FIRE AS A SILVICULTURAL TOOL IN THE JARRAH FOREST

This Guideline supersedes Silviculture Guideline 1/91.

CONTENTS

1. INTRODUCTION

Fire is the most important management tool available for extensive application in the forest. It is most prominent in hazard reduction burning, but it also has significant silvicultural use - particularly for the regeneration process (e.g. for creating ashbeds and stimulating seedfall).

Since the 1960's rotational fuel reduction has been a pre-eminent concern in the management of many jarrah stands, but burning practices and priorities are adjusted to accommodate a variety of specific fire management objectives, including ecological, silvicultural and hazard reduction needs. This guideline seeks to link burning strategies with silvicultural objectives by defining:

- how burning can achieve silvicultural goals;
- the range of burning intensities to meet specific burning objectives;
- where fire exclusion should be adopted.

2. FIRE CHARACTERISTICS

Fire intensity is useful as a measure of the behaviour of a fire and its potential impact on vegetation. The principle variables that determine fire intensity in the jarrah forest are the rate of spread of the fire and the amount of fuel consumed in the flaming zone. Intensity may be approximated by the following formula (from Burrows, 1984):

FIRE INTENSITY (kW/m) = 0.5 X FUEL QUANTITY CONSUMED (t/ha) X RATE OF SPREAD (m/hr)

Fire intensity can also be used as a guide to the height of crown scorch and the level of stem damage resulting from a fire. The dryness of large woody fuels such as old logs, stumps and branchwood also has a major influence on the extent of stem damage during fire. Dryness varies according to the size of the material, the length of time that it has been on the ground and the extent of the seasonal drought influence. The Soil Dryness Index (SDI) provides a good indication of the moisture content of woody material that has been on the ground for more than 2 years.

3. TYPES OF BURNING

The following types of burning are referred to in the text and their value for both silviculture and fire protection are discussed.

3.1 Pre-harvesting Burning

A burn which is carried out immediately prior to a timber harvesting operation is termed an advance burn. This burn may have several objectives including improved faller safety, improved forest accessibility, hazard reduction and evaluation of advanced growth.

Where it is necessary to assess advanced growth stocking before timber harvest, an advanced burn should be at least 6 - 18 months prior to assessment.

Where the presence of dieback indicator species is critical, harvesting should be deferred until indicator species have regrown.

Burn intensity will vary and is not usually an important silvicultural factor except where it may cause the abortion of buds or premature seed fall from a shelterwood stand or may damage the bole or crown of trees to be retained. A low intensity burn (<350 kW/m) is generally preferred.

Advance burning should be planned as part of the normal aircraft burning programme, wherever possible, to maximize the protection value and minimise the cost and size of the burning programme.

3.2 Post-Harvesting Burning

Burning following harvesting can be divided into three types depending on the primary objective.

(a) ***Tops disposal burning*** is carried out to reduce hazard by the removal of flash fuels and woody material up to 2.5cm in diameter. Tops disposal burning will usually be done after thinning , single tree selection or in regeneration release areas where advanced growth has been released through an advanced burn. This burn may be carried out as a part of the normal aircraft burning programme.

If regeneration is already established, tops disposal burning must occur within 2 years of harvesting. Elsewhere the timing and intensity of these burns can be varied to meet diverse objectives such as the regeneration of understorey species, habitat manipulation etc.

Tops disposal burns are usually low intensity. To protect existing trees these burns must also take account of the soil dryness index (Table 1).

(b) ***Release burning*** is carried out to enhance the development of regeneration. It is particularly important where there has not been an advance burn. This burn is also of value in fuel reduction. The silvicultural objectives include:

- the removal of scrub competition
- the stimulation of dynamic growth of lignotubers
- removal of poorly-formed saplings

Release burning must occur within 2 years of harvesting. Burn intensity will vary with the condition of the advanced growth. A low intensity is sufficient to stimulate ground coppice, but a fire of moderate intensity will be required where deformed saplings need to be burnt back to reshoot from ground level. As hot burns in dry soil conditions will sometimes kill lignotubers these burns should conform with the constraints of the soil dryness index (SDI - Table 1).

(c) ***Establishment burning*** is carried out in the jarrah forest where the objective is:

- the removal of scrub competition
- the creation of suitable seedbed
- the stimulation of seedfall

These objectives are pursued on all areas cut to shelterwood as a means of establishing regeneration. There is also significant fuel reduction benefit.

Establishment burning should occur soon (< 12 months) after harvesting to maximise the combined effect of site disturbance and ashbed. Delaying this burn is acceptable where a seed crop will mature in the following year.

Establishment burning in shelterwoods needs to be of moderate intensity (Table 1) in order to achieve maximum seedbed preparation. Crown scorch is therefore acceptable.

3.3 Rotational Fuel Reduction Burning

Such burns are primarily for the purpose of hazard reduction. Their season and intensity may be varied to meet ecological or other management requirements without detriment to their fuel reduction value.

Rotational burning is excluded from stands where regeneration has been released but still remains vulnerable to fire damage (Section 4.2).

Regular rotational burning is of advantage in shelterwood stands to enhance the development of seedlings into ground coppice.

3.4 Strategic Fuel Reduced Buffers

Strategic fuel reduced buffers are located to restrict the spread of a major wildfire.

Harvesting within these buffers, where a regeneration objective would be applied may result in a conflict between fire exclusion and hazard reduction objectives. If harvesting with a regeneration objective must proceed in these buffers, close attention to the integration of operations may be required to ensure silvicultural and fire protection objectives are not compromised. Where the silvicultural objective is thinning or shelterwood, harvesting in the strategic fuel reduced buffers can proceed without conflict. Inspection by representatives of the CALM*fire* Unit and the Hardwood Silviculturist SFRBU, may be required before coupes in buffers are included on the harvesting plan, or before regeneration areas are included in the buffers.

TABLE 1: Guidelines for Post Harvest Burning

	TYPE OF BURN			
	Tops Disposal	Release		Regeneration
Objective	Thin	Gap	Burn Back	Shelterwood
Season	Spring	Spring #1	Spring #1	Spring/Autumn
F.D.I.	< 26	< 26	26 - 30	20 - 26
S.D.I. Spring	< 600	< 600	< 600	300 - 600 #2
S.D.I. Autumn	N/A	Fall by 400	Fall by 400	Fall by 400

#1 Autumn burning may be considered on a case by case basis. Approval required from the Hardwood Silviculturist, SFRBU.

#2 When no thinnings are involved, S.D.I.'s to 1000 may be considered.

NOTE:

- Prescribed F.D.I.'s (Fire Danger Index) are based on the litter component of available fuels.
- Prescribe for the most sensitive component of the silvicultural burn, eg. in a stand with mixed objectives, prescribe for thinning areas, in a stand of TEAS and gaps prescribe for the TEAS.
- Prescribe for nominal 6 metre scorch height in Spring.
- Prescribe for nominal 4 metre scorch height in Autumn.

4. FIRE AND SILVICULTURAL STRATEGIES

4.1 Thinning

Silvicultural Objective:
In stands where there is an adequate stocking of crop trees (trees capable of growing rapidly into higher quality products), the objective is to increase the growth of those trees by thinning. In some cases thinning is carried out for aesthetic reasons or to increase streamflow.

Burning Objective:
Hazard reduction : Rotational prescribed burning is compatible with the thinning objective provided that it is conducted within acceptable limits of fire intensity and SDI. The acceptable fire intensity increases with the age and development of the stand; guidelines are as follows:

TABLE 2: Acceptable Fire Intensity at Stages of Stand Development

STRUCTURE	DIAMETER (cm)	FDI (m/hr)	MAXIMUM SPRING FIRE INTENSITY*
Saplings	< 15	12 - 17	120 kW/m
Poles	15 - 45	20 - 25	250 kW/m
Mature trees	> 45	30 - 35	350 kW/m

* Autumn fire intensities will need to be significantly less to remain at the same scorch height. (see Burrows 1984, Sneeuwjagt and Peet 1985)

4.2 Regeneration

Silvicultural Objective:
In stands comprising mature and overmature trees where there are few crop trees but an adequate stocking of advance growth (ground coppice and saplings) the objective is to remove the overstorey to allow the development of vigorous regrowth. Stands suited to regeneration release should not be cut if they lie within a strategic burning buffer.

Burning Objective
Pre-harvesting : Hazard Reduction
Before the overstorey is removed rotational prescribed burning can proceed normally, but once cutting has released the regeneration it will rapidly develop into saplings and require protection from fire.

Post-harvesting : Regeneration Release/Hazard Reduction
After harvesting release or tops burning must be completed within 2 years. The intensity of such burning will vary according to stand conditions (Table 1).

Following Regeneration: Fire Exclusion:
Stands requiring protection from fire are:

(a) Those coupes containing areas which have been cutover for regeneration and contain adequate advance growth (Guideline 1/95), and

(b) All previously cutover coupes less than 10 years old.

Where it can be shown that the canopy cover of the residual overstorey is more than 20 per cent and gaps of less than 50 metres in diameter have been created burning may proceed. This may be established through aerial photographs and checked in the field (Table 3 relates canopy cover to basal area).

TABLE 3: **Basal Area (m^2/ha) of Overstorey for Effective and Optimal Regeneration by Stand Height Classes**

CANOPY COVER		
HEIGHT CLASS	**MAXIMUM - 20%**	**IDEAL - 10%**
A +	10 m^2/ha	5 m^2/ha
A	8 m^2/ha	4 m^2/ha
B +	6 m^2/ha	3 m^2/ha
B	5 m^2/ha	2.5 m^2/ha

These stands will require complete protection from fire until:
- tall enough (usually 6 metres) so that the growing tip will not be damaged, and;
- the bark is thick enough to insulate the cambium from the heat (once the diameter is 10cm) in a fire of low intensity. (Burrows, 1987)

Figure 1 outlines an idealised fire management regime for stands requiring regeneration.

4.3 Shelterwood - (Establishment of Advanced Growth)

Silvicultural Objective:
These stands are similar in structure to those described in 4.2 except they lack a sufficient stocking of advanced growth to adequately regenerate the site. The initial aim of management is to establish seedlings and "grow" them into suitable ground coppice and saplings. This is achieved by a partial removal of the canopy, removal of competing understorey rootstock species, burning to create ashbed and spreading seed or planting where poor natural seed stocks exist.

Burning Objective:
Pre-harvesting : Hazard reduction
Advance burning prior to harvesting is particularly important to readily identify where advance growth is present/absent and so determine the location of shelterwood stands. This should occur 3 to 4 years prior to harvesting in areas considered likely to contain shelterwood stands.

Post-harvesting: Establish Regeneration:
After harvesting, burning is essential as a means of creating ashbed, reducing competition , stimulating seedfall and reduction of fuel quantities. If possible this burn should be timed to coincide with an adequate seed crop, however burning soon after harvesting is the best opportunity for seedling establishment due to the disturbance by harvesting machinery. The burn should then proceed in late spring or autumn and may be of moderate intensity.

Subsequent low intensity prescribed burning is compatible with a shelterwood objective as it will enhance the development of lignotubers. The burning of stands cut to shelterwood should occur regularly - every 5-7 years - until the lignotubers are suitable for release.

Figure 2 outlines an idealised fire management regime for shelterwood stands.

4.4 Single Tree Selective Harvesting

In some stands effective regeneration cannot be achieved due to the inability to market a significant proportion of overstorey trees. The number, size and potential value of such trees makes regeneration (as defined in section 4.2) difficult to achieve commercially and expensive to attain non-commercially. Currently vigorous trees are retained and small gaps are created by removing several trees.

These gaps are generally well below the minimum diameter of 50 metres although portions of the stand may be adequately regenerated as defined in Table 3.

In general regeneration is not effectively released by harvesting in selectively cut stands and hence no special protection measures are warranted - except where specifically nominated following a post-harvesting inspection and recorded on SILREC.

4.5 Regeneration in Dieback Areas

Where regeneration has become dynamic on dieback areas (Guideline 4/89) it should be afforded the same protection as other regeneration (Section 4.3). Time taken to reach sizes suitable for hazard reduction burning are likely to be longer.

4.6 Crop Tree Protection

The burning of harvesting tops has the potential to damage the retained components of the forest (crop trees, habitat trees, habitat logs). Their protection by the removal of woody material (> 7.5 cm diameter) to a distance of at least 1 metre reduces the risk of damage in subsequent burning. This task must be completed by harvesting contractors.

5. INTEGRATED FIRE MANAGEMENT OF HARVESTED AREAS

Most areas recently harvested will contain a mosaic of the stand types described in section 4. The fire management of such an area may not be able to accommodate the ideal arrangement for each type.

As a general rule once an area has been harvested and burnt then the entire area must be protected from fire until the regeneration is old enough to withstand fire unless the areas of regeneration can be isolated.

This section discusses the management of stands with mixed objectives.

5.1 Regeneration Release and Uncut Patches or Strips

Fire management regime can proceed as described in figure 1.

Prior to Harvesting:
Rotational prescribed burning. Advance burn to assist identification of advanced growth where it is suspected to be poor.

After Harvesting:
If the stand was not advance burnt, release burning is required. It is optional where there are only scattered tops and the area has been advanced burnt. Burning to be completed within 2 years of the commencement of harvesting.

Protection and Burning:
Following the tops disposal burn, fire is to be excluded from the regeneration until regrowth is 6 metres in height and 10 cm in diameter. For strategic protection reasons, it may be desirable to burn uncut patches of forest or retained strips before the regrowth reaches these dimensions. Where this is required the first rotational burn must be completed within 5 years of the regeneration release burn. At this time there will be limited fuel in the gap and 5 leaf falls in the uncut patches of forest or retained strips. This burn should be undertaken at low intensity (<250 kW/m) and low SDI to minimise the risk of a significant fire run in the regeneration, hence it is vital that flash fuels have been effectively removed from the gap in the tops burn.

The second rotational burn should be scheduled as soon as the regeneration can withstand a burn of low intensity.

Rotational Prescribed Burning:
When the regrowth is able to be burnt it should initially be of low intensity, usually obtainable with an FDI of <20 m/hr. As regrowth size and diameter increase, so can the intensity of fire. See Table 3.

5.2 Regeneration and Thinning

Prior to Harvesting:
Rotational prescribed burning; advance burn to assist identification of advanced growth where it is suspected to be poor

After Harvesting:
Following crop tree protection, tops disposal burning for hazard reduction is essential where there has not been advance burning or where required for hazard reduction. It must be completed within 2 years of the commencement of harvesting. Tops burning is optional where there are only scattered tops and the area was advance burnt. Burn intensity must be geared to ensure the retained stands are not damaged by the burn.

Protection and Burning
As in 5.1 - discrete areas of thinning may be programmed for burning while differential fuel levels exist between areas of regeneration and areas of thinning.

Rotational Prescribed Burning:
As for 5.1.

5.3 Regeneration and Shelterwood

Prior to Harvesting:
Rotational prescribed burning and advance burning is essential where there exists the possibility of poor advance growth stocking.

After Harvesting:
A regeneration burn is required in the shelterwood. The timing of the burn will be critical if there is an existing seed crop.

Tops in the gap must be burnt.

Protection and Burning:
This stand containing shelterwood and young regrowth requires both ongoing protection (in the gaps where regeneration has been released) and regular burning (in the shelterwood areas).

As in 5.1 - discrete areas of shelterwood may be programmed for burning while differential fuel levels exist between areas of regeneration and areas of shelterwood.

The second rotational burn should be scheduled as soon as the regeneration can withstand a burn of low intensity.

Bradshaw (1986) discusses other burning and protection options in greater detail.

Rotational Prescribed Burning:
As for 5.1.

For areas which have been harvested to shelterwood only, the Fire Management regime can proceed as in Figure 2.

6. PRESCRIBED BURNING AND HERBICIDE TREATMENT

Burning can occur immediately before or at least 9 months following herbicide treatment. If burning before treatment the fire intensity must be low to ensure minimal crown scorch - otherwise notching will need to be delayed until crown flush.

7. RECORDS

The following silvicultural records are required to ensure achievement of objectives:

(1) **SILREC**
Location of silvicultural stand types (print 10)
Follow-up treatment required and completed (SILREC)
Monitoring of regeneration development in shelterwoods

(2) **MASTER BURN PLAN**
Record location and date of regeneration and their predicted period of protection. Location of shelterwoods, and when next due for burning.

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REFERENCES:

Bradshaw, F.J. (1986). Silvicultural Guidelines for Virgin Southern Jarrah Forest. CALM Tech. Report No. 4.

Burrows, N.D. (1984). Describing Forest Fires in Western Australia Forests Dept Tech. Pap. No. 9.

Burrows, N. (1987). Fire Caused Damage to Jarrah (*Eucalyptus marginata*) and Marri (*Eucalyptus calophylla*). CALM Research Paper No. 3.

Forests Dept. (1983). Fire Protection Handbook.

Sneeuwjagt, R.J. and Peet, G.B. (1985). Forest Fire Behaviour Tables.

FIGURE 1: STAND CONTAINI ADEQUATE ADVANCED GROWTH

ACTIVITY	YEAR	BURNING	STRUCTURE	SILVIC OBJECTIVE	FIRE OBJECTIVE	FDI GUIDE (Jarrah)
		X	Mature or overmature -overstorey dominated by old trees with few patches of young regrowth		Fuel hazard Reduction	< 35 mphr
Advance burn	-2	X				
Regen survey			Adequate stocking of advanced growth	Regenerate by gap creation		
Treemark and harvest	0					
Harvest		X			Reduce hazard	< 30 mphr
Cull overstorey		release	Dynamic growth of ground and stump coppice into saplings Overstorey crown cover < 10%	Regeneration release		
	10				Fire exclusion	
		X	Saplings		Fuel hazard reduction	12 - 17 mphr
	20	X				
Crown thinning				Thinning		
		X	Small poles			< 25 mphr
	30	X				
	40	X	Poles			25 - 30 mphr
	50	X				
Harvest	60	X				

(1/97)

FIGURE 2: STAND WITH INADEQUATE ADVANCED GROWTH

ACTIVITY	YEAR	BURNING	STRUCTURE	SILVIC OBJECTIVE	FIRE OBJECTIVE	FDI GUIDE (Jarrah)
		X	Mature or overmature overstorey dominated by old trees with few patches of young regrowth		Fuel hazard reduction	< 35 mphr
Advance burn	-4	X				
Regen survey			Inadequate stocking of advanced growth			
Treemark				Shelterwood		
Harvest	0					
Disturb soil		X		Establish seedlings	Ashbed, seedfall	20 - 26 mphr
Estab burn		regen.	Mature overstorey with adequate stocking of seedlings		Competition	
Regen survey				Development of ground coppice	Fuel hazard reduction, enhance coppice development	< 35 mphr
		X				
Regen survey	10		Ground coppice growing in size			
		X				
Regen survey			Ground coppice large enough for release			
	20					
				Regenerate by gap creation		
Treemark and harvest		X				
CONTINUE AS FOR FIGURE 1						