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What happens to fuels and fire potentials after drought-induced forest die-off?

Forest die-offs associated with drought and heat have recently occurred across the globe, raising concern that changes in fuels and microclimate accompanying die-off could affect subsequent fire behaviour. Despite widespread concern, little empirical data exist.

In 2011, a massive forest die-off event occurred in the Northern Jarrah Forest, southwestern Australia, in which over 16,000ha was affected (Matusick *et al*. 2013). Our key aim was to determine whether this drought-induced forest die-off caused changes in fuels and microclimate characteristics, and whether this could alter fire potentials. Such information would contribute to fire management and aid in predicting drought-fire interactions in this fire-prone region.

Methods and results

Following forest die-off, we measured surface fuels (including leaves, twigs, branches and logs) and standing dead trees within die-off and control plots (Figures 1 and 2).

Sixteen months post-die-off, die-off plots had significantly elevated 1-hr fuels (11.8 vs. 9.8 tons ha^{-1}; litter of 0–6mm in size), but there were no significant changes in larger fuel classes (10-hr and 100-hr fuels; litter of 7–25mm and >25mm, respectively) (Figure 3).

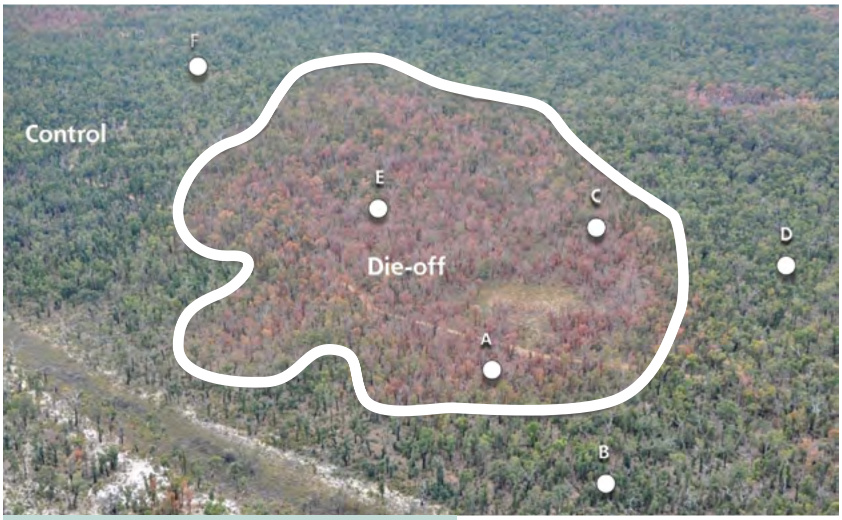

FIGURE 1 Example of the layout of plots (white dots) at a drought-induced forest die-off site (brown area) in the Northern Jarrah Forest

Due to stem mortality, die-off plots had significantly greater standing dead wood mass (100 vs. 10 tons ha^{-1}) (Figure 4).

Supplemental, mid-summer microclimate measurements (temperature, relative humidity and wind speed) were combined with long-term climatic data and fuel load measurements to parameterize fire behaviour models.

Results suggested that fire spread rates were predicted to be 30% greater in die-off plots with relatively equal contributions from fuels and microclimate (Figure 5).

FIGURE 2 Litter collection to determine amount and size of fuels resulting from drought-induced forest die-off

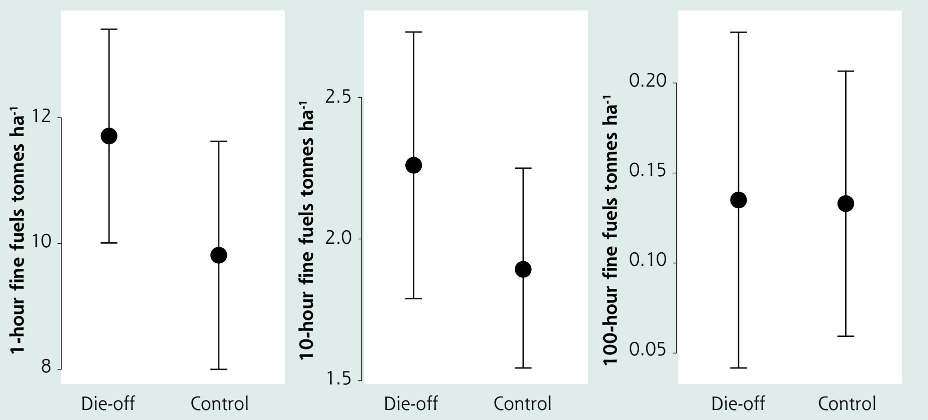

FIGURE 3 Mean levels of fuels (left) 1-hr, (centre) 10-hr, and (right) 100-hr (tonnes ha^{-1}) (95% confidence intervals) in die-off and control plots (n = 360 samples, 180 die-off and 180 control)

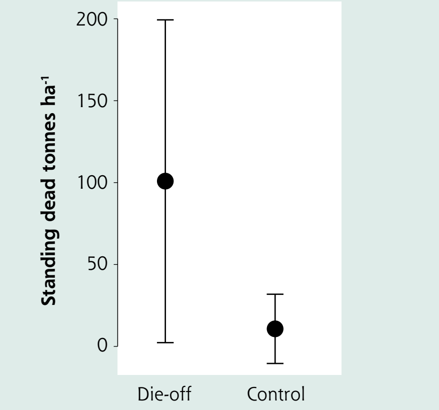

FIGURE 4 Mean levels of fuels of standing dead (tonnes ha -1) (95% CI) (n = 36 plots, 18 die-off, 18 control)

Conclusions

Our results underscore the potential for drought-induced tree die-off to interact with subsequent fire under climate change. Further research on drought and fire interactions will allow us to predict where and how the forest will respond to future disturbance events. ■

More information

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References

1 Matusick, G., Ruthrof, K. X., Brouwers, N., Dell, B. and Hardy, G. (2013) Sudden forest canopy collapse corresponding with extreme drought and heat in a mediterranean-type forest in southwestern Australia. *European Journal of Forestry* 132, 3, 497–510

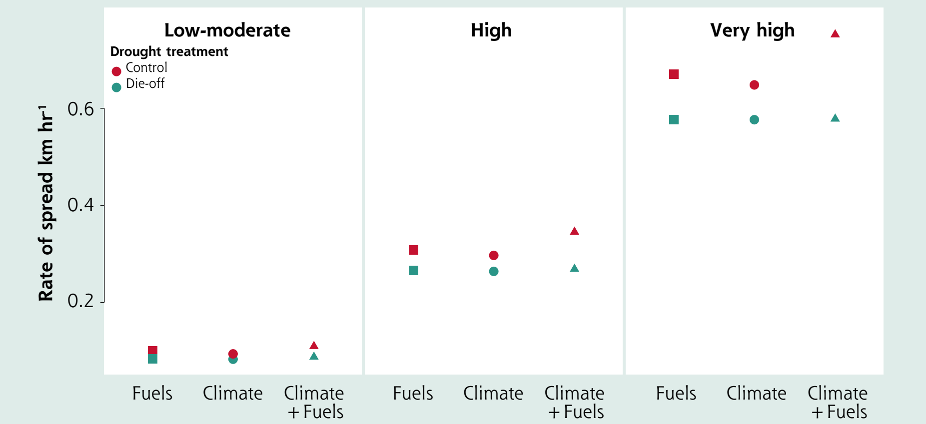

FIGURE 5 Effect on fire potentials (rate of spread km hr $^{-1}$) via elevated fuels, fire weather, and combined across three levels of fire danger. Fuels and climate each contributed approx. equal amounts to elevated fire spread (~ 30% higher in die-off plots)

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