PROGRAM B

FLAME PROPAGATION IN SHRUBS AND TREES FROM THE AUSTRALIAN ALPS

Philip Zylstra

National Parks and Wildlife Service, NSW

Snowy Mountains Region Fire Management Unit

INTRODUCTION

Sturtevant *et al* (2004) found in studies across the United States that growing density of understorey vegetation due to management practices increased the incidence of crown fire in some forest types, whereas it decreased crown fire incidence in others. In the first case, the understorey was dominated by fir species, whereas in the second case it was dominated by less flammable deciduous species. The flammability of plants varies with both leaf flammability and plant architecture, but the relationship needs to be better understood to avoid land management practices that could increase bushfire threat.

Figure 1. Changes in elevated fuels due to management practice

METHODS

Sclerophyllous leaves from 10 species of shrubs and trees common to the Australian Alps were burnt to measure flame length and duration from single burning leaves with moisture levels ranging from green and artificially drought-stressed green to oven dry. Flame length and duration were used as indicators of combustibility and sustainability (Gill & Zylstra 2005), and correlated with leaf dimensions, moisture content, an index of aromatic oil content and the ambient wet/dry bulb temperatures / relative humidity. Predictive equations were produced and re-worked to define the period of time for which a point would be exposed to flame from the burning leaf, using the structure:

$$\Delta = l.\frac{-S}{\lambda} + S \qquad [1]$$

where Δ is the period of exposure to flame in seconds, *l* is the distance of the exposed leaf from the burning leaf (cm), *S* is the flame residence time in the leaf (seconds), and λ is the maximum flame length (cm) from the burning leaf.

RESULTS

The equation for combustibility and sustainability of green sclerophyllous leaves had a correlation with measured values of 0.84, with the main predictors being leaf geometry. This equation was developed into a physical model of flame propagation through a plant, that uses as predictors leaf ignitability, combustibility and sustainability of flame together with the spacing of leaves within the plant.

If we consider equation 1, as *l* decreases, Δ increases (figure 2). At the same time, the ignition delay time Ψ or time to ignition of the leaf decreases with the increase in temperature according to:

$$\Psi = \frac{r}{T-P} + m \qquad [2]$$

where *P* is the piloted ignition temperature of the leaf, *T* is the temperature of the plume, *r* is a constant affecting the rate of decrease in Ψ, and *m* is a constant defining a minimum possible value of Ψ. At or below the value of *l* where $\Delta = \Psi$ (shown in figure 2 at x, flame propagation of the plant will occur.

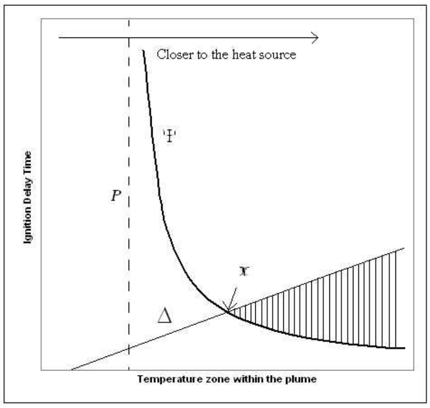

Figure 2. The interaction of ignition delay time (hyperbola) with period of exposure (solid straight line). The hatched area to the right of *x* represents the area where ignition of the adjacent leaf will occur.

DISCUSSION

An operational model will be complete when some further work has been done to model changes in Ψ with temperature, combine a model of plume temperatures and a model of flame merging in 3 dimensions. The complete model will be used to find the moisture content of a species below which it will catch fire. This is invaluable knowledge for planning better prescriptions and identifying thresholds for fire growth, such as the onset of crown fire behaviour. For the complete paper of this work, refer to the proceedings of the V International Conference on Forest Fire Research to be held November 2006.

REFERENCES

Gill, A. M. and Zylstra, P., 2005. Flammability of Australian forests. Australian forestry 68(2). 87-93

Sturtevant, B. R., Zollner, P. A., Gustafson, E. J., Cleland, D. T., 2004. Human influence on the abundance and connectivity of high-risk fuels in mixed forests of northern Wisconsin, USA. Landscape Ecology 19, 235 - 253