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Fuel dynamics in Banksia woodlands

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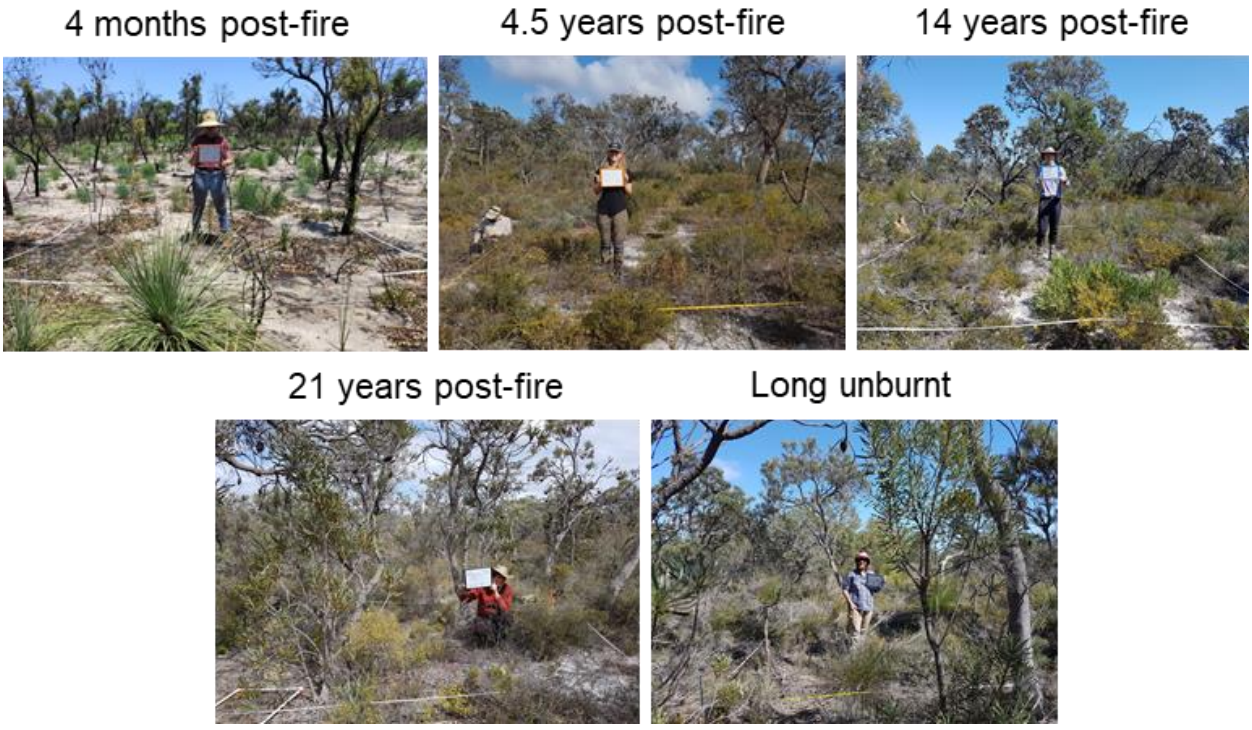
Background

Banksia woodlands have both considerable ecological values and an extensive wildland-urban interface that presents a complex fire management challenge. Understanding fuel dynamics in fire-prone ecosystems helps to determine fire risk and support management decisions. Fuels are made up of litter, woody debris, live and dead plants, and may vary with plant community composition, soil type, climate, and time since last fire, among other things. Identifying the relative influence of these factors on fuel accumulation and structure can help support increasingly sophisticated models of fuel dynamics under current or future environmental conditions.

This study set out to describe fuel dynamics of Banksia woodlands on the Swan Coastal Plain, including the role of climate and soil drivers. We examined the amount and arrangement of litter, woody debris, and shrub layer fuels as well as the structure of vegetation (bare ground cover, vegetation gaps, tree stem basal area, and tree height). We surveyed these in 126 sites varying from 0 to >50 years since fire (both prescribed burns and wildfires), on two major soil types (Spearwood and Bassendean sands), and across the rainfall gradient present across the central coastal plain (550 – 750 mm average annual rainfall).



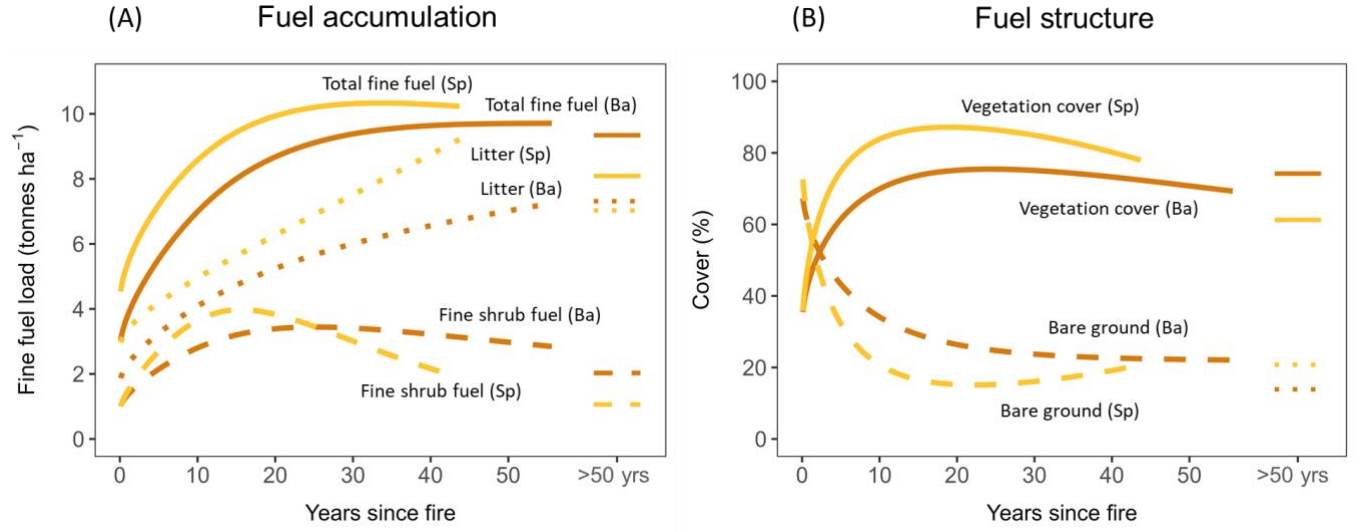
Typical fuel and vegetation structure over time in Banksia woodlands north of Perth.

Findings

The factors we tested explained up to 74% of the observed variation in fuel loads and vegetation structure, with time since fire having the strongest influence, and soil type and local climate (rainfall) playing relatively minor roles. Litter and woody debris tended to increase with age while understorey fuel loads peaked or

stabilised at around 15-20 years. Overall, total fine fuel loads increased with time since fire over the first 10-20 years and remained broadly stable thereafter.

- **Total fine fuels** stabilised at an average of 10 t/ha (75% of samples were <11.2 t/ha) at around 13 years on Spearwood sands, and 9 t/ha (75% <10.2 t/ha) at around 20 years on Bassendean sands.
- **Litter loads,** comprising leaf litter and small twigs <6 mm diameter on the soil surface, accumulated faster on Spearwood sands (reaching 8 – 9 t/ha by 40 years) relative to Bassendean sands (6 – 7 t/ha). Litter loads on both soil types averaged ~7 t/ha in the long absence of fire (>50 years).
- **Woody debris,** comprising fallen twigs and branches 6 – 75 mm diameter, accumulated steadily after fire to an average of 2.5 – 3.5 t/ha in long unburnt sites. Woody debris loads were slightly higher (+ 0.4 t/ha) on Spearwood relative to Bassendean sands.
- **Shrub fuels,** comprising live and dead standing understorey biomass, accumulated faster on Spearwood sands, peaking at around 4 t/ha at ~15 years, than on Bassendean sands which peaked at around 3.5 t/ha at ~25 years.
- **Vegetation structure** followed a similar pattern, with bare ground (gaps in litter continuity) increasing, and understorey vegetation cover decreasing over the first decade after fire. These trends seemed to stabilise on Bassendean soils, while bare ground increased and vegetation cover fell slightly on Spearwood soils as sites aged.



Modelled response curves for (A) fuel accumulation (**litter, shrub, and total fine fuel loads**) and (B) fuel structure (**understorey vegetation cover and bare ground cover**) by time (years) since the last fire across two main sand (soil) types on the Swan Coastal Plain. (Ba) = Bassendean sands; (Sp) = Spearwood sands. Sites >50 years since fire were pooled in a separate class as their dates are not known precisely.

Management implications

This study confirmed the strong influence of time since fire on fuel accumulation in Banksia woodlands. Findings also highlighted the varying post-fire dynamics of litter vs shrub layer fuels, as well as the secondary roles of local climate (rainfall) and broad soil type in accumulation rates. We also found that a small component (25–40%) of variation in Banksia woodlands fine fuel dynamics and vegetation structure was unrelated to these drivers, suggesting that local factors and site variation can also be important.

Expanding on previous studies of Banksia woodland fuels, this study applied a modern, flexible modelling approach, included factors other than time since fire, and sampled across a broader extent of the ecosystem – helping to improve predictions of fuel load patterns. Improvements in fuel estimates provide fire managers and conservation staff with a more nuanced and quantitative understanding of fuel risk profiles and habitat values able to be used in an adaptive management context.

Further information

Tangney R, Miller RG, Fontaine JB, Veber WP, Ruthrof KX, Miller BP (2021) Vegetation structure and fuel dynamics in fire-prone, Mediterranean-type Banksia woodlands. *Forest Ecology and Management* (https://doi.org/10.1016/j.foreco.2021.119891)