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Using silvicultural management to reduce the impact of wildfire in pine plantations

Large plantations of radiata pine (*Pinus radiata* D. Don) are susceptible to wildfires that compromise the sustainability of forest production and downstream industries. We evaluated the effectiveness of fuel management zones characterised by an intensive silvicultural prescription. The silvicultural prescription resulted in significantly lower predicted fireline intensity and likelihood of crowning under a broad range of burning conditions.

Managing fires in pine plantations

Wildfires are a frequent threat to the sustainability of industrial pine plantations in Australia with losses of large areas of plantation estates occurring sporadically across southern parts of the continent.

The growth characteristics and silvicultural systems that characterize these plantations can result in fuel complexes that are exceptionally flammable, particularly in younger ages. A mitigation strategy in large plantation estates is to implement a landscape scale network of fuel management zones (FMZ). FMZs comprise 50 to 200 m wide stands strategically located along roads where the silvicultural prescription (e.g. high pruning followed by a thinning) and other fuel treatments (e.g. prescribed fire or slashing) create a stand where fireline intensity and rate of spread are reduced, thereby allowing for: (i) safer and more effective fire suppression; and (ii) compartmentalization of the larger plantation estate to limit the spread of large wildfires. Despite considerable recurring investments in maintaining these FMZs, their effectiveness in reducing fire potential over a range of fire danger conditions had not been formally quantified.

Assessment of fuel management options

The study focused on the FMZ prescription used in large plantation blocks of radiata pine within the "Green Triangle" region of South Australia/Victoria. The prescription is defined by an initial low prune (P1) up to no less of 2.5 m when the stand has reached a mean tree height of 7.5 m and an age of 4 to 6 years. A second higher pruning (P2) to 6 m is conducted around the age of 7 to 9 years in high site quality stands. This pruning is followed by an early first thinning (T1; Fig. 1) that removes approximately 50% of the stock. After this first thinning, other silvicultural operations (e.g., a second (T2) or third thinning (T3)) coincide with operations in the rest of the compartment.

Figure 1. Understorey fuels in FMZ stand two years after T1 treatment (left) and a comparable untreated stand (right).

After characterisation of the fuel complex we calculated the potential rate of spread and incidence of crowning activity associated with each fuel

condition inventoried (P1, P2, T1, T2 in FMZ and contiguous control stands) using the Pine Plantation Pyrometrics (PPPY, Cruz et al. 2008) model system with local climatology data. This fire behaviour model is designed to predict fire behaviour in pine plantations and is implemented for two pine species in the Amicus software tool (Plucinski et al. 2017).

Fuel management reduces fire behaviour

The pruning and thinning treatments characteristic of FMZ areas in radiata pine plantations were found to have a significant effect on the fuel complex structure and associated fire behaviour. The pruning treatments removed the ladder or bridge fuels and increased the effective distance between the surface and aerial fuels. In the absence of pruning, the dead twigs and needle drape within the sub-canopy space can be an effective ladder fuel in stands up to 20- to 30-years old.

The relationships and interactions between stand structure, fuel characteristics, within-stand micro-meteorology and fire behaviour, make the determination of the effect of a silvicultural treatment on fire behaviour potential complicated. Some stand and fuel changes might increase the flammability in certain conditions, and decrease them in others. Simulations indicate a reduction in fireline intensity and incidence of crown fire activity in a FMZ after P2 under heightened fire danger conditions. After P2 and T1, the reduction of crown fire activity and fireline intensity in the FMZ stand would allow effective direct suppression action by ground resources that would not be feasible in an untreated stand (Fig 2).

The positive effect of the FMZ structure is extended to initial attack under more severe fire weather conditions, where the open nature of the stand enables effective fire-fighting in the build-up stage of a fire. The effect of the silvicultural operations conducted in the FMZs should not be viewed in isolation, but as a process that transforms a highly "flammable" fuel type into a low flammability state early in the stand's rotation, with this effect being maintained for the remainder of the rotation.

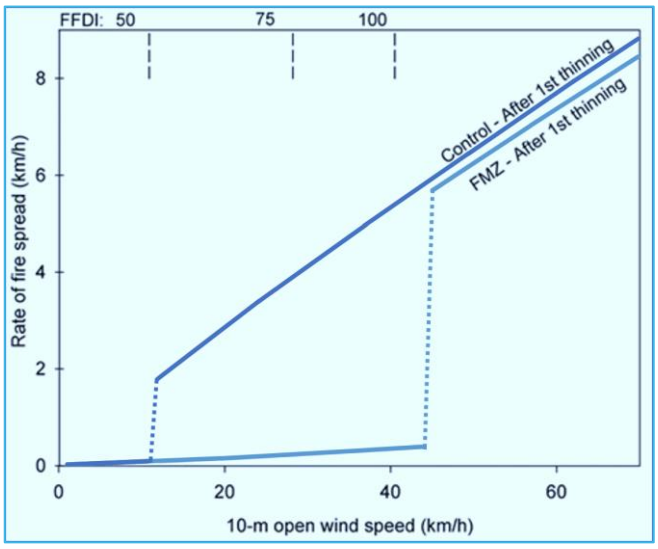

Figure 2. Simulated headfire rate of spread as a function of wind for FMZ and control stands. Forest Fire Danger Index (FFDI) calculation assuming an air temperature of 40°C, relative humidity of 10% and Drought Factor of 10.

The concept of the FMZ is not to create a stand that will stop a fire but to produce a low flammability fuel structure where fire suppression can be safely and effectively conducted. To be effective as a fire management proposition, the FMZ concept relies on the establishment of a network of FMZ stands strategically located across the landscape and a suppression force trained in their utilisation.

Further reading

Cruz MG, Alexander ME, Plucinski MP (2017) The effect of silvicultural treatments on fire behaviour potential in radiata pine plantations of South Australia. *Forest Ecology and Management* 397, 27-38.

References

Cruz MG, Alexander ME, Fernandes PAM (2008) Development of a model system to predict wildfire behaviour in pine plantations. *Australian Forestry* 71, 113-121.

Plucinski MP, Sullivan AL, Rucinski CJ, Prakash M (2017) Improving the reliability and utility of operational bushfire behaviour predictions in Australian vegetation. *Environmental Modelling & Software* 91, 1–12.

CONTACT US

t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

FOR FURTHER INFORMATION

Land and Water
Dr Andrew Sullivan
t +61 2 6246 4051
e Andrew.Sullivan@csiro.au
w www.csiro.au/en/Research/LWF

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