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Ref. 49.

FIRE MANAGEMENT OF FOREST PLANTATIONS

Discussion Paper for Valdivia Group/Forests Working Group

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INTRODUCTION

Fire management must form an integral part of forest management. The establishment of forest plantations usually represent a substantial and long-term investment. Also, it usually represents a substantial change in the nature and load of flammable fuels and thus changed fire behaviour from that commonly experienced in the surrounding countryside. In fire-prone environments plantation fuels may present new and difficult suppression problems so that wildfire represents a very significant and important threat to the investment.

All too often plantation establishments schemes are commenced without a proper evaluation of the consequences of severe wildfires and their potentially disastrous economic effects. Fire management requirements have a bearing on such fundamental factors as species selection, the size and siting of individual plantation units, roading networks and compartment design, and silvicultural and harvesting regimes. This, in turn, will determine whether the plantation program can be integrated into the land management practices of a rural community or whether or not it must be isolated and run by government or large corporations more or less independently of the rural community.

PLANNING FOR "WORST POSSIBLE" FIRE DANGER CONDITIONS

The concept of planning for "worst possible" fire danger has been adopted by Australian fire control authorities to establish protection standards for both native forests and plantations. Although the worst possible conditions cannot be defined nor can they be effectively catered for except in very localised situations, the concept does allow the manager to identify important factors which determine the behaviour of damaging fires and the likelihood of economic disaster. The requirement for fire management really reduces to the simple issue of whether or not a conflagration of disastrous economic proportion is likely to occur once or more per rotation (Cheney and Richmond, 1980). If it is, then the level of expenditure required for an adequate standard of protection can be determined from:

- the severity and frequency of dangerous fire weather;
- the rates of accumulation of hazardous fuels; and,
- the risk of ignition both within and outside the plantation estate.

If the fire environment is mild and damaging fires are unlikely to occur within the rotation then fire protection may be provided with rudimentary fire management and suppression of nuisance fires carried out with limited resources.

If on the other hand a disastrous conflagration is likely to occur once or more per rotation, fire management must determine the level of protection expenditure required to limit the losses under the "worst possible" conditions and expose this expenditure as a requirement that the project must be capable of meeting economically (Cheney and Richmond, 1980).

CULTURAL/FIRE ENVIRONMENT

The size and location of discrete plantation units depends very much on the cultural/fire environment into which they are to be located. If the fire environment is mild and the cultural use of fire is low, then small discrete plantation units can be scattered across the countryside. The risk of fire starting both within the plantation and in the surrounding countryside is low and fire protection can be gained basically by suppression alone. The management of individual units becomes possible with minimal fire control infrastructure and assistance with fire suppression can usually be sort from the surrounding community.

Where the cultural use of fire is high (e.g. through the use of slash and burn agriculture or the use of fire to maintain grazing) the establishment of small discrete plantation units is unlikely to succeed. In this environment, successful plantations programs are usually isolated from the rural community and managed by large corporations either government or privately owned. Individual units are usually large and continuous to gain economies from a substantial fire management infrastructure which will provide suppression forces. Substantial external firebreaks are required to prevent ingress of externally lit fires as is legislation to limit the lighting of fires on the plantation estate. Where it is impossible to isolate the plantation estate from the rural community it is essential to reduce fuel loads. In a moderate fire climate, forestry integrated with agriculture, grazing, and/or prescribed burning may be feasible to keep fuels and fire losses low, although few successful examples are available. The selection of fire resistant species may be essential if prescribed burning is to be used to reduce fuel loads.

Under severe fire climates plantation establishment is rarely successful until the cultural use of fire has been restricted either through legislation or economic development. Generally, large plantation units are easier to protect when fires occur under occasional very severe fire weather.

Even in a severe fire climate the occurrence of fire may become very low through a combination of strong legislation to limit cultural use and efficient rural fire suppression. In this environment there can be a tendency for the number of small plantation units managed by individual land holders to increase (Cheney 1982). These units remain vulnerable to damage by wildfires under severe weather conditions unless fuels are intensively managed through a combination of grazing and other fuel reduction techniques so that fire intensity within the plantation is similar to that of fires in the surrounding countryside and suppression can be managed by the rural fire protection organisation.

FIRE MANAGEMENT

Efficient fire management of plantations must take into consideration, from the outset, species selection, aspects of plantation design that influence fire protection and the need for fuel management.

Species selection: The selection of the most suitable species for a plantation program should take into account whether or not it is feasible to totally protect the plantation from fire. If it is concluded that it is not feasible to exclude fire from the plantation, either through firebreaks or through rapid fire suppression, then prescribed fire will be required on all or part of the plantation to make suppression easier and to limit the area burnt by wildfire. Plantation species with thick, fire resistant bark are needed to withstand regular prescribed fire and the occasional low-intensity wildfire. Prescribed fire to reduce fuel loads is inappropriate to use on plantations managed under coppice rotation of 5 to 10 years and some species with thin bark remain sensitive to even low-intensity fires at all ages.

Species with rough, fibrous bark which adequately protects the tree bole from moderate-intensity fires at a relatively young age may also be hazardous as they produce numerous firebrands which make fire suppression more difficult. Prescribed burning may reduce the flammability of rough-barked species and may reduce their spotting potential. While it has been proposed that fuel breaks planted with rough-barked species and managed by prescribed fire be incorporated in plantations of thin-barked species which are totally protected, there are few successful examples of this management.

The shape and size of discrete planted units: This is often determined by the availability of land for plantation and is influenced by both forestry requirements and the established land practices of the local community. As discussed, small units widely separated from one another by less fire prone land may be managed with minimal expenditure on protection where the fire climate is mild and the fire risk is low. Some losses from fire should be expected but they will be limited in extent.

The Australian experience is that where protection is difficult, fire protection is most efficient in large concentrated plantation units even though the potential for loss from a single fire is high. Where the main fire threat comes from outside the plantation the external boundary should be as short as possible and located where access and fire suppression is easiest. This may require acquisition of some costly land in order to secure an efficient plantation boundary.

The density and standard of access: The access and design of internal roads is largely dependent on the mobility of fire fighting apparatus. This governs the grades, design speeds, surface finish, the level of maintenance, and the distance between adjacent roads. The manager must reach a compromise between over capitalisation early in the rotation by building roads of too high a standard on the one hand, and the cost of equipping and maintaining a suppression organisation with off-road capability on the other. This compromise can be met by constructing a close network of roads but to a physical standard just sufficient to accommodate conventional motor vehicles. In Australia the road density is generally around 45 m per ha (average compartment size of 20 ha). On smaller units or on steep topography the road density will be higher around 70 m per ha. Road construction at this density may amount to 25% of the total establishment cost but, in addition to providing access for fire protection, they can be easily upgraded for harvesting provided the harvesting requirements are taken into account in their design.

Firebreaks/fuel breaks: Where the cultural use of fire is high, wide external firebreaks are essential. Firebreaks are most effective against grass fires and their effectiveness reduces dramatically where wooded or forested areas are adjacent to the plantation estate (Wilson 1988). In these areas, firebreaks need to be combined with protective burning around the external boundary sufficient to prevent wildfires spotting into the plantation. Firebreaks are of little use unless they are associated with a trafficable road. The requirement for internal firebreaks is greatest when the plantations are young, the fuels are mostly grassy, and the forest has not developed a high spotting potential. Under these conditions wide internal firebreaks provide additional security for fire fighters when high flames can occur under moderate weather conditions and visibility within the plantation is low due to low green branches and dense fuels. As the plantation ages the requirement for wide firebreaks is reduced and internal roads designed for logging and fire access are sufficient to assist fire fighters to suppress surface fires.

Fuel management: Fire management of plantations is facilitated if fuel management is planned from the inception of the plantation program and silvicultural techniques are scheduled to avoid excessive fuel accumulations. Factors to take into consideration are:

- At establishment, completely remove debris from the previous vegetation: wind-rows of old logging debris should be avoided by efficient harvesting or removed by burning and stoking.

- Control grass and herbaceous weeds by spraying with weedicide prior to planting or through clean-tending operations.

- Use establishment practices such as fertilising and competition control to achieve rapid growth and early crown closure to suppress grasses and weeds.

- Retain a high stocking by replanting, if necessary.

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

- Form prune as early as possible to remove large "wolf" branches.

- Carry out repeated pruning operations at short intervals to prevent excessive accumulations of pruning debris.

- Combine grazing within the plantation as soon as possible. Note that agroforestry combining grazing and timber production from wide spaced plantings may not provide adequate fuel control in mediterranean climates. In good seasons prolific grass growth may not be reduced by grazing pressures alone, particularly if good feed is available elsewhere and additional stocking is not readily available for agistment within the agroforest. Fast-moving grass fires have sufficient intensity to kill moderately fire resistant species such as *P. radiata* (Cheney 1982).

- Physical removal of fuel is costly and time consuming but may be deemed worthwhile in selected strategic areas to protect major assets.

- Prescribed burning can be carried out beneath fire resistant species from age 10 to 15 or when trees are greater than 15 cm dbh. Prescribed burning is most efficient when fuel loads consist primarily of fine materials less than 6 mm in diameter such as litter, grass and scrub debris. Large log material left from previous clearing operations can be a primary source of butt damage, and heavy accumulations of pruning or thinning slash severely complicate any burning operations: prescribed burning may then be impractical in any but the most fire resistant species. Prescribed burning is done most efficiently when all other fuel reduction measures suggested above have been carried out.

SUPPRESSION

Plantation fire suppression is based on mounting successful initial attack. The resources required to achieve this objective include early detection, efficient despatching and rapid travel to the fire. These are relatively simple to evaluate when fires start from a single ignition point within the plantation. Where the fire threat is from outside the plantation, and this is more often the case than not, the plantation suppression forces must be integrated with those of the surrounding rural community. Initial attack by plantation crews is directed at fires starting some distance from the plantation so they can be suppressed before they reach a substantial size or before weather conditions deteriorate making suppression impossible. Co-operative arrangements need to be made with rural fire organisations or specific legislation enacted to give the plantation authority control over lighting of fires and fire suppression within a stated distance of the plantation boundary.

Australian plantation authorities can provide examples of suppression organisations and equipment specifications which have been developed to different degrees to meet specific requirements determined by the plantation fuels and fire weather.

The following generalised guidelines have been adopted by Australian fire authorities in a severe fire climate:

- First attack requires direct suppression. The most effective is rapid application of large volumes of water or chemical retardant at high pressure. Tankers require a reasonable road speed (60 to 80 km/h) where road standards permit and this should not be sacrificed by excessive loads or off-road capability.

- Rapid head fire suppression in *P. radiata* plantations can be achieved by delivering water at a maximum rate of around 500 litres per minute at a pressure of 1000 kpa through at least 60 m of 20 mm diameter hose.

- Tankers should be dedicated to fire control, at least during the designated fire season. The design of slip-on tank and pump units for a range of prime mover sizes are available from Australian State forest services. These units allow the

  prime mover to be directed onto other duties outside the fire season or brought in on contract during the fire season.

- A range of tanker sizes is required for efficient initial attack. Small units of about 500 litres capacity have the advantage of speed and manoeuvrability. Large units of 4000 litres and above have longer endurance but are often slow to deploy. A combination of units can ensure that water is continuously available.

- The adoption of equipment primarily designed for logging and/or for weedicide application may have some superficial attraction but experience suggests that this is not a satisfactory solution.

- Manpower resources are usually readily available during establishment stages of the plantation, but as the planted area increases a serious manpower shortage for fire protection can insidiously develop.

- Regardless of what arrangements are made for equipment or manpower it is essential that there be a permanent core of trained fire fighters who can make up the initial attack forces and can act in a supervisory capacity as crew leaders in extended fire fighting campaigns.

CONCLUSION

Much is known about plantation protection in Australia and a range of practical examples can be drawn from Australian experience. The consequences of severe wildfires can ruin economically a plantation enterprise. Fire protection must therefore form an integral part of forest management and must be planned from the inception of the plantation scheme. In moderate and severe fire environments a small permanent fire management group is required to ensure planning, fuel reduction and suppression are efficiently integrated with other management activities. The degree that fuel management is required throughout the life of the plantation depends on the fire climate, the fire risk and the value of assets under threat.

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