THEME 2- FIRE SEVERITY AND IMPACT

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Subproject: Logging and fire severity

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OVERVIEW

1. Theme

Fire severity and past fire impact

2. Project question or problem statement

Does recent logging impact fire severity?

3. Key findings

- Statistical modelling was performed using point samples of fire severity over the Bees Nest (Figure 1) and South Coast (Figure 2) fires, across the Mixed Use Forest (MUF) land tenure, with a range of controlling meteorological and topographic covariates (Hammill & Bradstock, 2006). Points were limited to Wet Sclerophyll and Dry Sclerophyll vegetation formations, with vegetation type included as a factor in the model. ID of the 2019/20 fire ground was included as a random effect.
- The model testing the effect of harvested versus unharvested status on severity showed no significant difference between these two classes in the probability of elevated fire severity (Figure 3).
- A model testing the time since harvest on probability of elevated fire severity within harvested areas showed a slight effect (Figure 4), with slightly higher probability of high severity in the 20-30 year age class.
- Results are limited by the relatively small harvested areas within these fires; further analysis on a state-wide basis may improve ability to

detect a severity effect associated with harvesting and time since harvest.

4. Significance of findings in context of previous studies

- There has been debate in the scientific literature about the impacts of logging in native forests on fire severity, with researchers proposing that harvesting alters the forest microclimate and stand structure such that fire ignition and spread is encouraged and higher severity fire is likely (Lindenmayer *et al.* 2009, Lindenmayer *et al.* 2011), including claims that logging exacerbated fire at the landscape scale in the 2019/20 fire season (Lindennmayer *et al* 2020). Previous research has found evidence that recent logging does promote higher severity fire, and that logging does not act to mitigate fire (Price and Bradstock 2012), while other work has found the effect of stand age on fire severity is of minor importance compared to weather (Bowman *et al.* 2016). In our comparison of harvested and unharvested forests within the Bees Nest and South Coast fires, we study found no evidence for a change in probability of high severity in harvested forests as a whole, and inconsistent and minor effects with time since harvest.

5. Limitations and remaining knowledge gaps

- The satellite-based severity classification has an inherent limitation in detecting fire effects through dense canopies. There is also a lower limit to the sensitivity and resolution of satellite-based estimation in mapping patchy low severity ground fires, which may appear as unburnt. The FESM algorithm does not currently include any training data from the 2019/2020 fire season, but there are plans to revise and improve the severity classification using additional training data derived from interpretation of high-resolution post-fire aerial photography of this season's fires.

- Previous studies have highlighted the importance of weather as a driver of fire severity under extreme weather conditions; additional fine-scale fire progression and downscaled meteorological modelling may improve our ability to separate weather from stand age effects on fire severity.

- This study was limited to the relatively small harvested areas within two fire grounds; additional analysis over additional fires, including firegrounds in Victoria, may improve our detection of harvesting effect.

6. Implications for fire management

Calls to expand native timber harvesting within MUF forests, and indeed in conservation reserves, have been made, with the intent of reducing fire spread and severity. Our study found no strong effect of harvesting on fire severity, either positive or negative. In understanding the effects of native timber harvesting on fire severity, it is necessary to disentangle local-scale from landscape-scale effects, and acknowledge the importance of extrinsic factors, such as weather, on driving fire severity during extreme fire events.

7. Figures

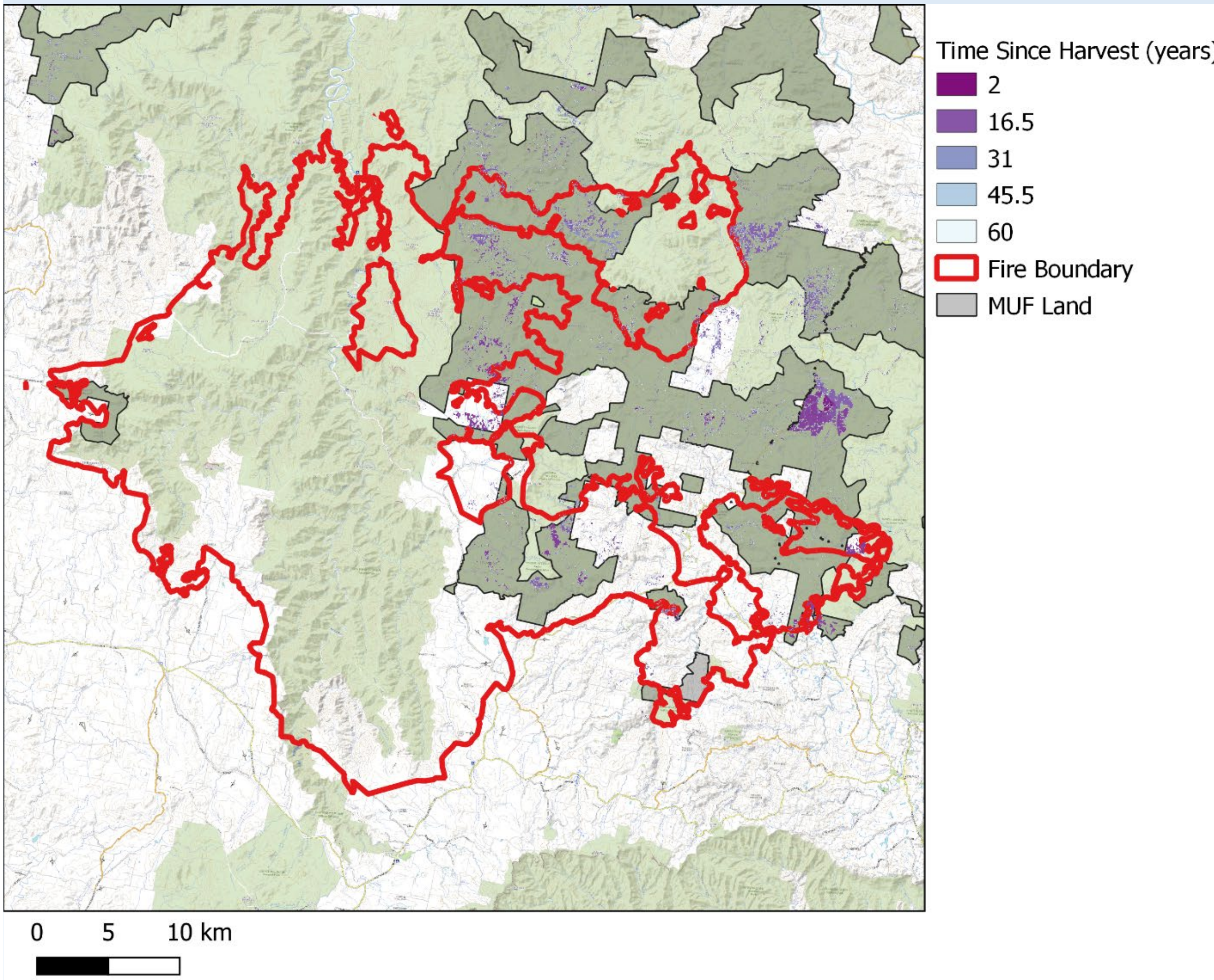

Figure 1. Bees Nest fire boundary, showing MUF tenure and harvested areas.

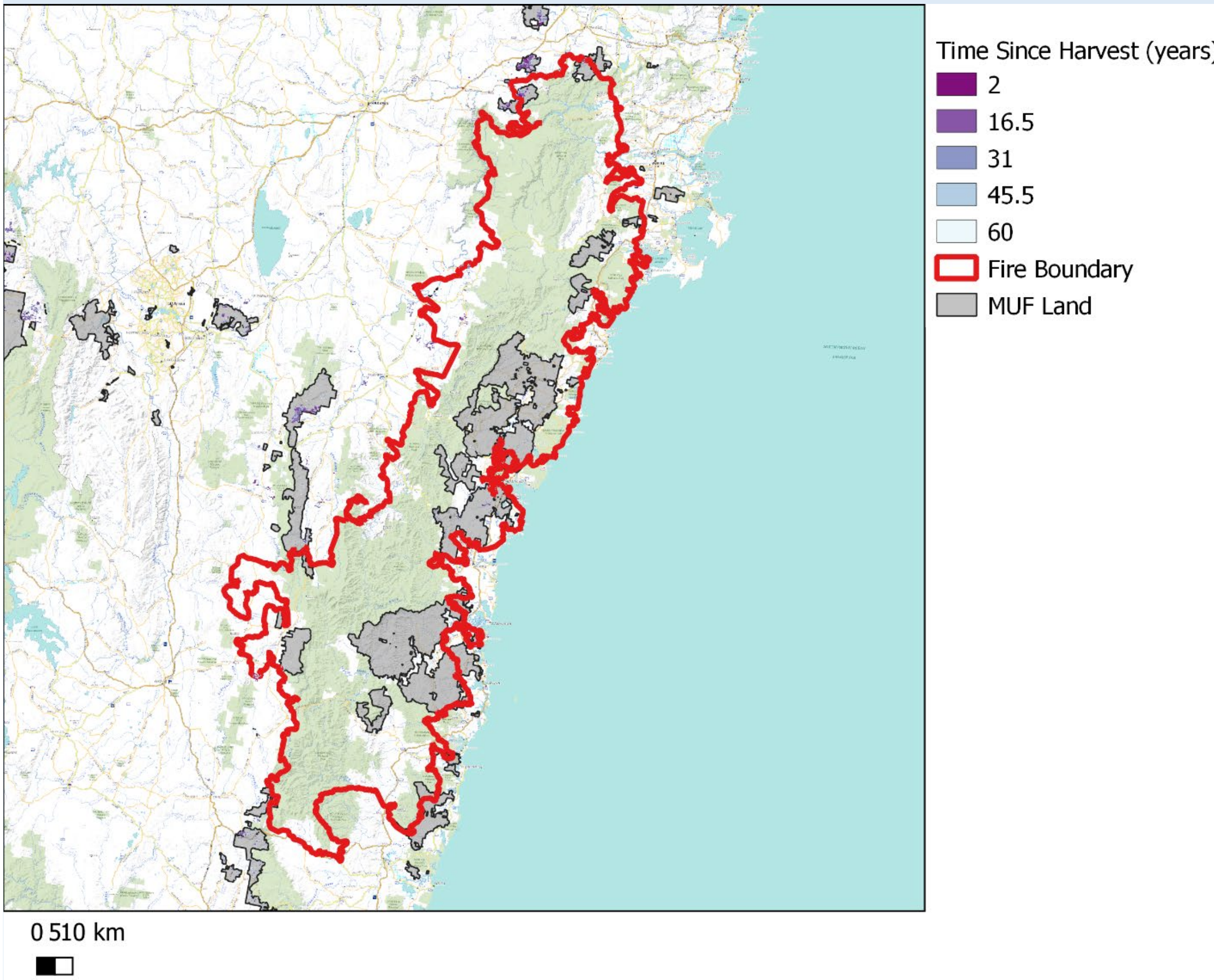

Figure 2. South Coast fire complex, showing MUF tenure and harvested areas.

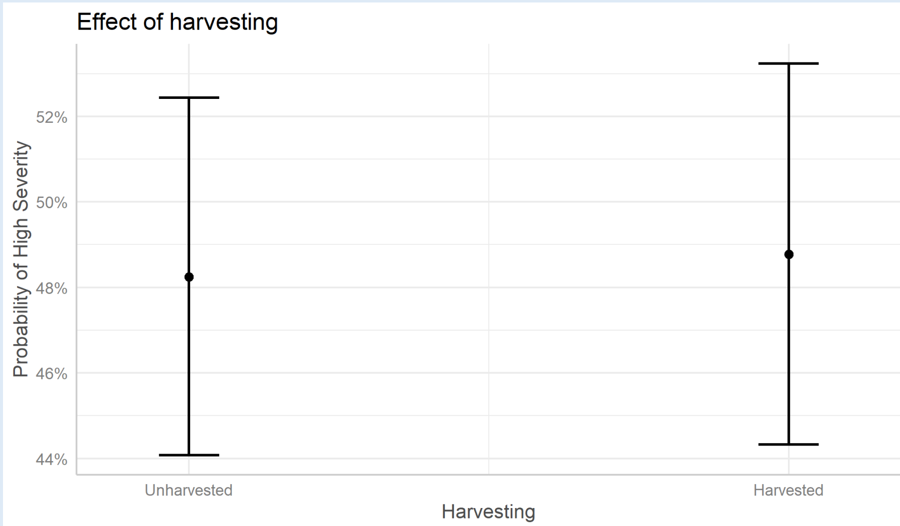

Figure 3. Effect of harvest status on the probability of high-severe fire severity category in 2019/20.

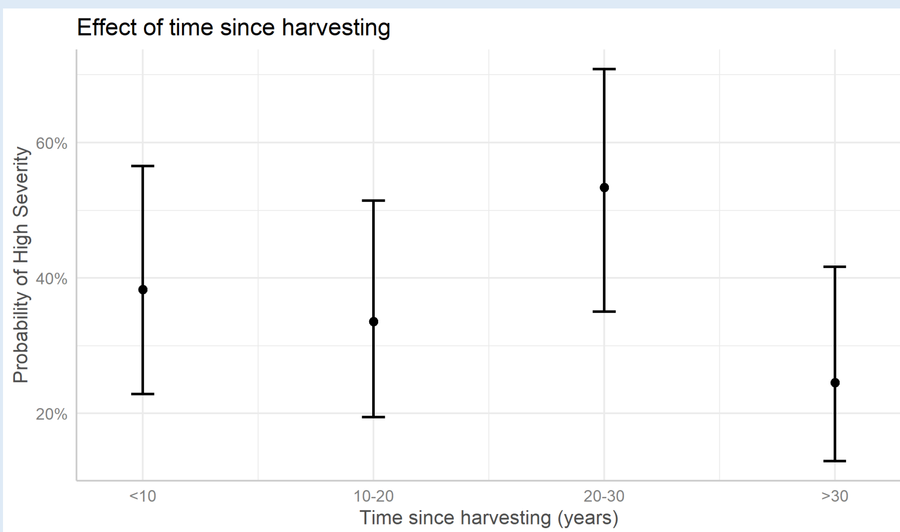

Figure 4. Effect of time since harvest on the probability of high-severe fire severity category in 2019/20.

8. Key reference list

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9. Appendix

Methods

- Past fire boundaries for New South Wales were obtained from the NSW RFS, for determining the location and time of previous prescribed and unplanned fires.

- The FESM fire severity mapping algorithm (Gibson *et al. 2020)* was applied across all fire grounds in New South Wales. In addition, the algorithm was applied within past prescribed burn and unplanned fire boundaries for previous years going back to 2017, the year in which the Sentinel-2 satellite imagery required for the algorithm became available. The highest FESM category, representing canopy consumption, is referred to as “Severe” in this report; it may be referred to as “Extreme” elsewhere.

- Vegetation formation mapping was obtained from the NSW State Vegetation Type Map, current to January 2019, for intersection and summarizing severity classes.
- Time since harvest data was obtained from a satellite SLATS (Statewide Landcover And Trees Study) analysis of NSW provided by the NSW Department of Planning, Industry and Environment.
- Fire progression polygons were obtained from the NSW RFS and were assigned distance-weighted mean FFDI values derived from Bureau of Meteorology weather stations within 100km for each timestep. FESM severity for each cell was attributed with the FFDI of the isochron it fell within, in order to summarize severity category by FFDI.
- Sample points were randomly generated at a density of two points per hectare across Mixed Use Forest in the Bees Nest and South Coast fire areas. The suitability of this sampling density was determined by inspection of the semivariogram of 2019/20 season severity across sample points. Sample points were attributed with 2019/2020 fire severity, past fire severity, past fire type, topographic position, roughness, slope, and northerly aspect index calculated from a 30m digital elevation model, vegetation formation, dead fuel moisture content (Nolan *et al.* 2016), harvest status, and time since harvest in years.
- Generalized linear mixed-effect binomial models with 2019/20 fire ground ID included as a random effect, were used to test two hypotheses;
  1 – Fire severity was higher inside harvested forests compared to unharvested forests.
  2 – Within harvested forests, fire severity was higher in recently harvested forests.
- Models 1 used 40,612 sample points, while models 2, limited to harvested areas, used 5,327 sample points.
- AIC-based model selection was used to identify the most parsimonious variable suite for each hypothesis. The severity contrast in the binomial models was between the low severity category, and the combined high and severe categories. Unburnt and moderate severity points were excluded. All statistical modelling was carried out in R version 4.0.0 using the lme4 package