PROGRAM B1.1 Managing fires in forested landscapes in southern Western Australia; B4.2. Multi-scale patterns in ecological processes and fire regime impacts

Wildfire return intervals in semi-arid southern Western Australia: effects of fuel age and spatial structure

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Importance of understanding natural fire regimes

- Basis for developing appropriate fire management strategies
- Historical context to assess significance of 'extreme' fire events and potential influence of climate change

Lake Johnston region, Western Australia

- Extensive area (15,500 km²) of relatively undisturbed semi-arid shrubland & woodland at the eastern margins of the southern Wheatbelt (Fig. 1)
- Lightning-caused wildfires are common, and intervention for fire management has been minimal

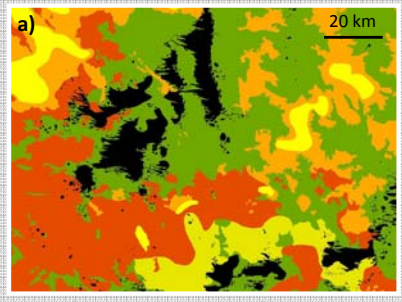
Fig. 1: Location of the Lake Johnston Region

Relatively 'natural' fire regime

Spatial controls of a 'natural' fire regime

Effect of fuel structure and age on wildfire return intervals

- We tested the effect of fuel structure and age on fire interval length by comparing fire interval *distributions* among vegetation types (with differing fuel structure) using survival analysis
- We generated fire interval distributions by fitting the 2-parameter Weibull model to empirical fire return interval data (1940-2007)
- Vegetation types defined by Beard (1976) were reclassified into 5 groups based on the structural distribution of fuels (Fig. 2)



Shrubland (open to dense low shrubs)
Mallee (multi-stemmed low trees, open to dense low shrubs)
Woodland (med to tall single-stemmed trees, sparse low shrubs
Thicket (dense tall shrubs)
Former Woodland (woodland, burnt & reduced to mallee – at time of mapping in the 1960s)
Salt Lakes

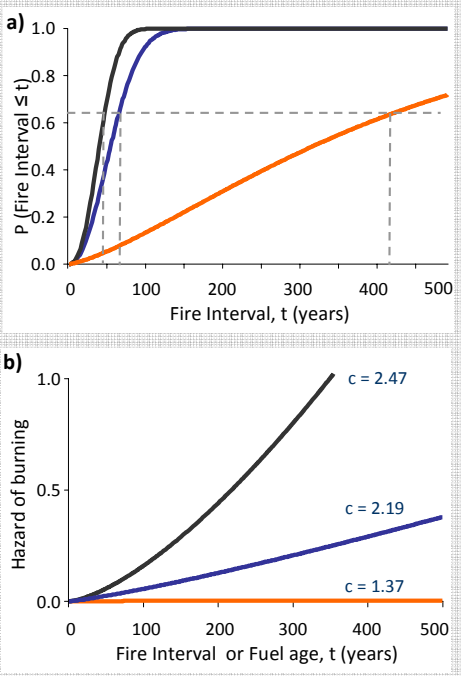
Fig. 2: a) Spatial distribution of vegetation types within the Lake Johnston region (Beard 1976), and examples of typical vegetation structure of b) shrubland, c) mallee, and d) woodland

We compared fire interval distributions based on the estimated values for the two Weibull parameters:

- 'b' (Scale) parameter: 'typical' fire interval length, or the interval that will be exceeded 36.79% of the time,
- 'c' (Shape) parameter: indicates the degree of age dependency, or the rate of change in probability of burning with time since fire (fuel age). Values close to 1 indicate a fire regime operating independently of fuel age, values close to 2 indicate a linear increase in probability of burning with fuel age, while values greater than 2 indicate exponential growth in probability of burning with fuel age (Moritz 2003).

Two forms of the Weibull distribution:

- The cumulative probability form (Mortality Function) indicates the probability of burning before time, t (Fig. 3a)
- The Hazard of Burning form indicates the instantaneous probability of burning at time, t, given that a fire has not already occurred (Fig. 3b).



Shrubland (open to dense low shrub assemblage)
Mallee (Multi-stemmed low trees, open/dense low shrubs)
Woodland (Med-Tall single-stemmed trees, sparse low shrubs)

Fig. 3: Weibull fire interval distributions for different vegetation types, displayed as a) the cumulative probability (mortality) form, and b) the hazard of burning form. Dashed lines indicate values for Weibull 'b' (Shape) parameters. Thicket and former woodland data not shown.

Fire interval length is dependent on veg type (fuel structure)

- The typical fire interval length (parameter b; Fig. 3a) for Woodland (414 yrs) is much longer than both Mallee (63 yrs) and Shrubland (47 yrs).
- Typical fire Interval length for shrubland is comparable to that of the Californian chaparral (33-42 yrs) (Moritz 2003).

Fuel age-dependency varies with vegetation type

- Fire regimes in Shrublands show moderate age dependency - exponential growth in the probability of burning with fuel age (Fig. 3b)
- Fire regimes in Mallee show some age dependency - linear growth in probability of burning with fuel age (Fig. 3b)
- Fire regimes in Woodlands are independent of fuel age – relatively constant low probability of burning despite increases in fuel age (Fig. 3b)
- All vegetation types show a reduced probability of burning following fire. Probability of burning is below that of an age-independent regime (i.e. c = 1) for 26 yrs for Shrubland, 34 yrs for Mallee and 117 yrs for Woodland following fire (data not shown).

References:

Beard, J. S. (1976) Vegetation of the Boorabbin and Lake Johnston areas: map and explanatory memoir. 1:250,000, Vegmap Publications, Perth

Moritz, M. (2003) Spatiotemporal analysis of controls of shrubland fire regimes: age dependency and fire hazard. Ecology: 84:351-361

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