JIM Group

Ref 70

STATE FORESTS

Discussion Paper:

Bushfire risk and the application of appropriate fire protection standards in pine plantation areas.

Issue

Following the fires that burnt through native vegetation and pine plantations into Canberra in January 2003, concerns have arisen in some communities about whether current regulatory arrangements applying to pine plantation establishment and management and bushfire management are adequate in terms of protecting communities from pine plantation fire risks.

Background

On 18 January 2003, a large, intense, uncontrollable bushfire burnt through forests, grazing lands and pine plantations impacting the suburban fringe of Canberra, tragically resulting in four deaths, and causing the destruction of 488 dwellings, approximately 100 other structures and 4000 head of livestock. The ACT component of the fire complex burnt a total of 157,170 hectares. The majority of the area (109,400 hectares, or 70 percent) was nature reserves, 16,770 hectares (11 percent) was plantation forest (including 10,500 hectares of pine plantation), and the remaining 31,000 hectares (19 percent) was rural land. The fire complex that impacted Canberra is widely recognised as an extreme fire event, in terms of fire weather, behaviour and impact.

In media coverage and post fire analysis/reviews, significant attention has been given to the presence of pine plantations in the fire area, and the proximity of plantations to some of suburban areas impacted by the fires. Concerns have arisen in some communities living in proximity to pine plantations, about the level of fire risk posed by plantations to communities in the wake of the Canberra fires in particular. Scientific analysis of the fire behaviour in the ACT pine plantations and other vegetation types burnt in the fires, and the factors contributing to house losses has been progressing since the event, but is yet to become available as scientific and/or informative material for fire authorities and the general public. In the meanwhile, some local communities have begun lobbying NSW Government agencies for changes to regulatory instruments and/or standards applying to fire protection in pine plantation areas.

This discussion paper has been prepared to assist NSW Government agencies dealing with these concerns to identify and distinguish between the facts and perceptions surrounding the issue.

Historical and current regulatory environment

Regulatory arrangements before the *Plantations and Reafforestation Act 1999*

Prior to the introduction of the *Plantations and Reafforestation Act 1999*, a number of Acts and several NSW Government agencies as well as local government could be involved in land use approvals for plantations. These included:

- Local Councils
- Department of Land and Water Conservation
- National Parks and Wildlife Service
- Environment Protection Authority
- NSW Fisheries
- Department of Urban Affairs and Planning

Few local Councils required consent for plantations and approvals for specific activities generally rested with NSW Government departments. Local Councils were the only agencies able to attach

consent conditions regarding management for fire and then only through the development application process. In the unusual circumstance that development consent was required, conditions of consent generally specified setback distances from dwellings, and firebreak standards. Accordingly, the range of conditions and standards across NSW was inconsistent, ranging from zero in many areas to a suite of conditions and standards that varied at the discretion of Councils over time and between specific applications.

In general, the process of obtaining the necessary consents, licenses and permits to establish a plantation was complex, time consuming, and costly. It was considered by the plantation forest industry in NSW to be a significant impediment to plantation investment in NSW, with investors more likely to pursue investment in other States. Concerned by this, the NSW Government established a Plantations Taskforce, chaired by the Premier's Department, with the end result being the introduction of the *Plantations and Reafforestation Act 1999* to remove plantations from the existing regulatory regime and establish a new, streamlined approvals process.

Plantations and Reafforestation Act 1999

Prior to the introduction of the *Plantations and Reafforestation Act 1999,* plantation development approval could require as many as 10 separate licenses, approvals or permits covered by more than five Acts. The NSW Government introduced the *Plantations and Reafforestation Act 1999* with the following prime objectives:

- To make the process for obtaining development consent and licences for plantation development streamlined and timely
- To make the cost of regulatory compliance for plantation development in NSW competitive both nationally and internationally.
- To retain the rigour of current regulatory processes aimed at ensuring ecologically sustainable development

These objectives were achieved through implementation of the following strategies:

- Reforming regulatory processes applying to plantation development to achieve reasonable and predictable timeframes for gaining approvals and licenses
- Providing a 'one-stop-shop' development approval and licensing process for plantation developers
- Maximising the predicability of the range of consent and license conditions required for plantation development.

The conceptual basis of the regulatory regime provided by the *Plantations and Reafforestation Act* was to remove the complex range of consents, licences and permits required under a raft of Acts and regulatory instruments, and bring necessary and appropriate regulatory standards into a single 'Code', compliance with which provides the means to provide a timely and simplified up-front approval process.

The Plantations Taskforce which oversaw the development of the Act and subsequently the 'Code' had representatives from the Government departments with an interest in plantation development as well as those with environmental protection and regulatory responsibilities in respect of plantation approvals. These agencies included, Department of Urban Affairs and Planning, The Cabinet Office, NSW Agriculture, Department of Information Technology and Management, Department of Land and Water Conservation, National Parks & Wildlife Service, Treasury, State and Regional Development, and State Forests.

Consultation with other departments, including the NSW Rural Fire Service, conservation groups and private plantation interests, was undertaken and normal public exhibition processes were followed. The expertise of CSIRO was engaged to assist the taskforce with the development of the 'Code'.

Fire protection standards were considered in the pre-public exhibition phases of *Plantations and Reafforestation (Code) Regulation* development, however, these were later removed at the request of conservation and private plantation sector representatives, and to remove potential for regulatory duplication. The removal also simplified what was becoming a complex Code and clarified which agency was responsible for regulating fire management. The removal of draft fire protection conditions was offset by the inclusion in clause 8 of the *Plantations and Reafforestation (Code) Regulation 2001* of provision requiring compliance with appropriate provisions of the *Rural Fires Act 1997*. These provisions ensure that the Code does not prevent the following:

- measures taken in an emergency,
- measures taken in accordance with section 63 (notified steps) of the *Rural Fires Act* or
- any clearing carried out in accordance with a bush fire risk management plan.

The *Plantations and Reafforestation (Code) Regulation* details environmental standards for road and track construction (including fire trails) if they are constructed on the authorised plantation area.

Under the *Plantations and Reafforestation Act*, plantations are defined quite broadly (section 5):

> An area of land on which the predominant number of trees or shrubs forming or expected to form the canopy are trees or shrubs that have been planted (whether by sowing seed or otherwise):
> (a) For the purpose of timber production
> (b) For the protection of the environment (including for the purpose of reducing salinity of the land or otherwise repairing or improving the land, for the purpose of biodiversity conservation or for the purpose of acquiring or trading in carbon sequestration rights, or
> (c) For any other purpose
> But not principally for the purpose of the production of food or any other farm produce other than timber

Exempt farm forestry is defined as the carrying out of plantation operations on a farm as long as the total area of plantation does not exceed 30 ha and consent for clearing is not required. Exempt farm forestry does not require consent under the *Plantations and Reafforestation Act 1999*, and is exempt from the need for development consent under the *Environmental Planning and Assessment Act 1979*.

Therefore all revegetation which involves planting trees or shrubs is a plantation and needs to either qualify as exempt farm forestry or seek authorisation under the *Plantations and Reafforestation Act 1999*.

NSW Bush Fire Coordinating Committee - Notified Step

Section 63(4) of the *Rural Fires Act 1997* provides for the Bush Fire Coordinating Committee to develop and advise persons of "notified steps" for areas or activities to which bushfire management activities apply. 'Notified steps' means:

> (a) any steps that the Bush Fire Co-ordinating Committee advises a person to take under subsection (4), or

(b) any steps that are included in a bush fire risk management plan applying to the land.

The NSW Bushfire Coordinating Committee (BFCC) developed a specific 'notified step' for planted forests to ensure that:

- Plantations are recognised appropriately as assets requiring fire protection, in accordance with BFCC Bushfire Risk Management Planning methodologies
- Plantations are appropriately classified in terms of bushfire 'hazard', 'vulnerability' and 'threat' criteria in accordance with BFCC Bushfire Risk Management Planning methodologies
- A range of appropriate bushfire risk management strategies are identified in relation to plantations

Planted forests are not defined in the notified steps and a size limit for when the notified steps apply is not included.

The 'notified steps' issued by the BFCC limit plantation establishment within 30 metres from habitable buildings, and identify that habitable buildings should not be approved to be built within 30 metres of an existing plantation. They also identify the need to establish and maintain suitable access roads and fire breaks, and as appropriate, watering points, and hazard reduction by grazing and/or burning (copy of BFCC 'notified steps' attached).

This notified step attempts to recognise the significant commercial investment and assets in local and regional economies and that they face a significant risk from bush fire.

These notified steps apply to any person(s) who establish a planted forest in any area of the State.

The BFCC 'notified steps' in relation to plantation were circulated for necessary action to all Bushfire Management Committees in NSW and internally through BFCC member agencies.

Planning for Bushfire Protection

Planning for Bushfire Protection (2001) produced by the Rural Fire Service and Planning NSW, provides the necessary planning considerations when developments are proposed that are in close proximity to areas likely to be affected by bushfire. These considerations are applied through the development consent process under the *Environmental Planning and Assessment Act 1979*.

This document outlines the minimum setbacks required for habitable buildings in bushfire prone locations. These setbacks or Asset Protection Zones (APZ), are required for any building development adjoining a bushfire hazard area. The broad intent of an APZ is to provide separation between the development and the hazard to prevent structure ignition from radiant heat/direct flame impingement and to provide 'defensible space' in which home owners/firefighters can safely defend against ember attack ignitions after the passage of the fire front. The APZ is achieved by ensuring a progressive reduction of bushfire fuels. The APZ is comprised of an Inner Protection Area (IPA) and an Outer Protection Area (OPA). In the IPA fuels are minimised close to the development, with most trees and shrub removed. In the OPA, fuel loads are reduced to decrease the intensity of potential approaching fires. The distances of both IPA and OPA are dependent on vegetation type and slope of land and are detailed in Table 1 below.

Table 1 – Minimum specification for asset protection zones for residential purposes in bushfire prone areas (taken from RFS, 2001) based on group 2 – plantations

Position of hazard from asset	Slope	Asset Protection Zone (APZ) (m) APZ=IPA+OPA	Inner Protection Area (m) (IPA)	Outer Protection Area (m) (OPA)
Upslope	$>5^0$	20	20	0
	$5 - 0^0$	30	20	10
Downslope	$>0 - 5^0$	35	25	10
	$>5 - 10^0$	40	30	10
	$>10 - 15^0$	50	40	10
	$>15 - 18^0$	60	50	10

It is important to note that the setback distances specified in the *Planning for Bushfire Protection* are based on theoretical modeling undertaken by the CSIRO. This modeling takes into account only radiant heat levels required to break glass (i.e. 14 kW/m^2) and does not consider ember attack or residency time. The research underpinning these setback distances, are based on incomplete and unverified research and modeling. This level of radiation is beyond the pain threshold of firefighters in normal fire clothing and it would be prudent to use a greater set back if fire fighting around the building is proposed at the time of fire front impact.

It is also important to note that the standards apply in relation to the approval of dwellings/buildings near plantations, but not in reverse to the establishment of plantations next to dwellings/buildings as this is dealt with through the notified steps under the *Rural Fires Act 1997*.

Common perceptions and realities about pine plantation fire risk

Plantation fires as a threat to communities

Community attitudes toward the expansion of softwood plantations are variable within and between rural communities. Differences in opinion divide largely on the perceived benefits of plantation forestry relative to alternative agricultural uses such as livestock production. Some rural communities, with long and proud histories of livestock production, feel threatened by the establishment of pines on former grazing lands, while others welcome new industry and employment opportunities. These underlying social/change issues often sit behind issues of fire protection concerns.

There is concern in some rural communities that pine plantations significantly increase the fire threat to surrounding life and property compared to previous land uses (predominantly agricultural). Much of this concern is based on the belief that fires in pine plantations are more difficult to suppress when compared to other fuels, as well as some local perceptions that fire intensities are greater in Pines than in Eucalypts. The large number of houses destroyed in the recent Canberra fires has intensified this concern in many areas. How valid are these concerns and perceptions?

Cheney et.al, (1998) identify that the overall fire risk in districts with well established plantations is in fact decreased in relation to districts without plantations because:

- there is typically improved access for fire control in the district,
- existing local firefighting resources are supplemented by additional forest industry specialised fire management infrastructure established to protect plantations (and other assets)
- the increased work force associated with the plantation improve the overall efficiency of fire control both within the plantation and in the surrounding district.
- It is also important to note that fire develops more slowly and spreads less rapidly in plantation than fire in grassland.

In terms of historical losses in plantation areas as compared with non-plantation areas, records and data are difficult interpret due to inconsistency and incompleteness. However, there is no evidence that house/agricultural infrastructure losses are greater in plantation areas than in non-plantation areas, and it is more likely that the reverse is true. Large plantation fires, which emerge from plantations into agricultural areas are very rare. Over State Forests of NSW long history of plantation management the following record shows just how rare:

- **Walcha Plantation Area**: no recorded house/structure loss from plantation fires. Ten fires have burned in or into plantations in the 22 years from 1979 to 2002, burning a total of 40 ha (0.02% of net planted area per annum). Of the 40 ha burnt, 30 ha were burned by a single fire in 2000 – this fire was of low intensity (escaped private property burn) and no plantation loss resulted.
- **Macquarie Plantation Area**: no recorded house/structure loss from plantation fires. 138 fires have burned in or into plantations in the 22 years from 1979 to 2002, burning a total of 4244ha (6.5% plantation area). Of the 4244ha burnt, 3410ha (80%) was burnt in two large plantation fires. The Glenwood fire of 1982 started in the plantation from a lightning strike. Drought had resulted in drier than normal fuels in the plantation and severe fire weather resulted in 2500 hectares burning (971ha SF plantation and 320ha private plantation). The Canobolas fire of 1985 burnt 9,610 hectares (2,439ha of State Forest plantation). The fire started on private property 5km from State Forest.

- **Hume Plantation Area**: no recorded house/structure loss from plantation fires. On average less than 0.01% of this regions plantation estate has burnt on any given year. In the 22 years from 1979 to 2002, no single fire has burnt more than 20ha. During this period, no fires have escaped the plantation estate onto private land.
- **Bombala Plantation area:** no recorded house/structure loss from plantation fires. 178 fires have burned in or into plantations in the 22 years from 1979 to 2002, burning a total of 6551ha (6.5% plantation area). Of the 6551 hectares burnt, 6475ha (98.8%) was burnt in one extreme fire event. The Bondi fire of 1983 started from a lightning strike, 28km south-west from a State Forest plantation, in Victoria. Nine days after ignition, a violent SW change with winds of 100-120km/h, gusting to 160 km/h forced the 18km wide fire front north through tall, long unburnt, drought affected eucalypt forest into NSW. In less than 1 hour 6475ha of plantation were burnt, along with other forests and agricultural lands.

The above historical data supports the Cheney et.al., (1998) observation that fire risk is reduced in areas with well established plantation infrastructure and management systems. In recent history, the major plantation forest fires that also involved significant property loss (Ash Wednesday (1983) and ACT fires (2003)) involved large uncontrollable fires burning in extreme weather conditions, in which structures were burnt adjacent to a range of vegetation types including eaten out pastures, woodlands, Eucalypt forests and pine plantations.

To address the perception that pine forests are more flammable than eucalypt forests, the conditions under which pine fuels are more or less flammable than eucalypt fuel must be carefully defined. Under mild conditions the moisture content of extinction in pine litter (the moisture content at which fire stops spreading and goes out) is higher (25 – 30%ODW) than it is in eucalypt litter (18 – 20 %ODW). Both pine litter and eucalypt litter respond slower to changes in atmospheric moisture than grass fuel and fires in both forests will burn for longer during the evening when the humidity rises than fires in grasslands. In South Australia in 1983 fires in the pine plantations persisted overnight and continued burning for several days when the fire perimeter in the surrounding grasslands largely went out during the first night. This is typical of fires burning in landscapes with a mix of grasslands and forests.

Under weather conditions that produce high intensity forest fires, the difference in flammability between pine and Eucalypt disappears and the fire behaviour is largely determined by the structure of the forest and the amount of fine fuel on the ground. Maximum rates of spread of 10 - 12 km/h have been recorded in both mature pine and tall eucalypt forests under FDI exceeding 100. The flame heights produced under these conditions then largely depend on the height of the forest. During the 2002/03 fires, major fire runs through Eucalypt forests covered in excess of 40 kilometers in a single day, with long, intense crown fire runs and long-distance spotting being a feature of these fires. There is no credible evidence that the fires that burned through the ACT plantations burnt any more quickly or intensely than the major fire runs in Eucalypt fires burning in southern NSW and northern Victoria under the influence of similar drought and weather conditions. Post fire analysis of plantation fires in Bombala in 1983 and Sunny Corner in 1982 identified that fire progress was slower through the pine plantation than through hardwood (Eucalypt) retention areas (Moore, 1987).

In relationship to spotting distances, current science pre-dating the Canberra fires identifies that spotting distances from a range of Eucalypt forest types significantly exceed spotting distances from pine plantations under similar conditions. Spotting distances from pines rarely exceed 3 – 5 km even under extreme conditions and while spotting from eucalypt forest depends strongly on the type and condition of the bark spotting from mixed species dry forest may often be 15 km down wind. Evidence from the Canberra fires suggests that the spotting distances from both forests were lower

than expected during the major runs but it appears that the occasional recorded long distance spotting originated from fires burning in eucalypt forest (N P Cheney Pers comm.).

A NSW report on the 1985 fire study tour to North America records observations on the reduced rates of spread of coniferous forest fires versus Australian eucalypts. Smith (1985) notes,

> *"Northern Hemisphere conifer forests exhibit some fire behaviour characteristics significantly different to Australian Eucalypt forests. Difference in spotting potential is perhaps the most significant from a suppression angle and it is the low potential for North American forests to throw long distance spot fires which renders these forests amenable to aerial suppression activity. Nevertheless an intensity level is reached where aerial attack ceases to be effective and continued use of either retardant mixtures or pure water is a sheer waste of resources."*

At the lower end of the fire weather/behaviour spectrum, the historical evidence is that very few fires starting in pine plantations escape control efforts and spread through and out of plantations to damage other assets. While there has been no scientific analysis of why this may be the case, operational expert opinion concludes:

- With the high stocking rates of plantations (relative to most native forests) and relatively early and high degree of canopy closure, surface fuel moisture and sub-canopy relative humidity are very often significantly higher than in more open native forest types under the same conditions. This provides more favourable conditions for initial attack success, more often.
- Relatively good access within the plantation (relative to other rural land uses and native forest conditions) provides for higher probability of initial attack success
- In general the higher concentrations of dedicated forest fire detection and suppression resources in plantation areas in comparison to other rural land use areas increases initial attack suppression success probability.

It is widely acknowledged that grass fires are easier to suppress than forest fires. Suppression of grass fires can occur over a greater range of conditions than forest fires, and in extreme fire conditions attack can be mounted on the flanks of grass fires. The easier suppression of grass fires is due to the nature of the fuels in grasslands that closely track changes in atmospheric moisture. The result is that fires in grasslands are often of short duration (ie less than one day) due to rises in humidity leading to self-extinguishment overnight. By comparison, plantation and native forest fires will very often persist overnight during the fire season increasing suppression difficulty. However, grass fires burning in windy conditions often cover very large areas during their burning time in comparison to forest fires.

When considering the ease of extinguishment however, the setting of the landscape where plantations occur or are proposed must also be considered. Plantations are generally planned for moderate rainfall locations that allow for good growing conditions. These landscapes are not solely occupied by agricultural crops and grasslands but in nearly all situations are intermixed with numerous scattered remnant patches of native forest. When significant fire events do arise in these landscapes, the ease of extinguishment in these predominantly grassland settings is negated as the fire usually enters into the remnant patches of native forests, increasing the difficulty of suppression. Fires in the remnant patches continue burning well after grassed areas have extinguished, regardless of their size, and provide a potential source for future re-ignitions.

The general conclusion that may be drawn from the foregoing historical risk analysis is that it is likely that communities living in areas with well developed and managed pine plantations are exposed to significantly lower fire risk than communities in similarly forested areas with native Eucalypt forests.

Large plantation fire analysis

The following examines some of the research that has resulted from recent significant fire events.

Canberra Fires, ACT, 2003

The 2003 Canberra fires, destroyed the second largest area of softwood plantation on record (second only to Ash Wednesday fires) , which makes it somewhat of an unusual fire event.

In these fires it was difficult to establish a direct correlation between house loss and adjacent vegetation type. The major loss of houses was certainly downwind of pine plantations but this was also in the path of the major headfire that burn towards the suburbs. A substantial number of houses were also lost adjacent to eaten-out grass paddocks, woodlands and amenity plantings of native trees carrying relative low fuel loads. There were also house losses associated with a fire induced tornado that appeared to be generated by the confluence of the two major fires and travelled ahead of one of the headfires though open grassland and grazed woodland for 6km before striking the suburbs. Wind speeds were estimated to be in excess of 200 km/h in a narrow path 200m wide and it unroofed homes and smashed windows before the fire arrived making them more vulnerable to ember attack (NP Cheney pers. comm.).

The CSIRO Bushfire Behaviour and Management team has been working to understand the behaviour and effects of the bushfires that burnt into Canberra's suburbs. The initial phase of their work has been to document the destruction and damage to the houses in the Canberra suburbs. Of primary interest to the group were garden design and the effect this had on the survival of the house. Observations show that setback distances were sufficient to protect houses from radiant heat and flame impingement (NP Cheney pers. comm.). Preliminary observations of the gardens of houses affected by the bushfires highlighted the significance of trees and shrubs that retain dead leaves and other material. Trees and shrubs such as conifers (cypress, pencil pines, etc), banksias or wattles that were not neatly maintained and contained significant dead material provided ready sources for ignition from sparks, embers and flame contact. If such trees and shrubs were located next to the house they then appeared to provide a route for the fire to enter the house, via decks, pergolas, eaves or windows. Thick mulch on garden beds and some wooden fences also appeared to provide a wick to houses, garages and sheds and were responsible for many houses burning down (CSIRO, 2004).

The CSIRO Manufacture and Technology section is also researching the damage to houses from the Canberra fires. They examined suburban areas including those with pine plantations adjacent to residential areas where houses were destroyed or damaged. In many locations, plantation occurred within 40m of houses. Most significantly, the evidence revealed that no homes were destroyed by the radiant heat and/or flame impingement from the plantations. Ellis (pers.comm.) found that there was no evidence of glass windows breaking from radiant heat. According to Leonard (2003), the actual fire front never got close enough to any houses to actually impose radiant heat or flames directly on the structures themselves. The set back distances in the Canberra situation were sufficient to prevent any of that. This evidence was readily apparent from examination of the vegetation in front of burnt houses where the gardens showed very little sign of radiant heat or direct flame impact, except for the actual house burning down (Leonard, 2003).

Evidence has shown that houses were not enveloped in flames from the advancing fire front, but were ignited by ember attack entering houses via attack points such as timber decks and sub floor vents. Fires resulting from embers entering houses developed slowly and the houses burnt down as

a result from the combustible material inside the house catching fire in the hours after the fire front was well gone (CSIRO, 2004).

Previous research had never shown ember attack to cause the level of destruction seen in Canberra, with clusters of houses destroyed. Leonard (2003) believes that there were a significant number of house-to-house ignitions. Once a house became alight, it spread to the next house due to the limited fire fighting resources available to prevent adjacent houses burning.

Some of the "on-the-spot" TV footage of Canberra fires showed massive movement of embers. Most of the cleared grassy areas between perimeter roads and forest areas burnt – but that is the nature of vegetation under extreme fire conditions. Essentially anything that can burn, and is impacted by one or more embers long enough to set it alight, will catch alight and will burn. A very similar picture emerged in Como-Jannali in 1994 when house losses immediately above the Glen Reserve were substantial. The echelon of houses closest to the bush suffered extensive losses, but so too did the second, third, fourth, fifth and sixth echelon. In many instances, inadequate ember proofing coupled with an inadequate standard of fire hygiene contributed enormously to the losses (Smith pers. comm.)..

Another important observation from the Canberra fire situation was the extent to which, in the absence of firefighters/appliances, able bodied, fire aware residents were able to save their own and in some cases neighbours homes as well. A number of determined residents were able to extinguish numerous small fires starting from ember attack which otherwise most likely have burnt down their home.

However not all 'defended' homes could be saved. Failed attempts mostly occurred where the houses being defended had large or multiple flammable shrubs close up to the house (Smith pers. comm.). In locations where the head fire emerged from adjacent forest some residents' efforts to defend their houses were overwhelmed by prolific ember attack (NP Cheney pers. comm.), however, others with very little in the way of combustible material nearby the house remained unburnt with little intervention (Smith pers comm.). The other area where 'defended' houses were lost was in the areas subjected to extreme wind speeds that damaged the house exposing it to overwhelming ember attack. The radiant heat load in the setback zone although insufficient to break grass was certainly sufficient to drive people indoors and the ember density associated with the head fire passage was sufficient to ignite gardens and houses before the residents emerged.

Research has shown that firebrand density falls off exponentially with distance from the source (Ellis, in prep.). Therefore there is a good observational case to provide a setback from any forest that is greater than the theoretical distance where the radiant heat flux will not break glass. Set-backs specified in *Planning for Bushfire Protection* are based on modelled distances at which radiant heat flux will not break glass (14 kW/m^2). These set-backs distances are <u>not</u> set so as to provide radiant heat flux levels in the set-back zone which are safe for firefighting by homeowners or fire fighters dressed in bushfire protective clothing during the period of fire front impact.

<u>Ash Wednesday Fires, Victoria & South Australia, 1983</u>

Following the Ash Wednesday fires, the House of Representatives Standing Committee on Environment and Conservation conducted an inquiry. The resulting report identified that most bushfire damage to houses was caused by embers lodging in openings and cracks in houses and gaining entry through eaves, under tiles and in gaps around doors and windows (Australian Government, 1984).

Once again research by the CSIRO (Ramsay *et al.*, 1986, Ramsay *et al.*, 1987) found that in the majority of cases, ignition appeared to have been caused by wind-borne burning debris, although radiant heat and flame played a significant role in cases where the houses directly abutted dense undeveloped vegetation. This research found that burning debris attacked houses for some time before and for many hours after the fire front, whereas the fire front itself impinged on the houses for only a few minutes.

The presence or absence of firefighting resources for property protection also affected the scale of house loss. At Mt Macedon, 90% of the houses defended by able bodied occupants survived, whereas only 30% of unoccupied houses (which were also unattended by neighbours or firefighters) survived (Wilson et. al, 1986).

During the extreme conditions of Ash Wednesday, it was also noted that even major natural firebreaks such as four-lane highways had no impact on the run of the fire.

Beaumaris Fires, Victoria, 1944

In 1944 many bushfires threatened the outskirts of Melbourne. At Beaumaris fires destroyed some 58 houses. A scientist from the Division of Forest Products of the Council for Scientific and Industrial Research (CSIR) conducted a study on the affected houses, in order to determine the influence of the type and details of construction on the resistance of houses to external fire hazards (Barrow 1945). This was the first occasion on which a scientific study of this nature had been attempted.

Barrow's (1945) findings contrasted sharply with the then-held community view of bushfire attack on buildings, which held that the destruction of timber-clad houses was virtually inevitable, with brick houses standing a better chance of surviving. Barrow determined that 'in a fire of the type that swept Beaumaris, the chances of a house surviving are determined more by the nature of the surroundings and the details of construction than by the materials used in the walls. He found that fires started inside the houses, i.e., in the roof space, in rooms, or under the floors, the immediate cause of ignition in such cases being the entrance of flame, sparks and burning debris through openings such as ventilators, eaves and windows'.

Barrow was the first person to scientifically identify the ignition mechanisms of bushfire attack on houses, and to document the fact that houses tended to burn down from the inside. His work attacked existing myths about the destruction of houses in bushfires, and gave clear guidelines to improving the performance of houses in bushfire-prone areas.

The conclusions that can be drawn from post-fire impact evidence at these major fires involving plantations are:

- There is empirical evidence to suggest that even under extreme weather conditions, a set-back distance (between houses and pine plantations) of 30 metres (on level ground) is sufficient to safeguard houses from radiant heat and direct flame impingement.

- The setback distances in the Canberra fire situation were adequate to provide some but not all homeowners with the opportunity to successfully defend homes from ember attack where they chose to do so. Factors associated with ember attack overwhelming suppression effort were the condition of the home and surrounding garden, and house location in relation to the head fire or destructive wind paths.

- Improvements to home/garden/fuel maintenance immediately adjacent to structures, to building design and construction standards, and to education programs that increase home owner ability to counter ember attack are far more likely to significantly reduce house losses than are major increases in set back distances.

- The fire behaviour associated with multiple large fires in forests carrying heavy fuels can create conditions that exceed the general specifications for home protection for a single fire under extreme conditions.

Pine Plantation Fire Risk Management – the integrated picture

The history of fires in pine plantations around Australia is that most fires are contained without significant loss of plantation assets. The overwhelming majority of plantation losses have resulted from fires that have burnt into plantations from adjoining native forest or grassland under severe fire weather conditions, rather than from fires that commenced in pine plantations.

Plantation losses are low due to the fire protection strategies employed. These strategies have developed over many years and are aimed at reducing the impacts of fire by adopting a range of measures that minimise the occurrence and impact of fires. The fundamental principles of plantation fire management are:

- to provide a system of reliable access to plantation areas
- to carry out appropriate fire prevention and mitigation works such as hazard reduction burning in adjacent areas
- to maintain a reliable, multi-level system of fire detection
- to have in place a systematic approach to pre-emptive dispersal of initial attack resources
- to carry out determined initial attack with skilled and experienced personnel and effective appliances and equipment
- to progressively scale up suppression response and conduct operations cooperatively with other firefighting authorities
- to ensure that aggressive initial attack and suppression extends beyond plantation boundaries to adjacent land to minimise fires entering plantation.

These are the core elements of State Forests of NSW approach to fire protection in all its plantation regions. It is important to note that State Forests self-insures it plantations (carries no fire loss/damage insurance) in respect of fire management, and resources its fire management infrastructure accordingly. Most privately owned plantation growers choose to address their fire risk differently, with most having fire loss/damage insurance policies in place as a major part of their risk management. (ACT Forests followed this doctrine, but was unusual in this regard as most Government instrumentalities across Australia follow the self-insurance model.).

In general, where native forests are in close proximity to urban structures or close to rural properties it is desirable to carry out fuel reduction and modification (mostly by fuel reduction burning) in the adjacent native forest. This is in additional to the requirements of an Asset Protection Zone, although there are no regulatory provisions that make such action mandatory.

In Australia, fuel reduction burning is not widely practiced in *Pinus radiata* plantations due to the fire sensitivity of the species. Fuel modification in young *Pinus radiata* is most often achieved by grazing, and in older age classes may be achieved by successive thinning and pruning treatments. Such treatments however cannot prevent significant ember attack when fires are running under

extreme weather conditions, just as hazard reduction burning in eucalypt forests does not prevent significant short distance spotting from such forests in similar conditions. The Canberra fires dramatically illustrate this point, as fire generated prolific ember attack from sections of plantation that had been thinned, pruned and had even been subject to low intensity needle litter burning.

The key point arising from examining the elements that make up an integrated approach to plantation fire risk management, is that regulatory approaches to setbacks and fire trail provision/standards can only ever be a small component of a much broader picture.

Plantation Fire Behaviour and Risk - Summary

Australia has a history of destructive bushfires causing property damage and loss of life. There are a number of factors that determine the likelihood of a house being destroyed. Research following significant fire events such as the recent Canberra fires, provides clear evidence that the most significant factor in determining whether a house is damaged or destroyed is ember attack. The risk of damage or destruction to houses from fire is strongly associated with the ability of embers to gain access into houses.

The impact of ember attack is also greatly affected by the fuel loads present in gardens around houses. Examination of the urban edge in Canberra identified high fuel loads in gardens and on the nature strips as a result of plantings and other activities by residents such as garden mulching. These fuel loads greatly increased 'spot-fire' intensity and provided a route for the fire to enter many houses.

To compound the impact of ember attack, the presence/absence of firefighting resources for property protection also affects the scale of losses. Without the intervention of firefighters/residents to suppress ember attack ignitions during the passage of a fire, the number of houses lost greatly increases.

Even though the use of firebreaks or setbacks are successful in protecting property from radiant heat and flame impingement, they have proven to be largely ineffectual against ember attack. The fires in Canberra illustrated the extent that embers emanate from fires. As part of their research, the CSIRO collected post-fire ember material from road gutters that included grass, leaves, and pine needles. Some of these ember materials were collected over 300 metres from urban interface (Cheney & Ellis pers comm.). Other evidence has shown that spotting distances of fires within pine plantations are considerably lower than of fires burning within eucalypt forests (generally only 10-20% of the eucalypt distance) and that fire can cross 60 metre wide firebreaks just as easily as it crossed 20 metre breaks (Bartlett, 2004).

Further evidence has shown that firebreaks of up to 100 metres width have proved no more effective than narrower breaks and in some respects may exacerbate the difficulty of control by allowing wind to penetrate the plantation and thereby increase fire behaviour within the plantation (Bartlett, 2004). All this evidence illustrates that fires will cross/spot over large distances.

There is a commonly held, albeit very mistaken belief that pine plantations increase the fire risk. Evidence from Canberra has shown that there was a poor correlation between house loss and adjacent vegetation type. In these fires, houses were lost adjacent to a range of vegetation types including grass paddocks (some of which were heavily grazed & eaten out), native forests & woodlands and pine plantations. Historical analysis of fire occurrence in the major pine plantation districts of NSW indicates that fire risk is more likely to decrease than increase.

The regulation of plantation establishment in NSW through instruments, such as the BFCC 'notified steps', is just one aspect of the fire protection measures required to protect rural assets such as property, houses and plantation. Such instruments do not obviate the responsibilities of consent authorities and residents from issues such as controlling home siting, design, building materials and removal of as much fuel as possible from around their property. Successful fire protection requires a partnership approach based on shared responsibility – it cannot be achieved exclusively by regulatory approaches. Residents must play their part by making their properties as defendable as possible in the event that a fire eventuates, that they can remain and defend their property. In this regard, fire authorities have a significant role in fire protection education and empowering communities to take safe prevention and defensive actions to prevent property losses and damage.

It should also be recognised that plantations are a legitimate land use and require protection measures from neighbouring land uses. The myth that plantations represent a greater fire threat to agricultural neighbours, needs to be addressed through pro-active public education programs as historical data illustrates that the converse is true.

Conclusions

Current scientific knowledge and evidence from recent post fire analysis support that current plantation set-back distances are sufficient to prevent homes catching fire from radiant heat exposure or direct flame impingement during major fire impact events.

Current set-back distances (applying to plantations and native forest alike) provided for in *Planning for Bushfire Protection* are based on radiant heat flux levels at which glass will not break under exposure to bushfire impact. The setbacks are not devised to provide safe defensible space at the time of fire impact. Fire service educational materials promote that residents only engage in suppression of ember ignitions before or after the passage of the main fire front when the radiant heat levels around the home are tolerable and safe.

House and garden 'fire protection hygiene' in the set-back or Asset Protection Zone, as detailed in *Planning for Bushfire Protection* is a vital component of the standards. Failure to implement the house and garden 'fire protection hygiene' components will severely compromise the protection levels provided by the setback distances.

Evidence from recent post fire analysis and historical plantation fire risk appraisal indicate that community fire risks have not been increased by the expansion of plantations in rural landscapes. This information also shows that areas with well managed plantations, and established protection infrastructure, that the community fire risk is more likely to be decreased. Well-trained, permanent plantation fire protection capacity plays a key part in reducing plantation fire losses and community fire risk.

Current fire science knowledge and evidence from recent post fire analysis identifies that home design and construction standards play an important role in reducing fire damage and losses. Importantly also, it has been identified that education programs that improve homeowner awareness of 'shared responsibility' with fire and land management authorities for fire protection, and ember attack defence techniques can significantly reduce fire damage and losses.

Recommendation

1. That when reviewing fire protection standards and regulatory instruments, the scientific and historical knowledge summarised in this discussion paper be utilised to guide the development of appropriate standards.

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