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Changes in the way people perceive the biophysical condition of jarrah forest

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ABSTRACT: 'Naturalness' is a concept central to the management and conservation of biodiversity in jarrah forest. Ecologically Sustainable Forest Management has an axiom that any manipulation of a forest ecosystem should emulate the 'natural' disturbance patterns of the region. This paper explores the concept of naturalness, and shows that it is culturally based and therefore continues to change. The frequency, extent and intensity of the major 'natural' disturbance (fire) changed dramatically with Aboriginal occupation of the landscape (~50 000 years ago), and again with European arrival (1829). As losses of biodiversity (i.e., genes, species, ecological processes) have resulted from changed fire regimes (and other disturbances including logging and mining), it is important to interpret naturalness with the view to conserve the biodiversity that evolved within the jarrah ecosystem. One way this can be done is through using the paradigm of 'Ecosystem Health'.

1 INTRODUCTION

Humans have removed half of Australia's forest (Norton and Dovers 1994). The continued removal of remaining forest for agriculture, housing developments, minerals and wood products have generated concern about critical habitats and endangered species in many regions (e.g., Recher *et al.* 1980; Kirkpatrick and Bowman 1982; Loyn 1985; Davey and Clarke 1992; Lindenmayer 995; Calver *et al.* 1998). As existing baseline inventories of 'biodiversity' (i.e., genes, species, ecological process) are incomplete, current attempts designed to protect biodiversity are based on constructs that reflect political, cultural and economic prejudices as much as they are based on firm ecological principles. Until a common understanding of these constructs is reached, objectives and plans for the sustainable the management of forests will be ineffective (Kimmish 1996). The aim of this paper is to explore one construct ('naturalness') and discuss how its interpretation has influenced the management of jarrah forest. It then discusses why an alternative construct ('Ecosystem Health') is a more appropriate approach to conserving biodiversity in jarrah forest ecosystems.

2 PRINCIPLES FOR MANAGING JARRAH FOREST

'Jarrah forest' is forest dominated by the jarrah (*Eucalyptus marginata*) tree. The jarrah forest is distributed across approximately 5 million hectares on the subdued topography of the Darling Plateau in southwest. This is a remarkable forest because it grows on nutrient poor soils and in inhospitable climates (Dell and Havel 1989). Sclerophyll 'scrublands' occur in all other regions that

have similar climate. Trees that live for centuries and grow in excess of 40m in height and 3m in girth overhang a community of organisms that are diverse and unique (e.g., see Brennan 2002; Judd 2004).

The management of the jarrah forest has been a highly contentious issue for over a century (Calver and Wardell-Johnson 2004). While jarrah forest is significantly less modified than other temperate forests (the Western Australian Regional Forest Agreement (1999) estimated that over 70% of pre-European forest cover remains), it has nonetheless been subjected to marked human-induced modifications (Hobbs 1996). Timber harvesting, mining, 'dieback' and altered fire regimes have caused large changes to forest structure and have impacted upon biodiversity (e.g., Postle 1986; Christensen 1997; Craig 1999; Brennan 2002). Principles of 'Ecologically Sustainable Forest Management' (ESFM) are now used to manage the jarrah forest (see Commonwealth of Australia 1999; Conservation Commission of Western Australia 2003).

One major principle of ESFM is to conserve 'biodiversity'. Central to this principle is the concept of 'naturalness'. This is because ESFM has a central axiom that any manipulation of a forest ecosystem should emulate the 'natural' disturbance patterns of the region in order to conserve biodiversity (Hunter 1999;Burrows *et al.* 2002). The assumption is that forest communities have evolved with endogenous disturbance regimes, and will be better able to cope if exogenous disturbance (e.g., logging) are within the 'natural' spatial and temporal bounds range of severity (Hansen 1991; Attiwill 1994; Peterken 1999). However, the problem with attempting to emulate 'natural' disturbance regimes is there is no single definition of naturalness.

3 WHAT IS NATURAL?

The concept of naturalness has been considered by many (e.g., Elliot 1997; Carter 1997). Taylor (1990) reviewed the concept and showed that the failure to recognise naturalness as a cultural concept, rather than universal concept, has produced management plans that lack precision and ecological rigor. For example, many 'Western Technological' societies consider humanity and nature as binary opposites, with humanity having a domination over nature. In this sense, humans must behave within the 'natural' boundaries that other organisms exist in order to be natural. Conversely, Indigenous societies often have a 'biocentric' view of the world, which recognises that humanity is one of the many natural agents of landscape change, instead of external force acting on a 'natural ecosystem'. The management of fire in the jarrah forest exemplifies the enormous ramifications these differing views have had on the conservation of biodiversity.

4 FIRE MANAGEMENT IN JARRAH FOREST

Fire has been the most regular and widespread 'natural' disturbance of jarrah forest since the Oligocene (45 Ma BP) (Hopper 2003). Natural fire regimes were caused by lightening strike, and in regions adjacent to the jarrah forest, are suggested to have occurred at 30-100+ year intervals (Hassell and Dodson 2003). This irregular fire regime changed significantly with human inhabitation starting ~ 50 ka BP (Hassell and Dodson 2003). Although very little is known of the actual burning practices of people 50 000 years ago, it is hypothesised that Indigenous people harnessed naturally occurring fires to their economic advantage, increasing the frequency of fires and decreasing their intensity (Bowman 2003). One study estimates that the jarrah forest were burnt every ~ 3- 5 years in the centuries prior to European arrival (see Ward *et al.* 2001). In burning frequently, Indigenous people were not emulating natural fire regimes, but were using fire as a tool to create, conserve, and exploit 'fine-grained habitat mosaics' (Hallam 2002). These mosaics did not mimic the fire regime that existed prior to human occupation and are thought to have had a profound impact of the diversity and distribution of many species that evolved within the forest of Western Australia (Bowman 2003).

European arrival in 1829 saw the end of Indigenous fire practices in jarrah forest. By the 1860s, there were no longer Indigenous people living in traditional ways in the jarrah forest. Bringing with

them Western Technological concepts of 'naturalness', the new managers of the forest quickly attempted to arrest the 'unnatural' disturbance caused by fire. The conservator of forests (Lane Poole 1916) stated that 'the total exclusion of fire will enable natural succession to proceed, resulting in less undergrowth and a less flammable forest'.

Until 1955, it was believed that a natural fire regime was no fires at all. All attempts were made to exclude large fires in the forests. Although wildfire still existed in some areas, the exclusion of regular fire resulted in a build-up of woody debris that had not been experienced for many thousands of years. The policy of fire exclusion was finally abandoned after several high intensity fires destroyed houses, and killed humans, other animals and 'fire-tolerant' trees (e.g., jarrah), and was replaced with 'prescription burning' (Christensen and Abbott 1989). Under this management paradigm, attempt is made to burn every 5-7 years throughout all forests. Although similar in frequency to Aboriginal burning practices, prescription burning does not create fine–grained habitat mosaics created by these people, nor does it emulate the 'natural' fire regime that existed prior to Aboriginal inhabitation of southwest. The location, timing and frequency of fire is determined by Western science and by the location of houses and farms, wind direction, and fuel. Given the relationship between fire regimes and plant reproduction (Burrows and Wardell-Johnson 2003), arthropod diversity (Springett 1979; York Main 1987) and cycling of nutrients (Horwitz *et al.* 2003), the continuing alteration of 'natural' fire regimes (whatever they are) can be presumed to impact upon biodiversity within jarrah forest.

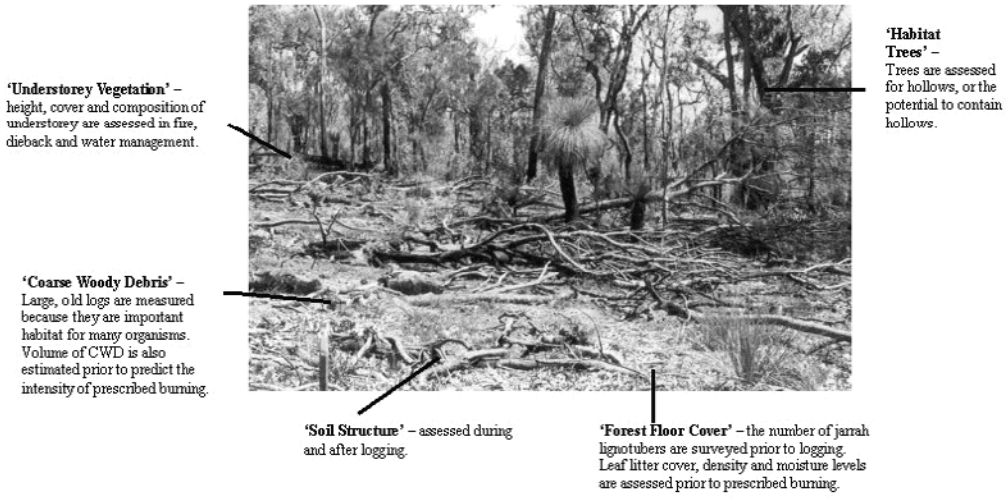

Fig. 1. Some attributes of 'natural' jarrah forest measured to investigate fire, dieback, water relations and fauna habitat in jarrah forest.

5 USING 'ECOSYSTEM HEALTH' TO MANAGE 'NATURAL' ECOSYSTEMS

The problem with strategies that attempt to emulate natural disturbances is that there is no clear definition that outlines what a 'natural' jarrah forest is. Prior to the 1970s, a natural forest was one that was considered 'vigorous' and 'productive' (Mills 1989). Most early research in jarrah forest measured components that were directly utilised by the timber industry (e.g., stages of regeneration, height-girth relationships, growth rates, and stand basal area of jarrah) (e.g., Chandler 1935; Stoate and Bednall 1940; Harris 1953). In recent years, other structural attributes have been

measured to investigate dieback (e.g., Davidson 1997), water relations (e.g., Greenwood *et al.* 1985; Stoneman and Schofield 1989; Stoneman et al. 1989; Crombie 1992; Crombie 1997) and habitats required by specific species (e.g., Williams and Faunt 1997; Whitford 2001; Whitford 2002; Whitford and Williams 2002) (Fig. 1). There is no agreed set of attributes that can be used to assess whether an ecosystem is 'natural or 'unnatural'.

'Ecosystem Health' has been promoted as one way to understand whether humans are detrimentally impacting ecosystems (Calver 2003). Unlike naturalness which is very difficult to quantify, many clearly defined measurements can be undertaken to assess whether a particular stand of trees is healthy (Yazvenko and Rapport 1996). Human activities that may threaten ecosystem health values in jarrah forest include those that (modified from Kimmins 1996):

- Deplete site nutrients, moisture and fertility enough to impair tree and shrub nutrition, vigor and resistance to insects and diseases,
- Deplete site organic matter reserves enough to impair soil moisture, architecture, chemistry, and to influence populations and activities of critical soil organisms to the point at which 'normal' soil function is impaired (this can include excessive accumulations of coarse woody debris).
- Increase the incidence and risk of pathogens to the level at which ecosystem processes (e.g., cellulose production; water cycling) are altered beyond the range for which is being managed.
- Prevent sequences of seral stages that maintain the multi-age forest which itself maintains soil fertility, soil physic and biological conditions.
- Eliminate, or reduce below critical levels, populations of organisms that play a key and indispensable role in controlling pathogens or which play a key role in nutrient cycling (e.g., organic matter decomposition).
- Eliminate microclimates that have allowed for the evolution of a diverse understorey flora important for forest regeneration and ecosystem function.

Maintaining and investigating the health of this forest requires increasing our knowledge about biological and physical processes (Regens and Hodges 1996). An integrated monitoring system based on a system of permanent sites throughout the forest need to be established. At these sites, nutrients, soil properties, pathogen levels, populations of fundamentally important taxa, and microclimates should be routinely measured to provide baseline data. This data can be used to assess activities that are predicted to impact the health of the forest (Stone *et al.* 2001). Given the technology and expertise is available, this type of investigation needs to be implemented immediately given the extent to which the jarrah forest is disturbed by dieback, mining, logging and changed fire regimes.

6 CONCLUSION

The concept of 'naturalness' is implicit in all attempts to assess humanity's role in landscape change (Taylor 1990). In jarrah forest, the conservation of biodiversity is currently dependent on attempts to emulate 'natural' disturbance regimes. I believe this model is unacceptable because we can't define or quantify what 'natural' is, and suggest that Ecosystem Health be used as a paradigm to investigate how human disturbances impact jarrah forest biodiversity.

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