November 2006

Tuart decline
RESEARCH FINDINGS

Eucalyptus gomphocephala

Tuart Bulletin No.6 A series outlining key research findings associated with tuart health in south-west Western Australia

6 The role of fire in tuart decline at Yalgorup?

Robert Archibald, Barbara Bowen and Giles Hardy (Murdoch University), Lachie McCaw (Department of Environment and Conservation) and Dugald Close (University of Tasmania/Bushfire CRC)

The tuart (*Eucalyptus gomphocephala*) woodlands of Yalgorup have a long history of grazing and frequent, low intensity burning. The local Aboriginal population burnt the undergrowth as often as every two to four years to assist hunting and promote good grazing conditions for their marsupial prey. Similar land management practices were continued by European cattle graziers until State forest and national park areas were declared (around 1930 and 1970 respectively). In recent decades, prescribed burning has occurred every 10 to 20 years in the State forest and intense wildfire has occurred infrequently in the national park. During this period, the understorey has increased in density and the condition of the tuart canopy has declined. This raises the question as to whether there is a link between altered fire regimes, understorey density and tuart decline at Yalgorup.

Figure 1: The recovery of tuart saplings one year after complete crown scorch from fire.

Fire and tuart survival

An immediate effect of fire on tuarts is the short-term loss of foliage from scorch or combustion. However, tuart trees and saplings generally recover rapidly after foliage loss from low and moderate intensity fire (Fig. 1) due to an abundance of epicormic buds and a thick bark layer on the stem. Saplings of only one metre can survive fire if located in patches where the fire intensity is low.

Saplings with stem diameters greater than six centimetres resprout from crown branches following low to moderate intensity fire. This ensures the rapid replacement of leaf area and restoration of growth.

High intensity fire can cause whole tree death or a permanent decline in canopy condition (Fig. 2), especially where trees are immature or in poor health. High intensity wildfires have occurred in parts of Yalgorup National Park and may have contributed to the poor crown condition of mature tuarts in some areas today. Occasional intense fires in a healthy tuart stand would not normally threaten the long-term persistence of tuart because of the potential for post-fire seedling regeneration to replace the dead or weakened trees. However, repeated high intensity fire is likely to be destructive and has been implicated as a factor in decline of stands of tuart in the Perth metropolitan area.

Fire and tuart regeneration

Tuart seedling regeneration occurs almost exclusively following fire. Heat from the fire dries the seed capsules and seed is released onto the ashbed. Seedling establishment and development is especially favoured on ashbeds which can be extensive following high intensity fire (Fig. 3). The nutrient rich ashbed supports the rapid growth that is necessary for tuart seedlings to attain rooting depth sufficient to withstand the summer drought. In addition, rapid early growth allows seedlings to compete with undergrowth and for stems to develop a thick bark layer that protects the epicormic buds from subsequent fire.

Figure 2: Tuart woodland in Yalgorup National Park in 2004 burnt by severe wildfire in 1996 (above) and a nearby tuart woodland unburnt in the 1996 wildfire (below).

For example, tuart seedlings that established on ashbeds following wildfire in Yanchep National Park in 2005 grew to three metres tall in less than two years. Under the regime of frequent fire and grazing in historical times, the capacity of tuart to grow rapidly may have ensured the survival of sufficient seedlings to replace the loss of old or diseased trees, thus maintaining tuart dominance over the long-term.

Tuart population structure

Fire history determines the size-class structure of a tuart population. Cohorts of young size classes are critical for the persistence of a tuart population so that trees in decline, or trees at the end of their life expectancy, are replaced. Currently an unstable size-class structure prevails in long-unburnt parts of Yalgorup (Fig. 4). Old trees and those in decline produce little seed, limiting regeneration in the event of a fire. Therefore, intervention in the form of seeding or planting may be required to ensure the persistence of some of the populations in Yalgorup.

Vegetation structure in the absence of fire

Observations suggest the peppermint tree (*Agonis flexuosa*) has increased in density and height throughout much of the tuart woodland in Yalgorup. A decline in fire frequency may have allowed peppermint seedlings to establish and develop in abundance.

Unlike tuart, peppermint seedling establishment occurs between fires and the seedling rapidly develops a lignotuber. Once formed, the lignotuber enables both resprouting following fire (if protected below the soil surface) and increased survival under the competitive pressures of undisturbed vegetation. The ability of peppermint seedlings to establish and persist in the absence of disturbance probably accounts for the contrasting structure of tuart and peppermint populations in long unburnt areas (Fig. 4).

Peppermint, tuart and competition

Tuart saplings do not develop under a vigorous understorey of peppermint. In addition a negative association between the health of mature tuart trees and the density of peppermints has been observed (Fig. 5). The presence of a denser, taller understorey also poses the risk of further decline by raising the probability of intense, crown-damaging fires occurring.

Do the soils at long unburnt sites contribute to tuart decline?

It has been proposed that changed soil conditions (biological and chemical) in the long absence of fire may have contributed to eucalypt declines in southern Australia. While some long unburnt sites in Yalgorup National Park have very poor canopy

Figure 3: Dense tuart seedling regeneration following intense wildfire at Yanchep, north of Perth.

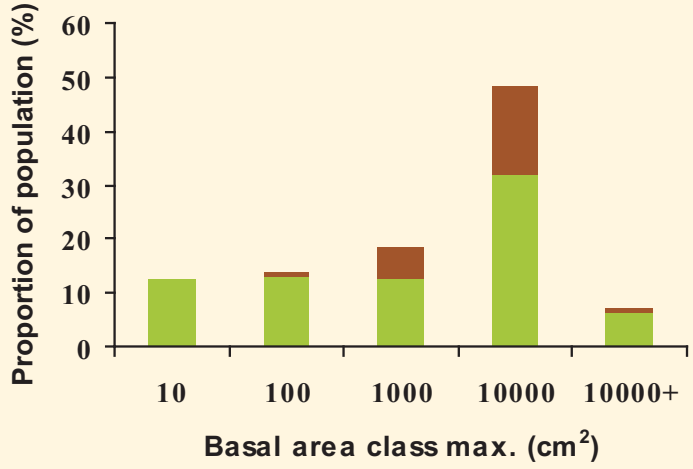
health, health is also poor in areas of the adjoining State forest where burning has been conducted approximately once per decade. Thus, it does not appear that this simple theory may alone account for tuart decline. Nevertheless, burning the understorey increases plant-available nutrients and temporarily reduces competition. Tuart are advantaged by the pulse in nutrient and moisture availability following fire, relative to less fire resistant understorey species.

Preliminary work has shown increased canopy vigour for tuart trees where fire scorched less than 10 per cent of individual tree canopies (Fig. 6). Further work is required to examine the processes that may link burning, soil conditions and eucalypt health. A project team within the Bushfire Cooperative Research Centre is undertaking trials in the tuart woodlands of Yalgorup and nearby State forest. The team brings together expertise from Murdoch University, University of Tasmania, the Department of Environment and Conservation, CSIRO ENSIS, State Forests NSW, and Forestry Tasmania.

A series of replicated treatments including burn, burning after understorey felling, understorey removal and unburnt controls are planned for long unburnt sites in Yalgorup National Park and in frequently burnt sites in nearby State forest. Soil and plant nutrition, and mycorrhizal fungi both pre- and post-fire will be studied in relation to vegetation structure and tuart condition over an initial program of three years.

Interactions between fire and other decline processes

In addition to altered fire regimes and increased understorey competition, average annual rainfall has decreased since the middle of last century. Borer and pathogen attack targeting stressed trees appears to have accelerated the decline. Under the current high-stress environment, future fires of high intensity will likely cause further decline where trees are in poor health.



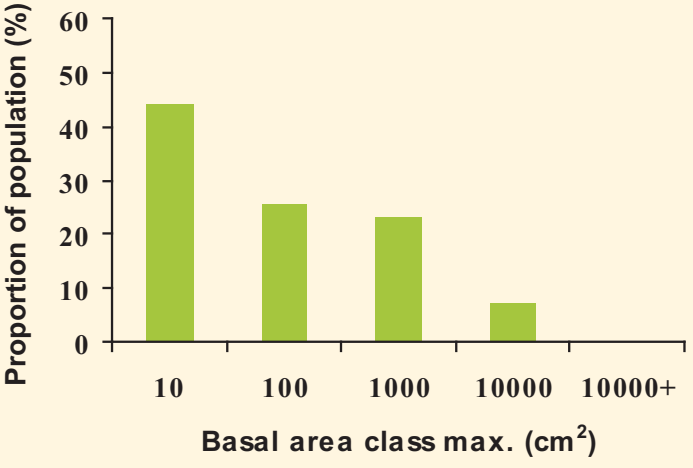


Figure 4: Proportion of population in basal area classes for a) tuart (above, n = 129) and peppermint (below, n = 43) > 1.5 m tall in a long unburnt area within Yalgorup National Park in 2005-06. Proportion of dead individuals is denoted by ■

Fire and the management of tuart decline

The re-introduction of a regular burning regime in Yalgorup is recommended to limit the potential extent and impact of damage from high intensity fire, reduce understorey competition, promote natural tuart regeneration and restore and/or maintain tall-open tuart woodlands in the landscape.

Such a re-introduction should involve an adaptive management approach whereby trial areas are treated and monitored initially. In areas where little tuart canopy remains, restoration may necessarily involve additional measures including direct seeding or tubestock planting.

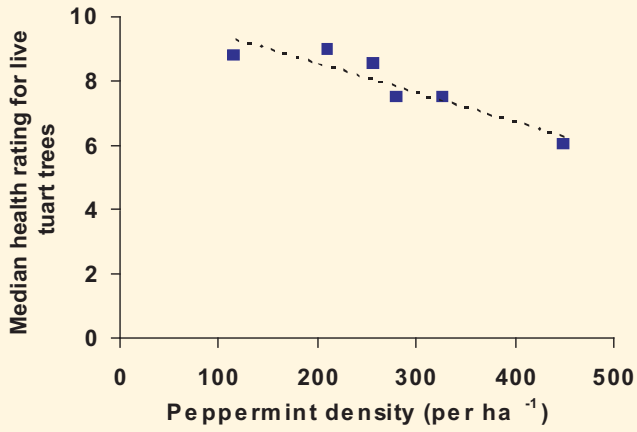


Figure 5: Health rating of live tuart trees (> 5 cm trunk diameter) and density of peppermints (> 1.5 m tall) for six sites across State Forest and National Park in the Yalgorup area in 2005-06.

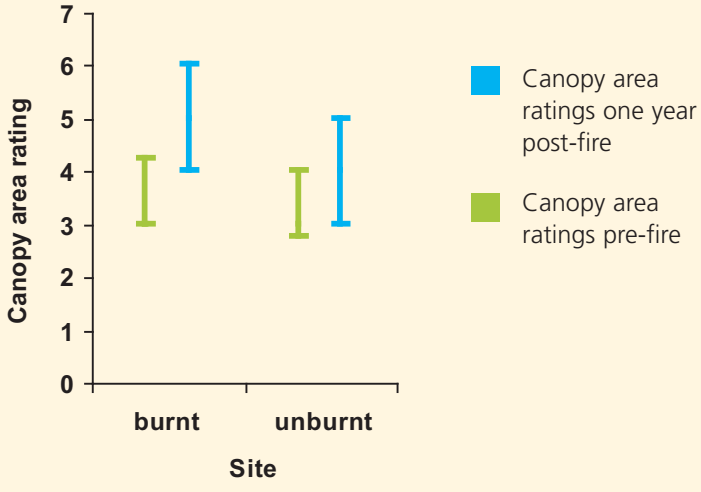


Figure 6: Canopy area ratings pre-fire and one year post-fire for tuart trees (< 5 cm trunk diameter) at a controlled burnt site (n = 22) and unburnt site (n = 26) in Yalgorup National Park. The trees at the burnt site with leaf scorch of between 1 and 10 % of total canopy area were selected. Ratings were based on Grimes (1978) with modifications. Interquartile ranges are shown.

Key references/further reading

Archibald, R.D., G.J. Bowen, G.E.St.J. Hardy, J.E.D. Fox and D.J. Ward. 2005. Changes to tuart woodland in Yalgorup National Park over four decades in M. Calver et al., editors. *Proceedings 6th National Conference of the Australian Forest History Society Inc. Augusta, Western Australia. 2004*, Millpress, Rotterdam.

Bradshaw, F. J. 2000. Recommendations for the regeneration and maintenance of the tuart forest in the Yalgorup National Park. Consultants report to the Department of Conservation and Land Management.

Fox, J. E. D. and S. J. Curry. 1980. Notes om the tuart tree (*Eucalyptus gomphocephala*) in the Perth area. The Western Australian Naturalist **14**;174-186.

Grimes, R.F. 1978. Crown Assessment of Natural Spotted Gum (*Eucalyptus maculata*) – ironbark (*Eucalyptus fibrosa, Eucalyptus drepanophylla*) Forest, Queensland Department of Forestry, Brisbane.

Jurskis, V., and J. Turner. 2002. Eucalypt dieback in eastern Australia: a simple model. Australian Forestry **65**:87-98.

Ward, D. 2000. Trouble in the Tuart: A brief fire history. Department of Conservation and Land Management.

2006405-10-500