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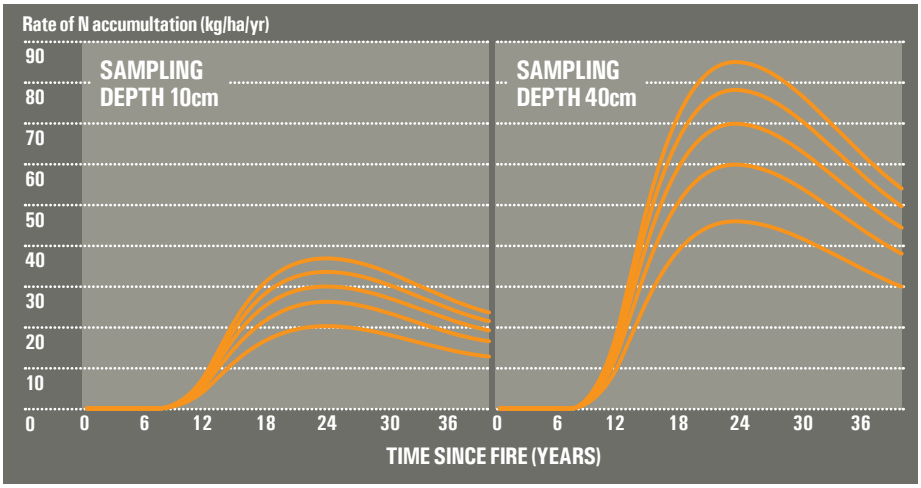
FIRE NOTE

ISSUE 79 MAY 2011

THE PROCESS AND PATTERN OF EUCALYPT FOREST DECLINE IN THE ABSENCE OF FIRE

ABOUT THIS FIRE NOTE

This research is part of the *Tree decline in the absence of fire* project. The author is Vic Jurskis, Silviculturist, Native Forest Operations, Forests New South Wales. For more information about this project, contact Vic Jurskis at vicj@sf.nsw.gov.au



▲ **Figure 1:** Rate of N accumulation (kg/ha/yr) at the soil surface (0-10cm) and at depth (40 cm) with time since fire. Multiple lines represent five different levels of total P in the surface soil (20, 40, 60, 80, 100 kg/ha).

BACKGROUND

Vic Jurskis and Todd Walmsley of Forests NSW collected information about declining eucalypt stands in coastal New South Wales from the Queensland border to the Victorian border. They collated the local knowledge of staff as well as information from various ground and aerial surveys and identified various combinations of the factors that were consistently associated with decline in the absence of repeated burning or analagous treatments such as slashing or low intensity grazing. Jurskis and Walmsley used GIS to map these factorss and make a preliminary estimate of the distribution of forests predisposed to decline. When the output was compared with the available maps, reports and local knowledge of declining stands the estimates appeared to be reliable in most regions.

Declining stands are found in areas of poorly drained or aerated soils, with pronounced changes in soil chemistry and microclimate and challenged tree roots. Particular eucalypt species are associated with particular affected soils, meaning information about geology, landform and type of forest can be used to identify eucalypt forests with a predisposition to decline if managed inappropriately.

An estimated 790,000 hectares of New South Wales forests – 18 per cent of eucalypt forests in the study area – were predisposed to decline without such active management as burning, grazing or slashing.

THE LINK BETWEEN LACK OF FIRE, TREE DECLINE AND SOIL PROCESSES

Soon after European settlers displaced Aboriginal people, whose culture and economy were based on fire, naturalists such as Mitchell, Curr and Howitt observed dramatic changes in vegetation, decline of eucalypt stands and pest outbreaks in New South Wales and Victoria. Studies conducted by Dr John Turner and colleagues in dry mixed eucalypt forests near Eden in New South Wales have recently shed new light on the processes that cause tree decline when fire is excluded from fire dependent ecosystems. On granitic soils in the Eden region, samples were collected from 156 sites with varying time since fire ranging from one to 39 years. Soil analyses showed that after about 10 years without fire, there was substantial accumulation of soil nitrogen (N) (see Figure 1) and a corresponding decline in the carbon to nitrogen (C/N) ratio and pH. There was a greater

accumulation of nitrogen at depth (40 cm) than at the soil surface (0-10 cm) and a greater accumulation in soils with a higher phosphorous (P) concentration at the surface.

At a long term burning study area, seven adjoining frequently burnt and long unburnt sites were compared in a topographic sequence from upper to lower slope. Two additional sites on a creek flat were also sampled, however there were no repeatedly burnt sites for comparison. A third unpaired, long unburnt site was sampled where there was a dense subcanopy of *Allocasuarina littoralis*, a nitrogen-fixing species. The repeatedly burnt plots had lower levels of both litter and understorey, and the overstorey trees generally had healthier crowns than in the unburnt plots. On average, unburnt plots had twice as much exchangeable mineral nitrogen and exchangeable aluminium (Al) and lower pH (4.1 in 1:1 water) compared to burnt plots (4.4). The differences between burnt and unburnt plots increased down the slope and the highest levels of nitrogen, aluminium and acidity occurred on the long unburnt creek flats where the mature canopy was dead (Figures 2a and 2b).

Even higher levels of nitrogen, aluminium and acidity occurred on the same soil type under a long unburnt stand of dead *E. consideniana* and declining *E. globoidea* with a dense subcanopy of *Allocasuarina littoralis* (Figures 3a and 3b), indicating that development of nitrogen-fixing understoreys can compound the problem of nitrogen accumulation and eucalypt decline in the absence of fire.

The changes in soil condition described here in declining eucalypt forest are similar to those causing decline in many forests and woodlands around the world where high levels of nitrogen may also accumulate as a result of industrial emissions. High levels of nitrogen, aluminium and manganese can be harmful to the roots of eucalypts as has been shown for many other trees around the world. Tree declines typically originate in poorly structured soils and affect roots. As the trees weaken, pests, parasites and diseases may attack other parts of the trees. The harmful changes in soil properties may not occur on more fertile, well structured soils such as ferrosols which are better buffered against increasing acidity. These soils support tall, wet eucalypt forests, known as wet sclerophyll forests, which have naturally dense, mesic understoreys and depend on infrequent, high intensity fires for regeneration.

Many burning studies have reported that repeated burning diminishes the nutrient status of forest soils. However Dr Turner emphasises that long-unburnt areas should not be used as experimental controls in dry and moist eucalypt forests which evolved with a regime of repeated low to moderate intensity fires. "Our studies show that repeated burning maintains stable low nutrient conditions suitable for eucalypts". When fire is excluded from dry and moist eucalypt ecosystems, which include about 95 per cent of eucalypt dominated vegetation in Australia, the soil changes can adversely affect established trees and promote woody thickening, allowing a few fire sensitive understorey species to choke out the naturally diverse ground layers (see Figure 3b).

▲ **Figures 2a and 2b:** Long unburnt stand of *Eucalyptus angophoroides*, showing: (a) dead canopy, (b) dense ground layer..

THE PATTERN OF EUCALYPT DECLINE IN THE LANDSCAPE

Declining stands are usually associated with relatively flat or concave sites low in the landscape with soils that are not well drained or aerated and are poorly buffered against acidification and related changes. This is where changes in soil chemistry (N, pH and Al) are most pronounced and where tree roots are physically challenged. Poorly structured soils are associated with particular geological substrates and there are particular eucalypt species or combinations of species that are associated with such soils and sites in any given region. Thus information about geology, landform and forest type can be used to identify eucalypt forests in each region that are predisposed to decline if managed inappropriately.

It was estimated that 790,000 hectares of

▲ **Figures 3a and 3b:** Long unburnt stand showing: (a) dead *E. consideniana* and declining *E. globoidea*, (b) dense *Allocasuarina littoralis*..

forests comprising 18 per cent of the eucalypt forests in the study area were predisposed to decline if managed inappropriately (that is, if there was no active management such as burning, grazing or slashing). Some forest types are so broadly defined that they may or may not include species indicative of high risk of decline. These were classed as high/low in predisposition and Jurskis and Walmsley considered that about half the area of these types, or 75,000 ha, were at risk. Broadscale topographic information was used in one region in combination with forest type and geology but it did not improve the prediction. Jurskis and Walmsley consider that fine scale Digital Elevation Models could be used to improve the estimates in some areas, however the cost of obtaining and using these models across a region would be prohibitive.

About half the area of forests predisposed to decline is privately owned and much of this area comprises Endangered Ecological Communities identified under New South Wales legislation. Twelve maps of risk are being published (as pdfs on CD) for forests in coastal NSW and these will be used in fuel management plans to integrate socioeconomic protection with forest health management. A section of the Eden map is presented here as an example (Figure 4, next page). The dead and declining stands shown in Figures 2 and 3 are within the area classified on the map as having high predisposition to decline on the basis of vegetation and geology.

Throughout coastal New South Wales, red gum types (including *Eucalyptus tereticornis* and closely related species) and all eucalypt types on Quaternary alluvium are predisposed to decline. Woolybutt (*E. longifolia*) types appear to be at risk throughout their range from Newcastle to Eden. Sydney blue gum (*E. saligna*) types appear to be susceptible where they occur on poorly structured soils (indicated by several geological substrates) north from Nowra. All grassy eucalypt ecosystems on the Cumberland Plain around Sydney are at risk. On the central coast, Patonga Claystone indicates sites prone to eucalypt decline. North from Coffs Harbour, all mixed species stands on the Walloon coal measures are predisposed to decline. A number of other eucalypt types, geological substrates or combinations thereof can indicate risk in the various regions along the coast.

END USER STATEMENT

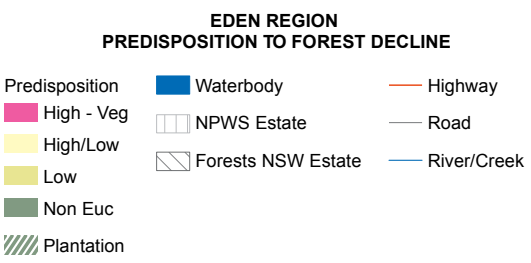
"Many foresters and fire managers have long been aware of the loss of crown health and vigour in those dry and moist eucalypt forests that have been long unburnt. Vic Jurskis and his colleagues in New South Wales have reported on this phenomenon over many years, and these concerns have been echoed in other forests throughout Australia where fires have been excluded for long periods for one reason or another.

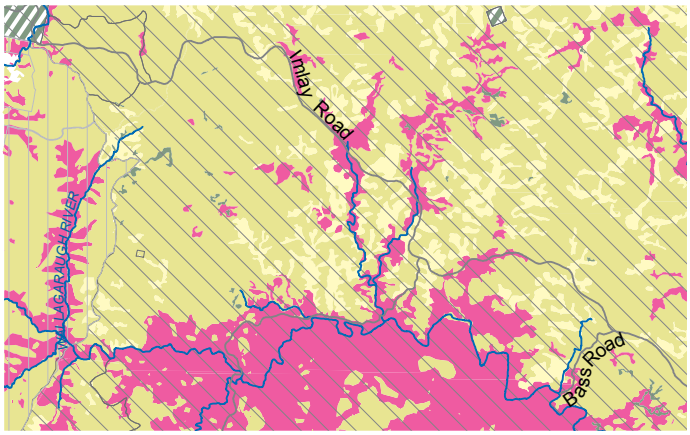
"The findings of the studies by Vic Jurskis and colleagues that are reported in this *Fire Note* indicate the effects that fire exclusion has on the nutrient cycle of the forest ecosystem and the severe impacts that are likely to befall our forests in the absence of a program of regular prescribed fires. These findings are in general agreement with similar studies on long-unburnt sites in Western Australia and Tasmania, undertaken by Bushfire CRC researchers based at the University of Tasmania (Neil Davidson, Allan Jones, Dugald Close, Bryony Horton).

"These works are of importance to fire managers who need the support of scientific basis for the planning and implementation of prescribed burn programs."

– Rick Sneeuwjagt, Principal Fire Projects Officer, Department of Environment and Conservation, Western Australia

Figure 4: A section of the Eden map





CONCLUSION

The patterns and processes described here are in agreement with studies conducted in Tasmania, Western Australia and elsewhere around the globe on the causes of tree decline. These studies show the importance of prescribed burning to the nutrition and health of forests and that nutrient cycles should be an important consideration in planning a healthy fire regime. In Western Australia prescribed burning has been more widely and consistently used with greater public support than in eastern Australia. This research supports extension of burning programs in Western Australia and reinvigoration of programs in eastern Australia. Adaptive management programs are being widely implemented in North America using various combinations of thinning and burning to restore health, resilience and fire safety in ecosystems that have been degraded by exclusion of fire. Similar programs are urgently needed in Australia where various combinations of burning, thinning, grazing and/or slashing could be used on various tenures as appropriate.

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Fire Note is published jointly by the Bushfire Cooperative Research Centre (Bushfire CRC) and the Australasian Fire and Emergency Service Authorities Council (AFAC). This Fire Note is prepared from available research at the time of publication to encourage discussion and debate. The contents of the Fire Note do not necessarily represent the views, policies, practices or positions of any of the individual agencies or organisations who are stakeholders of the Bushfire CRC.

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Bushfire CRC is a national research centre in the Cooperative Research Centre (CRC) program, formed in partnership with fire and land management agencies in 2003 to undertake end-user focused research. Bushfire CRC Limited ABN: 71 103 943 755

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