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Identifying critical feedbacks between vegetation change, fuel structure, and fuel moisture in the Mountain ash forests of south east Australia

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The structure and composition of tall Eucalyptus regans (Mountain ash) forests in south east Australia can change dramatically and abruptly to alternative "stable" states dominated by stands of short-lived Acacia spp, or shrublands dominated understory species (Gill et al., 1981). These threshold changes result from the interaction between the reproductive strategies of the different species and the frequency and severity of fire, which is likely to change in response to reduced rainfall, higher temperatures, and longer fire seasons (Bowman et al., 2014; Fairman et al., 2015). These vegetation changes alter understory fuel loads and microclimate, which can in turn dramatically change flammability and fire frequency, and result in structure and composition feedbacks. However the nature of these interactions and feedbacks is currently poorly understood, making predictions of fire risk and potential feedbacks on other forest values (eg. water supply, carbon storage, biodiversity) extremely difficult, compromising strategic policy decisions by land managers. In this study we aim to address this critical uncertainty by quantifying the differences in the flammability of these alternate stable states. Measurements of fuel load and fuel structure from adjacent 8 year old and 78 year old stands of each of these three forest types (6 treatments) are combined with continuous (15 minute) monitoring of the understory fuel moisture status using automated 10-hour fuelsticks calibrated against gravimetric measurements of the surface and elevated dead fuels, shallow soil moisture sensors calibrated to the live understory fuels, and microclimate sensors for short-wave radiation and fuel temperature. A full weather station in a nearby cleared area monitors the ambient open climatic conditions. Initial data from 3 months of monitoring over a summer period indicates substantial and important differences in fuel and flammability metrics between some of the forest states and ages, providing robust quantitative evidence of potential feedbacks between system states and fire frequency. The new data will be used to parameterize a state-transition model to estimate how the equilibrium proportions of these alternate stable forested states will respond to the drying and warming climate of south eastern Australia, and to estimate the likely implications of these changes for ecosystem services such as water, carbon and biodiversity.

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