inspector-General for Emergency Management to recommend that the state move from a hectare-based target to a risk reduction based target for hazard reduction burning (which they did in 2015/16).

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