CSIRO PyroPage
Putting science into practice

www.csiro.au

Number 4 | **October 2015**

The Dry Eucalypt Forest Fire Model

The Dry Eucalypt Forest Fire Model (DEFFM), developed from Project Vesta, predicts the rate of spread of wildfires based on estimates of wind speed, fine dead fuel moisture content and a visual assessment of surface and near-surface fuel characteristics. Fuel characteristics are described using a numeric fuel hazard score (from 0 to 4) or fuel hazard rating (Low to Extreme) and the height of the near-surface fuel layer. Example default fuel values for a modest productivity eucalypt forest with a shrubby understorey are given for when site-specific data are not available.

Why a new fire spread model?

Fire behaviour guides for dry eucalypt forest were first developed in the early 1960s by Alan McArthur of the Commonwealth Forestry and Timber Bureau and George Peet of the Western Australian Forests Department. These guides were based on measurements of small experimental fires that were ignited from a point and allowed to develop for up to an hour as well as opportunistic observational reports of spread of wildfires.

These guides have been shown to significantly underpredict, by as much as three times, the spread of high intensity wildfires. The under-prediction bias is believed to arise from limitations of the original experiments, namely fuels were predominantly comprised of leaf litter and occasional low shrubs, and the limited size of the fires.

Importance of fuel

The Project Vesta experiments (Gould *et al*., 2007a; were conducted in south-western Australia at two sites in eucalypt forest with contrasting understorey fuel structures of tall and low shrubs that had developed for periods of two to 22 years since the last fire.

Figure 1. An experimental fire from Project Vesta burning in dry eucalypt forest typical of southern Australia.

Extensive analysis of the effects of fuel characteristics on fire spread concluded that:

- the dependence of rate of spread on surface fuel loading is weak and not as strong as assumed by the earlier guides of McArthur and Peet;
- the near-surface fuel layer has the strongest effect on rate of spread; and
- visual assessments of fuel hazard that reflect the quantity and arrangement of fuel could be used to explain the effect of fuel structure on fire behaviour.

For a practical fire spread model for field use in dry eucalypt forest, the influence of fuel variables can be accounted for by either visual numeric hazard scores or fuel hazard ratings translated into fuel hazard scores. The result is the Dry Eucalypt Forest Fire Model (DEFFM).

Fuel inputs

Fuel hazard scores and height of the main fuel strata exhibit a pattern of change with time after fire similar to that of fuel load. Field guides, such as the Victorian Fuel Hazard Guide (Hines *et al*. 2010) and the Vesta Field Guide (Gould *et al*. 2007b), provide a systematic method for assessing surface and near-surface fuel hazard and the height of the near-surface and elevated fuels. With a good sampling design and adequate training, practitioners can apply these guides to make rapid and consistent assessments of fuel hazards necessary to use the DEFFM.

To aid implementation of the DEFFM, a set of default fuel parameters for different fuel ages are presented

in Table 1. These generalised values for a typical dry eucalypt forest of modest productivity with a shrubby understorey, derived from observations of forest structure, can be used when specific field data are not readily available; however, actual observations or localised fuel dynamics models would provide better estimates of the fuel parameters. A more comprehensive set of values for common forest conditions will be presented in a future PyroPage bulletin.

Table 1. Default fuel values for different aged fuels in dry eucalypt forest with a shrubby understorey.

Fuel age (years)	Fuel Hazard Score		Fuel Hazard Rating		*Near-surface height* (cm)
	Surface	*Near-surface*	*Surface*	*Near-surface*	
~3	2	1.5	M	L-M	15
3 – 8	2.5	2	M-H	M	18
8 – 12	3	2.5	H	M-H	20
12+	3.5	3	VH	H	25

DEFFM predicted rates of spread for the default fuel values at 7% fuel moisture content and a range of wind speeds are shown in Figure 2.

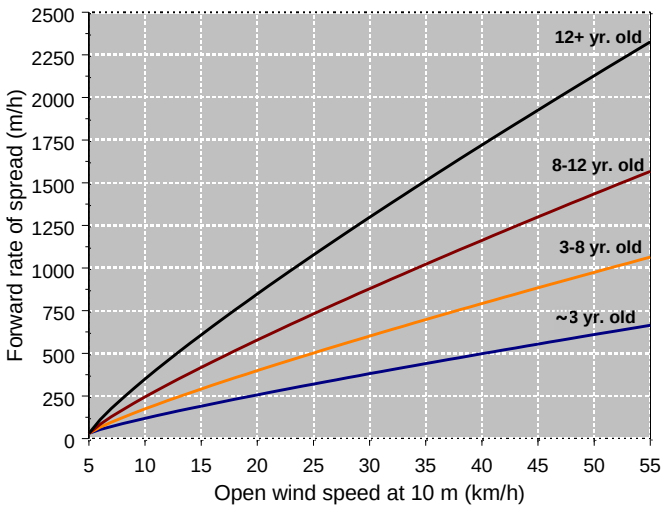

Figure 2. Comparison of rate of spread estimates at 7% fuel moisture content for fuels of different age using the default fuel hazard values given in Table 1.

Importantly, rate of spread predictions from the DEFFM were evaluated against independent fire spread data from experimental fires and well-documented wildfires in a range of dry eucalypt forests in south-eastern and south-western Australia. Predicted spread rates had average errors of 35% and 54% for the experimental and wildfire data respectively. The greater error in wildfire predictions is due to uncertainty regarding the fuel structure and weather conditions at the fire location and difficulties in obtaining accurate measurements of the rate of spread.

The DEFFM is designed for application in dry eucalypt forest under dry summer conditions with a litter and shrub understorey—it has not been validated in forests where the understorey is predominantly grassy fuel. It predicts the potential average rate of spread for wildfires burning for 30 minutes or more after ignition. The model will not predict the build-up stage of a fire, from ignition to attainment of steady-state rate of spread. During the build-up period, the model will tend to over-predict the rate of fire spread.

Further reading

Cheney NP, Gould JS, McCaw WL, Anderson WR (2012) Predicting fire behaviour in dry eucalypt forest in southern Australia. *Forest Ecology and Management* **280**,120-131.

Gould JS, McCaw WL, Cheney NP (2011) Quantifying fine fuel dynamics and structure in dry eucalypt forest (*Eucalyptus marginata*) in Western Australia for fire management. *Forest Ecology and Management* **252**, 531–546.

McCaw LW, Gould JS, Cheney NP, Ellis, PMF, Anderson WR (2012) Changes in behaviour of fire in dry eucalypt forest as fuel increases with age. *Forestry Ecology and Management* **271**, 170–181.

References

Gould JS, McCaw WL, Cheney NP, Ellis PF, Knight IK, Sullivan AL (2007a) Project Vesta. Fire in Dry Eucalypt Forest: fuel structure, fuel dynamics, and fire behaviour. Ensis-CSIRO, Canberra, ACT and Department of Environment and Conservation, Perth, WA, Australia.

Gould J, McCaw WL, Cheney NP, Ellis PF, Matthews S (2007b) *Field Guide- Fuel assessment and fire behaviour prediction in dry eucalypt forest*. Ensis-CSIRO, Canberra, ACT and Department of Environment and Conservation, Perth, WA, Australia.

Hines F, Tolhurst KG, Wilson AAG, McCarthy GJ (2010) Overall fuel hazard assessment guide, Fourth edition. Department of Sustainability and Environment, Melbourne, Victoria.

CONTACT US

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

FOR FURTHER INFORMATION

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

An archive of this and previous CSIRO PyroPages is available from: http://research.csiro.au/pyropage