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ALTERED FIRE REGIMES AS A POTENTIAL FACTOR IN DECLINE OF TUART FORESTS AND WOODLANDS

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Summary

There is strong evidence to support the proposition that fire is now much less frequent in the Tuart forests and woodlands between Busselton and Mandurah than it was in the 19th century and first half of the 20th century. Altered fire regimes have been proposed as a factor contributing to Tuart decline in the Yalgorup area, with increased competition from a dense understorey of *Agonis flexulosa* providing a possible mechanism contributing to decline. However, there is currently no information about the extent of competition between Tuart and various understorey species, and the competition hypothesis has yet to tested experimentally. Intense summer fires result in severe damage to mature trees, and are unlikely to provide an effective technique for establishing a cohort of regeneration in Tuart woodlands that have a dense understorey of *A. flexulosa*. The role of fire regimes in maintaining healthy Tuart communities is an important topic and deserves further investigation.

Introduction

Throughout the world there is a growing awareness of the role of fire regimes in maintaining the health and vitality of natural ecosystems. Altered fire regimes have potential to affect a wide range of ecosystem processes including nutrient cycling, competition and regeneration with resulting effects on the structure and floristic composition of plant communities, and on the population dynamics of invertebrate and vertebrate fauna. In particular, countries that underwent extensive colonisation by European settlers during the 19th century are only now beginning to understand the impacts on fire regimes that have resulted from changes in settlement patterns, land use and the activities of indigenous people. Such changes to fire regimes cover the full spectrum of effects ranging from increased frequency of fire and the associated encroachment of highly flammable annual weeds, through to the deliberate exclusion of fire from previously fire-prone communities. Examples of both extremes can be found within the environments where Tuart communities occur on the Swan Coastal Plain.

In this paper we review the available information about fire regimes within the forests and tall woodlands of Tuart between Busselton and Mandurah, and examine possible effects that altered fire regimes might have on stand condition and regeneration processes for Tuart.

Fire regimes – past and present

Historical accounts by colonists and travellers in the south-west of Western Australia during the early to mid 19th century make repeated reference to the widespread use of fire by Aboriginal people. These sources have been comprehensively reviewed by Hallam (1975), and more recently by Abbott (in press). General themes emerging from these reviews include a relatively high frequency of fire at intervals as short as 2-4 years, a preference for burning during the drier summer and autumn months, and the use of multiple ignition points resulting in burnt patches at a scale of tens to hundreds of hectares. Specific accounts of the use of fire by Aborigines on the coastal plain between Mandurah and Busselton by Lieutenant H. W. Bunbury (Bunbury & Morrell 1930), and by Lt. Colonel J. Molloy, F. C. Singleton and G. Eliot (cited in Ward 1997) are consistent with these general themes.

The influence of aboriginal burning had probably begun to decline by the 1850's, coinciding with the occupation of the land by pastoralists attracted to the open woodlands and the presence of herbage palatable to cattle. Grazing began about 1840 in the Ludlow area, and intensified after 1918 when it's role as a method of fuel-reduction became advantageous to systematic forest management (Bradshaw 2000). At Yalgorup, grazing began about 1860 and continued for the next 100 years. Bradshaw (2000) noted that, at least in the latter years of pastoralism at Yalgorup, burning was used as a tool in pasture management with autumn fires at a two to three year interval.

The Yalgorup National Park was created in 1968, and since that time fire has become relatively infrequent. In the current management plan for the national park, the planned use of fire is restricted to relatively narrow buffer strips and a significant proportion of the park has been unburnt for more than 20 years. Substantial areas within the Ludlow tuart forest have also been unburnt for several decades.

Recently, Ward *et al.* (2001) have developed a technique that enables historical fire frequency to be determined from the pattern of dark bands in the stems of Balga grass-trees (*Xanthorrhoea* spp.). This technique has been applied to a sample of 58 Balga located in Tuart communities on private property and national park in the Yalgorup area (Ward 2000). Data obtained from Balga illustrate the decline in fire frequency from a median of about three fires per decade prior to 1850 to about two fires per decade up to the 1950's, and to a frequency of much less than one fire per decade at the present time. Expressed another way, prior to 1900 more than 90 per cent of Balga would have been burnt in the previous five years with a further 7 per cent burnt between five and ten years previously. In contrast, for the decade 1990-1999, only 7 per cent of Balga had been burnt in the previous five years, and more than 34 per cent had been unburnt for at least 20 years (Ward 2000).

Several hundred hectares of Tuart woodland in the Yalgorup National Park were burnt by a wildfire during early March 1996. The fire burnt under hot, dry conditions and

fully scorched the crowns of most mature Tuart trees. Understorey trees and shrubs were killed back to ground level, with species such as *Agonis flexulosa* and *Banksia grandis* re-sprouting from rootstock. Many of the mature trees suffered severe crown damage and have been slow to produce epicormic crowns, but the *Agonis* understorey has recovered rapidly and is now 5 to 6 m tall and, in places, very dense. A regeneration survey undertaken by officers of the Department of Conservation and Land Management in 2002 found that seedlings or saplings of Tuart were present at a density of >650 stems/ha at 57 per cent of the sample points. However, more than half of the seedlings/saplings were less than 2 m tall at an age of six years and already suppressed, making it unlikely that they will persist in the longer term and develop into mature trees. If another high intensity fire were to burn through the same area within the next decade it is probable that the condition of the stand would deteriorate substantially with further loss of mature trees and death of much of the cohort of young regeneration.

What role for altered fire regimes as a cause of Tuart decline at Yalgorup?

Reduced frequency of fire and an associated increase in the density and dominance of understorey trees, principally *A. flexulosa*, have been suggested as contributing factors to the decline of mature Tuart trees in the Yalgorup area over recent years (Ward 2000). A potential mechanism for this decline is the increased competition for water and nutrients resulting from the presence of a dense intermediate layer of *A. flexulosa*, although at this stage there are no specific data that quantify the extent of competitive effects (Bradshaw 2000). What is certain is that the absence of fire and the presence of a dense *A. flexulosa* understorey do pose a barrier to recruitment of Tuart because of the lack of receptive seed-bed (ash-bed) and the level of competition imposed on seedlings (Bradshaw 2000).

Longman & Keighery (2002) have proposed that competition from the understorey is not likely to be a stress factor contributing to Tuart decline in the Yalgorup area. They base their argument on the grounds that mature Tuart have also declined in parkland cleared areas where understorey competition is not a factor, and that *A. flexulosa* thickets have been a significant component of Tuart woodlands in the area for a long period of time rather than a relatively recent phenomenon attributable to declining fire frequency. They also argue that *A. flexulosa* is favoured by frequent fire because it regenerates from a lignotuber, by epicormic growth and from seedlings.

However, we are of the view that regular fires at intervals of 2 to 3 years could conceivably prevent seedlings from recruiting into larger and more fire-tolerant stages of growth, and that this would lead over time to a situation of clumped mature *A. flexulosa* in a matrix of light surface litter and low shrubs.

Opinions also vary as to the composition and condition of the understorey in Tuart forests and woodlands at the time of first contact between Aborigines and European settlers. Bradshaw (2000) and Ward (2000) have favoured a literal interpretation of the descriptions of grassy understoreys in areas of Tuart around Lake Preston and Ludlow, and suggest that the abundance of grass was both a product of, and a necessary requirement for a regime of regular low intensity fires in summer and early autumn. In direct contradiction to this, Keighery & Keighery (2002) argue that early descriptions of grassy understoreys in the Vasse River area failed to distinguish

between genuine grasses and sedges (Cyperaceae), and that late 19th and early 20th century accounts of grassy understoreys reflect the introduction of annual weeds. While this subject is worthy of further study and debate, it should not distract attention from the more immediate issue of identifying the factors contributing to Tuart decline.

Towards a better understanding of the role of fire regimes in maintaining health of Tuart ecosystems

An important advancement in addressing the issue of fire regimes and Tuart decline at Yalgorup would be to understand the role of understorey composition and density in possible competitive interactions with mature Tuart trees. This could be achieved through fundamental studies of nutrient dynamics, water balance and tree water potential. Interactions between tree growth, environmental stress, and pre-disposition to insect attack would form an important part of this investigation.

The understorey competition hypothesis is amenable to testing through experimental manipulation of existing understoreys in stands showing symptoms of decline. This would probably involve mechanical removal of some or all of the taller understorey species prior to the return of a regime of regular low intensity fires. Experimental manipulations are more likely to yield meaningful results if they are conducted at the advancing margin of observable decline, rather than in the core area where decline may have already reached an irreversible stage and populations of Tuart borers (*Phoracantha* sp.) may be at outbreak level.

Bradshaw (2000) has provided prescriptions for regenerating Tuart, together with options for subsequent fire management depending on the structure and composition of the understorey that may be desired to meet conservation and landscape amenity objectives. There is scope to incorporate a trial of regeneration techniques in association with an experimental investigation of the competition hypothesis.

Investigation of the relationships between fire regimes, and the floristics and structure of Tuart communities is also fundamental to understanding the role of fire regimes in ecosystem health.

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