Queensland **the Smart State**

Using fire in spotted gum - ironbark forests for production and biodiversity outcomes

Guidelines for landholders

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TIMBER QUEENSLAND

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These guidelines have been prepared for spotted gum - ironbark forests and woodlands and are not necessarily applicable to other forest and woodland ecosystems. The recommendations provided in these guidelines should be used as a guide only.

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Contents

Introduction

Spotted gum - ironbark forests are the most extensive hardwood forest types across Queensland and northern New South Wales. In the Burnett Mary region alone, **there are an estimated 1.4 million hectares** of spotted gum - ironbark forests.

Spotted gum - ironbark forests and woodlands are important contributors to both grazing productivity and the hardwood timber industry. Grazing occurs in most privately owned forests and is the primary source of income for most landholders. However, combining timber production and grazing can be productive with minimal impacts on either grazing or timber outputs. Indeed, timber production may be equally or more productive than grazing in the long-term if well-managed.

Fire is a common management tool used in naturally growing spotted gum - ironbark forests, but there is little information available to landholders to assist with fire management. Fire management needs to consider not only productive outputs (timber and cattle) but also the conservation and enhancement of wildlife and plants that are native to an area (i.e. biodiversity).

The aim of these guidelines is to assist landholders who are managing a mixed grazing timber resource to determine the best fire regimes for their property; specifically to:

- Enhance timber value
- Improve grazing productivity
- Maintain soil health
- Benefit biodiversity

The spotted gum - ironbark forest/woodland ecosystem

These guidelines refer to vegetation classified as dry sclerophyll forest or woodland dominated by spotted gum and grey ironbark.

Common tree species:

Spotted gum (*Corymbia citriodora* var. *variegata*)†
Queensland grey ironbark (*Eucalyptus siderophloia*)
Narrow-leaved ironbark (*E. crebra*)
Broad-leaved ironbark (*E. fibrosa*)
White mahogany or yellow stringybark (*E. acmenoides*)
Forest red gum or Queensland blue gum (*E. tereticornis*)
Pink bloodwood (*C. intermedia*)
Grey box (*E. moluccana*)

Common understorey species:
Wattles (*Acacia* spp.)
Box species (*Lophostemon* spp.)
Red ash (*Alphitonia excelsa*)
Lantana (*Lantana camara*)

Common grasses:

Kangaroo grass (*Themeda triandra*)

Queensland blue couch (*Digitaria didactyla*)

Pitted bluegrass (*Bothriochloa decipiens*)

Blady grass (*Imperata cylindrica*)

Wire grasses (*Aristida* spp.)

Black spear grass (*Heteropogon contortus*)

† In this document we refer to both *Corymbia* spp. and *Eucalyptus* spp. as 'eucalypts'.

The spotted gum - ironbark forests and woodlands occur on undulating plains, low hills and ridges. The soils are generally grey shallow sands, sandy loams, or loams over heavy clay subsoils. They generally have very low fertility and poor drainage and may be sodic.

General effects of burning practices

Managed (prescribed) fires can have positive or negative effects, depending on **fire frequency, fire intensity and patchiness and season of burn**.

Potential advantages of managed fire

- Reduces risk of wildfire
- Maintains a grassy understorey
- Improves forest structure and health
- Improves recruitment if not used too frequently
- Leads to more productive pasture
- Benefits diversity of some plants and animals
- May encourage tree seedling establishment
- Spreads grazing pressure over larger areas

Potential disadvantages of managed fire

- Short-term losses of pasture and grazing income from burnt areas
- Risk of poor tree recruitment from very frequent fire and poor wood quality from high intensity fires
- Short-term losses of ground cover and increased erosion risk
- Reduces soil fertility on some sites as a result of very frequent burning
- Encourages some invasive species
- Reduces diversity of some plants and animals
- Reduces water infiltration into the soil

Note: These disadvantages can be minimised by careful fire management

Understanding the effects of fire management

Understanding of the effects of fire management on production and the environment has increased in recent years but some areas need more research.

We have applied the following scale to the content to provide the reader with an indication of the strength of the evidence available:

1. **Anecdotal and unpublished scientific evidence, including experience of landholders**
2. **Scientific evidence from ecosystems other than dry forests. Also refers to evidence based on theory and conflicting scientific evidence in a few cases.**
3. **Scientific evidence from dry open forests**
4. **Direct scientific evidence from spotted gum - ironbark ecosystems**

Scores are provided in boxes in the right margin. Where a score of 1 or 2 is given, there is less scientific evidence to support the information and it should be treated with more caution.

The guidelines are divided in five major sections:

1. Timber production
2. Livestock grazing production
3. Balancing production and biodiversity
4. Fire management planning for the property
5. Recommendations for landholders

1. Timber production

Spotted gum - ironbark forests are an important component of the Queensland forestry industry, with **net merchantable volume growth of up to 1 m^3 per hectare per year.**

Fire management planning for timber production should consider the impacts of fire on tree growth, recruitment and survival as well as wood quality and soil health. The effect of livestock grazing also should be considered when burning for timber production since it changes the amount and characteristics of combustible forest fuel†.

Fire plays an important role in dry eucalypt forests and is used to:

- Reduce woody regrowth
- Promote tree regeneration
- Reduce build up of forest fuel loads that contribute to damaging wildfires
- Maintain a productive grassy understorey for grazing

<u>1.1 How does fire affect tree growth?</u>

Controlled low-intensity fire generally has **no major effects** on long-term tree growth for most commercial species in spotted gum forests.

The growth of some tree species (e.g. forest red gum) may increase from annual burning. However, **annual burning is not recommended** for sustainable timber production, due to potential negative impacts on tree recruitment and soil nutrients (see ***1.2 How frequently do I burn?*** page 9). 4

Short-term growth increases may occur when fire is re-introduced after a long period of fire exclusion (although these increases are unlikely to last more than 3 years).

Factors such as soil fertility and fire intensity may change the impact of fire on tree growth.

The effect of fire on tree growth will also depend on tree density 2
(see ***1.7 Should I use fire to thin a commercial forest?*** page 19).

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† In this document 'forest fuel' refers to all combustible materials in this forest/woodland ecosystem (e.g. grasses, leaf litter, branches, etc.). See page 15 for more detail.

1.2 How frequently do I burn?

In most situations, we recommend burning **once every 3 – 7 years** for timber production areas, according to:

- **How quickly fuel accumulates**
- **Grazing pressure**
- **Slope**

In some heavily grazed areas in low rainfall regions, burning may be less frequent (closer to one fire in 7 years) due to reduced pasture fuel loads from grazing.

3

To prevent erosion and removal of top soil, burn less frequently in steep country and heavily grazed areas (see *2.3.4 What is an appropriate fire frequency for grazing management?* page 28). 3

We recommend that:

- **Burning is not carried out on a strict cycle** (e.g. every 3 years) but varied according to rainfall fluctuations and grazing intensity.

- **A mosaic of different fire frequencies is created across the property** that includes: 3

    - Burning at intervals that are greater than 7 years between fires. 3

    - Fire exclusion areas for fire-sensitive vegetation (e.g. rainforest, softwood scrub), and riparian margins, particularly adjacent to permanent creeks. 2

The use of very frequent fire (once every 2 years) **should be limited to**:

- Buffer strips that surround important production areas, fire-sensitive vegetation and long unburnt areas. Strategically placed buffer strips or fire breaks can also be used to divide large forested or grazed areas into smaller areas. 2

- Areas where high rainfall has led to sufficiently high quantities of fuel, **such that:**

    - Burning in **low risk weather conditions** after 3 years without fire could lead to an uncontrollable and damaging fire. However, if fuel loads build up quickly, burning in cooler conditions should always be attempted before increasing fire frequency to once every 2 years.

- Short periods for controlling very high densities of woody species that compete with eucalypt seedlings.

Burning every 2 years should not be used as a long-term fire management strategy over large areas of the property.

1.3 Is high intensity or low intensity fire better for timber productivity?

Low intensity fires are recommended for timber production.

High intensity fires are **more likely** to:

- Kill trees
- Scorch tree crowns and reduce diameter growth
- Damage stems and cause wood defects 3
- Remove protective bark
- Allow entry of damaging insects and fungi
- Deplete soil nutrient reserves, reduce plant cover and increase erosion and water infiltration

Fire damage to a spotted gum tree

Lower intensity fires may still damage or kill regeneration. The degree of damage will depend on the height of scorch from the fire, which in turn is related to fire intensity and flame height (see also ***1.6 How do I use fire to encourage forest regeneration if it is required?*** page 17).

1.4 When do I burn?

Burning should be carried out to achieve **a low intensity burn and low scorch height**. Typically, this is possible:

- In cooler temperatures (**<25°C**; preferably **May – August**, but may be possible in spring months in some grazed forests) 3
- When humidity is moderate - high (**40-70%; early morning, late afternoon, evening, after rain**)
- When forest fuel moisture is greater than 10% (**high humidity days**)
- When wind speeds are **less than 15 km/h**
- When winds are from a favourable direction (**generally SE**) 1
- When burning **downhill** or across level ground 3

Where moderate to heavy levels of grazing occur under the forest, low intensity burning can be achieved in spring due to reduced pasture fuel loads from grazing. This is preferable for many landholders as winter burning reduces stock feed reserves.

However, **care should be taken when burning in spring**, particularly with high fuel loads that are more likely to contribute to a high intensity fire in warmer conditions. Where there are fallen logs and tree stumps, smouldering woody debris will reignite more easily in warmer, windier spring conditions and may start another fire several days or even weeks later. 1

Fallen trees and stumps may reignite in warmer conditions long after the fire has been extinguished

Weather conditions vary from year to year so it is important to base your decision to burn **on the number of days since last rain, rainfall amount and current weather conditions** (e.g. temperature, humidity, wind speed and wind direction).

Examples:

- In a relatively **dry summer and autumn**, the forest fuel will be drier than usual and you may need to **burn earlier in the winter** to achieve a low intensity fire.
- **If the winter has been relatively wet**, you may need to **wait until late winter or early spring** to allow forest fuel to dry out before burning can be effective.
- Effective fuel-reduction burning may only be achievable in the middle of the day (11 am – 2 pm) under certain weather conditions (e.g. a relatively cool winter day with little wind).

1.4.1 Is there a more accurate way of working out the best time to burn?

Greater flame heights will lead to greater tree scorching, so it is important to be able to predict what your flame height might be when lighting a fire on a given day.

An accurate way to predict the flame height of a fire is to use the CSIRO fire spread meter for Northern Australia. The meter converts information on air temperature, relative humidity, the percentage of dead grass, wind speed and pasture condition into the forward rate of spread of the fire. From rate of spread, flame heights can be estimated. 3

There are seven steps to use the fire spread meter (shown on page 13):

1. Set arrow (A) on the inner wheel to the air temperature on the day of burn. This information is also available from Bureau of Meteorology (see step 2).
2. Obtain relative humidity (B) from Bureau of Meteorology on day of burn. The easiest way to obtain this information is ring 07 3239 8700 and select the menu option to speak to a forecaster.

Alternatively, relative humidity is available using the internet on the Bureau of Meteorology website (www.bom.gov.au/weather/qld/qld-observations-map.shtml) by clicking on the nearest weather station to your property.

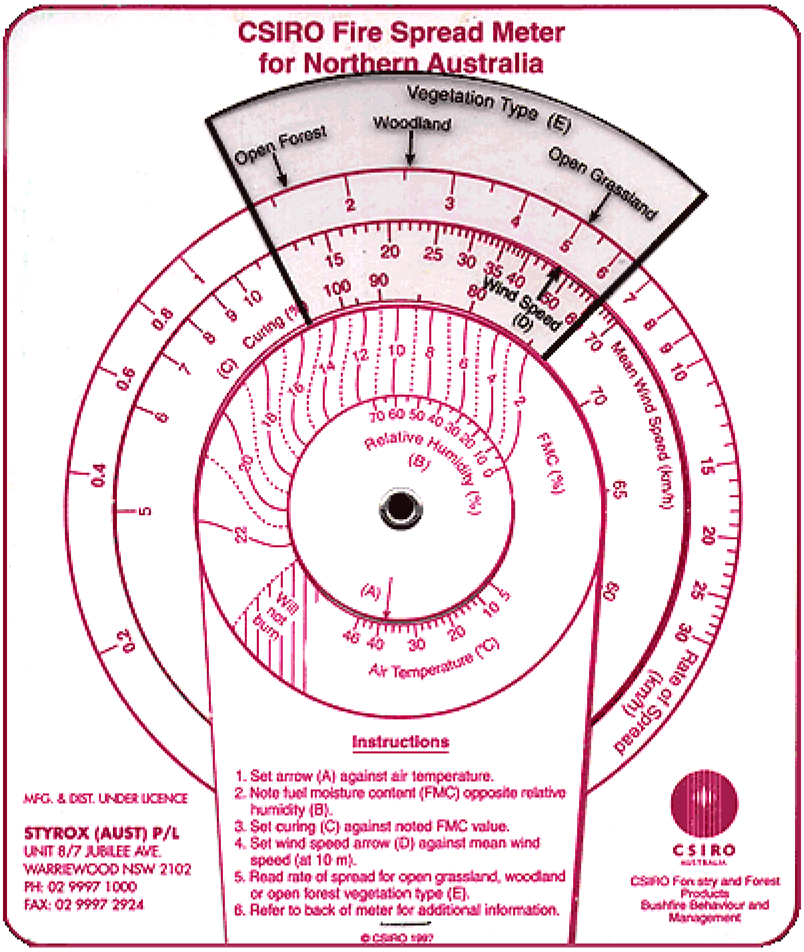
3. Once you have relative humidity, note the predicted fuel moisture content (FMC) opposite relative humidity (B) on the dial. In the diagram of the meter below, where the air temperature is 38°C and relative humidity is 30%, the predicted fuel moisture content is 6%. Forest fuel is unlikely to burn when the moisture content is greater than 22%. 3

4. Estimate the proportion of dead grass in the pasture (% curing) and set curing percentage (C) to the fuel moisture content predicted in step 3. If there is no green grass in the pasture it is fully cured (100%).

5. Estimate average wind speed (in km/h) and set the wind speed arrow (D) to the appropriate value. To assist with estimating wind speed in km/h, use the table in Appendix 1. Wind speed is estimated at a height of 10 m over a period of at least 15 minutes. Wind speed at a height of 10 m can be estimated by multiplying wind speed at a height of 2 m by 1.25.

For example, a wind speed of 4 km/h at 2 m would equal a wind speed at 10 m of 4 × 1.25 = 5 km/h.

If the winds are zero or light and variable, use a wind speed of 5 km/h.



3

6. Read rate of spread for open grassland, woodland or open forest, using the following definitions:

    a. Open grassland – Undisturbed or very lightly grazed continuous grasses, generally more than 50 cm tall. May contain scattered trees and shrubs.

    b. Woodland – Undisturbed or very lightly grazed continuous grasses, generally more than 50 cm tall under open woodlands that are generally 7-10 m in height. 3

    c. Open forest – Undisturbed or very lightly grazed continuous grasses, generally more than 50 cm tall under open eucalypt forests that are generally 15-20 m in height.

7. Finally, use the table below to convert rate of spread into average flame height.

Rate of fire spread (km/h)	**Average flame height (m)**		
	Natural (ungrazed) grassland	Grazed grassland	Eaten-out grassland
1	1.8	0.9	0.3
6	3.1	1.3	0.5
10	3.6	1.5	0.7
20	4.4	1.9	-

Where:

a. Grazed grassland – grazed pastures that are generally less than 10 cm tall.

b. Eaten-out grassland – very heavily grazed pastures that are generally less than 3 cm tall with scattered patches of bare ground.

Average flame heights of below 1 m are recommended to minimise the amount of foliage scorch and timber damage.

Important:

Fire behaviour information provided by the meter is a guide only. Unfortunately, a similar meter has not yet been developed for grazed spotted gum - ironbark forests.

The flame heights table above does not consider flame heights that could result when a wildfire burns through the canopy of a forest or woodland.

The meter will be inaccurate if used to predict fire spread in tall, closed forests or tall forests with a substantial understorey shrub and litter component. 3

If the land is very steep, the rate of spread will double up a 10° windward slope and quadruple up a 20° windward slope. Rates of spread will correspondingly decrease on a leeward slope.

1.4.2 How can I obtain a CSIRO fire spread meter?

The CSIRO fire spread meter can be purchased from Styrox (Aust) P/L (Tel: 02 9997 1000) for less than $15 at time of publication. They are available in two formats: a larger cardboard meter or smaller plastic field meter.

1.4.3 How does flame height influence tree scorch?

Greater flame heights will lead to greater canopy scorch.

Low fire intensities with an **average flame height of 1 m** will generally result in a **scorch height of 5 m or less**. 3

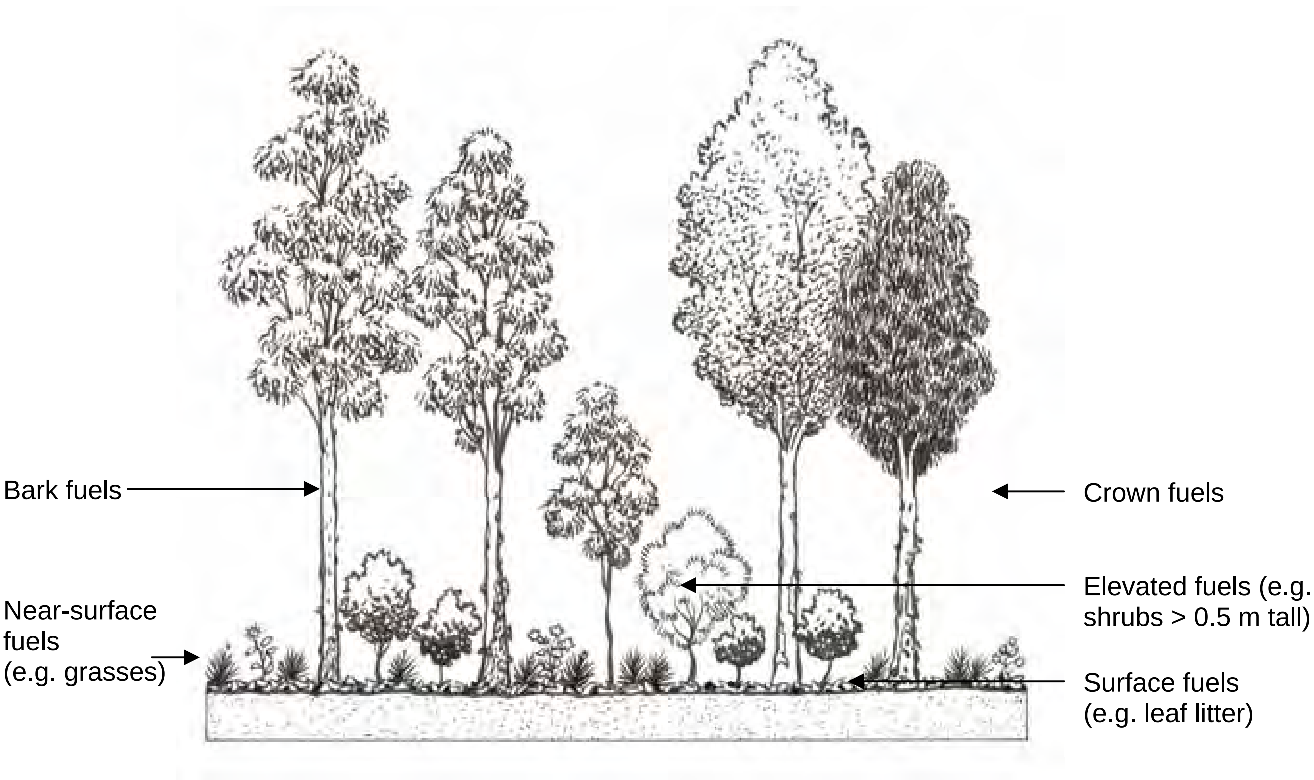
However, when burning is carried out in hotter, drier weather, when the fire risk is greater, scorch height may be up to **9 – 10 times the flame height**.

Under prolonged dry conditions, low flame heights (0.5 m) have been known to scorch trees up to 30 m, possibly as a result of low moisture in the leaves of the canopy. 1

1.4.4 Which forest fuel characteristics are important in determining fire behaviour?

There are five main forest fuel components in managed fire:

- Surface fuels (e.g. litter layer) 3
- Near-surface fuels (e.g. grasses)
- Elevated fuels (e.g. shrubs)
- Bark fuels
- Crown fuels



For most low intensity burns, surface and near-surface forest fuels (litter and grasses) will be the main drivers of fire intensity. Elevated forest fuels (shrubs) become increasingly important in hotter, drier weather, when the fire risk is greater (e.g. spring).

There are **four important characteristics** of forest fuel that influence the behaviour of a fire. They are:

1. Height of the most continuous forest fuel layer (surface, near-surface, elevated, crowns) – the layer that is most likely to sustain a continuous fire front 2

2. Percentage of dead forest fuel (more than 20% dead material is required for the fire to spread)

3. Horizontal and vertical continuity of forest fuels (i.e. how easily flames extend to the next piece of available fuel, either across the ground or up towards the canopy).

4. Amount and arrangement of dead forest fuels < 6 mm diameter and live fuels 3
< 2 – 3 mm diameter. For example, **doubling the quantity of these fuels may double the flame height and the rate of fire spread, and quadruple fire intensity in certain weather conditions**.

1.5 Are all trees equally vulnerable to fire damage?

The degree of fire-resistance for individual trees depends on tree size and species characteristics, particularly the type and thickness of bark.

Less vulnerable to fire	***More vulnerable to fire***
species with rough or thick bark (**e.g. ironbarks, pink bloodwood**)	Species with smooth or thinner bark (**e.g. spotted gum, forest red gum**)
larger diameter trees	smaller diameter trees
trees with greater canopy height	trees with lower canopies

3

The risk of tree death is increased by intense fires when:

- 100% scorch of foliage occurs
- The stem is heated beyond a critical temperature

If leading shoots of saplings are removed by fire, stem defects may result, reducing commercial value at harvest. 3

If total crown scorch occurs: 3

- Smaller trees can resprout from underground clusters of buds (lignotubers)
- Most seedling regeneration will be destroyed

Saplings required for future timber production should be protected from fire until:

- Most of the crown is above scorch height (see *1.4.3 How does flame height influence tree scorch?* page 15) 3

Tree species resprouting from underground buds (lignotuber)

1.6 How do I use fire to encourage forest regeneration if it is required?

Future forest productivity relies on lignotuber and seedling regeneration to replace trees that are eventually harvested.

There are three methods of eucalypt regeneration: 4

- Regeneration from **seed**
- Resprouting from suckers (**lignotubers**)
- Reshooting from the stump to form a **coppice**

Regeneration in dry eucalypt forests is initially from seedlings. The seedlings develop and form a lignotuber underground. The amount of regeneration will vary from year to year. 4

When the stem and canopy are killed in a fire, small eucalypts can reshoot from the lignotuber.

Lignotubers remain in the ground for at least 15 years, and some may persist for 40+ years, until there is enough light, water and nutrition to grow into a tree.

A. Protect regenerating trees from fire

If eucalypt regeneration is required as part of forest management, new seedlings should be protected from fire for **a minimum period of 3 years,** and preferably longer in areas where natural regeneration is infrequent. Conservative grazing in this period may also be important to minimise damage to eucalypt seedling regeneration. 3

Despite the need to protect regenerating trees there is anecdotal evidence to suggest that regeneration still occurs in areas burnt very frequently (e.g. biennially). This is likely to be the result of fire patchiness associated with frequent burning, which allows regeneration to survive in patches that are not burnt. 1

Eucalypts are likely to be killed by fire if the tree crown is less than the scorch height resulting from the fire. The period of fire exclusion should allow at least 50 young saplings (with a diameter at breast height of less than 10 cm) to be retained per hectare. 1

B. Burn to reduce competing woody species

Dense populations of wattle, lantana or other woody plants may suppress eucalypt regeneration. 4

While high intensity fires can remove some woody species, they may damage commercial trees. We recommend that methods of woody plant removal other than fire are considered in timbered areas to reduce the risk of timber scorching.

If fire is the chosen method for woody plant control, identify the species you wish to control with fire. This is necessary because some species are encouraged by fire (see ***2.1 Is fire effective in controlling woody species?*** page 23).

Where biennial burning is practiced for a few years to control woody species (see *2.1.1 How often should I burn woody species?* page 24), it is important that longer fire intervals of 3 years or more are introduced again to encourage eucalypt regeneration. 3

<u>1.6.1 Should I burn to prepare a fertile seed bed?</u>

Eucalypt seedlings in dry forests do not require fire for successful germination. However, burning does provide favourable conditions for early growth of seedlings.

Burning for seed bed preparation in dry forests is not as important as in wet eucalypt forests where bare earth increases seedling establishment.

Seed shed may be encouraged by fire. However, burning to coincide with seed fall events is not usually practical. This is because seed fall may occur during the warmer months, when burning is not advisable. 3

Top-disposal burning (burning of tree heads and branches) after harvest is an alternative way to encourage regeneration (but see ***1.8 Should I use fire to remove post-harvest/thinning debris?*** page 20).

Burnt ground can encourage tree regeneration

There are no long-term benefits to either recruitment or seedling growth in spotted gum - ironbark forests from the 'ash-bed' effect of frequent fire. 4

Rainfall and competition among trees are likely to be much stronger influences on whether a seedling survives and develops into a productive tree. Thus, further timber management to reduce tree competition may be required after initial recruitment. 3

<u>1.7 Should I use fire to thin a commercial native forest?</u>

Thinning is a recognised tool to promote the growth rate of trees and reduce the overstorey canopy cover to encourage regeneration. 3

However, caution should be used when burning, as fire is a **non-selective** method of thinning that can damage the future timber crop.

For example, a low intensity fire could be used to thin new regeneration, when an older pulse of regeneration is present, provided that most canopies of the older regeneration group are not within scorch height.

1.8 Should I use fire to remove post-harvest/thinning debris?

Using fire to remove post-harvest or thinning debris will reduce heavy forest fuels. However, this practice may also:

- Remove nutrients from the site that are important for pasture and tree growth (e.g. nitrogen)
- Increase erosion and topsoil loss by increasing overland water flow
- Damage remaining commercial trees

2

It is recommended that forest fuel-reduction burning is carried out **1 – 2 years before** thinning or harvesting. This will improve visibility and access for tree selection, cutting and snigging (removal of timber). It will also reduce the number of smaller stems and forest fuel load, and may reduce the need for burning after timber removal. 1

Fire-damaged trees can be removed from the stand during the thinning or harvesting operation.

A delay in forest fuel-reduction burning for 3 – 5 years following thinning or harvesting may allow time for greater decomposition of nutrient rich leaves and will improve regeneration success. 3

To reduce the risk of damaging trees from managed burning, log debris should not be allowed to accumulate within 1 m from the base of any tree prior to burning. 2

For recruitment, habitat, feed or nest trees (as defined by the code applying to a native forest practice on freehold land), logging debris that is to be burnt should not be retained within 2 m of the tree.

1.9 What happens if I don't burn at all?

Frequent and infrequent fire intervals both have benefits to your property.

Leaving some areas unburnt is important to provide wildlife habitat and protect fire-sensitive plants that need a long enough period to mature and produce seed before the next fire. 3

Fire sensitive vegetation (e.g. vine thickets, rainforest, softwood scrub) and riparian vegetation, particularly around permanent streams, should be protected from repeated burning to maintain good water quality and to preserve biodiversity. 3

As part of a property management plan, it is advisable to include some long inter-fire intervals (7 – 25 years) in parts of the property. Such areas are associated with a greater fire risk due to the amount of combustible forest fuel available. However, by surrounding long unburnt areas with fire breaks and frequently burned buffer strips, the risk of fire spreading to or from long unburnt areas is greatly reduced.

When fire is used infrequently and/or grazing pressure is low, fire breaks should be constructed around and within property boundaries to limit the risk of wildfire spread to neighbouring properties. Fire breaks will also provide access tracks to assist in fighting wildfires. 1

Creating fire breaks in steep country may be difficult and could lead to increased soil erosion. In such cases, planning the best positions for fire breaks should be carried out in conjunction with neighbouring properties. 1

Refer to ***4.2 Property management planning*** (page 34) for advice on the legal requirements in clearing vegetation for fire breaks.

Long periods of fire exclusion (greater than 25 years) for timber production areas are not recommended.

Long-term removal of fire in spotted gum - ironbark forests may lead to:

- High risk of a damaging high intensity fire or wildfire.
- Less successful eucalypt seedling regeneration by encouraging high densities of understorey shrubs. 3
- Poor tree health and dieback of branches.

Tree canopies and branches that are lacking leaves are an indicator of poor tree health and dieback

1.10 I have signs of poor tree health on my property – does this mean I should be burning more frequently?

Infrequent burning is often not the sole cause of tree decline and dieback. Tree decline and dieback are likely to be caused from a combination of factors:

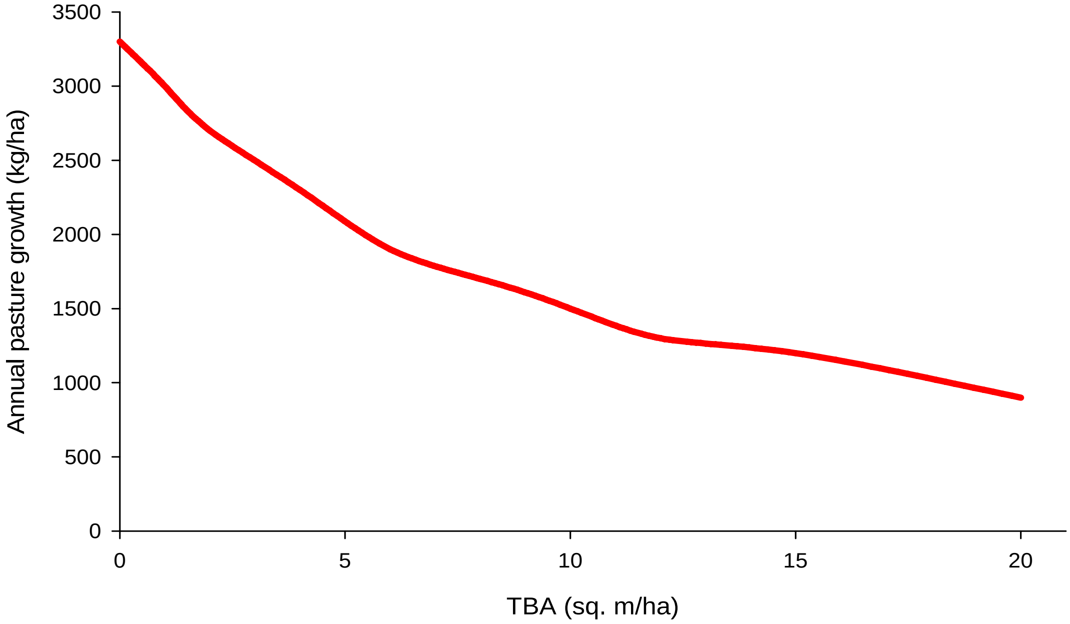
- Insect attack (leaf-eaters, sap-suckers and borers)
- Intensive livestock grazing and associated nutrient enrichment of soils which can favour populations of tree feeding insects 3
- Vegetation clearing and leaving isolated trees
- Storms, drought, floods, frost
- Old age 2
- Increased soil salinity
- Pathogens of roots and leaves (e.g. root rot fungus)
- Mistletoe infestation
- Reductions in populations of insectivorous animals (e.g. birds and bats) due to declines in the number of nesting sites
- Long-term absence of fire, or the occurrence of wildfire

Dieback is commonly associated with insect attack, which may be in turn driven by other factors causing physiological stress to the tree.

2. Livestock grazing production

Management of grazing under native forests differs to that of cleared areas due to the influence of trees on grass growth. The number of trees in an area and their basal area has an important influence on the amount of pasture growth.

Expected relationship between tree basal area (TBA) and annual pasture growth for pastures in good condition in dry open forest



3

2.1 Is fire effective in controlling woody species?

If the density of shrubs or trees becomes too great then losses in agricultural
productivity can occur. Forests that are burnt frequently generally have a grassy 4
understorey and fewer shrubs. Infrequently burnt areas are generally associated more
with high densities of shrubs. 2

Infrequent burning. Less pasture growth and a high abundance of shrubs

Frequent burning. Productive pasture growth with few shrubs

Effectiveness of fire in the control of woody species depends on the species present.

Wattle species show a range of responses to fire:

e.g. Hickory wattle (*Acacia aulacocarpa)* often increases in density after fire but black wattle (*A. leiocalyx*) may be killed by frequent fire. 4

Extreme caution is needed when using fire (low or high intensity) to control wattles, as some species may benefit from fire.

Fires of high intensity can encourage germination of some wattle species and red ash. 2

2.1.1 How often should I burn woody species?

Frequent burning (e.g. every 2 years) for several years should prevent seedlings from maturing and control dense infestations of some woody species. 3

After initial control of woody plant populations, a lesser fire frequency **(one fire every 3 – 7 years)** can be used to **maintain low numbers of woody species.** However, monitoring woody species density after a fire is important under these lower frequencies. Monitoring of regrowth height will allow you to determine when fire is necessary. 1

Low intensity fire is unlikely to control woody plants taller than 1 – 2 m. 2

An example of 3.5 t/ha of standing grass

Grassy fuel loads (standing grass only) of 3.5 t/ha or more may be necessary to provide sufficient fire intensity to suppress certain woody species. 1

However, such high fire intensities may lead to tree damage and poor timber quality.

2.1.2 When is the best time of year to burn for the control of woody species?

Burning just before or during the dry season[†] may be beneficial to limit the regeneration of woody species (i.e. seedlings are more likely to be killed by dry conditions and frosts). Using low intensity fires during the dry season also **reduces the chance of scorching or killing commercial trees**. 2

[†] In this document 'dry season' refers to the winter months, but can also include some of autumn or spring, depending on when rainfall occurs.

Low intensity, slow-moving fires may be effective at reducing densities of some woody species less than 1 – 2 m tall through the extended duration of soil heating and subsequent damage to plant roots. However, greater soil heating can encourage the germination of some wattle species. 2

2.2 Will fire encourage or reduce pasture weeds?

Pasture weeds are undesirable non-woody plants that compete with the pasture (e.g. wiregrasses, parthenium). The effect of fire on pasture weeds varies depending on the weed species present, which is largely influenced by past management.

Fire may encourage undesirable species by creating conditions suitable for their establishment and growth (e.g. bare ground). This is **more likely to occur in** areas that have been **heavily grazed or degraded, or where nutrient enrichment has occurred** (e.g. stock camp areas, or small paddocks). 2

In some cases, the absence of fire or infrequent fires is associated with greater occurrence of pasture weed species. 3

Preventing weeds from flowering and producing seeds (by either burning or grazing) will reduce their population. 2

Some perennial native grasses (e.g. wiregrasses) are undesirable for graziers. Spring burning in at least two successive years can be used to reduce wiregrasses and encourage more desirable pasture grasses (e.g. black spear grass). 3

2.3 How does fire affect pasture condition

For graziers it is important that the pasture under forest remains in a productive condition.

Maintaining pastures in a healthy state is more cost effective than trying to restore land condition after deterioration has occurred. 2

Burning will not be effective in immediately restoring land that is in poor condition.

<u>2.3.1 When is the best time to burn perennial grasses?</u>

Burning in early spring after rainfall (30 – 50 mm) **is recommended** to limit the period of time without stock feed for grazing production and for maintaining pasture condition. Burning after rain will ensure that some organic matter (i.e. soil humus) is retained on the soil surface. 2

Burning in spring may not always be possible if forest fuel loads are high as fire intensity will be increased (see ***1.4 When do I burn?*** page 11). High intensity fire can incinerate the soil organic matter, exposing the top soil and increasing potential for soil erosion. Intense fire can also have an adverse effect on the viability of soil fungi (important for efficient nutrient and water uptake by plants). 3

While spring burning is best for ensuring a rapid recovery of the pasture (given rain), least damage is done to the pasture when most of the grasses are dormant (i.e. during the dry season). 3

Low intensity burning when the soil is moist (after rainfall) is recommended to:

- Retain organic matter and ground cover.
- Favour conservation of nitrogen in the organic layer.
- Minimise impacts on timber trees.

 3

What effect does fire have on soil nutrients?

The availability of soil nutrients is often greater immediately following fire, although this increase is usually short-lived. Some losses of nutrients occur during a fire due to volatilisation (e.g. nitrogen in plants is lost with burning).

Repeated burning over many years (decades to centuries) in spotted gum-ironbark forests may result in small losses in soil nutrients. In the case of nitrogen, the amounts lost through repeated burning may be partly replaced by nitrogen-fixing legumes, and by bacteria and fungi in the soil. 4

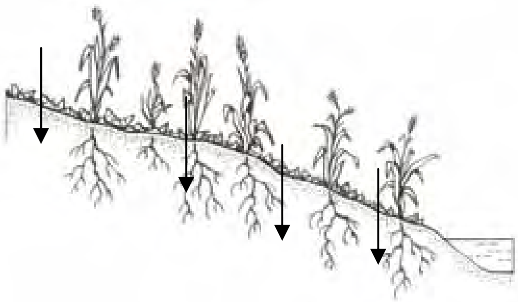
Burning during drought periods is unlikely to occur given the need to retain stock feed. In ungrazed areas, burning during droughts is not advisable due to increased potential for erosion when rainfall does occur. 2

Perennial grasses and grazing

Perennial grasses provide greater grazing benefits than annuals as they:

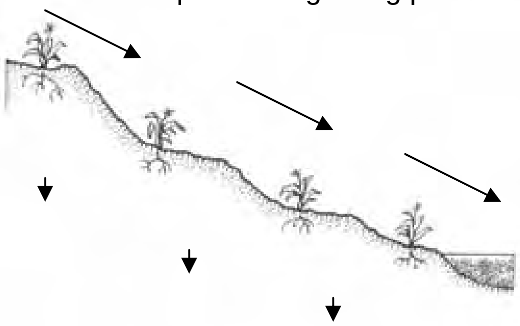
- **provide valuable stock feed through periods of low rainfall**
- **maintain soil structure and water infiltration**
- **maintain good grazing land condition**

1. Appropriate fire and grazing regime



- Good (high) grass cover
- Recruitment of perennial grasses
- High infiltration
- Healthy soil fungi
- Nutrients available
- Good litter cover
- Minimal runoff
- Good water quality

2. Fire too frequent and grazing pressure high 2



- Poor (low) grass cover
- High bare ground
- Little grass regeneration
- Low infiltration
- Fewer nutrients available
- High water runoff and soil erosion
- Poor water quality

Kangaroo grass and black spear grass both respond favourably to burning once every 1 - 5 years (although in grazed areas this response might not be seen because these grasses will be selectively grazed by cattle). 2

There are **economic benefits** from a conservative stocking rate in the long-term. Land degradation is more likely to occur where grazing pressure is high, especially if combined with poor fire management. In addition, overgrazing will severely limit opportunities for burning (due to lack of forest fuel accumulation).

Extended periods of heavy grazing can also encourage woody shrub recruitment. 2

Refer to DPI&F Grazing Land Management for further information on pasture condition (http://www2.dpi.qld.gov.au/beef/18481.html)

2.3.2 Is it best to graze or rest the pasture after fire?

Grass health is weakened if heavy grazing occurs in the immediate recovery period after fire. However, **the regrowth phase of the vegetation is palatable and more productive for livestock** as nutrient levels in grasses are often highest in the first few months after fire. 3

Pastures should be rested (i.e. de-stocked) after burning until the grass is at least 20 cm high, or ideally until the grass plants are fully grown. 1

Resting burnt areas for at least 4 months will benefit pasture yields in black spear grass pastures.

Grass regrowth following fire and rainfall

2.3.3 How much area to burn?

Burning large areas of the property (particularly at the start of the dry season) will significantly reduce pasture reserves. However, it is recommended that areas that are burnt are large enough to prevent overgrazing in burnt areas. 1

2.3.4 What is an appropriate fire frequency for grazing management?

Frequency of burning depends on the management goals (e.g. cattle production, timber production, biodiversity conservation, wildfire risk management).

Annual burning is not recommended due to increased risk of soil erosion.

- This is especially important on steeper slopes where severe soil erosion can occur. 3
- Annual burning is also likely to have a negative impact on soil biota, soil processes and some native plant and animal species.

There is some anecdotal evidence to suggest that burning pastures every two years is sustainable from a grazing perspective. However, **burning every 3 – 7 years is recommended** for pastures under spotted gum - ironbark forests to ensure sustainability across a property with some variability in soil, vegetation composition and rainfall. In drought years, periods between fires may need to be further extended. 1

Similarly, **less frequent burning and careful management will be required for sodic soils, sandy soils and shallow rocky soils.** The productivity of these soils requires maintenance of the topsoil (i.e. lack of soil erosion) for nutrient supply and favourable root growth. 2

More frequent fire (every 2 years) may be necessary to control woody plant populations, to create protective buffer strips (to prevent spread of wildfire) and in exceptional conditions where forest fuel quantities accumulate very quickly (see *2.1.1 How often should I burn woody species?* page 24 and ***1.2 How frequently do I burn?*** page 9).

2.3.5 What will happen if I don't graze at all?

Not grazing at all may result in forest fuel loads that could result in an intense fire (especially if regeneration of woody species occurs) that can damage timber and be difficult to control. 3

However, de-stocking certain areas (e.g. areas retained as wildlife habitat) can be beneficial for some plants and animals that are sensitive to livestock grazing. Grazing can be used to change forest fuel loads. Removal of grazing from a paddock for one growing season may be necessary to allow forest fuels to build up prior to burning. Where forest fuel loads are too high for a low intensity burn, grazing should be introduced to reduce the fuel loads prior to a managed fire. 3

Varying fire frequency across the property is important

Different land types within a property may need to be managed in different ways. For example, timbered areas may require less frequent burning than previously cleared areas managed for grazing. It is important to consider both pasture growth and forest fuel loads in timbered areas (see ***1.4 When do I burn?*** page 11).

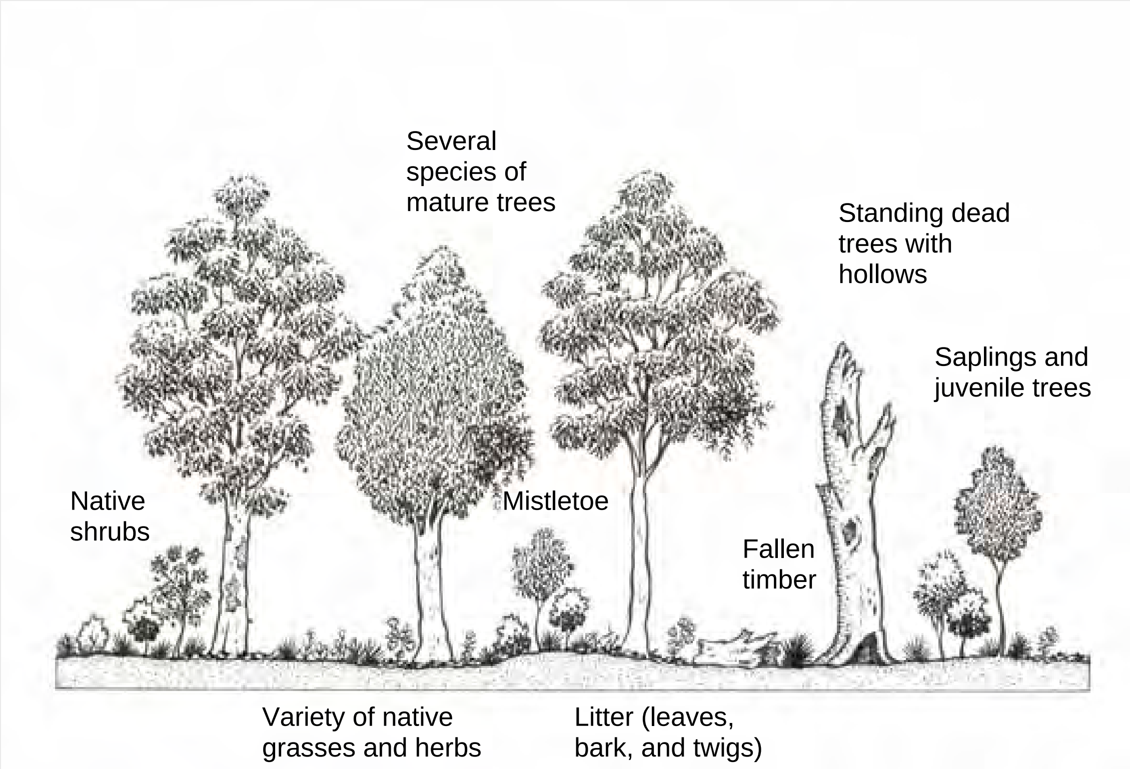
Native forest area managed for grazing and timber production

Cleared area managed for grazing production

3. Balancing production and biodiversity

Burning to conserve native plants and animals should be incorporated into fire management for production outcomes.

Important features of healthy woodland and open forest ecosystems



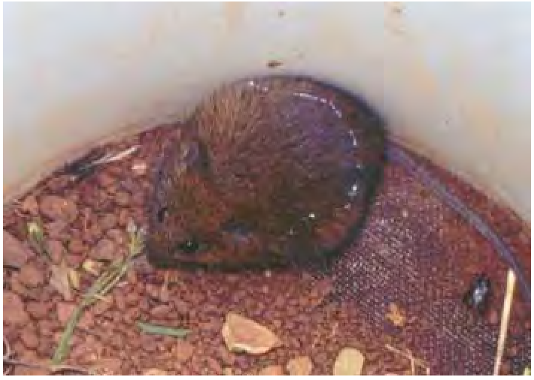
3

- Many Australian plant species in dry eucalypt forests can tolerate fire, while some plant species require fire for regeneration. However, the interval between fires is critical in determining whether fire is beneficial or detrimental to an individual plant species:
  - If the period between fires is not sufficiently long enough for a plant to mature and reproduce, the species may go into decline (e.g. some *Banksia* species). 3
  - Other plants that are able to mature and reproduce quickly may thrive on short inter-fire periods (e.g. many grasses).

- Similarly, native animal species vary in whether they respond positively or negatively to frequent low intensity fire.

- Some small native mammal species may be sensitive to repeated fire, particularly where the amount of habitat for nesting and feeding is removed by fire (e.g. the native Bush Rat, *Rattus fuscipes*). 3

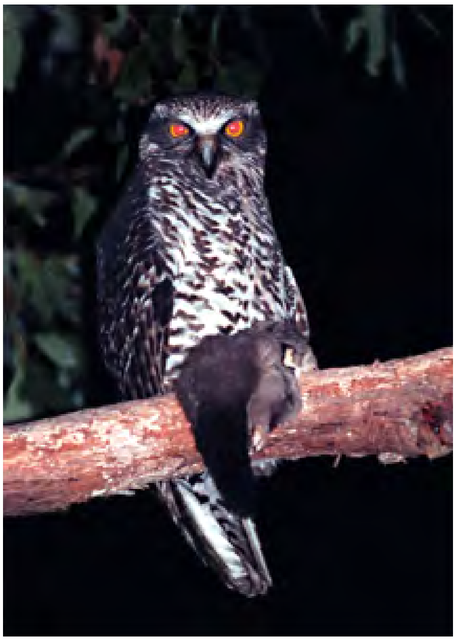
- In contrast, many other Australian animals are remarkably resilient to fire or require fire to maintain their habitat (e.g. the Eastern Chestnut Mouse prefers heathland areas regenerating after fire). 2



Eastern Chestnut Mouse, *Pseudomys gracilicaudatus*

- Some animals will use post-harvest debris for habitat and food supply.

- Some native animal species require tree hollows for their survival. Habitat trees (trees with visible hollows) should be retained, especially in forested areas on the property. Refer to 'the code applying to a native forest practice on freehold land' for information on the numbers of trees to be retained for wildlife habitat values. This is available from: http://www.nrw.qld.gov.au/about/policy/documents/2078/pdfs/2005_28_nov_vma_fp_code.pdf



Gliders and owls require tree hollows for habitat

There is no one fire regime that suits all native plants and animals due to the range of responses to fire. 3

Continuous use of a single fire regime over a property will not benefit biodiversity.

The best way to encourage biodiversity on the property is to:

- **Use a varied fire regime (season, frequency and intensity) over the property.** 3
- **Manage at least 10% of the property primarily to conserve and encourage wildlife, where burn intervals are longer than in production zones (one fire every 7 – 25 years).** 3
- **Protect fire sensitive vegetation such as vine thickets, rainforest and softwood scrub and riparian vegetation from burning.** 2

Properly maintained fire breaks and frequently burnt areas should surround less frequently burnt areas to reduce the risk of wildfire.

Areas that are infrequently burnt are more prone to wildfires. However, it is important to
maintain a range of fire frequencies and intensities for native wildlife. Many Australian 3
animal species are resilient to low intensity fires as they are able to avoid the effects of
the fire (e.g. by taking refuge in burrows or under rocks). Some other groups of fauna
(e.g. invertebrate litter fauna) may prefer fires that move across the ground quickly as
slow moving fires can heat up the ground.

Many animals, particularly birds, mammals, reptiles and some insects, can move across
large areas and are not solely dependent on single small areas for their habitat and
feeding requirements. While a localised wildfire may decrease populations of some
species within the affected area, the larger population should be less affected if there are 3
other areas of suitable habitat nearby that are large enough to support the species.

Ideally, forested areas managed to encourage native wildlife should be close to
other forested areas on the property and on neighbouring properties. This will 3
provide larger patches of feeding and breeding habitat, which will support greater
populations of some species.

4. Fire management planning for the property

4.1 Planning a burn

Prior to burning, there are a number of steps that should be taken to ensure a safe and effective burn. A good guide on preparing for burning can be found by visiting http://www.rfs.nsw.gov.au/file_system/attachments/State/Attachment_20060131_C4C3FB83.pdf[†]. **Before conducting a burn you must contact your local fire warden to obtain a permit** (permits will only be given when conditions are considered safe).

In some years there may be few days when low-risk weather conditions occur, particularly in spring. Therefore, it is very important to prioritise burning on days when conditions are favourable for low intensity burning.

The information in this guide is designed to assist in determining the weather conditions that are safe for low intensity fires. However, gaining experience is an important part of fire management.

Small-scale trial burns within areas surrounded by fire breaks are a useful way to test the predictions of the CSIRO fire spread meter for Northern Australia and gain experience with fire management under different weather conditions.

After completing all burns, it is important to check the perimeter of the burnt area regularly over 2 – 3 days to ensure the fire has not escaped containment.

4.2 Property management planning

Fire planning should be related to land capability and use, and we recommend that it is incorporated into your property management planning.

It is very important to work with adjoining landholders when planning fire management. Working in conjunction with neighbours will help to reduce the risk of wildfire spread across multiple properties. Allocating less frequently burnt areas for wildlife conservation across property boundaries also provides benefits to biodiversity (see page 32).

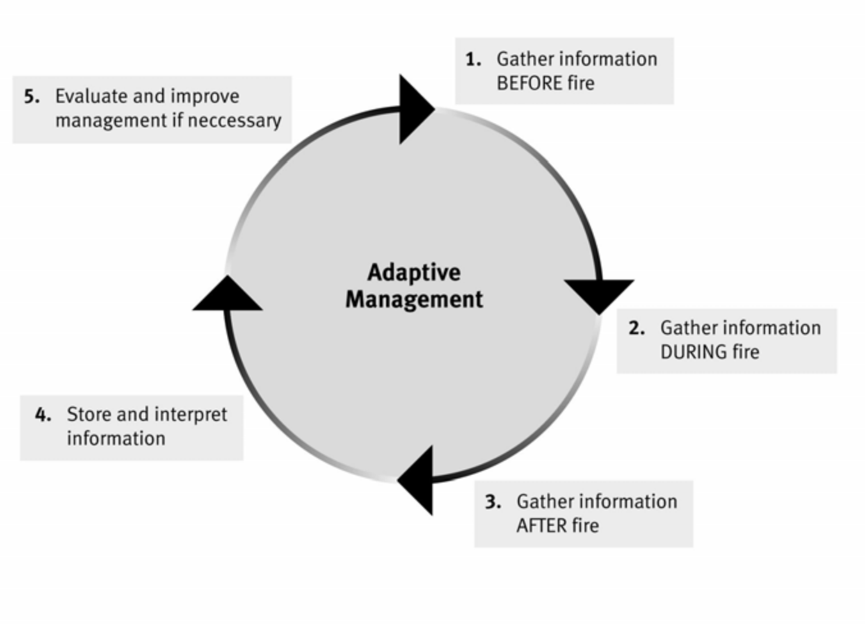
Some important things to consider when planning fire management:

- What areas will be burnt each year?
- What frequency of burning will be suitable for each area?
- Which areas have greater priority for burning based on forest fuel loads?
- What time of year will each area be burnt?
- Will forest fuel loads (litter, pasture, shrubs and bark) be adequate to carry a fire?
- Will forest fuel loads to be too high and threaten existing timber resources and tree regeneration?
- Where will I create fire breaks and protective buffer strips to best protect my property and my neighbour's property from wildfire?
- How do I incorporate my neighbour's concerns into fire management planning?

[†] Most of the information in this web document is applicable in Queensland but some of the information relating to permits and approvals may be specific to NSW fire regulations.

- Are there areas of fire-sensitive vegetation and riparian strips around creeks that should be protected from fire?
- Are the proposed fire management actions **acceptable** under the *Vegetation Management Act 1999* (and amendments) and 'the code applying to a native forest practice on freehold land', plus any other legislation or local government regulations that exist?

Once you have developed and implemented your burning plan, you can make future improvements to it by monitoring the effects on paddocks before, during and after a fire.



1. Before a fire. Useful information includes:

- Weather conditions (temperature, humidity, wind speed, previous rainfall, days since last rainfall)
- Slopes
- Aspects
- Quantity of forest fuels present
- Density of unwanted woody species present
- Density and height of required woody species (e.g. eucalypt regeneration)
- Location of assets that require protection (fences, yards, pipelines, etc)
- The condition of fire breaks
- Legal obligations

Fire breaks: Legal requirements for clearing vegetation for fire breaks in 'remnant' mapped vegetation areas are described in Queensland's *Vegetation Management Act 1999* and Codes of Practice produced by the Department of Natural Resources and Water (NR&W). For more information refer to: http://www.nrw.qld.gov.au/vegetation/pdf/forest_practice/fpc_guide_v1_1.pdf

Bare-earth fire breaks around property or paddock boundaries should be less than 10 m wide.

2. During a fire. Useful information includes:

- Weather conditions (previous rainfall, temperature, humidity, wind speed)
- Rate of fire spread and average flame height

3. After a fire. Useful information includes:

- Average scorch height on trees
- Effectiveness of the burn in reducing forest fuel loads
- Proportion of eucalypt regeneration killed
- Changes in the number of woody and non-woody species present
- Whether soil erosion has increased after the fire
- Changes in pasture composition

It is important to keep a record of when fires occur so that you can build up a good fire history for different parts of the property. This will allow you to determine the long-term effects of your fire management.

An easy way to monitor an area is to take regular photographs (e.g. every 12 months) using the same point to take the photograph each time. We recommend taking the photograph from the north so that the sun is behind you.

You should store this information and photographs in a safe and accessible place, preferably on a computer, so that you can refer back to information from previous years.

Further information on monitoring can be found at the South East Queensland Fire and Biodiversity Consortium's website (http://www.griffith.edu.au/school/asc/fire2/home.html)

5. Recommendations for landholders

Recommendations for timber and grazing production:

- **Burn production areas once every 3 – 7 years to achieve a mosaic of different fire frequencies across the property.**

- **Vary fire frequencies according to the amount of forest fuel, previous rainfall, grazing intensity and soil fertility.**

- **Burn less frequently where grazing pressure is high and when rainfall has been low, and where soil erosion is likely (e.g. on steep slopes).**

- **Aim to achieve low intensity burns to prevent canopy scorch of trees. This should preferably take place in late winter or spring depending on forest fuel loads and weather conditions.**

- **Don't let woody species get out of control (e.g. high densities that are greater than 1 m in height). If controlling a severe infestation of woody plants, burn every 2 years for a short period only.**

- **Be extremely cautious if using fire to carry out major tree thinning (silviculture).**

- **Retain some post-harvest woody residue on site, but keep it at least 2 m from recruitment, habitat, feed or nest trees and 1 m from all other trees prior to any burning.**

- **Areas burnt should be large enough to prevent overgrazing but not too large as to compromise available pasture for stock.**

- **Plan stock movements around the need for hazard-reduction burning on the property.**

- **Burn after rainfall and do not burn during drought years. Give pastures a recovery period without grazing following each fire.**

- **Monitor invasion of pasture weeds and control if necessary.**

- **Ensure you comply with legal obligations (e.g. *Vegetation Management Act 1999*, 'the code applying to a native forest practice on freehold land', local government rules and regulations).**

Recommendations for using fire to conserve and enhance biodiversity:

- **Create a mosaic of different fire regimes (frequency, intensity and season) across the property.**
- **Burn at variable intervals of between 7 – 25 years to encourage plant and animal diversity over at least 10% of the property.**
- **Don't burn fire sensitive vegetation or riparian zones, particularly adjacent to permanent streams.**
- **Leave some woody debris (e.g. hollow logs) unburnt as native animal habitat.**

Recommendations to all landholders to ensure safe and effective fire management:

- **Create a network of fire breaks to protect against wildfire and provide access for firefighting.**
- **Maintain more frequent fires (once every 2 years) in strategic buffer strips to reduce the risk of wildfire spread.**
- **When reducing high forest fuel loads, burn in low risk weather conditions (low temperatures, moderate-high humidity, nil - light winds).**
- **Work with neighbours to reduce the risk of wildfire to properties and assist neighbours with fire fighting on their properties.**
- **Monitor the effects of fire on your property and change your management if necessary.**
- **Monitor weather conditions prior to and during burning.**
- **Ensure fires are well planned and controlled.**
- **Ensure all legal requirements are met (e.g. contacting neighbours prior to burning).**

Appendix

Beaufort wind scale and corresponding wind speeds in km/h and description of wind effects.

Beaufort scale	**Descriptive term**	**Units in km/h**	**Description of wind effects**
0	Calm	0	Smoke rises vertically
1 – 3	Light winds	1–19 km/h	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
4	Moderate winds	20–29 km/h	Raises dust and loose paper; small branches are moved.
5	Fresh winds	30–39 km/h	Small trees in leaf begin to sway; crested wavelets form on inland waters
6	Strong winds	40–50 km/h	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty.
7	Near gale	51–62 km/h	Whole trees in motion; inconvenience felt when walking against wind.
8	Gale	63–75 km/h	Twigs break off trees; progress generally impeded.

This table has been adapted from contents of the Bureau of Meteorology website.