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PRIVATE FORESTRY SERVICE QUEENSLAND

Fire Management Guide For Timber Production

Eucalypt and Cypress Pine Forests

Queensland

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Revision History and Version Control

Version	Author	Changes	Approved By	Approval Date
3	S Ryan	original		September 2012
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Introduction

Fire is an integral management tool for native forest management. However on private land the use of fire is often seen more as a grazing management tool rather than specific to forest management. Indeed many graziers that practice cell grazing eliminate fire as a tool of management. Most landholders with tracts of native forest see themselves as graziers, managing areas of cleared land intermixed with areas of forested land that has a dual purpose of timber production and grazing. Mostly there is little differentiation between the fire management regimes practised within these two areas. Generally landholders use fire to achieve a range of outcomes, namely:

1. Reduce fuel loads and thus the risk of wildfire,
2. Provide a green pick for grazing
3. Control of eucalypt and wattle regrowth to manage woodland thickening.

Fire management in this form is not necessarily achieving the best outcomes for the forest, indeed a high intensity fire may knock back wattle and regrowth development but can also cause a range of problems including significant damage to tree bole or crowns. *In eastern Australia the loss of revenue attributed to bole defects, largely of fire origin, can be more than twice the revenue actually obtained from log sales (Greaves et al 1965, 1967).* Crown scorch can range from the death of leaves right through to death of branchlets and major branches, and the recovery period can reduce productivity for up to three years. Bole damage is usually more serious, particularly where heat from the fire results in desiccation of the bark and the death of the cambium layer of the tree. This level of damage causes a permanent injury to the tree resulting in 'dry side', a deeper burnt fire scar or the development of a kino vein or 'fire ring'. Kino veins and rings are one of the major reasons for a downgrade from sawlog to salvage grade, or alternatively butt docking to waste to ensure a log meets an A class sawlog classification. Pole specifications now have no tolerance for dry side so it is either docked or fails.

The purpose of this guide is to outline the role of fire in the management of Native Forests in SE Queensland and formulate a guide using case studies to demonstrate actual process on the ground.

Eucalypts and Fire

It is generally accepted that eucalypts are a fire tolerant, fire dependant species that have benefited over other species from a cycle of regular burning. While this is clearly the case, the cumulative effects of fire damage can cause significant production losses, particularly once one hot fire has resulted in stem damage. Subsequent fires, even mild ones will contribute to the deterioration over the production cycle of the tree leaving the tree prone to fungal attack and termites.

Eucalypts produce significant levels of fuel per year and particularly in dry forest types the fuel persists on the forest floor for long periods and can accumulate at more than 1 tonne/ha/yr. Fuel loads in dry forest types tend to have a higher calorific value per tonne due to higher carbon and lower ash content of the fuels and with the lower fuel moisture tend to burn more regularly. Consequently dry sclerophyll forests are generally made up of fire resistant species with the ability to survive even extreme wild fires. Couple this with the capacity of seedlings to produce a lignotuber, a woody carrot like root with the ability to exist on the forest floor and survive reoccurring fire, grazing or drought for many years, dry forest types are well equipped to survive regular fire. This of course does not mean the wood properties are not impacted by fires occurring under adverse conditions. Another consequence of this fire resistance is a stand made up of a mixed age classes.

Moist forests produce a higher quantity of fuel per year but due to the higher moisture content it tends to break down at a greater rate. This can change rapidly in drought conditions with a rapid build up of finer fuels as leaf and branchlets shed and the humus layer dries out resulting in a layer of loosely packed highly flammable fuel. When a fire occurs under these conditions the combination of high fuel level and extreme weather conditions result in a catastrophic event, killing a large proportion of the stand. This in turn stimulates a massive regeneration event and progresses into the even aged stands common in wet sclerophyll forests.

Native Forest Management and Fire

Until 1965 fire was deliberately excluded from Queensland State Forests, mostly as a result of the severe damage that had occurred with the early indiscriminate use of fire by settlers as a clearing mechanism. However it became clear that as fuel levels increased disastrous fires would be inevitable and did occur in 1951 and 1957. Accumulating fuels were not the only concerns, regeneration was virtually non existent in the dense fuel layers, whereas fire susceptible species were greatly advantaged and proliferating, significantly changing the species mix of the forest.

This unnatural exclusion of fire changes soils and nutrient cycling processes (Turner and Lambert 2005), creating an unfavourable environment for eucalypts and a more favourable environment for their pests and competitors (Jurskis 2005). Sick trees provide abundant high-quality food, allowing pests and diseases to proliferate (White 1993, 2004).

Conversely over-burning does not appear to have a detrimental effect on timber growth rates in the short term, but will impact on successful establishment of regeneration. Over burning also reduces soil carbon and the ground humus layer and is likely to contribute to a gradual deterioration in land condition and soil water permeability.

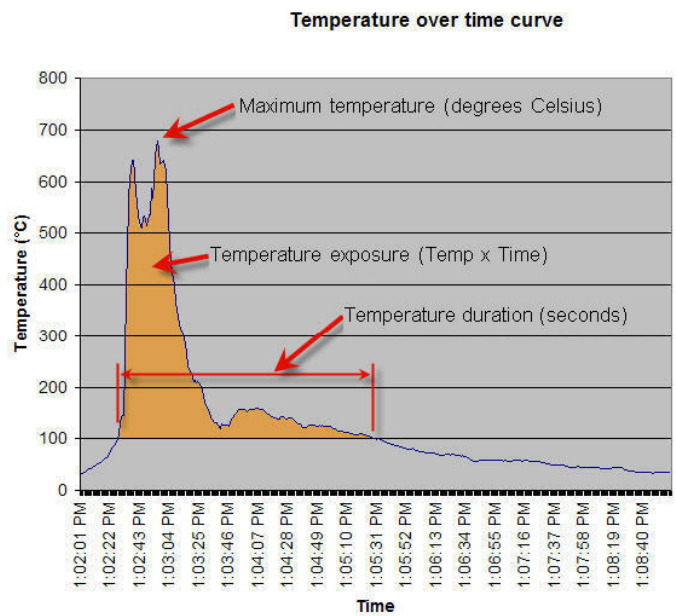
Fire and Wood Quality

Like all management tools, misuse or poor understanding of the implications of burning at the wrong time can have a substantial and long term loss of value and production in a forest stand. Very intense fires or fire burning for an extended period of time around the base of a tree will cause death or severe damage to the cambium layer of the tree. This can result in range of defects from fire scars, permanent loss of bark (dry side), through to damage to the cambium layer that, as it grows over, results in a separation of the wood fibres, causing a growth ring to occur. Rings are the major source of log downgrade by rendering that section of the log useless. Ultimately when the log is sawn the timber falls apart at the ring and is worthless.

Photo 1. Extensive dry side on a young pole, reducing the potential product to only salvage grade material

Long term wood deterioration is generally not caused by the actual fire and the immediate tree damage, but the long term tree growth reaction to that damage and any subsequent attacks by fungi, bacteria or insects.

Photo 2. Severe ring associated with damage to the cambium layer followed by its recovery and continued growth leaving a permanent separation in the wood fibres



Graph 1. Bark temperature against time exposure to fire. (Phil Lacy: The 'brown line' and the response of bark to fire) 2006

The duration and locality of the fire in relation to the tree bole will have as much impact as intensity. Graph 1 shows the rise and fall of the temperature of the bark, 1 m above the ground as a fire passes the tree. The longer the temperature is in the 500-700 Cº zone, the higher the probability of permanent damage occurring. This prolonged fire occurs as a result of burning when the drought index is high and the broad spectrum of fuels dries out allowing the heavy fuels to ignite and burn for an extended period. This is particularly the case with bark shedding trees. Fuel loads tend to increase in late spring in forest types dominated by bark shedding trees such as spotted gum and grey gum. Shed bark accumulates around the base of the tree and as conditions dry out, the dry bark contributes markedly to the risk of fire damage to the base of the tree.

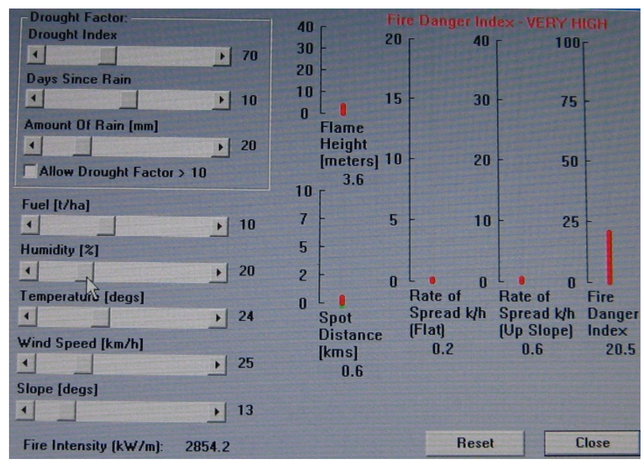
Drought and Fire Danger Indexes

Drought Index is a measure of moisture into, and evaporation out of soils. It commences at 0 from the last saturating rain event and accumulates each day by your local drought factor (SE Queensland has a drought factor of 1.) and corrected by any rainfall received. The Drought Index gradually increases to a total of 200 if no rain falls. It gives a very good indication of the moisture level of fuels, the higher the drought index the drier the fuel becomes particularly the medium to heavy fuels. When these fuels dry out, it takes a significant rain event to raise their moisture level, and so, even though you may receive 20 – 30 mm of rain and conditions look good for burning, the medium to heavy fuels such as dead hollow trees, logs, stumps and their underground roots are likely to catch and burn for a prolonged period. This can cause much wider problems if the weather conditions turn bad. From a timber management perspective burning when the drought Index is over 100 runs an elevated risk of fire damage to either crown or bole.

Table 1. Simplified Drought Factor Table Calculator

Date	Rainfall (last 24hrs)	Corrected Rainfall	Temperature	Corrected Drought Index	Drought Factor	Drought Index
1	**2**	**3**	**4**	**5**	**6**	**7**
		Subtract 5mm from col. 2 if no rain fall previous 24 hrs		Subtract rainfall (3) from total column 7	Drought factor for your area	Add 6 and 5
29.5	0	0	24	76	1	77
30.5	13	8	24	69	1	70
31.5	10	10	24	60	1	61

The Fire Danger Index is the overlaying of the drought factor with the fuel load, humidity, wind speed, temperature and slope to give an indication of flame height, rate of spread and fire intensity. A very useful tool, an interactive McArthur Forest Meter, has been developed by the Country Fire Authority of Victoria. The program allows you to put in data from the current Drought Index through to average Slope of the proposed burn site, and gives you the expected fire intensity and other predicted fire attributes. The index calculates the expected flame height which this Guide uses as the key indicator of burn timing and its ramifications.



Fuel Load and Burning Conditions

In very simple terms fuels are broken into two categories, light and heavy. Fuels less than 6mm diameter are considered light fuels, and greater than 6mm, heavy fuels. The light fuels are further categorised into:

1. Aerial or aerated fuels e.g. dead grasses, lightly packed twigs, leaves, shed bark and low shrubs or
2. Compact fuels, old leaf and twig litter forming the humus layer and partly broken down with little available oxygen to burn.

Aerated fuels are the most volatile fuels as these are surrounded by air (essential for anything to burn) and quickly absorb moisture from the atmosphere when the humidity is high and just as quickly lose moisture when the humidity is low or when pre-heated as the fire front approaches. As a rough guide, when the drought index is below 100 mostly only the light fuels burn but the higher the index rises above 100, the greater percentage of the heavy fuels burn. Obviously this can have a dramatic effect on the time it takes for a fire to pass a given point and the intensity of the fire.

Drought index, fuel quantities and its condition, wind speed and relative humidity are the four key factors affecting fire behaviour. Fuel quantities and condition has the strongest impact on flame height and wind speed on fire spread, however humidity strongly affects all factors including intensity. For example, with the drought index on 100 on the day of a burn, a forest block has an average of 10 tonnes of fuel per hectare of combined grass and forest debris, the forecast humidity for 2 o'clock is 50%, the average slope across the block is 10º and the wind speed is 15km/hr – the predicted flame height will be 1.5m, rate of spread 200m/hr and intensity 766 kW/m.

If forecast humidity was incorrect and humidity drops to 20% then the predicted flame height is suddenly 3.5m and will travel at 500m/hr with an intensity of 2233kW/m. The low humidity causes the fuel to ignite well ahead of the fire increasing the rate of spread and significantly intensifying the fire. This scenario is equivalent to raising the fuel level to 16 tonnes/ha.

Fuel Load

Fuel (considered available fuel) is measured in tonnes/hectare and is usually a mix of grass and forest debris. Available fuel is a measurement of only the light fuels, (less than a pencil thickness). The fuel is measured for depth and percentage cover.
If forest debris (leaf litter, twigs, small branches and bark) and its depth is consistent across the block, then each 1cm of debris is estimated to be equivalent to 5 tonnes/ha. If it is patchy and only 50% coverage, then multiply the depth in cm by 5 and then by the percentage cover. (4 cm x 5 tonnes x 75% = 15 Tonnes/ha)

Grass cover is also measured for consistency, thickness and height, each 300 – 400mm of dry grass cover relates to around 5 tonnes of fuel.

Photo 3. Spotted Gum forest with no grass cover and around 5 cm of consistent fuel equivalent to 25 tonnes/ha

Photo 4. Grass cover at around 300 mm depth and 50% cover, equivalent to 2.5 tonnes/ha

Photo 5. Consistent dry grass cover (100% cured) 600mm in depth and equivalent to 9 – 10 tonnes/ha

Fuel Condition

Assessing fuel condition, usually grasses but also annual shrubs is an important indicator of the volatility of the fuel. Fully cured fuel requires very little heat to ignite and as such will produce a high intensity fire that will spread very quickly. The higher the moisture content, the more heat and energy it requires to burn, so it draws energy away from the fire reducing the intensity and taking longer to spread and usually resulting in a patch work of burnt and unburnt areas.

State of Curing – Grasses

% Cured	Colour	Development
0%	Green	Germination to seed head development
10%	Green	Seed heads formed to flowering
20%	Greenish-yellow	Seed heads maturing and opening
30-40%	Yellowish-green	Most heads mature and dropping seed
50-60%	Straw-patchy YG	Most heads dropped and colour turning
70-80%	Straw very little green	Some green in lower third stems
90%	Straw	Odd stalks with some green
100%	Bleached	All stalks fully cured

Fuels will burn when fuels are 50-70% cured

Fuels will burn fiercely when 80% plus

Table 2. Grass curing stages - colour and development

Photo 6. Consistent grass cover with patches of green (70% cured) 600mm in depth and equivalent to 9 – 10 tonnes/ha

Table 3. Factors Influencing Fire Behaviour (Rough guide only)

	Rate of spread (ROS)	Intensity	Flame height
Slope - 5°	x 1.3	X 1.3	Generally does not affect flame height
10°	x 2	X 2	
20°	x 4	X 4	
Wind	Doubles in speed - ROS x 4	10km/h – x1.26 20km/h – x 1.6	10km/h x 1.2 20km/h x 1.4
Fuel Load	Double load ROS x 2	Double Fuel x Intensity x 4	Double Fuel x double flame Ht
Humidity 60%	X 1	X 1	X 1
40%	X1	X 1.6	X 2.5
20%	X2	X 3.5	X 4.2
10%	X4	X 5	X 5.6

Fire Management Units

Fire management units for burning are based on the same criteria that relate to other forest practices, namely vegetation types and what specific management is relevant to that unit. Changes in vegetation are usually related to slope, aspect and change in soil type or depth and often profoundly influence species mix, understorey, fuel moisture content and thus volatility. For example an understory such as *Pultenaea villosa* (Hairy Bush Pea), *Xanthorrhoea johnsonii* (Grass Tree), or Melaleuca species such as Paper Barked Tea Tree are all very volatile species and will provide significant aerial fuels even when green, providing ladder fuels to canopy fires in the wrong conditions. Generally northerly or westerly slopes dry quicker, have sparser vegetation and will burn earlier than easterly or southerly slopes. Easterly and southerly slope also tend to support more succulent species, such as *Lophostemon confertus* (Brush Box-Supple Jack) and *Alphitonia exelsa,* Red Ash etc which suppress fire activity.

Fire Management Units need to consider these vegetation changes, generally using ridge tops and other natural features to break up the block into manageable units of approximately 50 - 100 hectares. Each unit has an external fire break of up to 10 metres and sufficient internal firebreaks and access tracks to safely ignite, control and suppress fire. Firebreaks and roads should be strategically placed to provide the best protection possible considering block geography, access to water and predominant weather patterns. Firebreaks should be grassed with most trees removed and preferably incorporating a graded track (bare earth) to allow quick access for fire suppression and to allow a clean line for fire lighting or back burning.

Firebreaks of up to 10 metres in width are 'exempt' clearing and allowed under the VMA, wider than 10m requires a clearing permit if in 'remnant vegetation' (coloured areas)

Forest Management Objectives and Methodology

What management objective are you trying to achieve by burning and how do you achieve it? The first consideration is, what state is your forest in, and what part can fire play in its management.

Photo 7. Ironbark/Spotted gum forest carrying an approximate fuel loading of 15 tonnes/ha

(1) Unburnt Dry Forest type ready for harvest

Management Objective – reduce fuel load before harvest and to ensure ease of access and good visibility conditions for the harvest and ensure post harvest regeneration.

Operation plan

- Ensure all fire breaks are maintained and adequate
- If poles or piles are to be harvested, six months lead time may be required to ensure the logs will bark easily
- If insufficient regeneration present, check for available mature seed in the canopy of the desired species (see regeneration)
- Calculate fuel levels, fire danger index and average slope within the block as well as ignition pattern to calculate probable flame height and fire intensity. (See - When to Burn)

- Plan for a burn in mild conditions using the above information to ensure an average flame height of <1m
- Organise fire permits, drip torches, fire suppression equipment and assistance
- Burn when the conditions meet the above criteria
- Harvest

(2) Unburnt Wet Forest type ready for harvest

Management objectives and operational plan is as above, but with a far greater emphasis on the regeneration criteria. 'Wet' forest types do not regenerate from lignotuber and successful regeneration establishment is critical to the future productivity of the stand. There must be mature seed available and the fire needs to be intense enough to consume a percentage of leaf litter to bare earth and kill competing weeds to allow for the very small eucalypt seed to germinate and survive. To achieve this, the fuel needs to be dry but the temperature mild. Due to a much heavier biomass of these forest types, harvest residues will be high and a top disposal burn will also be required after the harvest.

Photo 8. Blackbutt forest with up to 40 tonnes of fuel /ha

(3) Young heavily overstocked regrowth in need of thinning

Management Objectives – Thin down to 200 stems/ha using chemical injection and then burn to reduce fuel load and control woody weeds and unwanted small regrowth.

Photo 9 . Young heavily overstocked regrowth stand in urgent need of thinning.
- Note:- burning needs to be delayed for at least 6 months to ensure all injected stems are totally dead before the burn

Operational Plan

- Paint mark best 200 trees/ha for retention considering form and crown health
- Inject unmarked trees with Tordon DS 1 : 4 water, (1ml /cut with cuts at 12.5cm centres, over 23cm dbh, 2ml /cut)
- Wait six months to ensure all injected stems are dead
- Ensure all fire breaks are maintained and adequate
- Calculate fuel levels, fire danger index and average slope within the block as well as ignition pattern to calculate maximum probable flame height and fire intensity.
- Plan for a burn in mild conditions using the above information to ensure an average flame height of <1m and scorch height of < 5m
- Organise fire permits, drip torches, fire suppression equipment and assistance
- Burn only when the conditions meet the above criteria

Photo 10 (left). Unplanned burn in a stand of high quality very heavily stocked, young Blackbutt regrowth resulting 100% scorch and indiscriminate death. As a result of the burn, some trees will die outright but many will re-shoot from the base, resulting in a multiple stems and a management conundrum.

The short term management impact of this is a stand now very difficult to thin. The more economical stem injection method is now impossible as most of the stems are dead and are re-shooting with multiple stems from the base.

The only option is to selectively spray the regrowth with Garlon 600® or similar herbicide.

Photo 11 (right). A similar stand 4 months after burn with heavy regrowth coppicing. The regrowth grows very quickly allowing a very short window of opportunity for chemical control.

(4) Overstocked dry forest not burnt for many years

Photo 12. Overstocked dry forest unburnt for many years

Management Objectives

Burn to reduce very high fuel levels, mark for retention the best 80 - 120 trees/ha, harvest any available product not marked for retention, stem inject all remaining unmarked trees within the confines of the Code of Practice

Operational Plan

- Ensure all fire breaks are maintained and adequate
- Calculate fuel levels, fire danger index and average slope within the block as well as ignition pattern to calculate probable flame height and fire intensity. Plan for a burn in strictly mild conditions using the above information to ensure an average flame height of <1m
- Organise fire permits, drip torches, fire suppression equipment and assistance
- Burn when the conditions meet the above criteria
- Mark for retention best available 80-120 stems/ha depending on stand quality
- If poles or piles are to be harvested,
- six months may be needed to lapse after burning to ensure logs will bark easily
- Harvest all unmarked trees with a merchantable product
- Chemically thin all remaining unmarked trees at least 6 months after burn (generally, burning impacts on short term sap flow which can impact on chemical injection results)

(5) Well managed forest incorporating grazing

Photo 13. **Regularly burnt well managed spotted gum forest**

Management Objectives – Maintain a highly productive forest, ensuring adequate regeneration and control of fuel levels, woody weeds and unwanted regrowth with the judicious use of fire.

Operational Plan

- Burning management plan in place based on management units incorporating timing and frequency specific to each unit. Maintain a system for pre-burning fuel and weather monitoring
- Ensure all fire breaks are maintained and adequate
- Check on status of regeneration (needs to be 3m+)
- Calculate fuel levels, fire danger index and average slope within the block as well as ignition pattern to calculate probable flame height and fire intensity.
- Plan for a burn in mild conditions using the above information to ensure an average flame height of <.5m (remember every 1m of flame height results in around 6m of scorch height)
- Organise fire permits, drip torches, fire suppression equipment and assistance
- Burn when the conditions meet the above criteria

(6) White Cypress Pine

White cypress is very sensitive to fire, particularly in the early regeneration stage, and great care and considerable experience is required to successfully use fire as a forest management tool. Uncontrolled or indiscriminate burning will result in loss of regeneration and damage or even death to quite large trees.

However fire can be a very useful and cost effective management tool if used carefully and with adequate infrastructure in place to ensure maximum control throughout the burn. Tracks and firebreaks that break up the forest into manageable areas are essential to protect the forest from wildfires and for the management of fuel reduction burning. Burning should only be undertaken in May, June and July when conditions are very mild with temperatures in the low 20's, light winds (<10km/hr) and stable relative humidity.

The limited fuel reduction burning trials carried out by DPI Forestry suggest that, under appropriate weather conditions, cypress stands carrying even quite high levels of ground fuel can be successfully burnt, with little resultant mortality in the commercial component of the crop. This has been particularly successful with the use of aerial incendiary ignition, providing a tight pattern of ignition and reducing the development of long fronts on the fire. It is strongly recommended when considering a fuel reduction burn to use a similar spot ignition technique under controlled 'mild' conditions. Recommended grid spot ignition spacings are approximately 100 x 100m.

Photo 14. Spot ignition - 1 minute after ignition

Photo 15. Spot ignition point - 10 minutes after ignition

Preparing for a Burn

Preparation for burning is as important as the burn itself. The planning should include:

1. Inspect forest block to confirm the need to burn in line with management objectives
2. Obtain a burning permit - In Queensland, the Rural Fire Service controls the use of fire.

A Permit to Light Fire is required all year round for burning off or clearing fires where an open fire is going to be larger than two metres in any direction. Permits are available from your local Fire Warden at no charge. All requirements of the permit must be met.

3. Calculate Drought Index, fuel loading and estimate average slope of the block
4. Check weather forcasts for predicted wind and relative humidity
5. Calculte Fire Danger Index to predict flame height and fire intensity
6. Check all fire management equipment, drip torch, mobile fire tank and hoses, chainsaws etc
7. Plan operation - who is in charge, ignition pattern and who is actually lighting each section, communication system, emergency response, mopping up.

Fire Ignition Patterns

Fire ignition pattern and location plays an important role in determining fire intensity. Igniting a block in a continuous line at the base of a steep slope will significantly increase the intensity, speed of travel and flame height of the burn. Conversely spot ignition along the top of a slope reduces rate of spread and fire intensity.

Photo 16. Strip ignition raises fire intensity (Photo supplied by DPI&F)

Photo 17. Spot ignition 10 minutes after ignition in moderately heavy 50% cured fuel

Case Studies

Cooloola

The Cooloola block is located adjacent to the Gympie north railway station. The block supports a high quality dry sclerophyll forest dominated by *Corymbia variegata*, Spotted Gum 60%; *Eucalyptus acmenoides,* White Mahogany 15%; *Eucalyptus major,* Grey Gum 15% and *Eucalyptus Moluccana*, Grey Box 10%. Scattered occurrences of *E. fibrosa,* Broad Leaved Red Ironbark, *E. excreta*, Queensland Peppermint and *Syncarpia glomulifera,* Turpentine also exists. Understorey species include brown and black wattle, dogwood, *Lophostemon confertus,* Brush Box-Supple Jack and *Alphitonia exelsa,* Red Ash. The average slope across the block is around 12º and had fuel loading in excess of 25-30 tonnes/ha of fine fuels, as well high levels of medium to heavy fuels left over from the harvest operation.

The block was burnt in 2002 followed by a harvest in April 2003. The harvest and subsequent thinning/treatment operation left the forest in a very good condition with a high quality stand of timber supporting areas of good pole quality trees ready for harvest within ten years. No post harvest burn was undertaken and the block remained unburnt until late October 2006.

The burn was undertaken in late October by the rural fire brigade, commencing at around twelve noon with a drought index of 180+, wind less then 10km/hour and Fire danger index of 6.5 (moderate). Considering these conditions if the McArthur Fire metre had been used a predicted flame height of 6.5 m could have been expected with a fire intensity of 5, 239 kW/m. This would be a very severe fire from a timber management perspective with an expectation of a high proportion of heavy fuels igniting and continuing to burn for a prolonged period.

Considering the conditions, the brigade should have expected a very hot fire but were more concerned about the deteriorating drought conditions and the increasing fire risk associated with the block and the threat to adjacent housing.

Predictably the heavy fuels ignited and in many cases burnt completely providing prolonged very high temperature around many trees. The fire caused immediate and extensive damage, resulting in 100% scorch in trees up to 15m+ in height in many areas. Many trees also received severe stem damage resulting in permanent fire scares or dry side effectively dropping the value from high value poles to salvage class saw logs.

Photo 18. Advanced growth spotted gum with excellent form slowly recovering from 100% crown and stem scorch.

Management Implications

The fire will result in a number of management conundrums that will require a detailed assessment of the site to ascertain the range and extent of damage. Namely:

1. The percentage of trees (with a merchantable product) that will not recover, or will deteriorate before the next harvest, or whose growth rates will be unacceptable and will need removing now in a salvage harvest
2. The extent of younger stems without a current product in them that have been permanently damaged and require chemical treatment.
3. The appropriate methodology and timing for thinning the regrowth and regeneration resulting from the fire to recapture the highly productive forest that it was
4. Establish an appropriate fire management regime to prevent a reoccurrence

Photo 19. Young permanently fire damaged tree that must now be chemically treated to allow space for young regeneration

Photo 20. Spotted Gum permanently damaged by the fire to be removed in a salvage harvest. Note heavy coppice and regeneration that will require thinning when tall enough to show form

Kin Kin

The Kin Kin case study examines a forest block that was harvested and then burnt in 2001. It considers the condition of the forest prior to the harvest and burn, the burn, and the subsequent progress over the last 6 years.

The block is located 25 km east of Gympie in south east Queensland and supported a wet sclerophyll forest dominated by a heavily stocked stand of Gympie Messmate (*Eucalyptus cloeziana*), with other species present such as Tallowwood (*E. microcorys),* Grey Gum (*E. propinqua),* Red Mahogany *(E. resinifera), and* Red Bloodwood *(Corymbia intermedia).*

The stocking rates before harvest (stems/hectare) and the tree size class distribution are presented in Table 2 and show a heavily stocked stand.

Table 1. Average stocking rate by DBH size class (2001)

DBH Class (cm)				
10-20	**20-30**	**30-40**	**40+**	**Total/ ha**
158	107	68	57	Av 390

Due to a lack of disturbance, including fire exclusion for at least 30 years prior to the harvest, a complex scrubby understorey had developed under the heavy canopy of eucalypts. Significantly no eucalypt regeneration was apparent. High quality advanced regrowth to 25cm dbh had regenerated adjacent to a fence line cleared 25 years ago.

Excluding fire or any other form of disturbance from the stand had a significant impact on the stand. Large quantities of debris still remained from the original logging and an understorey of scrub-woods and Brush Box prevented any eucalypt regeneration occurring. The ecological values dependant on a eucalypt forest environment were changing due to lack of management and fire exclusion and in time the flora and fauna dependant on this forest environment, as well as the timber productivity would be significantly altered.

Due to the heavy stocking rates and the size of the trees, the harvest produced a large volume of residues. Ideally the block should have been burnt before harvest to reduce fuel loads before adding to it from the harvest residues. However, due to substantial numbers of potential poles in the harvest and the consideration that burning needs to be undertaken 6 months prior to pole harvesting, due to the bark sticking to the logs for some time after a burn, it was decided to postpone burning till after the harvest.

On completion of the harvest any accumulated fuel around retained stems was removed to limit any fire damage to the base of the tree. Due to a prolonged period of dry weather the burn was not undertaken until November 14th, two days after 130 mm of rain fell.

Although this was late in the season, the recorded 130 mm of rain reduced the Fire Drought Index to 0 and the Fire Danger Rating to low. The resulting burn was still hot with areas of concentrated fuel from the logging debris very hot. Due to the very high canopy height there was little scorch in the residual stand and minimal impact on tree bark health.

Permanent photo points to monitor regeneration were set up in ten locations. These covered a variety of disturbed and undisturbed areas including low, medium and high fire intensities and the original log dump. These points capture the response to the fire and the sequence of re-establishing a eucalypt forest amongst very heavy regeneration of Wattle (*Acacia oshanesii.)*

The summer immediately after the harvest was one of the driest on record with temperatures consistently in the high thirties and early forties. Four months after the burn an inspection of the site was carried out to ascertain the levels of regeneration and coppice response. Follow-up photos were taken at each of the 10 points (see photos portraying regeneration sequence for 2 photo points over 6 years). Even with the dry conditions, significant regeneration of Messmate survived in the burnt areas with some Tallowwood and Grey Gum also present along with patches of heavy acacia regeneration. Areas with a low regeneration count were planted with Messmate seedlings (approx. 200) raised from seed gathered from the site. Interestingly at this stage the coppice from the stumps is well ahead in the regeneration growth rates followed by planted stock and then the natural regeneration.

Management Implications

As discussed, wet sclerophyll forests require a very significant disturbance event to regenerate, and will not regenerate until that happens, be that wild fire, cyclone or man made disturbance in the form of harvest or burn. Timing the harvest to coincide with a good seed crop and burning to provide a suitable seed bed will generally result in successful regeneration development providing an ample choice of good quality stems with excellent form. The heavy wattle regrowth in this case has only a short life span of less than ten years and will gradually die out leaving a stand of young eucalypts ready to be thinned and grow on into a highly productive forest.

Multiple stems developing from coppice of the harvested stumps require thinning to one stem and can only be achieved by cutting with a chainsaw. The chosen stem should have developed as close to the ground as possible to protect from wind-throw.

Once form and vigour has been established in the seedlings (8m+ height) coppice and regeneration should soon be thinned to achieve an overall stocking of no more than 200 stems/ha (average spacing 7.5m) and be growing into a gap in the canopy. Regeneration is best thinned by chemical injection.

A burning rotation of 5-10 years (depending on grassy or scrubby understorey) should then be maintained to reduce fuel loads and control lantana and undesirable species.

Photo Point 1

November 2001 - showing an area of accumulated harvest debris resulting in very hot burn

March 2002 – good regeneration development with a range of species including a heavy young wattle count

March 2007 – Very heavy wattle regrowth removed from selected high quality Messmate regeneration

Photo Point 2

November 2001 – 1 day after burn

2002 - 4 months after burn, showing significant regeneration and coppice development

2007 - selected regeneration development and very heavy wattle regrowth thinned out in foreground