

Functional traits: their roles in understanding and predicting biotic responses to fire regimes from individuals to landscapes

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Introduction

In the first edition of 'Flammable Australia' Whelan *et al.* (2002) remarked on conflicting needs for a general understanding of biotic responses to fire regimes and the precision and realism required to make informed fire management decisions for biodiversity conservation. They rejected descriptive studies as a path toward generalisation, in favour of empirical approaches that elucidate the causes of changes in populations and communities in response to fire regimes. This will support more reliable predictions of effects of varying fire regimes.

The development of generalisations in fire ecology is challenging, because there are high levels of variability in species, fire regimes, landscape factors and climate, as well as their interactions with one another across multiple temporal and spatial scales. Gill (1981) suggested that 'species responses to fires depend on the life cycles of the plants, the fire regimes to which they are subject and the local postfire environment.' Whelan *et al.* (2002) also identified species' life-cycle processes as central to their approach, extending conceptual advances in the fire ecology of plants to review understanding of fire responses in animals.

The characterisation of species' life-history traits that govern fire responses and the functional classification of species with shared traits provides a powerful framework for comparative studies (Pate *et al.* 1990), predictive modelling (Moore and Noble 1990) and fire management for biodiversity conservation (Keith *et al.* 2002b). This framework for generalisation provides a structured and transparent way of designing management strategies aimed at conservation of many species based on the detailed knowledge of relatively few (Keith *et al.* 2002b). Life-history approaches applied to plants have been highly influential on the development of fire management strategies within Australia and overseas (van Wilgen *et al.* 1994; Keith *et al.* 2002b; Pausas 1999; Menges 2007). Often, this has been to the comparative neglect of fire management requirements for fauna (Clarke 2008), for which equivalent approaches and understanding have been slower to develop (Whelan *et al.* 2002).

This chapter reviews different approaches to derivation of functional classifications and proposes a unifying framework to identify and examine key sets of species traits that influence fire responses at different scales of ecological organisation. It uses this framework to review current understanding of key ecological processes and related species' traits that govern fire responses. The primary focus is on plants, but the chapter also shows how the same framework can be useful for improved understanding of fire responses among animals. It concludes with a