THEME 4- HOW WILL THE 2019-20 NSW BUSHFIRES INFLUENCE NEAR-FUTURE RISK?

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Subproject: Future risk analysis

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1. Theme

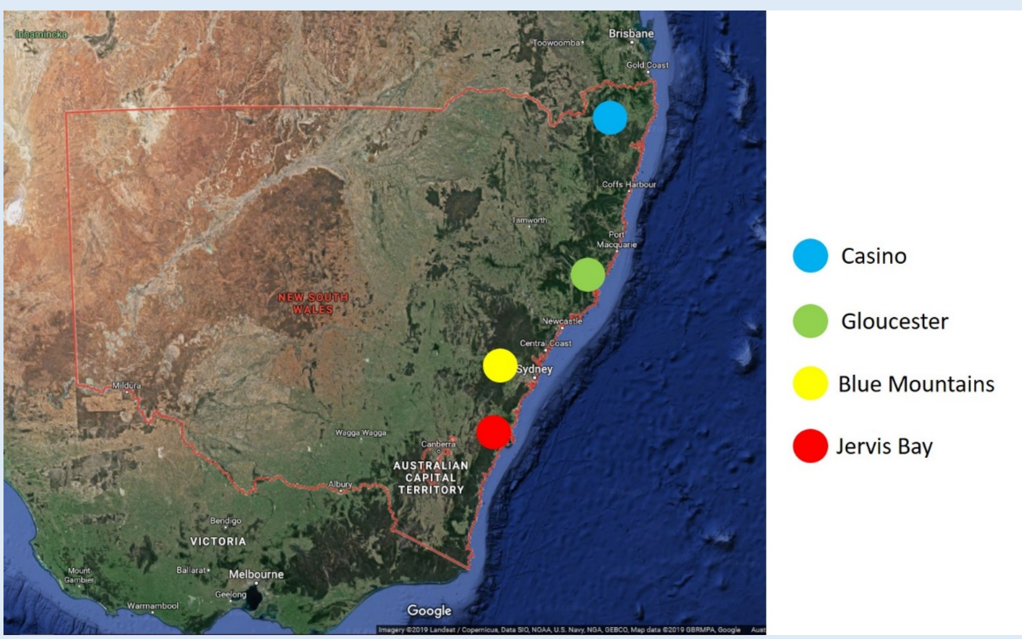
Options for bushfire risk management in the future up to 2025

2. Project question or problem statement

How will the implied reduction in fuel loads due to the 2019-20 NSW bushfires influence the future trajectory of risk to life, property and environmental values?

3. Geographic extent

Figure 1. Location of case study landscapes.



4. Key findings

- The estimated reductions in fuel load due to the 2019-20 fire season are predicted to lead to widespread short-term reductions in the potential area burnt by wildfire and associated risks: i.e. loss of life, houses and infrastructure damage.
- Reductions are also predicted in the risk of vegetation being burnt more frequently than its tolerable ecological threshold. (For information on the direct influence of the 2019-20 fire season on vegetation condition, see separate Project Report).
- The reductions in future wildfire risk as a result of the 2019-20 fire season are partial and temporary. Even with reduced fuel loads some residual risk remains, often quite considerable, and over the next six years the risk is predicted to increase, in some cases returning to or even exceeding pre-2019-20 levels. In four case study landscapes the potential area burnt by wildfire in 2021 is predicted to range from 30-80% of pre-2019-20 levels. By 2025, potential area burnt by wildfire is predicted to rise to 50-90% of pre-2019-20 levels.
- The estimated risk mitigation resulting from fuel reduction from the 2019-20 fires is predicted to be greatest in the Jervis Bay case study landscape, followed by the Blue Mountains, Gloucester and Casino. This appears to be due partly to the proportion of each case study landscape burnt by the 2019-20 fires, with Jervis Bay having the greatest area burnt (72%) followed by Blue Mountains (49%), Gloucester (29%) and Casino (25%). Further differences may relate to variation in case study landscape climate, vegetation types, land use and arrangement of assets.
- Prescribed burning has the potential to mitigate some, but not all of the risk associated with the accumulation of fuel after the 2019-20 fire season, depending on case study landscape and management value.
- Until at least 2025, no more than 5% of the case study landscapes in Casino, Gloucester or the Blue Mountains can be treated if vegetation is to be maintained within its tolerable ecological threshold. In Jervis Bay this figure is 2%.

5. Significance of findings in context of previous studies

These findings are consistent with previous studies which have found that

- prescribed burning may offer partial risk mitigation, not risk elimination (e.g. Price et al. 2015)
- the risk mitigation potentially resulting from prescribed burning varies considerably between regions and management values (e.g. Cirulis et al. 2019). That is, there is not a ‘one size fits all’ solution to prescribed burning treatment.

6. Limitations and remaining knowledge gaps

This analysis was based on large scale fire behaviour simulations under a range of fire weather conditions, ignition locations and prescribed burning treatment rates and locations, conducted with and without the area burned in the 2019-20 fire season.

This approach assumes that fire spread is a function of fire weather, fuel load and factors such as topography. An evaluation of fire behaviour simulators was recently conducted (Faggian et al. 2017). The approach also assumes that planned and unplanned fires consume most fuel and that fuel begins to accumulate after fire as a function of time since fire, eventually stabilising at an equilibrium amount. In reality fuel consumption rates vary considerably within any given fire and are typically lower in prescribed fires than wildfires (see Project Report on fire severity).

These results represent simulated properties of a wildfire originating from a single ignition. Simulations include relatively short histories of prescribed burning (two years for the 2021 case, 6 years for the 2025 case). Some of the effects of different prescribed burning treatment strategies may take longer than this to become apparent. This may explain why 2025 risk exceeds pre-2019-20 levels in some cases, along with the fact that the 2019-20 control does not include any treatment. These simulations do not take into account any future changes in climate or fuel moisture.

Further information about methods can be found in the Appendix, including details of how house loss, life loss, road and powerline damage and area burnt below minimum tolerable fire interval were estimated.

7. Implications for fire management

- Wildfire risk in the aftermath of the 2019-20 fire season is likely to be reduced, although residual risk may be substantial in some areas.
- Prescribed burning can contribute towards further risk mitigation, although overall risk is likely to rise steadily in the coming years.
- In some areas wildfire risk may not return to pre-2019-20 levels until 2025 or later.
- There is a limit to the amount of prescribed burning that can be undertaken if vegetation is to remain within its tolerable ecological threshold after the 2019-20 fire season.

8. Figures

Figure 2. Potential future risk trajectory for area burnt. Risk is relative to control scenario (with pre-2019/20 fuel load and no prescribed burning). Individual markers represent risk under different rates (0-5%) and locations (edge = size, landscape = colour) of prescribed burning.

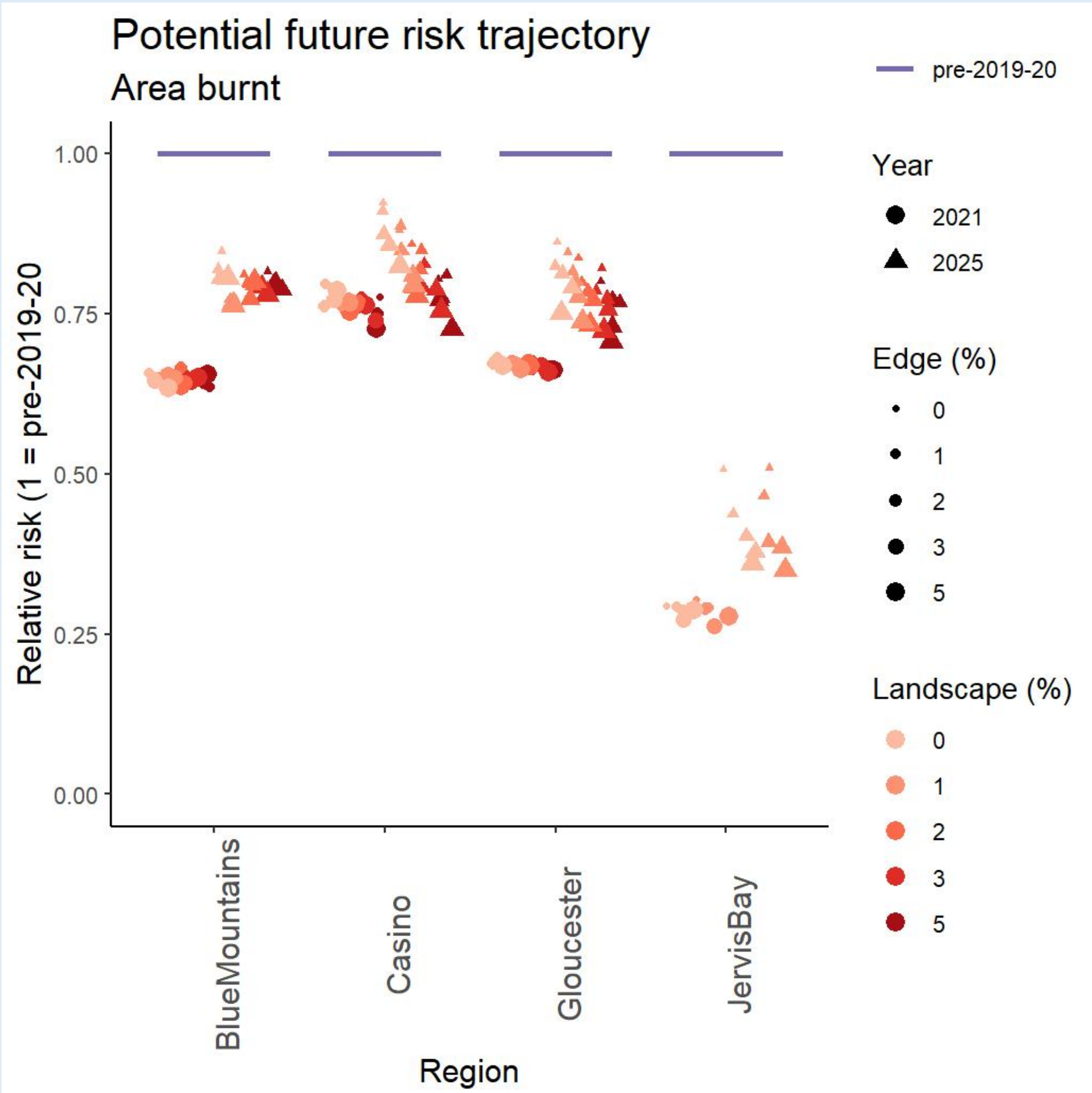


Figure 3. Potential future risk trajectory for life loss. Risk is relative to control scenario (with pre-2019/20 fuel load and no prescribed burning). Individual markers represent risk under different rates (0-5%) and locations (edge = size, landscape = colour) of prescribed burning.

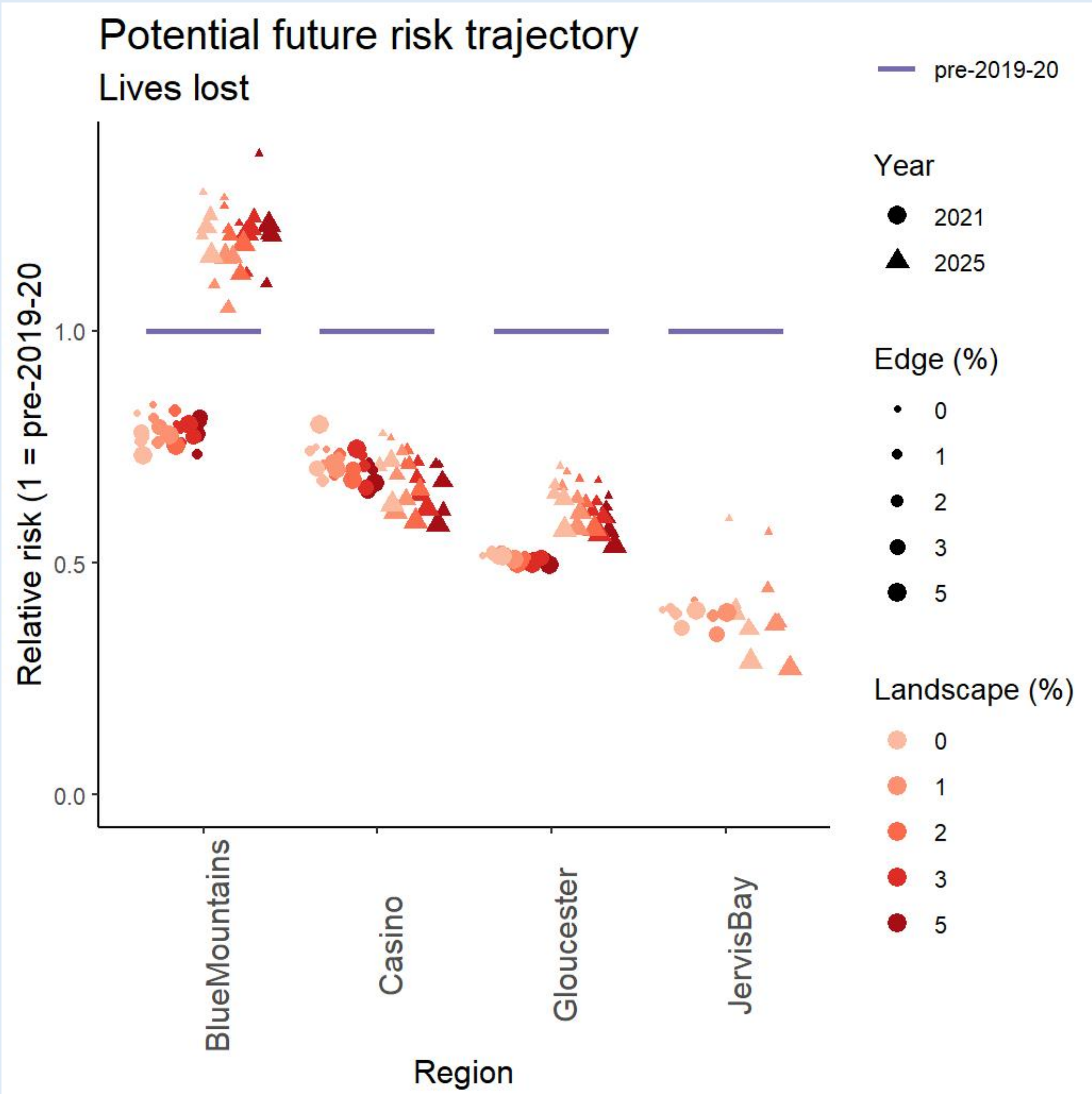


Figure 4. Potential future risk trajectory for house loss. Risk is relative to control scenario (with pre-2019/20 fuel load and no prescribed burning). Individual markers represent risk under different rates (0-5%) and locations (edge = size, landscape = colour) of prescribed burning.

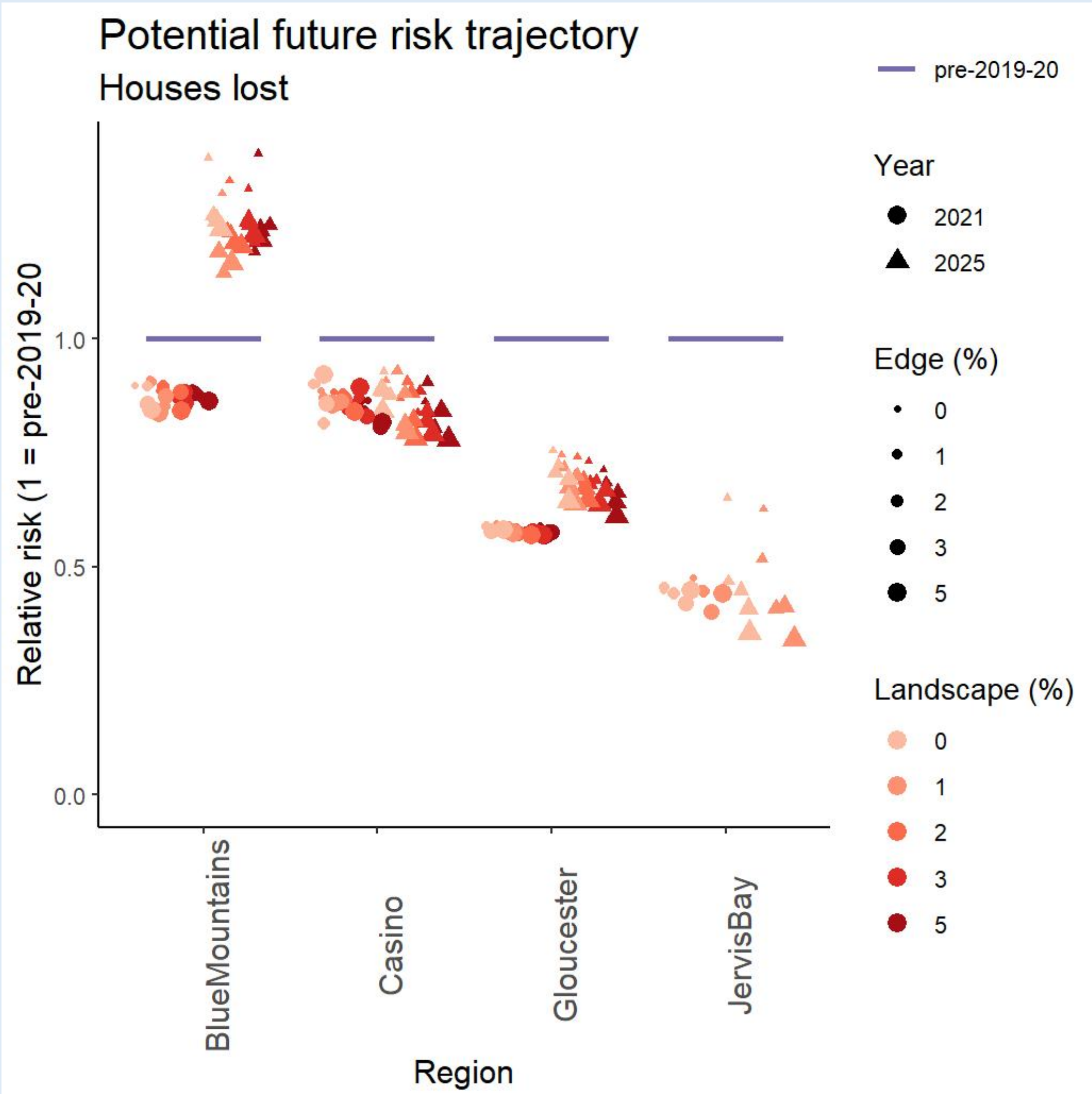


Figure 5. Potential future risk trajectory for length of road damaged. Risk is relative to control scenario (with pre-2019/20 fuel load and no prescribed burning). Individual markers represent risk under different rates (0-5%) and locations (edge = size, landscape = colour) of prescribed burning.

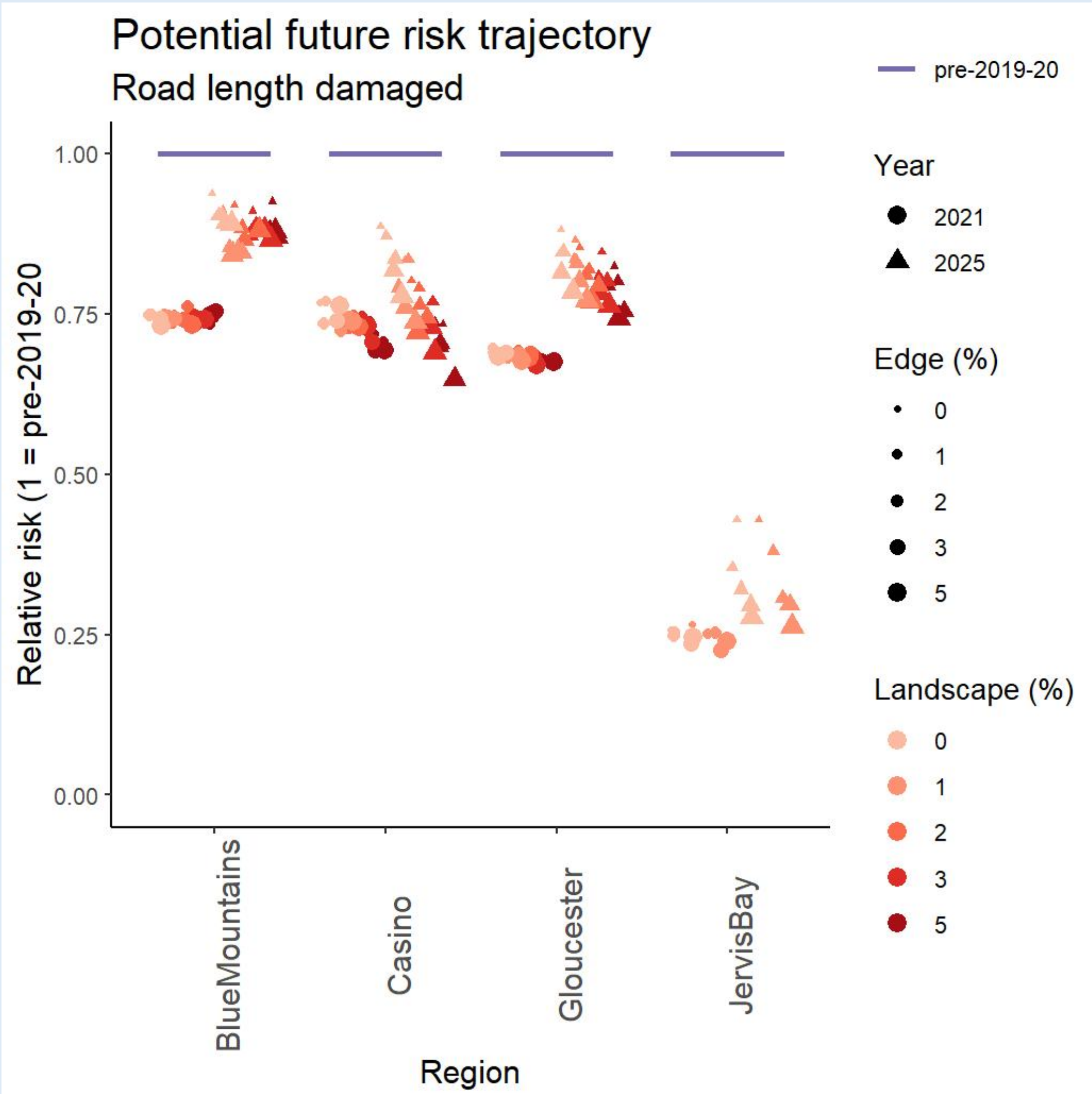


Figure 6. Potential future risk trajectory for length of powerline damaged. Risk is relative to control scenario (with pre-2019/20 fuel load and no prescribed burning). Individual markers represent risk under different rates (0-5%) and locations (edge = size, landscape = colour) of prescribed burning.

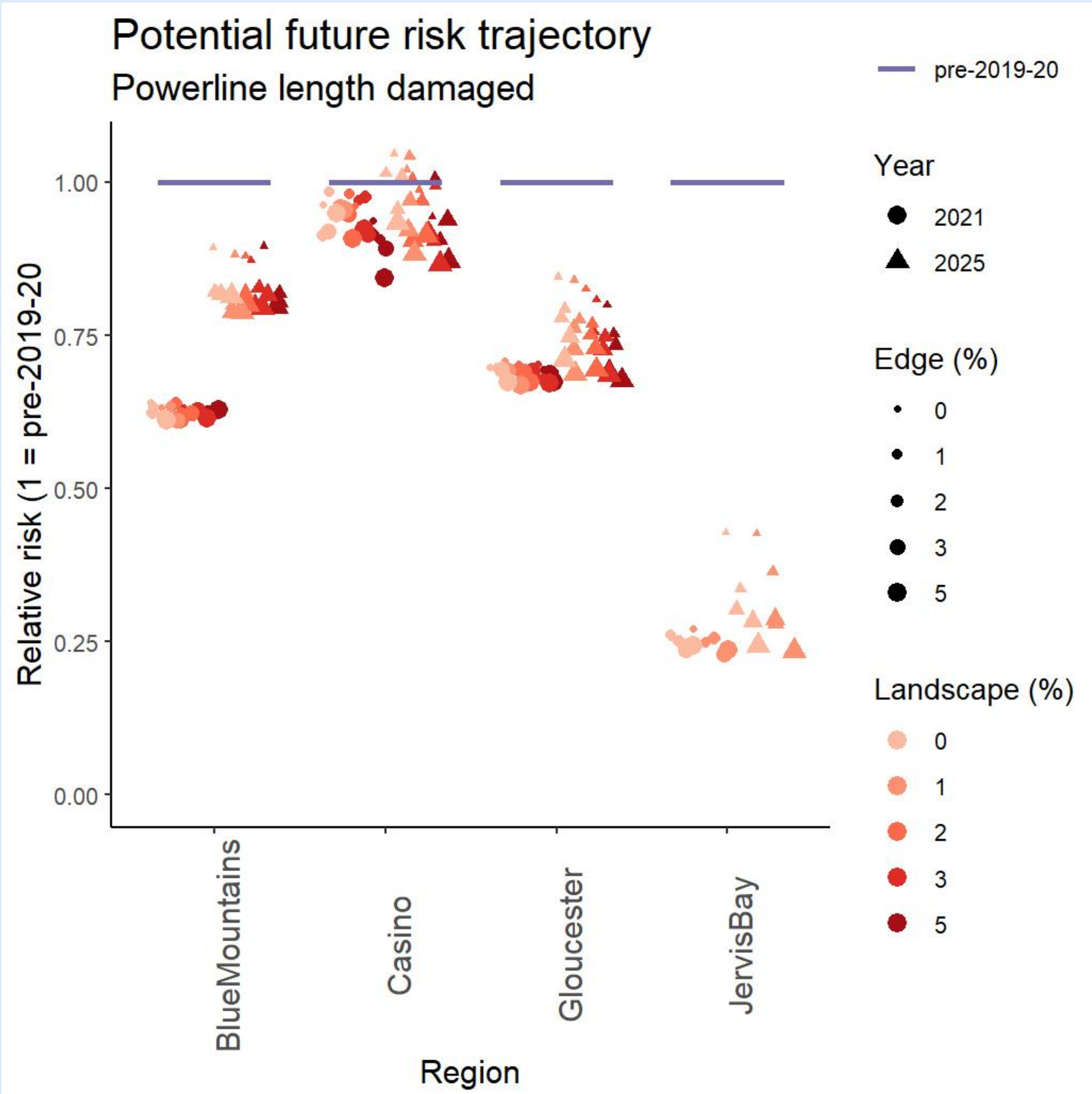


Figure 7. Potential future risk trajectory for area burnt below minimum tolerable fire interval (TFI). Risk is relative to control scenario (with pre-2019/20 fuel load and no prescribed burning). Individual markers represent risk under different rates (0-5%) and locations (edge = size, landscape = colour) of prescribed burning.

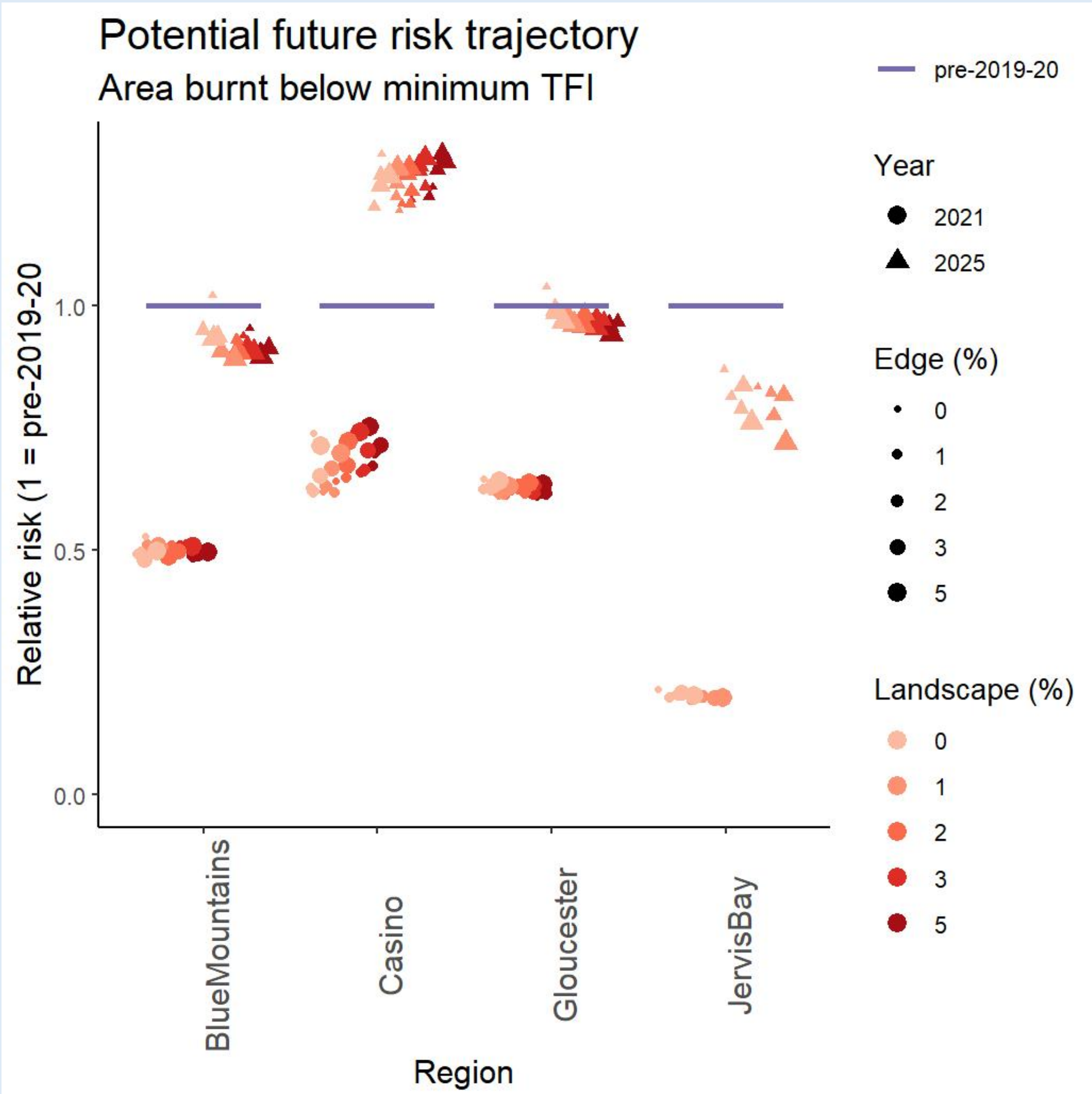


Figure 8. Location of Casino case study landscape

Figure 9. Location of Gloucester case study landscape

Figure 10. Location of Blue Mountains case study landscape

Figure 11. Location of Jervis Bay case study landscape

9. Key reference list

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10. Appendix

Summary of methods

Fires were simulated at 1,000 different ignition locations in each case study landscape. This was repeated for up to 25 permutations of edge and landscape treatment (0, 1, 2, 3 and 5% for both locations). This was also repeated for each FFDI category that had been observed at the nearest Bureau of Meteorology automatic weather station to each landscape. The pooled results from the resultant fires were measured to estimate the impact on five management values. Further details can be found in Cirulis et al. (2019). The key difference is that three sets of simulations were run: 1) with a fire history not including the 2019-20 fire season or any prescribed burning (the control scenario), 2) with a fire history including the 2019-20 fire season as well as various rates and locations of prescribed burning through to 2021 (i.e. 2 years after the 2019-20 season) and 3) the same as (2) except through to 2025 (i.e. 6 years after the 2019-20 season). Key features are paraphrased below.

Fire behaviour simulations

We used PHOENIX RapidFire v4.0.0.7 (Tolhurst et al. 2008), applied operationally in NSW and other south-eastern Australian states. Fire growth and rate of spread follow Huygens' propagation principle of fire edge (Knight and Coleman 1993), a modified McArthur Mk5 forest fire behaviour model (McArthur 1967; Noble et al. 1980) and a generalisation of the CSIRO southern grassland fire spread model (Cheney et al. 1998). A 30-m resolution digital elevation model was included to allow PHOENIX to account for the influence of topography on fire behaviour. Fuel accumulation models for major vegetation types of the case study landscape were provided by the NSW Rural Fire Service. Output included ember density, convection, intensity and flame length.

Model input data

Weather was supplied from the nearest Bureau of Meteorology automatic weather station for each case study landscape. Weather streams were grouped by the five fire danger categories that have been recorded in each case study landscape (Low–moderate, High, Very high, Severe, Extreme). Road and powerline location data was supplied by the NSW Department of Planning, Industry and Environment. PHOENIX estimates fuel loads using separate fuel accumulation curves for combined surface and/near-surface, elevated and bark fuels (Hines et al. 2010). These curves use a negative exponential growth function and vary between vegetation types (Watson 2011). The treatable portion of each case study landscape was separated into management-sized 'burn blocks'. Where available data were provided by the NSW Department of Planning, Industry and Environment. For burn blocks classified as edge, a minimum burn interval of 5 years was used as it reflects what is feasible to achieve by the agencies while still allowing fuels to recover sufficiently. For landscape blocks, the minimum burn interval is the minimum tolerable fire interval for the majority of the vegetation type within each block. Ignition locations were selected based on an empirical model developed for similar forest types (Clarke et al. 2019). Individual fires were ignited at 1100 hours and propagated for 12 h, unless self-extinguished within this period.

Impact estimation

Area burnt was a direct output from the fire behaviour simulations. Effectiveness of prescribed burning at mitigating wildfire impacts was assessed on five values: house loss, loss of human life, length of powerline damaged, length of road damaged and area burnt below minimum tolerable fire interval (TFI). Area burnt below TFI was calculated from area burnt and existing TFI mapping supplied by management agencies. The probability of house loss was calculated as a function of ember density, flame length and convection as presented in Tolhurst and Chong (2011). House loss was calculated per 180-m cell and then multiplied by the number of houses in that cell to estimate the number of houses lost per fire. Statistical loss of human life was based on house loss (using the house loss function), the number of houses exposed (using simulation output) and the number of people exposed to fire (Harris et al. 2012). We used a simple threshold of 10 000 kW/m to determine if roads or powerlines within each 180-m cell were considered damaged by fire.

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