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THE LEVEL OF FIRE RISK ASSOCIATED WITH PLANTATIONS

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Introduction

Historically, in Australia, plantations have been established in relatively large estates either by Government of by large corporations. These plantations have often been established by the conversion of native forests or woodlands of low productivity. Generally the overall fire risk has decreased because improved access within the plantation, a professional fire management infrastructure of the Government Department or Corporation, and the increased work force associated with the plantation establishment and management to carry out fire suppression has improved the overall efficiency of fire control both within the area converted to plantations and in the surrounding district.

If the 2020 vision of plantations for Australia is to achieve the target of trebling the plantation area by the year 2020 it is likely that in many districts plantations will need to be established on cleared agricultural land. There may well be a substantial increase in the number of plantations in small holdings, managed either by private individuals or by individuals in co-operation with larger organisations in share-farming arrangements. With this scenario there may well be concerns that the fire risk associated with plantations in the future will be considerably greater than the historical fire risk associated with agricultural activities.

Fire risk is technically defined as the chance of a fire starting. In this paper I am going to examine the problem from a fire control perspective and consider fire risk as difficulty of suppression. This, technically, is equivalent to the fire danger or fire threat associated with

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[1] Paper presented to Plantation 2020 The Local Government Perspective, 14-13 May 1988, Old Parliament House, King George Terrace Park, Canberra.

plantations. The difficulty of suppression in plantations will be compared with th. .n grasslands. I have assumed that the greatest concern will be in areas where the local Government fire control infrastructure has been largely developed around grassfire suppression and changes may be required to cope with a sudden increase in plantation estate in the region.

Difficulty of Suppression

The difficulty of suppression in a plantation depends on the species used, the age and development of the plantation, and the silvicultural management of the plantation. Few quantitative data exists for plantation fires so I will compare suppression difficulty in open grasslands with that in a mixed-species dry eucalypt forest. Suppression capability also depends on the training, experience and equipment of the suppression forces. In both cases I have assumed that suppression is undertaken by experienced, well-trained and well-equipped crews.

It is generally considered that a grass fire can be controlled directly up to a maximum fire intensity of 10,000 kW m^{-1} (McArthur 1966, Luke and McArthur 1978). This intensity represents a fire burning at around 5 km h^{-1} in a natural, undisturbed grass sward carrying 4 t ha^{-1} fuel load. The maximum intensity that a forest fire in mixed species eucalypt forest can be controlled is around 2000 kW m^{-1} (Loane and Gould 1986, Buckley 1994) This intensity represents a fire burning in a 10 t ha^{-1} fuel load at around 400 m h^{-1} . In both fuel types this level of intensity is reached at approximately the same weather conditions; i.e. at an ambient temperature of 35 °C; a relative humidity of 20% and a mean wind speed in the open of 23 km/h. These conditions represent a grassland fire danger index of 21 or just into the very high fire danger classification (McArthur 1966). To experienced fire control people, this index may appear low as an upper limit for fire control but it represents a fire which is large enough to maintain its potential rate of spread for the prevailing conditions and is spreading continuously at this intensity. In practice, this average fire intensity is not maintained continuously across the landscape and suppression forces can take advantage of reduced fire behaviour, for example when a fire burns down slope, to bring the fire under control. Generally effective fire suppression in both fuel types can be undertaken at most levels of the very high fire danger classification.

In forests, the factor which overwhelms suppression forces and determines the fire intensity at which suppression fails is the onset of severe spotting. In a mixed-species eucalypt forest containing stringy-barks and other fibrous-barked eucalypts this level of spotting occurs at the intensity of around 2000 kW m^{-1} used above. In tall, closed-canopy plantations with a low spotting potential (eg. smooth-barked eucalypts such as *Eucalyptus globulus* or other eucalypts in the blue gum group), and with a compacted surface fuel structure effective suppression can be carried out a higher intensity than is possible in native forests - perhaps up to 4000 kW m^{-1} . This means that effective suppression can be undertaken in some plantations at a higher level of fire danger than is possible in open grasslands.

The traditional tactical response to suppression of fires in native forests involves the use of earth -moving equipment to prepare a bare-earth fire line around the fire. The rate that such equipment can prepare fire line in unthinned plantation may be considerably less than in native forests due to the difficulty in moving trees aside to form the line.

There are several other factors that should be considered when comparing the potential threat of plantation fires with that of grassfires. At the extreme fire danger classification suppression of the head fire is impossible in practically all fuel types. In grasslands some effective suppression on the flanks of the fire can be undertaken at all levels of fire danger even when the head fire cannot be controlled. In forests, however, fire suppression becomes exceedingly hazardous to firefighters once the fire danger enters the extreme classification (ie FDI =50) and it is often unsafe to attempt fire suppression on any portion of the fire. Under these conditions suppression forces should be properly withdrawn until weather conditions ameliorate or until the fire emerges from the forest into grasslands.

Another factor is the seasonal change in the flammability of grasslands. Early in the fire season forest fuels will burn when the surrounding grasslands are green although most often suppression presents little difficulty. Late in the fire season and particularly after extended droughts, grass fuels are substantially reduced by heavy grazing, fire suppression in grasslands becomes particularly easy. On the other hand, difficulty of suppression in forests tends to increase as the season progresses due to increased litter fall, and decreased moistures in large fuels and live vegetation.

Grass fuels are much more responsive to changes in relative humidity than are forest fuels so that under normal summer conditions grass fires are self-extinguishing at night where as forest fires continue to burn. Although grass fires may burn huge areas by virtue of the very high rates of spread they rarely persist for more than one day. Large forest fires on the other hand will often continue to burn over several days or even weeks particularly if suppression is complicated by difficult and inaccessible terrain. For example the 1983 Ash Wednesday Fires in the SE of south Australia stopped spreading in the grasslands on the evening of the first day but continued to spread in the pine plantations for a further three days before they were brought under control (Keeves and Douglas 1983).

These factors suggest that forests present a much greater fire threat than do grasslands. Indeed under extreme fire danger conditions the threat to life and property within forest areas is greater than the threat in open grasslands. However, when comparing the relative threat on a regional basis, the facts that fire in forests develops more slowly and spread less rapidly than fire in grassland should be taken into consideration. Also, plantation estates can be managed to reduce the fire threat and make suppression easier so that the total area burnt within the district may well be lower under increased plantations than before.

Fire Growth

All fires starting from a point ignition go through a growth phase before they reach their potential rate of spread. Under strong winds, i.e. in excess of 25 km/h, grassfires reach their potential rate of spread when the width of the head fire exceeds 150 to 200 m (Cheney and Gould 1995, 1997). We have less reliable information for forest fires but it appears that the width of the head fire required to achieve potential rate of spread is similar to that in grasslands.

The time taken to reach the potential rate of spread depends both on the average wind speed, and fluctuations in wind direction which can cause the head fire to expand rapidly. Grassfires are

extremely responsive to changes in wind direction because there is little convective resistance to the wind. Under the weather conditions given above, a grassfire may reach its potential rate of spread in as short as 12 minutes with an average of around 20 minutes. Forest fires, on the other hand, have greater convective resistance to changes in wind direction due to the heavier fuel loading and more persistent burning. This means that fires starting from a point ignition generally remain narrow and well below their potential rate of spread for long periods. Under high to very high fire dangers a developing forest fire may have reached only one third of its potential rate of spread an hour after ignition. In many cases a forest fire starting in the early afternoon only reaches its potential rate of spread late in the day when burning conditions, particularly wind speed, have reduced.

This important difference in fire behaviour means that a fire starting in an established plantation can be easily suppressed during its growth phase before it reaches its potential rate of spread even under very high to extreme fire danger conditions. Under the same conditions a fire in grasslands will generally reach its potential rate of spread in 15 - 20 minutes and unless the initial attack is very rapid suppression forces will not be able to control the head fire and very large areas will be burnt.

Suppression Capability

Whereas fires in grasslands may be readily suppressed with water particularly in light fuels, forest fires are more difficult. Suppression often requires the use of hand tools or machinery to create a bare-earth fire trail around the fire. Much more attention must be given to mop-up and patrol once the fire has been suppressed. Rural brigades which are primarily equipped to suppress fires in open grassland may be quite inexperienced and ill-equipped to fight fires in forest plantations. Thus even though plantation fires may be easy to suppress when rapidly attacked, as described above, brigades may be reluctant to enter the plantation because they don't have the right equipment. Brigade members are also likely to be unfamiliar with the plantation roads and unused to the limited visibility when the trees reduce their view of the fire.

In many cases the brigades may adopt a strategy of suppressing fires at the plantation perimeter or burn out from a compartment boundary rather than carry out initial attack within the compartment. This tactic, although superficially attractive, can create problems because any action that allows the fire to increase in size and intensity increases the likelihood of escape from the plantations into the surrounding grasslands.

These problems will be magnified where the new plantations are predominantly small holdings and owned by absentee land holders for investment. In this case the burden of fire suppression is quite unfairly placed on the graziers and farmers in the rural community and there may well be resentment from the local firefighters if the plantation owners cannot contribute to the suppression effort or have not taken steps to reduce the flammability of fuels within their plantations. One approach may be to levy a fire control tax on plantation owners but this may have the undesirable consequence of absentee owners adopting the attitude that they are entitled to protection from the rural brigades and carry out little action to protect themselves - an attitude which is already evident among some rural residents on the outskirts of Canberra.

l al government will need to address the problem of properly equipping and training rural brigades, and obtaining an equitable contribution to the fire suppression effort from absentee landholders. Perhaps the most practical approach is to reduce the hazard within the plantation so that suppression is considered practical with standard equipment for fighting rural grass fires.

Reducing The Hazard In Plantations

The fire hazard in plantations can be substantially reduced by good management. This is most effective when hazard reduction measures are commenced at establishment, and silvicultural techniques are adopted which reduce excessive fuel accumulation during the life of the plantation. Some factors to take into consideration might be:

- Completely remove the debris from the previous vegetation at establishment. Windrows of large logs are very difficult to mop-up in the event of a fire and should be removed by stoking and burning. This may be of lessor importance for the initial 2020 plantations but will be most important when these plantations are harvested and replanted.

- Control unpalatable grass (eg *Poa* sp tussocks) and herbaceous weeds by spraying with weedicide prior to planting. In subtropical areas where there is prolific growth of annual grasses clean tending operations may be required early in the life of the plantation.

- Obtain rapid early growth and early crown closure by fertilising and competition control at establishment. This will rapidly suppress grasses and weeds and a newly established plantation in this way will have very low fuel loads for some years until litter beneath the plantation starts to accumulate.

- Select species which are self pruning, or prune conifers to at least 2 m as soon as possible to increase visibility within the plantation and to create a gap between the surface fuels and the tree crowns.

- Retain a high stocking by re-planting failed areas if necessary.

- Remove double, deformed or other unwanted stems in the first 2 to 3 years after planting before they contribute to substantial fuel loads in later thinning operations.

- Reduce grass fuels within the plantation by grazing as soon as the trees are large enough to avoid damage by stock. Grazing within the plantation not only reduces grass loads but also breaks up debris from pruning slash. If high pruning is required carry out repeated pruning operations at short intervals to prevent excessive accumulations of pruning debris.

Although theoretically attractive, combining grazing and timber production in a wide-spaced agro-forestry operation is not as practical a fire control measure as it may first appear. In good seasons prolific grass growth may not be reduced by grazing pressure alone particularly if feed is available elsewhere and additional stock are not readily available for agistment within the

forest. Fast-moving grass fires in heavy grass fuels have sufficient intensity to kill moderately fire resistant species such as *P. radiata.*

Prescribed burning can be carried out beneath fire resistant species from age 10 to 15 or when the trees are greater than 15 cm dbh. However, prescribed burning in young plantations is a difficult and exacting task with a small window of opportunity. In most cases it is impractical for effective prescribed burning to be carried out by individual holders of small plantation lots although some notable exceptions exist.

However good fuels management early in the life of a smooth-barked eucalypt plantation can make them virtually fire proof for up to 8 years after establishment until litter stars to accumulate beneath the trees.

Conclusions

The establishment of plantations in former agricultural areas does not necessarily increase the fire threat to the surrounding community. However the plantations need to be established with fuel management for fire protection from the outset and maintained throughout the life of the plantation. Rural brigades must be capable of rapid initial attack within the plantation. They need to be provided with suitable equipment and may need retraining in fire suppression tactics to handle the different requirements of forest and grass fire suppression.

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