Department of National Parks,
Recreation, Sport and Racing

# Planned Burn Guidelines

## Mulga Lands Bioregion of Queensland

Queensland Government

Prepared by: Queensland Parks and Wildlife Service (QPWS) Enhanced Fire Management Team, Queensland Department of National Parks, Recreation, Sport and Racing (NPRSR).



First published May 2013
Published by the Department of National Parks, Recreation, Sport and Racing

**National Library of Australia Cataloguing-in-Publication**

Planned Burn Guidelines – Mulga Lands Bioregion of Queensland
First edition
Bibliography
ISBN 978-1-7423-0929
1. Planned Burn – Guideline 2. Fire Management 3. Bioregion – Queensland

**Disclaimer**

This document has been prepared with all due diligence and care based on the best available information at the time of publication. The department holds no responsibility for any errors or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties. Information contained in this document is from a number of sources and as such, does not necessarily represent government or departmental policy. All Queensland Government planned burning should be done in accordance with government policies, procedures and protocols.

**Acknowledgements**

The following people made substantial contributions to the intellectual content of these planned burn guidelines based on experience and/or expert knowledge with regard to fire management in the Mulga Lands bioregion. QPWS staff include: Mark Handley, Stephen Peck, Andy Coward, Christine Crafter, and Teresa Eyre. The following people made considerable efforts in ensuring the guidelines were supported by accurate and comprehensive photographs: Mark Handley, Jenny Handley, Stephen Peck, Robert Ashdown, Karen Smith, Teresa Eyre and Rob Murphy.

This guideline has been developed and produced by the QPWS Enhanced Fire Management Team: Mark Cant, David Shevill, Wayne Kington, Jenise Blaik, Kerensa McCallie, Troy Spinks and Justine Douglas; supported by David Clark, Caroline Grayson, Ellen Thyer and Tim Killen. Following a successful pilot project (QPWS South East Region Planned Burn Guidelines) initiated and developed by QPWS staff: Wayne Kington, David Kington and Mark Burnham.

**Front cover photograph:** QPWS, Idalia National Park, overview showing vegetation changes over the landscape.

Bp2014

## Foreword

The Mulga Lands bioregion is dominated by flat to undulating plains and low ranges which support a range of mulga Acacia aneura dominated forest and woodland communities. The area is considered semi-arid and often experiences periodic high rainfall events which result in floods followed by a rapid increase in the vegetation biomass.

The landscape is considered one of the most degraded in Queensland (Sattler and Williams 1999). The causes of this degradation are complex and are often the result of a combination of factors that include property size, socio-economics, grazing and stocking practices and vegetation management. One resulting implication of this degradation has seen a significant change in the frequency, severity and behaviour of fire in the Mulga Lands landscape.

The use of fire as a land management tool within the Mulga Lands bioregion is highly variable. Subject to the effects of the boom and bust cycle of the Mulga Lands the recent fire history of this bioregion has been dominated by the infrequent, large-scale and high-intensity fires of the 1950s and 1970s, followed by long periods of limited or absent fire within the landscape. The aim of this guideline is to provide important supporting information for the use and management of fire in the landscape to achieve resilient and sustainable biodiversity and improved conservation outcomes.

Stephen Peck
Ranger
South West Region
Queensland Parks and Wildlife Service.

# Table of contents

**Foreword** ........ iii

**Purpose of this guideline** ........ vi

**Scope** ........ vii

**Fire and climate in the Mulga Lands bioregion** ........ ix

**How to use this guideline** ........ x

**Chapter 1: Eucalypt forest and woodland** ........ 1

- Issue 1: Maintain healthy grassy eucalypt forests and woodlands ... 2
- Issue 2: Maintain mixed eucalypt and acacia woodlands ........ 16
- Issue 3: Manage eucalypt forests where understorey fuels are not usually continuous ........ 25
- Issue 4: Manage invasive grasses ........ 27
- Issue 5: Reduce overabundant saplings/seedlings ........ 28

**Chapter 2: Grasslands** ........ 29

- Issue 1: Maintain spinifex grasslands ........ 30
- Issue 2: Maintain other tussock grass communities ........ 41
- Issue 3: Manage invasive grasses ........ 51
- Issue 4: Reduce overabundant saplings/seedlings ........ 52

**Chapter 3: Wetland and melaleuca communities** ........ 53

- Issue 1: Limit fire encroachment into melaleuca communities ....... 54
- Issue 2: Avoid fire in wetland communities ........ 56

**Chapter 4: Cypress pine and allocasuarina communities** ........ 60

- Issue 1: Maintain open cypress pine or allocasuarina forests ........ 62
- Issue 2: White cypress pine production forests ........ 75
- Issue 3: Manage invasive grasses ........ 83
- Issue 4: Reduce overabundant saplings/seedlings ........ 84

**Chapter 5: Mulga dominated communities** ........ 85

- Issue 1: Limit fire encroachment into mulga communities ........ 86
- Issue 2: Manage invasive grasses ........ 90

**Chapter 6: Acacia dominated communities........................................ 91**

Issue 1: Limit fire encroachment into acacia communities............92

Issue 2: Manage invasive grasses ................................................97

**Chapter 7: Riparian, fringing and saltpan communities...................... 98**

Issue 1: Limit fire encroachment into riparian, fringing and saltpan communities ..............................................99

**Chapter 8: Common issues.............................................................. 104**

Issue 1: Hazard reduction (fuel management) burns ...................105

Issue 2: Planned burning near sensitive cultural heritage sites....113

Issue 3: Limit fire encroachment into non-target fire vegetation groups........................................................122

Issue 4: Manage invasive grasses ..............................................129

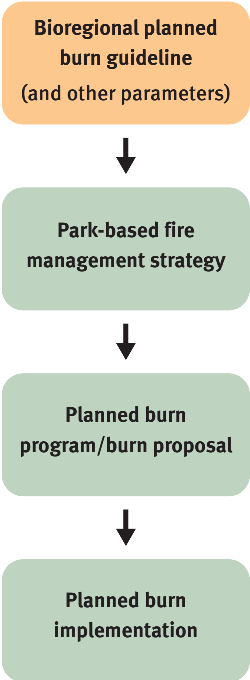
Issue 5: Reduce overabundant saplings/seedlings .....................141

**Glossary of fire terminology............................................................ 149**

**References........................................................................................ 157**

**Appendix 1: List of regional ecosystems .......................................... 160**

**Appendix 2: Mosaic burning ............................................................ 166**




How the planned burn guideline fits into the QPWS Fire Management System.

# Purpose of this guideline

This guideline was developed as part of the Department of National Parks, Recreation, Sport and Racing's (NPRSR) Queensland Parks and Wildlife Service (QPWS) Fire Management System to support the formation of fire strategies, burn proposals and on-ground planned burn implementation (supported by the Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go). They assist rangers and other land managers to:

- protect life and property
- maintain healthy ecosystems
- promote awareness of fire management issues in the field
- identify clear fire management objectives to address those issues; and how to assess objectives to assist in adaptive management
- identify suitable fire behaviour, burn tactics and weather conditions to achieve objectives
- provide information and tools to assist in implementing planned burns.

Please note that this planned burn guideline uses 'fire vegetation groups' provided in ParkInfo that assist their integration into maps and fire strategies. A fire vegetation group is a group of related ecosystems that share common fire management requirements.

# Scope

- This guideline applies to the Mulga Lands bioregion (refer to Figure 1) and covers the following fire vegetation groups: mulga dominated communities, eucalypt woodlands, grasslands, melaleuca communities, cypress pine and bulloak communities, other acacia dominated communities and riparian/springs/fringing communities (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Mulga Lands. In some cases, there will be a need to include issues in burn proposals beyond the scope of this guideline (e.g. highly specific species management issues).
- This guideline recognises and respects Traditional Owner traditional ecological knowledge and the importance of collaborative fire management. Consultation and involvement should be sought from local Traditional Owners in the preparation and implementation of planned burns and specific guidelines incorporated into fire strategies where relevant.
- Development of the guideline has been by literature review and a knowledge-capturing exercise, using both scientific and practical sources. It will be reviewed as new information becomes available.

Robert Ashdown, QPWS, Thrushton National Park.


**Figure 1:** Map of the Mulga Lands bioregion of Queensland

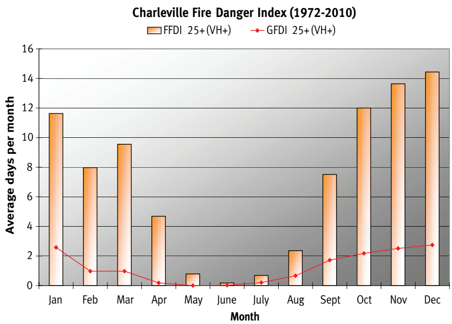
# Fire and climate in the Mulga Lands bioregion

Stretching from St George in the east to Thargomindah in the west and north to Jundah in Central Queensland, the Mulga Lands bioregion is dominated by a hot, persistently dry, semi-arid climate which has cold winters, hot summers and receives variable rainfall from 200 to 500 mm annually, with protracted dry spells.

Many fire vegetation groups do not generally have enough fuel to carry a fire and therefore planned burns have rarely been used in the bioregion by either Aboriginal or European land managers other than to maintain seasonal grasslands and more recently, to control vegetation thickening. Burning generally has occurred in years following above average rainfall when late summer, monsoonal low-pressure systems or rain depressions often result in floods producing heavy rainfall in southwest Queensland (Neldner 1984). This rainfall variability influences the production and distribution of available biomass fuel which in turn influences the opportunities for ecological prescribed burning and the chances of a wildfire event. The 'normal' fire season in the Mulga Lands runs from October to April, however under optimal conditions, ecological fires outside these periods can be applied to specific vegetation communities. The fire season is generally characterised by hot dry conditions with periods of reduced temperature and increased humidity during rain events (which provide storm burning opportunities) or influxes of southern airflows.

Where sufficient fuel is available, fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). The average temperature on these days is often above 34˚C with low humidity (below 15 per cent) and sustained winds of more than 16 km/hr (refer to Figure 2).

**Further information can be found in the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go and on the Bureau of Meteorology website at <www.bom.gov.au>.**



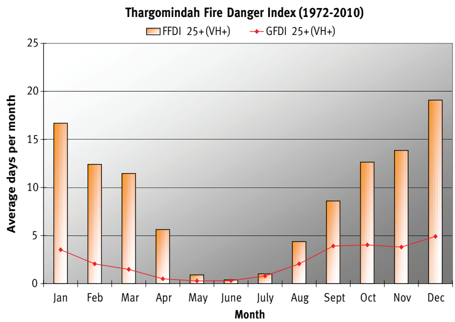




**Figure 2:** Fire weather risk in the Mulga Lands bioregion.

The likelihood of a fire weather day or sequence of days (FDI 25+) increases significantly from September to March. Data (Lucas 2010).

# How to use this guideline

**Step 1: Know your local fire strategy.** This planned burn guideline works with and supports your local fire strategy. While the guideline should address the majority of issues in your area, it is essential you also review your fire strategy before completing your planned burn proposal to ensure all ecological issues are considered (e.g. zoning plan, threatened species, fire histories, *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* and other legislative requirements).

**Step 2: Observe the country.** It is essential to regularly observe the country that you manage (and the surrounding landscape). Familiarise yourself with this guideline so it becomes part of your observation of the environment as you go about your work. To assist you in observing the environment, undertake this simple exercise:

1. If a **canopy** is present (e.g. for open forests and woodlands) observe the following:
   a) Is tree branch foliage dying? Is there epicormic regrowth on branches? Are there any dead trees?
   b) Are there habitat trees (e.g. trees with hollows)?
   c) Are there rainforest, scrub or riparian ecosystems nearby?
2. For fire vegetation groups with a **mid-layer** (trees above the height of shrubs and grasses but not yet in the canopy) observe the following:
   a) What are the mid-layer trees (young canopy trees, wattles, casuarinas or rainforest species)? How open or dense is the mid-layer?
   b) Is there evidence of fire? What is the prevalence and height of blackened bark?
3. For fire vegetation groups with a **ground-layer** of grasses, sedges or shrubs, observe where relevant:
   a) The presence of grasses and grass clumps. Do the grasses look healthy and vigorous? Are there well-formed grass clumps?
   b) Is there a build-up of dead and decaying matter associated with grasses, shrubs, ferns or sedges?
   c) Are shrubs looking healthy and vigorous? Are there dying crowns on the shrubs?
   d) Does the ground-layer have a diversity of species or is it dominated by one or a few juvenile tree species? Are weeds dominating the understorey?

**Step 3: Read the relevant chapters of this guideline and decide which issues apply to the area you are observing.** It is common for burn proposals to address more than one issue—do not necessarily limit yourself to one issue per burn proposal.

**Step 4: Consider your fire management priorities.** Each chapter offers guidance for determining fire management priorities. The statements about priorities are based on a standard QPWS planned burn proposal prioritisation framework intended to guide both land managers and approval bodies.

**Step 5: Choose measurable objectives.** Each chapter of this guideline provides measurable objectives to include in your burn proposals (be guided also by the objectives in your fire strategy). Choose one or more objectives whilst observing the land. Do you need to adjust the objectives so they apply to your situation? Do you need to develop objectives not already included in these guidelines? If you find it difficult to identify your objectives, contact your natural resource management ranger or equivalent.

**Step 6: Write a burn proposal.** The **measurable objectives, fire behaviour, tactics** and **weather conditions** sections of each chapter can be copied directly into your burn proposals. Copy (ctrl+c) statements from a PDF version of this guideline and paste them (ctrl+v) into the burn proposal. Note that you may have to adjust the wording.

**Step 7: Is your burn ready to go?** Refer to the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go. Becoming familiar with the tools in this guideline will enable you to predict fire behaviour and achieve your burn proposal objectives.

**Step 8: Review the measurable objectives in your burn proposal.** After a fire, undertake the post-fire assessment recommended by this guideline (as defined in your burn proposal). This will indicate if you have achieved your planned burn objectives. This guideline provides information on how to report the results in your fire report.

**Step 9: Review your fire management issue (re-apply this guideline to the burn area starting from Step 1).** Return to the burn area after one year and then a few years after the original burn—once again applying this guideline. Many issues (such as weed control) are not resolved with a single burn and it is important to keep observing the land. If the results of fire management are unexpected or difficult to understand please seek further advice. If this process identifies shortfalls in your fire strategy, consider reviewing it. Step 9 can be implemented as part of a structured photo-monitoring process at various locations within the estate. Instructions can be obtained from the QPWS Fire Management System.

# Chapter 1: Eucalypt forest and woodland

This fire vegetation group occurs throughout the Mulga Lands bioregion and contains a variety of communities that vary with annual rainfall, landform and soil type. The canopy is between 12–25 metres (m), dominated by one or a few eucalypt species. In most areas, common species include poplar box *Eucalyptus populnea*, silver-leaved ironbark *Eucalyptus melanophloia* and coolabah species *Eucalyptus coolabah*, with an understorey of smaller trees, shrubs, grasses and herbs.

## Fire management issues

A key management issue for this fire vegetation group is extensive wildfires impacting its ecological values and nearby fire-sensitive communities. This is exacerbated by large tracts of inaccessible land, long dry spring periods and extended periods of very high fire danger.

Overabundant saplings in the mid-stratum can lead to woody thickening. Often this is associated with an absence of fire or mass germination events associated with severe fire.

Invasive grasses pose a significant threat to eucalypt community health.

### Issues:

1. Maintain healthy grassy eucalypt forests and woodlands.
2. Maintain mixed eucalypt and acacia woodlands.
3. Manage eucalypt forests where understorey fuels are not usually continuous.
4. Manage invasive grasses.
5. Reduce overabundant saplings/seedlings.

**Extent within bioregion:** 783 201 hectares (ha), 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Thrushton National Park, 13 265 ha; Mariala National Park, 13 000 ha; Currawinya National Park, 10 066 ha; Albany State Forest, 1 327 ha; Narkoola National Park, 441 ha; Culgoa Floodplain National Park, 404 ha; Powrunna State Forest, 24 ha.

## Issue 1: Maintain healthy grassy eucalypt forests and woodlands

Maintain healthy grassy eucalypt forest or woodland with mosaic burning.

### Awareness of the environment

**Key indicators of a healthy eucalypt forest or woodland with a grassy understorey:**

- Eucalypt trees vary in age from seedlings just above the grassy layer to mature canopy trees with occasional stags and live trees with hollows.
- Some young canopy species may be present in the mid and lower stratums (enough to eventually replace the canopy) but are not having a noticeable shading effect on ground-layer plants.
- Grasses dominate the ground-layer and may be continuous and/or clumps are well-formed with little thatch or dead material.
- Although dominated by grasses the ground layer has a diversity of other plants such as herbs and sedges.
- Logs and fallen branches of various sizes may be scattered on the ground providing refuge for fauna.
- Overall, it is easy to see and walk through.

Maintaining fire in open forests on floodplains with tall grasses will ensure the health, diversity and structure of the community and control overabundant saplings (e.g. *Eremophila* spp. and *Acacia stenophylla* in the red soil country) and cypress pine.
John Neldner, Queensland Herbarium, south-west of Dirranbandi.

**The following may indicate that fire is required to maintain a grassy eucalypt forest or woodland:**

- Grass clumps are poorly formed, there is an accumulation of dead material and/or grasses have collapsed.
- Eucalypts, acacias, cypress pine *Callitris glaucophylla*, or hop bush *Dodonaea* spp. are beginning to emerge in abundance above the ground layer (up to around waist height, if they are higher refer to Issue 2) and are beginning to have shading impacts on the ground layer.
- There is a build up of fine fuels such as dead grass material, leaf litter, suspended leaf litter, bark and twigs.
- Where the ground layer was once dense and diverse it is becoming sparse with fewer species of grass and a lack of herbs between tussocks.

A fire would reinvigorate the grass diversity in this popular box community.
Robert Ashdown, QPWS, Thrushton National Park.

## Discussion

- High-severity fires during extended dry periods in floodplain communities, are detrimental to species that are in winter dormancy, such as river red gums *Eucalyptus camaldulensis*, as these species are less likely to recover from fire.
- Newly gazetted estates contain disturbed systems that may be recovering from previous land management practices (e.g. clearing and grazing). In these systems the canopy may be sparse with few large trees (including habitat trees) or not contain sufficient canopy-recruiting species of various ages. These areas may require targeted burning, followed by monitoring to ensure eucalypt regeneration is occurring and not damaged by subsequent fires.
- In some areas the canopy may become more closed as overabundant saplings have been left unmanaged. Provided grasses are still continuous enough in the understory to carry fire, the implementation of the guidelines for managing healthy grassy eucalypt forest or woodland should be sufficient to control the issue.
- The **vulnerable** yakka skink *Egernia rugosa*, has poorly understood habitat requirements, but is known to occur in association with open dry sclerophyll forest (ironbark) or woodland, brigalow forest and open shrubland (QPWS Wildnet). Using these guidelines will help land managers maintain a diversity of habitats within these communities to ensure the sustainability of suitable habitat.
- Overgrazing by domestic, feral and native animals in eucalypt communities with a grassy understorey can result in the loss of perennial grasses and in some areas has resulted in a dense layer of trees and shrubs (Myers et al. 2004). Grazing can contribute to ground-layer sparseness and removal of fuels (e.g. grasses) required for planned burns.
- Be aware that fire promotes conditions that can be suitable for the expansion of buffel grass, particularly if already established nearby (refer to Issue 4, for recommendations with regard to buffel grass management).
- Yapunyah *Eucalyptus ochrophloia* is a vital nectar tree for apiarists in the Mulga Lands bioregion. Avoid burning from April to October near where apiarists are operating, or restrict burning to small patches.
- Eucalypt floodplain communities are more influenced by rainfall and flooding events than fires. For example, a flush of coolabah, *Eucalyptus coolabah* saplings will often occur following major rainfall events and will naturally thin-out during dry periods.

Patchy to low-severity burns in surrounding areas that on some occasions trickle into floodplain communities (such as coolabah open woodlands on alluvial plains) may be useful to reduce fuel and mitigate the impacts of wildfire.

Rhonda Melzer, QPWS, Nairana National Park (2002).

Seasonal conditions will promote good growth of grass in open eucalypt flats. Avoid using fire until the grasses have cured and the seeds have fallen from the grass-heads into the soil.

Robert Ashdown, QPWS, Currawinya National Park (2006).

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| **Very high** | Planned burn required to **mitigate hazard** or **simplify vegetation structure**, usually within **wildfire mitigation zones**. |
| **High** | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Select at least two of the following as most appropriate for the site:

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| 40–70 % spatial mosaic of burnt patches. | Choose one of these options:<br>a. Visual estimation of percentage of vegetation burnt-–from one or more vantage points, or from the air.<br>b. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt.<br>c. Quantitative estimation of percentage of vegetation burnt from satellite imagery. | **Achieved:**<br>40–70 % burnt.<br><br>**Partially Achieved:**<br>between 30–40 % or 70–80 % burnt.<br><br>**Not Achieved:**<br><30 % or > 80 % burnt. |
| Proactive planned burning has prevented impact by subsequent wildfire to natural/ cultural resources or infrastructure. | Using fire scar remote sensing data, estimate area of planned burns against wildfire on an annual basis. | **Achieved:** Annual area planned burnt prevents impact by wildfire.<br><br>**Not Achieved:** Wildfire has had significant impact. |
| Minimal canopy scorch. | In the days post fire, walk through/ drive past planned burn area in three locations (that represent the variability of landform and ecosystems within burn area) and estimate percentage of canopy scorch within visual field. | **Achieved:**<br>< 10 % of the crown of the dominant tree layer scorched.<br><br>**Partially Achieved:**<br>10–25 % of the crown of the dominant tree layer scorched.<br><br>**Not Achieved:**<br>> 25 % of the crown of the dominant tree layer scorched. |

| | | |
|---|---|---|
| > 90 % of the grass bases remain as stubble. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate grass stubble remaining after fire. | **Achieved:**<br>> 90 % bases remain.<br><br>**Partially Achieved:**<br>75–90 % bases remain.<br><br>**Not Achieved:**<br>< 75 % bases remain. |
| > 95 % fallen logs (with a diameter ≥10 cm) retained. | Before and after the burn (immediately–very soon after), count the number of fallen logs crossed by one or more line transects (e.g. 100m long but length must be adequate to provide a representative sample of the area) and determine the percentage retained in each chosen location. | **Achieved:**<br>> 95 % retained.<br><br>**Partially Achieved:**<br>90–95 % retained.<br><br>**Not Achieved:**<br>< 90 % retained. |
| > 95 % of standing dead trees and standing live hollow-bearing trees (habitat trees) retained. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate number of habitat trees. Determine the percentage retained after fire. | **Achieved:**<br>> 95 % retained.<br><br>**Partially Achieved:**<br>90–95 % retained.<br><br>**Not Achieved:**<br>< 90 % retained. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

Assessing the objectives of a low-severity burn. Grass bases remain intact and have not been reduced to earth.

Mark Cant, QPWS, Cambooya Conservation Park (2010).

## Fire parameters

### What fire characteristics will help address this issue?

#### Fire severity

- **Low** or occasionally **moderate**. An occasional moderate-severity burn can help to ensure emerging overabundant trees are managed. It is important to strike a balance between tree reduction and canopy tree recruitment.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity ($kWm^{-1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| Low (L) | < 150 | < 0.5 | < 2.5 | Significant patchiness. Litter retained but charred. Humus layer retained. Nearly all habitat trees, fallen logs and grass stubble retained. Some scorching of elevated fuels. Little or no canopy scorch. |
| Moderate (M) | 150–500 | 0.5–1.5 | 2.5–7.5 | Moderate patchiness. Some scorched litter remains. About half the humus layer and grass stubble remain. Most habitat trees and fallen logs retained. Some scorch of elevated fuels. Little or no canopy scorch. |

Note: This table assumes good soil moisture and optimal planned burn conditions.

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and previous fire patchiness and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire responses (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between three to five years.

**Mosaic** (area burnt within an individual planned burn)

- A mosaic is achieved with generally 40–70 per cent burnt within the target communities.
- In moister areas (e.g. near gullies, rocky creek beds and the base of ranges) unburnt areas tend to remain when burning under mild conditions. This helps retain features such as micro-climates and dense pockets of vegetation.

**Landscape mosaic**

- In general, no more than 10–30 per cent of eucalypt forests and woodlands with a grassy understorey should be burnt within the same year in a management area.

**Other considerations**

- Once an area has recovered from a wildfire, plan mosaic burning to break up areas of continuous fuel and re-establish vegetation age-class. This will help manage overabundant seedlings/saplings (stimulated by wildfire) and prevent a cycle of repeated wildfire events promoted by single age-class fuel.
- The best mitigation against wildfires is the creation of a multi-aged mosaic to limit fire spread and severity.

## What weather conditions should I consider?

It is important to be aware of weather predictions prior to and following burns as part of the planning and so that undesirable conditions and weather changes can be avoided. Drought conditions may also lead to poor results and/or wildfires.

**Season:** Autumn to early spring

**FFDI:** < 13

**DI (KBDI):** Ideally 60–90, but < 120

**Wind speed:** Beaufort scale 1–4, or < 23 km/hr (ideally between 10–23 km/hr in forests).

### Soil moisture

It is important to burn under conditions of good soil moisture and when plants are actively growing. Good soil moisture is critical for a range of reasons:

- To protect and retain the bases of grasses—to ensure they have a competitive advantage over invasive grasses and woody weeds.
- Minimise loss of habitat features such as hollow-bearing trees and fallen logs.
- Maximise species diversity—aim to implement burns at varying times of the year (e.g. late in the dry season, during early storm season or after good spring rains). Good soil moisture at the time of burning is the critical factor.
- To limit the creation of bare ground—to prevent erosion and encroachment of weeds.
- To encourage species regeneration soon after fire.
- To promote a mosaic of burnt and unburnt areas—to facilitate later burning.

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

### Aerial ignition

- Aerial ignition from a fixed wing aircraft or helicopter is often used in the Mulga Lands bioregion due to the scale of areas being managed.
- A helicopter provides the opportunity to directly target topographical features such as peaks, ridges and spurs. Creating backing-fires that burn downhill or igniting the edges of non-target communities to create a buffer, allowing fire to burn away from the community.
- In some instances this tactic may be implemented in conjunction with ground ignition to secure an edge around the area being burnt. Be aware that this tactic requires a good understanding of the flight path or 'runs' of the plane and the spacing of the aerial incendiaries (smoke from fires lit by ground crews may impair the vision of the pilot and hamper lighting efforts).
- The use of aerial photographs, satellite images or quality topographical maps is recommended (if possible stereoscopic images are particularly useful) to gain an understanding of terrain. It is good practice to plot the incendiary drop path onto a map or aerial photograph and ensure ground crews are provided with a copy prior to ignition.

### Progressive burning

- Fires (of varying extents, severity and at various times) are lit in fire-adapted communities from late wet season to early dry season (as soon as fuels are sufficiently cured for a burn to carry), through to storm burning.
- Burning should begin very soon after the wet season (March to April), to secure boundaries—particularly when burning areas adjacent to fire-sensitive vegetation. Subsequent repeat ignitions can be used within the same section of land weeks or months after the boundaries have been secured by early burning. This produces a mixture of burnt areas with multiple ignition dates. After a good wet season or during a wet cycle the opportunity may exist for progressive burning of small areas. This will promote the availability and diversity of grasses and herbs providing habitat and producing seed—an important food source for birds and mammals.
- **Commence lighting on the leeward (smoky) edge. T**his can create a low-intensity backing fire into the burn area or create a containment edge for a higher-severity fire ignited inside the burn area.

- **A low-intensity backing fire with good residence time.** A slow moving fire will generally result in the more complete coverage of an area and a better reduction of available fuels. As the intensity and rate of spread are kept to a minimum, the fire has a greater amount of time to burn fuels in that area. This tactic is also useful to reduce fine fuels such as grasses, leaf litter, twigs and overabundant seedlings and saplings.
- **Spot ignition.** Can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of volatile fuels. Spots placed closer together will result in a line of fire that is of greater intensity (i.e. as spots merge they create high-intensity junction zones). Spots placed further apart will result in a lower-intensity fire. Note that the spacing of the spots should regularly vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Storm burning.** When possible aim to conduct some planned burns late from wet season to mid dry season (following sufficient rain). Ensure there is good soil moisture throughout the site including drainage lines) Good soil moisture indicators are visible surface water or flowing creeks. It is ideal if the likelihood of rain in the days post burn is high. Occasional higher-severity fires and storm burning at the start of the wet season can be useful to promote germination and the recruitment of native legumes and some grasses (Williams 2008). Contain burns that are unbounded by a constructed line (e.g. firelines).
- **Afternoon or evening ignition.** If conditions are not ideal (e.g. during periods of prolonged drought) but fire management is required, implement suitable tactics such as afternoon or night ignition to reduce environmental impacts. In this instance be aware of any containment issues, the current drought index and soil moisture, signs of poor health (e.g. tree death from drought stress) and the potential for fire to compound these issues.
- **Flooding events.** These events can remove fuel from a site (including heavy, coarse fuels) and can also deposit it. Following a flood there will often be large amounts of debris deposited around the base of trees. In this instance a low-severity mosaic fire may be useful to reduce the fuel load and limit the impacts of later high-severity fires. Be aware that large amounts of bark at the base of trees may be a result of many years of accumulation and is not restricted to a flooding event.

Spot lighting using matches. Spots closer together will result in a line of a greater intensity (as spots merge and create hot junction zones) while increased spacing between spots will result in a lower intensity fire. Vary the spacing of the spots throughout the area to cater for changes in weather conditions, topography and fuel loads.

Paul Williams, Vegetation Management Science Pty Ltd, Mount Elliot (2009).

# Issue 2: Maintain mixed eucalypt and acacia woodlands

Maintain healthy eucalypt and acacia woodland with mosaic burning.

## Awareness of the environment

### Key indicators of healthy woodland with an acacia understorey

- Trees appear healthy and the canopy is characterised by trees of various heights and ages. Hollow-bearing habitat trees may be present.
- Some young canopy species and smaller trees are present in the mid and lower-stratums (enough to eventually replace the canopy) and are not having a noticeable shading effect on the shrub or ground layer.
- Understorey is dominated by a diversity of shrubs (not juvenile trees). Often this will include smaller acacia species, hop bush *Dodonaea* spp. and false sandalwood *Eremophila mitchellii* and *E. deserti,* (usually of a height less than four metres).
- The shrub layer can vary from dense to patchy.
- Where the shrub layer is patchy there may be a ground layer with a mix of grasses and/or patches of bare earth.
- Scattered fire-sensitive shrubs including mulga and tangled lignum, may be present and of flowering age.

A healthy eucalypt woodland community that has benefited from a burn.
QPWS, Welford National Park (1999).

**The following may indicate that fire is required to maintain a mixed eucalypt and acacia woodland**

- Shrubs may look unhealthy (e.g. beginning to lose lower level leaves, spindly branches are present or some crowns are dying). There is an accumulation of brown leaves on shrubs.
- Species such as she-oak, cypress pine, false sandlewood, *Eromophila deserti*, hop bush, wilga *Geijera parviflora* or acacia are emerging among the grass layer. Weeds such as tree-pear and noogoora burr, may be becoming established.
- Suspended litter and bark perched in shrubs may be present.

Juvenile cypress pine developing in the understory. Planned burning while these trees are young could assist in managing the issue.

Tony Bean, Queensland Herbarium (2001).

## Discussion

- It is important to distinguish shrubs from juvenile trees or saplings. Shrubs are typically multi-stemmed, remaining as small plants when mature. Certain types of forests are characterised by an abundance of shrubs in the lower stratum. However, if an abundance of juvenile trees or saplings are present, without the intervention of fire, it is likely to result in thickening and loss of diversity.
- The bridled nailtail wallaby *Onychogalea fraenata*, has a preferred habitat of transitional vegetation that separates dense acacia woodland from open grassy eucalypt woodland. Using this guideline will help maintain both of these communities and ensure suitable habitat remains.
- Often shrub species that retain fruiting bodies on branches can be used as a guide to indicate time since fire. Examples include the fruiting nodes on hakeas and the generations of seed capsules on melaleucas. Be aware of the time required after fire for obligate seeders to mature and produce seed and aim for at least three years of seeding prior to burning again in some areas. This will ensure the localised survival of these species.
- Newly gazetted estates often contain disturbed systems that may be recovering from previous land management practices (e.g. clearing and grazing). In these systems the canopy may be understocked and have fewer larger trees (e.g. habitat trees) or overstocked but not containing sufficient recruiting canopy species in the understorey. As long as the structure of the understorey appears healthy, implementing this guideline should aid a more varied and mature system to re-establish over time.
- Overgrazing by domestic, feral and native animals in eucalypt/acacia communities can result in the loss of shrub species and in some areas has resulted in extended open areas. Grazing can contribute to ground layer sparseness and removal of fuels (e.g. grasses) required for planned burns. Goat, pig and horse paths and pads will break up the continuity of fuels affecting the extent to which burns will carry.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| Very high | Planned burn required to **mitigate hazard** or **simplify vegetation structure**, usually within **wildfire mitigation zones**. |
| High | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Select at least two of the following as most appropriate for the site:

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| 40–70 % spatial mosaic of burnt patches. | Choose one of these options:<br>a. Visual estimation of percentage of vegetation burnt – from one or more vantage points, from the air; on NAFI or ParkInfo2.<br>b. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt.<br>c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 metres or more through planned burn area estimating percentage of ground burnt within visual field. | **Achieved:**<br>40–70 % burnt.<br><br>**Partially Achieved:**<br>between 30–40 % and 70–80 % burnt.<br><br>**Not Achieved:**<br>< 30 % or > 80 % burnt. |

| | | |
|---|---|---|
| > 95 % of standing dead trees and standing live hollow-bearing trees (habitat trees) retained. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate number of habitat trees. Determine the percentage retained after fire. | **Achieved:** > 95 % retained.<br><br>**Partially Achieved:** 90–95 % retained.<br><br>**Not Achieved:** < 90 % retained. |
| > 95 % fallen logs (with a diameter ≥ 10 cm) retained. | Before and after the burn (immediately or very soon after), count the number of fallen logs crossed by one or more line transects (e.g. 100 m long but length must be adequate to provide a representative sample of the area) and determine the percentage retained in each chosen location. | **Achieved:** > 95 % retained.<br><br>**Partially Achieved:** 90–95 % retained.<br><br>**Not Achieved:** < 90 % retained. |
| Recruitment of obligate seeders (e.g. *Acacia* spp.) promoted over the burn area. | 6–12 months after the burn, seedlings of fire killed shrubs can be seen in the ground layer. Within unburnt areas of the burn footprint more mature shrubs remain. Visually assess from one or more vantage points or form the air. | **Achieved:** Fire killed shrubs are present at various heights/ stages of maturity across the burn area.<br><br>**Not Achieved:** Fire killed shrubs are all of a single age/height across the burn area. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

## Fire parameters

### What fire characteristics will help address this issue?

**Fire severity: Low** with the occasional **moderate**. An occasional moderate severity planned burn will be useful to ensure emerging overabundant trees are managed. It is important to strike this balance between tree reduction and canopy tree recruitment.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity ($kWm^{-1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | < 150 | < 0.5 | < 2.5 | Significant patchiness. Litter retained but charred. Humus layer retained. Nearly all habitat trees, fallen logs, and grass stubble retained. Some scorching of elevated fuels. Little or no canopy scorch. |
| **Moderate (M)** | 150–500 | 0.5–1.5 | 2.5–7.5 | Moderate patchiness. Some scorched litter remains. About half the humus layer and grass stubble remain. Most habitat trees and fallen logs retained. Some scorch of elevated fuels. Little or no canopy scorch. |

Note: This table assumes good soil moisture and optimal planned burn conditions.

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Fire frequency should primarily be determined through **on-ground** assessment of vegetation health, fuel accumulation and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between six to ten years.

**Mosaic** (area burnt within an individual planned burn)

- A mosaic is achieved with generally 40–70 per cent burnt area within the target communities.
- In moister areas (e.g. near gullies and rocky creek beds and protected areas along the bases of escarpments) unburnt areas tend to remain. This helps to retain features such as micro-climates and denser pockets.

**Landscape mosaic**

- Do not burn more than 30 per cent of forests and woodlands with a shrubby understorey within the same year in a management area.

**Other considerations**

- Planned burn programs within a broader grassy landscape can be planned in such as a way as to avoid the mixed eucalypt and acacia woodland on every second burn. To limit fire encroachment into eucalypt/acacia communities that are not yet ready to burn, target the surrounding grassy areas early in the dry season. This can be effective in creating a buffer around shrubby areas and limiting too-frequent fire (Williams 2008).
- Following a wildfire reassess the area and attempt to apply a mosaic of planned burns in order to prevent another wildfire event (and improve ecological health issues such as overabundant saplings).

## What weather conditions should I consider?

It is important to be aware of weather predictions prior to and following burns, as part of the planning and so that undesirable conditions and weather changes can be avoided. Drought conditions may also lead to poor results and/or wildfires.

**Season:** Autumn to early spring

**FFDI:** < 13

**DI (KBDI):** Ideally 60–90, but < 120

**Wind speed:** Beaufort scale 1–4, or < 23 km/hr (ideally between 10–23 km/hr in forests).

**Soil moisture:**

- Good moisture conditions are important to protect hollow bearing trees and fallen logs and promote a mosaic of burnt and unburnt patches.
- Early dry season burns with good soil moisture are also useful for conservation and hazard reduction (fuel management) burns and when burning in areas adjoining fire sensitive vegetation (Williams 2008).

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

### Aerial ignition

- Aerial ignition from a fixed wing aircraft or helicopter is often used in the Mulga Lands bioregion due to the scale of areas being managed.
- A fixed wing aircraft covers large areas while a helicopter provides the opportunity to directly target topographical features such as peaks, ridges and spurs. Creating backing-fires that burn downhill or igniting the edges of non-target communities to create a buffer, allowing fire to burn away from the community.
- In some instances this tactic may be implemented in conjunction with ground ignition to secure an edge around the area being burnt. Be aware that this tactic requires a good understanding of the flight path or 'runs' of the plane and the spacing of the aerial incendiaries (smoke from fires lit by ground crews may impair the vision of the pilot and hamper lighting efforts).
- The use of aerial photographs, satellite images or quality topographical maps is recommended (if possible stereoscopic images are particularly useful) to gain an understanding of terrain. It is good practice to plot the incendiary drop path onto a map or aerial photograph and ensure ground crews are provided with a copy prior to ignition.
- **Commence lighting on the leeward (smoky) edge.** This can create a low-intensity backing fire into the burn area or create a containment edge for a higher-severity fire ignited inside the burn area.
- **A low-intensity backing fire with good residence time.** A slow moving fire will generally result in the more complete coverage of an area and a better reduction of available fuels. As the intensity and rate of spread are kept to a minimum, the fire has a greater amount of time to burn fuels in that area. This tactic is also useful to reduce fine fuels such as grasses, leaf litter, twigs and overabundant seedlings and saplings.
- **Spot ignition.** Can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of volatile fuels. Spots placed closer together will result in a line of fire that is of greater intensity (i.e. as spots merge they create high-intensity junction zones). Spots placed further apart will result in a lower-intensity fire. Note that the spacing of the spots should regularly vary throughout the burn due to changes in weather conditions, topography and fuel loads.

- **Storm burning.** When possible aim to conduct some planned burns late from wet season to mid dry season (following sufficient rain). Ensure there is good soil moisture throughout the site including drainage lines) Good soil moisture indicators are visible surface water or flowing creeks. It is ideal if the likelihood of rain in the days post burn is high. Occasional higher-severity fires and storm burning at the start of the wet season can be useful to promote germination and the recruitment of native legumes and some grasses (Williams 2008). Contain burns that are unbounded by a constructed line (e.g. firelines).
- **Afternoon or evening ignition.** If conditions are not ideal (e.g. during periods of prolonged drought) but fire management is required, implement suitable tactics such as afternoon or night ignition to reduce environmental impacts. In this instance be aware of any containment issues, the current drought index and soil moisture, signs of poor health (e.g. tree death from drought stress) and the potential for fire to compound these issues.

Angophora woodland burning on dusk .

Bernice Sigley, QPWS, Mount Moffat (2009).

## Issue 3: Manage eucalypt forests where understorey fuels are not usually continuous

This fire vegetation group contains communities such as poplar box on clay pans and mallee forests on loose sand. These communities have very sparse understoreys.

### Discussion

- The condition of the understorey in these communities prior to historical clearing, grazing and altered fire regimes is unknown. Due to the extremely sparse and slow growing nature of the understorey vegetation, the ability of fire to carry during planned burns is limited.
- These communities may only burn during wildfires in dry conditions. An established mosaic of burnt and areas in the surrounding fire-adapted communities will assist in mitigating the impact of too-frequent or severe wildfire. This will also help protect species such as the endangered grey snake *Hemiaspis damelii*, recorded in Currawinya National Park.

Although the understory is usually sparse, this poplar box flat has a cover of grass following a flood event.
QPWS, Bulloo River (1995).

A low fuel Yapunyah community.

Robert Ashdown, QPWS, Currawinya National Park (2006).

Yapunyah in Murphy's Gorge, with sparse fuel.

Brett Roberts, QPWS, Idalia National Park (2011).

## Issue 4: Manage invasive grasses

It is important to be aware of the presence of invasive grasses. When established and wide-spread, these grasses can dramatically increase fire severity. Invasive grasses may be promoted by disturbances (such as fire), after which they have the ability to significantly invade and alter the vegetation community. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires resulting in the fragmentation and overall decline of eucalypt communities.

Refer to Chapter 8 (Issue 4), regarding information on fire management guidelines.

## Issue 5: Reduce overabundant saplings/seedlings

Overabundance of acacias, eucalypts or other trees or shrubs may lead to woody thickening; reducing the health of the ground layer through competition and shading.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

# Chapter 2: Grasslands

Grasslands are open and treeless or contain scattered trees or shrubs. The grasslands of the Mulga Lands bioregion occur on floodplains, flats, plains and undulating hills throughout the bioregion. These communities are diverse and their composition varies greatly depending upon climatic zones, annual rainfall, geology/soil type and topography. Grasslands or 'downs' vegetation generally grow to one metre and are characterised by a dominant species of grass (however, legumes and other herbs and scattered shrubs and trees such as poplar box *Eucalyptus populnea*, inland bloodwood *Corymbia terminalis* and silver-leafed ironbark *Eucalyptus melanophloia* may also be present). Grassland communities of the Mulga Lands bioregion are varied and include spinifex *Triodia* spp., kangaroo grass *Themeda* spp., Mitchell grass *Astrebla* spp., bluegrass *Dichanthium* spp., and *Bothriochloa* spp. The Bluegrass community is **endangered** under the Queensland *Vegetation Management Act 1999*.

## Fire management issues

The main fire management issue is retaining open areas of grasslands by preventing their invasion by trees and shrubs. Overabundant seedlings/saplings leading to woody thickening occurs where fire has been long absent, infrequently or repeatedly applied too early in the season (creating fires of insufficient severity to scorch seedlings/saplings) or as a result of grazing. The spread of exotic species into grasslands poses a significant threat to these communities. The occurrence of invasive grasses such as buffel grass within grasslands significantly increases available fuel loads and in-turn the potential frequency and intensity of fires. Post fire these invasive grasses can form dense swards, displacing native grass species (native grasses require fire but respond more slowly), reducing diversity and increasing the risk of severe fire.

### Issues:

1. Maintain spinifex grasslands.
2. Maintain other tussock grass communities.
3. Manage invasive grasses.
4. Reduce overabundant saplings/seedlings.

**Extent within bioregion:** 717 687 ha, 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Binya National Park, 692 ha; Culgoa Floodplain National Park, 515 ha; Narkoola National Park (Recovery), 2 ha.

# Issue 1: Maintain spinifex grasslands

Use regular low-severity fires to maintain spinifex grasslands.

This vegetation group is characterised by the presence of spinifex *Triodia* spp. hummocks with some scattered isolated shrubs (e.g. *Acacia* spp.) and trees (e.g. silver-leafed ironbark, Queensland peppermint *Eucalyptus exserta* and bloodwoods). Forbs, legumes, tussock grasses and sand patches may also be found within the interspaces between spinifex clumps.

## Awareness of the environment

**Key indicators of healthy Spinifex grasslands:**

- The ground layer is characterised by the presence of spinifex grass *Triodia* spp.—which grow as hummocks and can vary greatly in diameter. The hummocks have little or no dry grey matter present and they are not collapsing in the centre.
- Other native perennial grasses including wiregrasses *Astrida* spp. and forbs may be present, particularly after good seasonal rains.
- Scattered eucalypts, acacia and a mix of shrubs including *Eremophila* spp., may be common.

Bloodwood woodland with an understorey of spinifex. While generally bare, forbs, legumes and grasses may be found within the interspaces, particularly after good rainfall.
Rhonda Melzer, QPWS, Nairana National Park (2006).

**The following may indicate that fire is required to maintain spinifex grasslands:**

- The spinifex hummocks have expanded in diameter and are starting to collapse in the centre. Long unburnt spinifex is moribund (i.e. has no fresh growth, looks grey and old).
- Spinifex hummocks are contiguous and able to carry even low-intensity fire.
- Doolan *Acacia salicina*, gidgee *Acacia cambagei*, cypress pine *Callitris* spp. or *Eremophila* spp. may have become common and seedlings are starting to become visible amongst the spinifex, particularly after a good wet season.
- It is difficult to walk through grasses (entwined grasses).

Spinifex is being shaded out by developing cypress pine woodland.
Stephen Peck, QPWS, Alton National Park (2009).

## Discussion

- Grazing can impact on the health of spinifex communities by reducing their diversity (the cattle prefer soft forbs and spinifex seed heads) and by reducing the continuity of fuels required for fire management.
- Fires which are too severe and occur without sufficient soil moisture result in the death of sub-soil grass bases/roots (Wright and Clarke 2008) and slow post fire recovery time. Soil moisture avoids this and also promotes rapid post-fire spinifex seedling establishment. Burning without soil moisture will often kill the spinifex hummock or slow seedling establishment and give a competitive advantage to weeds and woody species.
- Two fires in quick succession in spinifex grasslands (if rainfall promotes sufficient fuel accumulation) can assist in controlling overabundance of some species such as *Eremophila* spp.

Strip burning spinifex to generate a long backing fire.

QPWS, Welford National Park (1993).

Spinifex recovering after a high-intensity burn which has killed many trees.

Stephen Peck, QPWS, Alton National Park (2009).

## What is the priority for this issue?

Maintaining healthy spinifex grasslands is a **very high** priority, however burning this community is reliant upon seasonal rainfall and growth post rainfall. Therefore planned burns in this community may be a **medium** priority until the desired rainfall levels and resulting growth are observed.

| Priority | Priority assessment |
|---|---|
| Very high | Planned burn required to **mitigate hazard** or **simplify vegetation structure**, usually within **wildfire mitigation zones**. |
| High | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |
| Medium | Planned burn in areas where **ecosystem health** is **poor** but recoverable. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| > 95 % of grass bases remain after fire. | Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity) and estimate cover of grasses that recover one to three months after fire. | **Achieved:**<br>> 95 % recover.<br><br>**Partially Achieved:**<br>90–95 % recover.<br><br>**Not Achieved:**<br>< 90 % recover.<br>Or, exotic grasses promoted. |

| | | |
|---|---|---|
| > 75 % of woody saplings/ seedlings < 1 metre in height are scorched to the tip. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity) and estimate the percentage of saplings/seedlings scorched. | **Achieved:** > 75 %.<br><br>**Partially Achieved:** 25–75 %.<br><br>**Not Achieved:** < 25 %. |
| Proactive planned burning has prevented impacts of wildfire on natural/ cultural resources and infrastructure. | Proactive planned burning has prevented impacts of wildfire on natural/cultural resources and infrastructure. | **Achieved:** Annual area of planned burns prevents impacts of wildfire.<br><br>**Not Achieved:** Wildfire has a significant impact. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

Within spinifex grasslands, it is important to maintain the mix and diversity of native perennial grasses. Monitor woody thickening as it can become a problem in some areas. Use simple monitoring techniques such as establishing observation points. Satellite imagery can be used over broad areas.

## Fire parameters

### What fire characteristics will help address this issue?

**Fire severity: Patchy** to **low** (occasionally **moderate**)

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity ($kWm^{-1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Patchy (P)** | < 50 | < 0.3 | ≤ 1.5 | High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels. |
| **Low (L)** | 50–100 | 0.3–0.5 | ≤ 2.5 | Some patchiness. Most of the surface and near surface fuels have burnt. Stubble still evident. |
| **Moderate (M)** | 100–1500 | 0.5–1.5 | Complete standing biomass removed. | All surface and near surface fuels burnt. Stubble burnt to blackened remnants. |

Note: This table assumes good soil moisture and optimal planned burn conditions.

A successful spinifex burn that carried across most spinifex clumps.
QPWS, Welford National Park (1993).

An unsuccessful spinifex burn that failed to carry.
Alicia Whittington, QPWS, Welford National Park (2010).

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Fire frequency should primarily be determined through o**n-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Dependent upon the growth achieved post wet season. Apply planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Generally it is recommended to not leave areas unburnt for more than 15 years.
- Across the landscape a mosaic approach is ideal for maintaining diversity.

**Mosaic** (area burnt within an individual planned burn)

- While it is important that the fire cover be sufficient to prevent wildfire later in the season, some internal patchiness is desirable to create diversity and provide animal refuges. Use appropriate tactics and burn with good soil moisture to assist in leaving sufficient areas unburnt.

**Landscape mosaic**

- Within the management area it is generally recommended not to burn more than 20 per cent of the grassland within the same year. In particularly good seasons it may be favourable to burn more than 20 per cent and in very poor seasons it may be necessary to reduce or restrict planned burns.

**Other issues**

- A moderate severity fire may be required when targeting woody species that are starting to become overabundant. High soil moisture will assist grasses in recovering quickly.
- Grassland fires can produce a lot of smoke. Smoke impacts on rural settlements and roads should be considered in burn planning and steps taken to minimise impacts.

## What weather conditions should I consider?

When planning a burn, it is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**Season:**

- Wet season to early dry season. Concentrate efforts after years of good rainfall. It is important to regularly monitor spinifex grasslands to ensure they remain open and to avoid the encroachment and establishment of woody species. Implement fire to address this issue as soon as sufficient fuels are available as woody species are more likely to be killed by fire when young.
- Spinifex is highly volatile (high resin content) and does not rely upon complete curing to carry a fire. Hummock spacing, humidity and wind are the primary factors in determining how effectively a burn will carry across this landscape.

**GFDI:** < 7

**DI (KBDI):** < 100

**Temperature:** Be aware that grass growth and recovery post fire is slower in winter which may result in patches of bare ground for longer periods, which become vulnerable to the encroachment of weeds.

**Wind speed:** Beaufort 1–2, or < 10 km/hr. Often some wind will be required to help the fire carry in grasslands.

**Soil moisture:** Good soil moisture is critical when burning spinifex grasslands. Burning with good soil moisture, high temperatures and before storm rainfall is a good strategy to encourage the regeneration of grasses and retain their bases. Timing burns to coincide with follow-up rain will further assist in promoting grasses. Soil moisture also promotes rapid post-fire spinifex seedling establishment. Burning without soil moisture will often slow down spinifex seedling establishment or kill the spinifex hummock giving weeds and woody species a competitive advantage within the landscape.

In areas of discontinuous spinifex hummocks during low wind conditions it may be difficult to get the desired burn coverage.
QPWS, Welford National Park (1993).

An approaching storm can provide the opportunity for storm burning.
Robert Ashdown, QPWS, Idalia National Park (2006).

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Spot ignition**. Can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of volatile fuels. Spots placed closer together will result in a line of fire that is of greater intensity (i.e. as spots merge they create high-intensity junction zones). Spots placed further apart will result in a lower-intensity fire. Note that the spacing of the spots should regularly vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Commence lighting on the leeward (smoky) edge.** This can create a low-intensity backing fire into the burn area or create a containment edge for a higher-severity fire ignited inside the burn area.
- **Limit fire encroachment into non-target communities.** In some cases, fire-sensitive communities can occur adjacent to grasslands. Use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community.
- Creating a **running** fire (through closely spaced spot ignition or line ignition with the wind) may help address the issue of woody species encroachment.
- **Storm burning.** When possible aim to conduct some planned burns late from wet season to mid dry season (following sufficient rain). Ensure there is good soil moisture throughout the site including drainage lines. Good soil moisture indicators are visible surface water or flowing creeks. It is ideal if the likelihood of rain in the days post burn is high. Occasional higher-severity fires and storm burning at the start of the wet season can be useful to promote germination and the recruitment of native legumes and some grasses (Williams 2008). Contain burns that are unbounded by a constructed line (e.g. firelines).

# Issue 2: Maintain other tussock grass communities

Use regular low-severity mosaic burns to maintain tussock grass communities.

This vegetation group is characterised by a continuous cover of dense bluegrass *Dichanthium* spp. and/or Mitchell grass *Astrebla* spp. with some scattered isolated shrubs (e.g. wattles) and trees such as silver-leaved ironbark *Eucalyptus melanophloia*, Queensland peppermint *Eucalyptus exserta* and bloodwoods. Forbs, legumes, and grasses may also be found within the interspaces between tussock clumps.

## Awareness of the environment

**Key indicators of healthy tussock grass communities**

- The ground layer is characterised by a continuous stand of bluegrass *Dichanthium* spp. and/or Mitchell grass *Astrebla* spp.
- Often there is a very diverse mix of other species of grasses, forbs and legumes (particularly after good seasonal rains).
- Scattered low trees and shrubs may occur including eucalypts, bloodwoods, acacia and melaleuca in drainage lines.

Healthy Mitchell grass tussock communities have a continuous layer of grasses interspersed with occasional forbs and legumes.

Mark Handley, QPWS, Binya National Park (2011).

Healthy bluegrass grasslands with a diverse mix of native grasses.
Rhonda Melzer, QPWS, Albinia National Park (2010).

Healthy Mitchell grassland.
Don Butler, Queensland Herbarium, Mantuan Downs, Tambo (1999).

**The following may indicate that fire is required to maintain tussock grass communities:**

- some dead material in tussock
- the diversity and abundance of herbs and forbs has declined, even following good seasonal rainfall
- mulga or other woody seedlings appear above the grass layer
- it is difficult to walk through grasses (entwined grasses)

Mountain wanderrie grass *Eriachne* spp., showing signs of heavy grazing. Removal of grazing pressure for a while will increase fuel loads and allow a fire to carry and help restore this grassland.

John Neldner, Queensland Herbarium, south of Adavale (1982).

Open grassy tussocks of mountain wanderrie grass *Eriachne* spp., including emergent desert bloodwood *Corymbia terminalis*. Usually only carry fire after a good wet season.

John Neldner, Queensland Herbarium, west of Charleville (1982).

Mitchell grasslands tend to be self-mulching. While some dead material will be present it mostly decomposes and will not accumulate as much as other grasses such as kangaroo grass *Themeda triandra*.

Paul Williams, Vegetation Management Science Pty Ltd (2008).

## Discussion

- Fires that are too intense or fires lit without sufficient soil moisture can result in damage to the grass bases often killing the tussock. These grasses take longer to recover, giving weeds and woody species a competitive advantage in the landscape.
- Burning encourages new growth even if a low rainfall season follows. Burning also stimulates seed production of Mitchell grass *Astrebla* spp. (Scanlon 1980).
- Current land management practises have largely confined undisturbed native grassland communities to protected areas, roadside verges and the corners of cropped paddocks. Heavy grazing, compounded by occasional large increases in macropod numbers following good seasons, can reduce the diversity and quality of native grasses. Surrounding land use and fragmentation has also had a significant impact on use of fire and therefore conservation of grasslands (Myers et al. 2004).

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| Very high | Planned burn required to maintain areas of **special conservation significance.** |
| High | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |
| Medium | Planned burn in areas where **ecosystem health** is **poor** but recoverable. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations, walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
| --- | --- | --- |
| > 95 % of grass bases remain after fire. | Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity) and estimate cover of grasses that recover one to three months after fire. | **Achieved:**<br>> 95 % recover.<br><br>**Partially Achieved:**<br>90–95 % recover.<br><br>**Not Achieved:**<br>< 90 % recover<br>**Or**<br>exotic grasses were promoted. |
| > 75 % of woody saplings/ seedlings < 1 m in height are scorched to the tip. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity), and estimate the percentage of saplings/ seedlings scorched. | **Achieved:** > 75 %.<br><br>**Partially Achieved:**<br>25–75 %.<br><br>**Not Achieved:** < 25 %. |
| < 60 % of grasslands (adjust as appropriate for seasonal conditions) in a management area burnt (by wildfire or planned burn) within the same year | Choose one of these options:<br>a. Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air.<br>b. Map the boundaries of burnt areas with GPS, plot on ParkInfo and thereby determine the percentage of area burnt.<br>In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating the percentage of ground burnt within visual field. | **Achieved:**<br>< 60 % burnt.<br><br>**Not Achieved:**<br>> 60 % burnt. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

Within tussock grass communities is important to monitor the diversity of native perennial grasses which can decline in the absence of fire. Consider monitoring woody thickening in areas where it can potentially become an issue. Monitoring woody thickening in grasslands can be done by comparing recent and historic satellite or aerial images and/or establish observation points at grassland/woodland ecotones.

# Fire parameters

## What fire characteristics will help address this issue?

### Fire severity

- **Patchy to low**, occasionally **moderate**. An occasional moderate severity fire helps to ensure emerging overabundant saplings/seedlings are kept low (in the ground stratum).

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity ($kWm^{-1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Patchy (P)** | < 50 | < 0.3 | ≤ 1.5 | High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels. |
| **Low (L)** | 50–100 | 0.3–0.5 | ≤ 2.5 | Some patchiness. Most of the surface and near surface fuels have burnt. Stubble still evident. |
| **Moderate (M)** | 100–1500 | 0.5–1.5 | Complete standing biomass removed. | All surface and near surface fuels burnt. Stubble burnt to blackened remnants. |

Note: This table assumes good soil moisture and optimal planned burn conditions.

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of intervals to create varying stages of post-fire responses (i.e. recently burnt through to the maximum time frame). For **bluegrass** grasslands use a broad-frequency guideline of five to fifteen years. For **Mitchell** grasslands use a broad-frequency guideline of not leaving areas unburnt for more than fifteen years, dependent upon growth post wet season. To create diversity, burn some **Mitchell** grassland areas at shorter intervals (e.g. less than five years or as favourable conditions permit) and some at longer intervals to aid diversity.

**Mosaic** (area burnt within an individual planned burn)

- Due to the contiguous nature of fuel associated with some grassland the entire planned burn area can burn with no internal patchiness, and this is especially the case as a result of wildfires. In many instances a mosaic will only be possible if planned at a landscape level (by targeting different areas in different years).
- Despite the above, appropriate tactics and burning with good soil moisture can assist in creating internal patchiness.

**Landscape mosaic**

- Within the management area it is generally recommended not to burn more than 30 per cent of tussock community within the same year. In particularly good seasons it may be beneficial to burn more than 30 per cent and in very poor seasons it may be necessary to reduce or restrict the amount of planned burning.

**Other issues**

- A moderate-severity fire may be required when targeting woody species that are starting to become overabundant. Prior to burning, ensure there is sufficient soil moisture to favour grass regeneration.
- Grassland fires can produce a lot of smoke. When planning burns aim to minimise smoke impacts on urban settlements and roads.

## What weather conditions should I consider?

It is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**Season:**

- Plan burns during late wet and early dry season when there is good soil moisture, during early storm season or after good spring rains. If planning burns during the spring ensure grasses have seeded, to promote regeneration.
- A mosaic of early dry season fires will limit the chance of extensive wildfires later in the dry season (Crowley 2003).
- Ensure grasses are sufficiently cured—enough to carry a fire. Often this is dependent upon the objectives of the burn and the curing percentage required to achieve this.

**GFDI:** < 9

**DI (KBDI):** < 100

**Temperature:** Grass growth and recovery post fire is slower in winter. This slower growth may result in patches of bare ground for longer periods and provide the opportunity for weed encroachment.

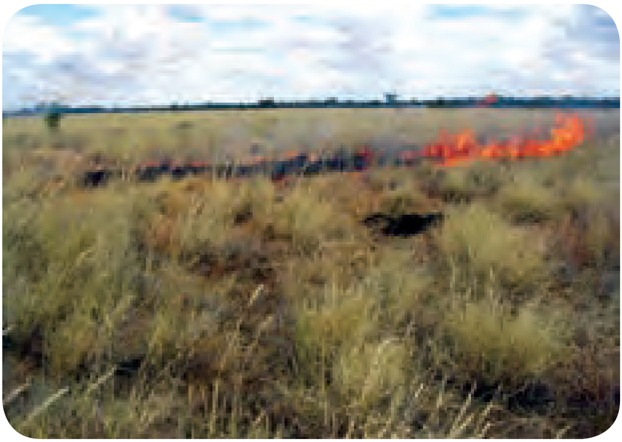
**Wind speed:** Beaufort 2–3, or < 20 km/hr. Often some wind will be required to help the fire carry in grasslands.

**Soil moisture:** Good soil moisture is critical when burning grasslands. Burning with good soil moisture, high temperatures and reliable rainfall is a good strategy to assist in the regeneration of grasses and retention of grass bases. Timing burns to coincide with follow-up rain will further assist in promoting grasses. Heavy dew is favoured when burning grassland, as this will often cause the fire to extinguish overnight. It is important to have a good understanding of local weather conditions and monitor the weather forecast in the days leading up to and following the fire. Align burns with expected rain events when practicable.

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low-intensity backing fire. Depending on available fuels and the prevailing wind on the day this may require either spot or strip lighting or a combination of both.
- **Spot ignition** is often used to alter the desired intensity of a fire and create the desired mosaic of burnt and unburnt areas. This can be achieved using a range of methods including drip torches, matches and incendiaries. Spots closer together will result in a line of a greater intensity (as spots merge they create hot junction zones) while spots further apart (or a single spot ignition) will result in a lower-intensity fire and greatly varied mosaic of burnt and unburnt patches. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Limit fire encroachment into non-target communities.** In some cases, riparian communities can occur adjacent to grasslands. Use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community.
- **Creating a running fire** (through closely spaced spot ignition or line ignition with the wind) may help address the issue of woody species encroachment.
- **Storm burning**. When possible aim to conduct planned burns from late wet season to mid dry season (following sufficient rain). Ensure good soil moisture exists throughout the site (including drainage lines).



Spot lighting using matches spaced every 50 to 100 metres can be useful to create a patchy mosaic in Mitchell grasslands.

Some wind will often be required to ensure the fire will carry.

Paul Williams, Vegetation Management Science Pty Ltd (2004).

## Issue 3: Manage invasive grasses

Refer to Chapter 8 (Issue 4), regarding the fire management of invasive grasses.

It is important to be aware of the presence of invasive grasses. When established and wide-spread, these grasses can dramatically increase fire severity. Invasive grasses may be promoted by disturbances (such as fire), after which they have the ability to significantly invade and alter the vegetation community. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high severity fires which gradually results in the fragmentation and overall decline of grasslands.

## Issue 4: Reduce overabundant saplings/seedlings

Overabundance of acacias, *Eremophila* spp., cypress pine *Callitris glaucophylla* or other shrubs and trees may lead to woody thickening; reducing the health of the ground layer through competition and shading.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

# Chapter 3: Wetland and melaleuca communities

Wetlands and springs are often dominated by sedges (e.g. *Eleocharis pallens*), tangled lignum *Muehlenbeckia florulenta*, samphire *Halosarcia* spp. and short grasses and are found in and around ephemeral lakes, mound springs, drainage lines and clay pans or in billabongs of semi-permanent or permanent water.

Melaleuca communities consist of sandhill honey myrtle *Melaleuca densispicata* shrubland with isolated stands of whitewood *Atalaya hemiglauca* and mulga *Acacia aneura*.

Bloodwood *Corymbia terminalis* also occurs inland on cemented aprons on the lower slopes and edges of dunes or fringing clay pans.

## Fire management issues

Fire regimes for melaleuca and wetland ecosystems require further research.

Wetland communities do not usually burn (due to lack of fuel or the presence of water) and if they dry out, fire should be avoided. Wetlands are critical habitat during seasonal flooding and drought events.

Melaleucas are fire-adapted however fires that are too intense or frequent will slow or prevent regeneration. High-severity fires may kill trees and lead to whipstick regeneration. Too frequent fire may result in a net loss of nutrients over time from an already nutrient-poor system. Limit fire encroachment into these communities.

### Issues:

1. Limit fire encroachment into melaleuca communities.
2. Avoid fire in wetland communities.

**Extent within bioregion:** 131 571 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Currawinya National Park, 15 432 ha; Lake Bindegolly National Park, 4 954 ha.

# Issue 1: Limit fire encroachment into melaleuca communities

Maintain a mosaic within surrounding fire-adapted communities to limit fire encroachment into melaleuca communities.

Refer to Chapter 8 (Issue 3), regarding fire management guidelines.

## Awareness of the environment

**Key indicators of a healthy melaleuca community:**

- A canopy dominated by melaleuca tree or shrub species usually in narrow areas in drainage lines or fringing wetlands or streams.
- Shrublands are interspaced with whitewood, mulga and/or inland bloodwood and a sparse ground layer of forbs.
- Seedlings or young melaleuca trees of varying sizes exist in the understorey. These should be sufficient to eventually replace the canopy, but not overabundant.
- Weed species are uncommon.

Melaleucas and eucalypts fringe this wetland.

Chris Pennay, Queensland Herbarium, St George Racecourse (2010).

## Discussion

- Melaleuca ecosystems often occur in patches or along natural drainage lines.
- While fire plays a role in these communities, they have longer fire intervals than surrounding areas. Do not target these communities for burning, and limit encroachment of unplanned fire through appropriate management of the surrounding areas (refer to Chapter 8 (Issue 3).
- Due to the dense nature of melaleuca shrublands, when they do burn, patchy fires will be unlikely. Care should be taken to ensure fire does not impact on these areas until they have matured and seeded at least twice (to ensure sufficient seed stock for recruitment).
- When they do burnt, high soil moisture (or the presence of water on the ground) will aid in the regeneration of melaleuca seedlings.

*Melaleuca densispicata* drought dieback. Avoid any fires encroaching on these communities during times of stress.

Jenny Handley, QPWS, Currawinya National Park (2011).

## Issue 2: Avoid fire in wetland communities

Refer to Chapter 8 (Issue 3), regarding fire management guidelines.

Avoid fire in these areas. The main strategy is to maintain a mosaic of burnt and unburnt patches in the surrounding landscape to limit late-season wildfires impacting wetland and spring communities.

Vegetation along major drainage lines into wetlands form critical habitat and should not be burnt.

Karen Smith, QPWS, Currawinya National Park (1995).

## Discussion

- Wetland communities are generally treeless or contain only scattered trees with a ground layer dominated by one or two species of sedges, rushes, with other ground layer species scattered. They may be permanently or seasonally inundated and are generally found in low areas of the landscape throughout the Mulga Lands bioregion.
- Mound springs are an **endangered** ecosystem (6.3.23) and are habitat for rare flora including salt pipewort *Eriocaulon carsonii*, native lovegrass *Eragrostis fenshamii*, pennywort *Hydrocotyle* spp., milfoil *Myriophyllum artesium*, samphire *Halosarcia* spp. and spring grass *Sporobolus pamelae* and fauna including endemic snails and other invertebrates. Fires in these communities can be devastating.
- Because wildfire often occurs under dry or otherwise unsuitable conditions, it has the potential to damage non-target and fire-sensitive fire vegetation groups. Proactive broad-scale management of surrounding fire-adapted areas with mosaic burning is one of the best ways to reduce impacts of unplanned fire on non-target and fire-sensitive communities.
- Wetlands are generally managed in association with the surrounding landscape using moisture to limit fire encroachment.
- Wetlands and swamps occupying narrow hydrological ecotones.
- Fire events reduce the surface cover of algae, lichens and other non-vascular plants around lake margins—which subsequently require four years to recover. The reduction or loss of surface cover has implications for soil surface stability and the infiltration of water.

Samphire and other wetland edge plants dry-out once water recedes. Exclude burning from these areas.

Robert Ashdown, QPWS, Currawinya National Park (2006).

Be aware that swamps and lagoons that are too dry may result in a large area being burnt. The fire can impact upon swamp and wetland species.

Chris Pennay, Queensland Herbarium, Horseshoe Lagoon (2009).

Mound springs viewed from the air, showing lack of surrounding vegetation.
Mark Handley, QPWS, Currawinya National Park (2008).

A mound spring with an exclusion fence used to protect this critical habitat from grazing. Protection from fire is equally as important.
Brett Roberts, QPWS, Idalia National Park (2011).

# Chapter 4: Cypress pine and allocasuarina communities

Cypress and allocasuarina (including casuarina) communities occur on a limited number of landforms within the Mulga Lands bioregion, predominately on plains and undulating country with deep sands. White cypress pine *Callitris glaucophylla* is a common species and is present throughout the eastern edge of the Mulga Lands bioregion. The structure of cypress stands vary depending upon landscape features and the community's exposure to fire and grazing. They may occur as open forest with associated eucalypts, as fragmented clumps containing mature and young trees or as a dense ('locked') stand of very large numbers of regenerating trees with few mature trees.

## Fire management issues

Depending upon management objectives, fire management will include fire exclusion, fuel load management or the maintenance of a more open cypress and/or allocasaurina communities with fire.

Although cypress pine and allocasuarina are fire-sensitive, low-severity fire plays a role in maintaining other elements of the community, especially in more open stands (refer to Issue 1). The absence of fire has promoted the formation of immature 'locked' stands, and has left these species vulnerable to wildfire impacts.

Within the Mulga Lands, there are small areas of production forests. These areas are not high quality production forests and may not require total fire exclusion. However, where the management objective is to exclude fire to preserve silverculture resources (refer to Issue 2).

Open cypress and allocasuarina communities support high floristic and faunal diversity, and provide refuge for species such as the vulnerable painted honey eaters, and Major Mitchell cockatoos. White cypress pine *Callitris glaucophylla* vegetation community is at the western limits of its geographical range in the Mulga Lands.

It is important to be aware of the presence of invasive grasses. These can greatly increase fire severity and draw fire into these communities resulting in fires of a greater frequency and/or severity.

## Issues:

1. Maintain open cypress pine or allocasuarina forests.
2. White cypress pine production forests.
3. Manage invasive grasses.
4. Reduce overabundant saplings/seedlings.

**Extent within bioregion:** 78 127 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Thrushton National Park, 2 174 ha; Powrunna State Forest, 1 150 ha; Narkoola National Park, 991 ha; Culgoa Floodplain National Park, 392 ha; Albany State Forest, 218 ha; Narkoola National Park (Recovery), 85 ha; Wycombe Environmental Purposes Reserve, 12 ha.

## Issue 1: Maintain open cypress pine or allocasuarina forests

Use low to moderate intensity planned burns to maintain open cypress pine or allocasuarina forests.

### Awareness of the environment

**Indicators of healthy open cypress pine or allocasuarina forests:**

- Open cypress pine forests may occur in pure stands or be associated with coolabah apple *Angophora melanoxylon*, flame-she oak *Allocasuarina inophloia* or Moreton Bay ash *Corymbia tessellaris*.
- Some allocasuarina/casuarina forests have a canopy dominated by western belah *Casuarina pauper*, flame she-oak *Allocasuarina inophloia* or belah *Casuarina cristata* often with caper-bush *Capparis* spp. in the mid-stratum.
- Mature cypress or allocasuarina trees often occur in distinct age classes through a number of germination events but should not occur as a 'locked' stand of narrow immature cypress or dense regrowth of allocasuarina.
- The mid and lower stratums are often sparse with a mix of smaller trees and shrubs, such as *Acacia* spp. and wilga *Geijera* spp. with some young canopy species present (enough to eventually replace the canopy).
- The ground layer can vary from sparse to dense and is often dominated by grasses such as kangaroo grass *Themeda triandra* and occasionally forbs.
- Leaf litter may be thick and compact, discontinuous or sparse.
- Logs and branches are scattered.
- Overall it is easy to see and walk through.

Healthy open allocasuarina forest with wilga *Geijera parviflora* understory.
Tony Bean, Queensland Herbarium (2001).

**Indicators that fire is required to maintain open cypress pine or allocasuarina forests:**

- Cypress or allocasuarina is starting to dominate forming dense, 'locked' stands of young trees usually of a height between one to three metres.
- There is an abundance of single-age class cypress or allocasuarina—one to three metres high.
- Cypress or allocasuarina are beginning to shade-out understorey diversity and out-compete recruiting juvenile trees of other species.
- Ground layer plants are beginning to show impacts from shading.
- Diversity has declined and the ground layer is becoming sparse.
- Grasses are becoming sparse or clumps are poorly formed. There is an accumulation of dead material and grasses have collapsed.
- The ground-layer is starting to accumulate a blanket of cypress pine leaf litter and there are some suspended fuels and an abundance of heavy fuels (e.g. fallen trees and branches).

Young cypress pines are beginning to form a locked stand and will gradually shade out the understorey. This site is still recoverable with fire.

Mark Cant, QPWS, Barakula State Forest (2010).

Some cypress communities will not carry a fire and are not targeted for planned burning.

John Neldner, Queensland Herbarium, south-east of Cunnamulla (1982).

## Discussion

- Appropriate fire management within cypress and allocasuarina forests is critical to avoid the forming of 'locked' stands. Mature and intermediate trees will survive low-severity fires however young trees and seedlings will not (Price and Bowman 1994). Fire can be used to maintain the health of the cypress and allocasuarina forests, reducing the overabundance of young trees.
- Protection of open cypress pine forests relies on low-severity fire in and around the community to mitigate against the impacts of wildfire.
- Cypress is particularly vulnerable to fire where there has been high residence time at the base of the tree, evident by complete charring or 'collaring' of the bark (use wind to push flames through in order to avoid this).
- Dense 'locked' cypress stands will naturally exclude fire as they create a thick impenetrable blanket of pine leaf litter and act as a 'wind break' that will generally impede fire spread. Despite this, under severe weather conditions, the locked stands will burn with a very high to extreme severity. These burns can cause significant ecological impacts within the community and in neighbouring areas (Taylor and Swift 2003).
- Historically, fire was excluded in cypress production areas, particularly within areas subject to intensive silvicultural (forest production) (Taylor and Swift 2003). The cypress communities on State forests within the Mulga Lands bioregion are classed as non-commercial for harvesting, therefore total protection from fire is not necessarily a requirement.
- The white cypress pine *Callitris glaucophylla* vegetation community found at the western limits of the mulga lands bioregion should be considered a priority to be maintained in a healthy condition to support its high floristic and faunal diversity.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |
| **Medium** | Planned burn in areas where **ecosystem health** is **poor** but recoverable. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Select at least two of the following as most appropriate for the site:

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Burn 40–60 % spatial mosaic of burnt patches. | Choose one of these options:<br>• Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air.<br>• Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt.<br>• In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating percentage of ground burnt within visual field. | **Achieved:** 40–60 % burnt.<br>**Partially Achieved:** between 30–40 % and 60–80 % burnt.<br>**Not Achieved:** < 30 % burnt or > 80 % burnt. |
| > 75 % of overabundant cypress < 3 m are killed. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity), estimate the percentage of overabundant saplings scorched. | **Achieved:** > 75 % of saplings < 3 m are scorched to the tip.<br>**Partially Achieved:** 25–75 %.<br>**Not Achieved:** < 25 %. |

| | | |
|---|---|---|
| > 95 % of trees with stems of 10 cm DBH (diameter breast height) retained. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate number of mature trees. Determine the percentage retained after fire. | **Achieved:** > 95 % retained. **Partially Achieved:** 90–95 % retained. **Not Achieved:** < 90 % retained. |
| > 95 % fallen logs (with a diameter ≥ 10 cm) retained. | Before and after the burn (immediately or very soon after) count the number of fallen logs crossed by one or more line transects (e.g.100 m long but length must be adequate to provide a representative sample of the area) and determine the percentage retained in each chosen location. | **Achieved:** > 95 % retained. **Partially Achieved:** 90–95 % retained. **Not Achieved:** < 90 % retained. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System, or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

# Fire parameters

## What fire characteristics will help address this issue?

### Fire severity

- In general **low** but vary with occasionally **moderate** to ensure the density of young cypress pines or allocasuarina are managed and to reduce the likelihood of 'locked' stands forming.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity ($kWm^{-1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | < 50 | < 0.3 | < 1.5 | High percentage of patchiness with minimal encroachment into cypress dominated communities. Undamaged cypress crowns. No signs of stem or bark damage. |
| **Moderate (M)** | 50–200 | 0.3–1.0 | 1.5–5.0 | Some patchiness, most of the surface fuels have burnt. Moderate scorch with up to 50 % of crown affected. Up to 25 % of stem circumference charred or weeping. |

Note: This table assumes good soil moisture and optimal planned burn conditions.

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between six to ten years.

**Mosaic** (area burnt within an individual planned burn)

- A mosaic is achieved with generally 40–60 per cent of area burnt within the target community.

**Other considerations**

- Cypress pine reaches reproductive maturity at six years. If a site has been identified as being at risk of becoming a 'locked' stand (either through lack of fire or a severe fire resulting in a flush of young trees) a fire frequency of less than six to eight years may be necessary. This frequency will reduce the number of young trees in the stand and assist in maintaining a diversity of cypress pine of varying ages. A similar approach can be used for allocasuarina.
- Extended fire-free intervals will ultimately lead to cypress or allocasuarina dominance (at the expense of other species), a decline in the capacity to implement successful planned burns and result in the accumulation of high fuel loads in the area.
- The fire frequency applied in this community will be somewhat dependant upon climatic conditions, fuel availability and grazing issues.
- Broad-scale management of surrounding areas with numerous small fires under mild conditions throughout the year will assist in limiting the potential impact of wildfires on cypress or allocasuarina forests.

Post low-severity, mosaic burn in a cypress forest. The fire has created a good mosaic, retained leaf litter and fallen logs and also scorched some cypress and allocasuarina saplings which will ensure the structure remains open.

Mark Cant, QPWS, Wondul National Park (2008).

Examples of low severity fires within cypress pine forests.
Stephen Berlin, DAFF.

Post moderate severity fire in open cypress pine forest. Note the severity has resulted in enough scorch to kill some young cypress pines while others have survived.
Stephen Peck, QPWS, Alton National Park (2009).

## What weather conditions should I consider?

It is important to be aware of weather predictions prior to and following burns as part of the planning and so that undesirable conditions and weather changes can be avoided.

**Season:** Throughout the year when good soil moisture exists. Avoid dry periods or burning during a period of increasing fire danger.

**FFDI:** < 12

**DI (KBDI):** < 100, up to 120 in mild conditions

**Wind speed:** Beaufort scale one to four (< 20 km/hr). Some wind may be necessary to help fire carry through the area and prevent residence time around the bass of trees (which may cause collaring of the bark and tree death). Dense cypress pine forest can act as wind breaks and slow rate of spread. This can impact immature cypress due to increased residence time. It may also reduce fire coverage where fuels are sparse.

**Soil moisture:** Good moisture conditions will protect the bases of grasses, hollow bearing trees, fallen logs and promote a good mosaic of burnt and unburnt patches.

A spot fire from an incendiary in cypress pine forest approx 10 minutes after ignition. Widely spaced spots in mild conditions will promote a low-severity fire such as that shown here.

Stephen Berlin, DAFF (2001).

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn, tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Smoke issues**. Cypress pine litter retains a high level of moisture and often low-severity planned burns will only remove approximately 10 mm of the top layer. Fires in cypress pine litter will often smoulder for long periods of time and create abundant smoke. Be aware that smoke may also impact on active apiary sites. Consideration should be given to apiarists when planning burns as smoke and heat will impact honey production.
- **Progressive burning:** Implement planned burns in surrounding fire-adapted communities (e.g. eucalypt forests and woodlands) during mild conditions. Planned burns can then be implemented in the cypress pine forest at a later date under conditions that will achieve the desired severity and fulfil the objectives of the planned burn. Progressive burning takes advantage of different seasonal conditions. Burning throughout the year (during the appropriate seasonal conditions) can assist in achieving the objectives in the burn proposal (e.g. fuel load management, weed invasion, the reduction of wildfire extent and severity, etc). Fires (of varying extents, severity and at various times) are lit in fire-adapted communities as soon as possible after the wet season with progressive lighting into the dry. Occasional higher-severity fires and storm burning at the start of the wet season can be useful to promote germination and recruitment of native legumes and grasses (Williams 2008) and also contain burns that are unbounded by constructed lines (e.g. fire-lines). Progressive burning will make it much easier to achieve burns later in the season that are severe enough to help address overabundant saplings.
- Be aware that **fuel loads** (particularly ground fuels) can vary greatly within cypress pine forests and need to be assessed carefully before implementing a planned burn. Although an area may appear to have appropriate fuel levels it is common in cypress forests to have some areas where there is an accumulation of elevated fuels and lack of ground fuels. Attempting a planned burn where there is a deficiency of ground fuel may exhaust fuels limiting later planned burn efforts.

- **Commence lighting on the leeward (smoky) edge.** This can be a useful way to create a low intensity backing fire into the burn area or to create a containment edge for a higher-severity fire ignited inside the burn area.
- **Spot lighting** can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of elevated or volatile fuels. Spots closer together will result in a line of a greater intensity (as spots merge they create hot junction zones). Spots further apart will result in a lower-intensity fire. The spacing of the spots will regularly vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- A **running fire** (using closely spaced spot ignition or strip/line ignition with the wind) is often favoured within cypress pine areas. This ensures the fire carries across the leaf litter (which is often heavily compacted in these areas) and limits residence time around the base of cypress pines (which can collar the bark and kill the tree). When using this tactic it is important to be aware of prevailing and predicted weather conditions on the day of the burn as it may result in a running fire of a greater severity than desired and potentially impact upon the community.

# Issue 2: White cypress pine production forests

Use fire in adjoining areas to protect white cypress pine production forests.

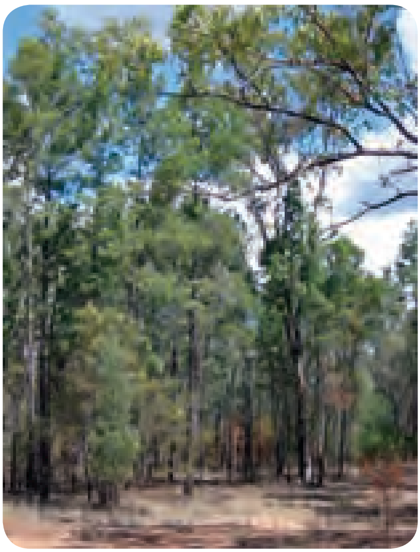
## Awareness of the environment

**Indicators of a white cypress pine forest where fire exclusion might be required:**

- The area is zoned by the Queensland Department of Agriculture, Fisheries and Forestry (DAFF) as a Production Forest.
- The leaf litter is predominately made up of thick and compacted cypress pine litter.
- More than 75 per cent of the canopy is dominated by cypress pine.
- There are often no signs of fire history at the site (e.g. charring of trees).
- Logs and limbs and a build-up of coarse or heavy fuels are present on the ground.
- The site lacks or has sparse understorey plants.

A high quality cypress pine production forest. There is a full healthy crown of cypress and on average a good spacing between trees.

Stephen Berlin, DAFF (2007).



An average cypress pine production forest. Note the mixed canopy, greater number of young cypress and reduced spacing between trees.

Stephen Berlin, DAFF (2006).

An open cypress production forest. There is no evidence of charring on young cypress trees. There are some understorey plants but these are sparse.
Stephen Berlin, DAFF (2006).

Compacted leaf litter and heavy fuels build-up can be found in some production forests.
Stephen Berlin, DAFF (2004).

## Discussion

- The protection of cypress pine production forests relies on appropriately managing surrounding areas with mosaic burning, and implementing low to moderate severity planned burns undertaken in suitable conditions, aimed at reducing fuel loads. The adjacent areas could be cypress pine forests of lower economic quality, or other fire-adapted communities.
- Cypress is often killed by fire and regenerates from canopy stored seed. It is particularly vulnerable where there has been flame residence time at the base of the tree and complete charring or 'collaring' of the bark.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| **Very high** | Planned burn required to **mitigate hazard** or **simplify vegetation structure**, usually within **wildfire mitigation zones**. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Select at least two of the following as most appropriate for the site:

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Reduce overall fuel hazard to low.<br><br>**Or**<br><br>Reduce fuel load to < 5 tonnes/ha. | **After the burn:** use the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b).<br><br>**Or**<br><br>Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations. | **Achieved:** Fuel hazard has been reduced to low Or fuel load has been reduced to less than five tonnes/ha.<br><br>**Not Achieved:** Fuel hazard has not been reduced to low Or fuel load is greater than five tonnes/ha. |

| | | |
|---|---|---|
| < 5 % of the white cypress pine production area is scorched. | **After the burn:** Visual estimation of percentage of area burn – from one or more vantage points, or from the air.<br><br>**Or**<br><br>**After the burn:** Walk through the site or representative sections (e.g. a 100 m long section of the margin in three locations) and estimate the percentage of area is scorched. | **Achieved:** Less than five per cent of the area is scorched.<br><br>**Partially Achieved:** 5–15 % of the area is scorched.<br><br>**Not Achieved:** > 15 % of area is scorched. |
| Fuel reduced sufficiently such that there are no corridors of fuel to promote passage of a wildfire across the area. | **After the burn:** Boundaries of burn assessed sufficiently to determine whether there are or aren't unburnt corridors that extend from one side of the area to the other. | **Achieved:** No unburnt corridors extend from one side of the area to another. Passage of wildfire will be prevented or substantially slowed.<br><br>**Partially Achieved:** No unburnt corridors extend from one side of the area to another but in some places the 'gap' between unburnt patches is very small such that the passage of wildfire may not be effectively prevented.<br><br>**Not Achieved:** Unburnt corridors extend across the area. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System, or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

# Fire parameters

## What fire characteristics will help address this issue?

### Fire severity

- In adjoining fire-adapted communities: In general **low** but occasionally **moderate**. Ideally aim for a fire that will self-extinguish late afternoon and/or on the cypress community's edge.

**Fire frequency / interval** (refer to Appendix 2 for discussion)

- Aim to burn the surrounding areas every seven to 10 years or as often as required to reduce fuel loads.

**Mosaic** (area burnt within an individual planned burn)

- A greater than usual coverage of fire in the target community surrounding cypress pine production forests (e.g. 70–80 per cent) is required to mitigate the impacts of unplanned fire on the area, create a buffer of low fuel loads and limit the impacts of re-ignition within the burn area.

### Landscape Mosaic

- One option is to use rotational burning of some surrounding areas in an eight year cycle to create a series of buffer blocks and variation of fuel loads.

### Other considerations

- Broad-scale use of fire in surrounding country under mild conditions in combination with recommended tactics (see below) throughout the year will assist in mitigating impacts of wildfires on cypress pine production forests.
- Production areas are defined by constructed fire-lines that assist to restrict fire spread and provide access. Fire-line maintenance is a key strategy.
- Following fire-line maintenance in cypress production areas, there will often be pushed up piles of debris from heavy plant such as dozers. Be aware that if fire carries into piles they will generally smoulder for long periods. Be aware that smouldering may not be immediately apparent but can cause relights or spot over's into adjoining areas.

## What weather conditions should I consider?

It is important to be aware of conditions prior to and following burns so that undesirable conditions and weather changes can be avoided, or to help with burn planning.

Optimal conditions for fuel reduction planned burns adjacent to cypress production forests have been identified (Taylor and Swift 2003) as per below:

**Season:** Traditionally, in the south of the Brigalow Belt bioregion, fuel reduction burning in cypress pine forests commences in April/May and extends to July (burns continue through to August in exceptional circumstances). Conditions are cooler during this period and the potential for fire to exceed the desired severity is limited.

**FFDI:** < 12

**DI (KBDI):** 80–120

**Wind speed:** Beaufort scale 1–3, (ideally 10 km/hr). Some wind is required to ensure the fire will carry through an area and avoid flame residence time at the base of cypress pines (residence time can cause collaring and tree death).

**Wind direction:** No easterly component

**Cloud:** Nil. No cloud cover is of critical importance (Taylor and Swift 2003)

**Relative humidity:** 30–40 per cent at 11:00 am and 15–20 per cent at 3:00 pm

**Temperature:** 19 to 23˚C, ideally 21˚C at 12:00 am to 1:00 pm

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (for example, due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Aerial ignition.** Gridding using aerial incendiaries from a fixed-wing aircraft allows for the efficient coverage of large, flat areas (ideal for cypress pine production areas) and can be used to effectively alter the desired intensity of a fire. Spots are spaced approximately 100 metres apart to promote a lower-severity fire and limit the chance of hot junction zones occurring.
- Lighting smoke beacons (via aerial ignition) on the perimeter of the planned burn area can help to clearly identify the area and provide some visual information on local weather conditions (e.g. wind directions). This knowledge allows the fire manager to adjust tactics to suit the prevailing conditions.
- In some instances aerial ignition may be implemented in conjunction with ground ignition to secure an edge around the area being burnt. Be aware that this tactic requires a good understanding of the flight path or 'runs' of the plane and the spacing of the aerial incendiaries as smoke from fires lit by ground crews may impair the vision of the pilot and hamper lighting efforts. Following the securing of an edge, follow up ground ignition may also be required within the area to achieve the desired fire coverage. Use of aerial photographs is recommended (stereoscopic images are particularly useful to gain an understanding of terrain) and it is good practice to plot the incendiary drop path onto a map or aerial photograph and ensure lighting crews are well aware of this prior to ignition.
- A **running** fire (closely-spaced spot ignition or strip/line ignition with the wind) is often favoured within cypress pine production areas to limit flame residence time around the bases of the cypress pines. When using this tactic it is important to be aware of the prevailing and predicted weather conditions on the day of the burn and any existing containment issues. If these are not adequately considered, a running fire of greater severity than desired may result and impact upon the cypress pine community.

Aerial ignition using a fixed wing aircraft in a cypress pine forest. Smoke plumes indicate the spacing between spots.

Stephen Berlin, DAFF (2009).

# Issue 3: Manage invasive grasses

Refer to Chapter 8 (Issue 4) regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses. When established and wide-spread, these grasses can dramatically increase fire severity. Invasive grasses may be promoted by disturbances (such as fire), after which they have the ability to significantly invade and alter the vegetation community. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires which results in the fragmentation and overall decline in the extent of cypress pine and allocasuarina open-forests and woodlands and the formation of dense 'locked' stands.

## Issue 4: Reduce overabundant saplings/seedlings

Overabundance of cypress pines may lead to woody thickening— reducing the health of the ground layer through competition and shading.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

# Chapter 5: Mulga dominated communities

Stretching from Jundah in south-west Queensland into north-west New South Wales, mulga communities characterise the Mulga Lands bioregion. This fire vegetation group occurs on flat to undulating plains and low ranges supporting a range of mulga *Acacia aneura* shrubland and woodland plant communities. Soils are generally very infertile sandy earths. Poplar box *Eucalyptus populnea* and other eucalypts co-dominate the mulga canopy in the higher rainfall (more eastern parts) of the bioregion. Brigalow *Acacia harpophylla*, gidgee *Acacia cambagei* and other acacia dominated communities scattered across the bioregion are covered separately (refer to Chapter 6). These generally occur on alluvial soils or soils produced from more fertile parent material (DNRM 2002).

## Fire management issues

In most instances, fire is not applied directly to mulga communities (e.g. planned burns) — instead, surrounding fire-adapted communities are managed to create a landscape mosaic of burnt and unburnt areas that mitigate the frequency, intensity and extent of unplanned fires that impact upon mulga communities. This is of particular importance where invasive grasses have become established along the margin of, or have penetrated into the community—these grasses increase the severity and encroachment of fire.

Mulga is fire sensitive and may be killed by hire-severity fire, although in normal seasons the fuel load in these ecosystems is rarely enough to carry fire.

### Issues:

1. Limit fire encroachment into mulga communities.
2. Manage invasive grasses.

**Extent within bioregion:** 7 219 145 ha, 39 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Currawinya National Park, 96 567 ha; Idalia National Park, 57 479 ha; Culgoa Floodplain National Park, 18 122 ha; Welford National Park, 10 197 ha; Thrushton National Park, 9 471 ha; Hell Hole Gorge National Park, 8 594 ha; Narkoola National Park, 8 250 ha; Lake Bindegolly National Park, 7 801 ha; Mariala National Park, 7 764 ha; Binya National Park, 5 866 ha; Powrunna State Forest, 1 521 ha; Narkoola National Park (Recovery), 830 ha; Tregole National Park, 713 ha.

## Issue 1: Limit fire encroachment into mulga communities

Refer to Chapter 8 (Issue 3), regarding fire management guidelines.

Maintain a varied landscape mosaic of burnt and unburnt patches in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging unplanned fires encroaching into mulga dominated communities.

A mulga community with a heavy body of grass following an extensive wet season.
Teresa Eyre, DSITIA, north of Wyandra (2008).

## Discussion

- Fire-killed acacias such as mulga, *Acacia petraea* and bendee *Acacia catenulata*, are reliant upon regeneration from a viable seed bank post-fire in order for the species to persist locally. These species are hard-seeded and need fire to promote germination. Although it is recommended to mitigate wildfire impacts by burning surrounding areas, the occasional high-severity fire does play a role in the persistence of this community in the landscape.
- Other acacias such as brigalow boree *Acacia tephrina*, gidgee *Acacia cambagei* and burra *Acacia ensifolia* are long-lived and fire-killed (or significantly top-killed). Fire plays no role in their germination which is very occasional and follows high rainfall years (refer to Chapter 6).
- Historically fire within most mulga communities was infrequent, estimated at between 10 to 50 years (this differs where mulga is associated with grasslands). In general fires have occurred following prolonged rainfall (resulting in substantial grass growth creating sufficient fuel to carry fire) (Hodgkinson 2002) or during extensive landscape wildfires. Changes in land use (e.g. clearing, grazing and the use of pastoral fire) and the spread of invasive grasses have resulted in fires of greater frequency and severity causing contraction of these communities.
- Following a fire that has affected a mulga community, a proactive approach to fire management in surrounding areas will be required to allow the mulga sufficient time for regrowth, recovery, maturation and seed bank replenishment (DERM 2002) prior to being exposed to fire again.
- Newly gazetted estates contain disturbed systems that may be recovering from previous land management (e.g. clearing and grazing). In these systems the canopy may be understocked (have fewer larger trees including habitat trees), overstocked (with whipstick mulga) or not contain sufficient recruiting canopy species of various ages. As long as the structure of the understorey appears healthy, implementing this guideline should allow a more varied and mature system to re-establish over time.
- Overgrazing by domestic, feral and native animals in mulga communities with a grassy understorey can result in the loss of perennial grasses and in some areas has resulted in a dense layer of trees and shrubs (Myers et al. 2004). Grazing can contribute to ground layer sparseness and removal of fuels (e.g. grasses) required for planned burns. Goat, pig and horse paths and pads will break up the continuity of fuels affecting the extent to which fire will carry.
- When conducting planned burns in areas adjacent to mulga communities it is important to be aware of the presence of invasive grass species (e.g. buffel grass). Refer to Chapter 8 (Issue 4) regarding fire management of invasive grasses.

A pure mulga stand with a sparse ground fuel layer.
Teresa Eyre, DSITIA, Adavale Road (2006).

Mulga showing drought stress and low surface fuels.
Mark Handley, QPWS, Lake Bindegolly National Park (2008).

Long undisturbed mulga that could benefit from a fire to promote revitalization.
QPWS, Mariala National Park (2008).

A mixed mulga stand with a dried-off body of grass that could carry a fire. As the stand appears healthy, exclusion of fire should be the main objective.
James Haig, QPWS, Idalia National Park (2011).

## Issue 2: Manage invasive grasses

Refer to Chapter 8 (Issue 4) regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses. When established and wide-spread, these grasses can dramatically increase fire severity. Invasive grasses may be promoted by disturbances (such as fire), after which they have the ability to significantly invade and alter the vegetation community. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires which gradually results in the fragmentation and overall decline of mulga dominated communities.

# Chapter 6: Acacia dominated communities

Typically these communities are dominated by acacia either as pure stands or in association with eucalypts or casuarinas. The understorey varies and may include some shrubs, grasses and forbs (Hodgkinson 2002).

Refer to Chapter 5 for mulga-dominated communities.

## Fire management issues

In most instances, fire is not applied directly to acacia dominated communities. Instead, surrounding fire-adapted communities are managed to create a landscape mosaic of burnt and unburnt areas that mitigate the frequency, intensity and extent of unplanned fires that impact upon acacia communities. This is of particular importance where invasive grasses have become established along the margin of, or have been able to penetrate into the community—as these grasses increase the severity and encroachment of fire.

Occasional fire plays a role in some acacia communities to stimulate germination, but this usually occurs through wildfire and does not need to be planned. In other acacia communities, fire plays no role (refer to discussion for more information). In either case, the management aim is to limit fire encroachment.

### Issues:

1. Limit fire encroachment into acacia communities.
2. Manage invasive grasses.

**Extent within bioregion:** 3 071 141 ha, 17 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Idalia National Park, 73 110 ha; Welford National Park, 40 960 ha; Currawinya National Park, 10 132 ha; Mariala National Park, 6 273 ha; Hell Hole Gorge National Park, 3 514 ha; Culgoa Floodplain National Park, 2 020 ha; Thrushton National Park, 231 ha; Narkoola National Park (Recovery), 189 ha; Binya National Park, 85 ha; Powrunna State Forest, 22 ha; Wycombe Environmental Purposes Reserve, 1 ha.

## Issue 1: Limit fire encroachment into acacia communities

Refer to Chapter 8 (Issue 3), regarding fire management guidelines.

Maintain a varied landscape mosaic of burnt and unburnt patches in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging unplanned fires encroaching into acacia dominated communities.

A lancewood dominated community. Although killed by fire, lancewood can regenerate post-fire from abundant seedlings which will often initially form dense clumps.

Paul Williams, Vegetation Management Science Pty Ltd, Blackwood National Park (2003).

A gidgee dominated community. This species is killed by all but the lowest severity fires and does not need fire for its regeneration.

Paul Williams, Vegetation Management Science Pty Ltd, Moorinya National Park (2007).

## Discussion

- Historically, fire within most of these acacia communities was infrequent, estimated at between 10 to 50 years (this differs where acacias are associated with grasslands). In general, fires have occurred following prolonged rainfall (resulting in substantial grass growth creating sufficient fuel to carry fire) (Hodgkinson 2002) combined with extensive landscape wildfires. Changes in land use (e.g. clearing, grazing and the use of pastoral fire) and the spread of invasive grasses have resulted in fires of greater frequency and severity causing undesirable impacts.
- Following a fire that has affected an acacia community, a proactive approach to fire management in surrounding areas will be required to allow the acacia sufficient time for regrowth, recovery, maturation and seed bank replenishment (DERM 2002) prior to being exposed to fire again.
- When conducting planned burns in areas adjacent to acacia communities, it is important to be aware of the dominant acacia species, their response to fire and in particular the presence of invasive species (e.g. buffel grass).
- Fire exclusion in acacia/eucalypt mixed open forest may result in an accumulation of fuels that promote high-severity, extensive single event wildfires. Patchy to low severity burns in surrounding areas that, on occasion, trickle into these areas is useful to reduce fuel and mitigate impacts.
- Acacias such as brigalow *Acacia. harpophylla*, gidgee *Acacia cambagei*, false gidgee *Acacia ammophila*, boree *Acacia tephrina*, umbrella mulga *Acacia brachystachya*, bastard mulga *Acacia stowardii*, river cooba *Acacia stenophylla* and mulga *Acacia aneura* are long lived, have soft seeds and are fire-killed (or significantly top-killed). Fire plays no role in their germination which is very occasional and generally follows high rainfall years. These areas are mapped as **'Acacia communities (exclude fire)'** and it is important to keep fire out of these areas by managing fire in surrounding areas if necessary.
- Other fire-killed acacias, such as lancewood *Acacia shirleyi, Acacia petraea*, bendee *Acacia catenulata* and bowyakka *Acacia microsperma*, bramble wattle *Acacia victoriae* and desert witchetty *Acacia stowardii* are reliant upon regeneration from a viable seed bank post-fire in order for the species to persist locally. These species are hard-seeded and need fire and good rain to promote germination. Although it is recommended to mitigate wildfire impacts by burning surrounding areas the occasional wildfire does play a role in the persistence of this community in the landscape. These communities are mapped as **'Acacia communities (limit fire)'**.

Lancewood *Acacia petraea* is a community that would be severely impacted by fire however the hard coated seeds will germinate post-fire.

John Neldner, Queensland Herbarium, south of Quilpie (1982).

Gidgee *Acacia Cambagei* is a community that would be severely impacted by fire and has soft seeds that rarely survive a fire.

John Neldner, Queensland Herbarium (1982).

Regrowth in an acacia community. This would be severely impacted by a fire.

QPWS, Idalia National Park (1998).

Timing burns when landscape features (such as melon holes retaining water) can assist in achieving a mosaic and limit fire encroachment into non-target communities.
Rhonda Melzer, QPWS, Nairana National Park (2006).

A patch of lancewood that has been affected by a high-severity wildfire. Note that there has been 100 per cent canopy scorch in most areas. Planned burns in surrounding areas can assist in limiting the extent and impact of wildfires on these communities.
Chris Crafter, QPWS, Boodjamulla National Park (2006).

Brigalow regrowth with low ground-fuel load.
QPWS, Idalia National Park (1998).

This brigalow regrowth would be easily destroyed by a hot fire.
Brett Roberts, QPWS, Idalia National Park (2011).

## Issue 2: Manage invasive grasses

Refer to Chapter 8 (Issue 4), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses. When established and wide-spread, these grasses can dramatically increase fire severity. Invasive grasses may be promoted by disturbances (such as fire), after which they have the ability to significantly invade and alter the vegetation community. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires which gradually results in the fragmentation and overall decline of eucalypt communities.

Buffel grass encroachment into brigalow. Invasive grasses pose the greatest potential threat (where they occur in adjoining areas) to brigalow communities. This is of particular concern if the community is more open and grassy, has been disturbed and/or the canopy opened.

Bernice Sigley, QPWS, Marengo Conservation Park (2011).

# Chapter 7: Riparian, fringing and saltpan communities

This fire vegetation group includes riverine wetlands, eucalypt fringing forests as well as saltpan scald areas.

## Fire management issues

Most of the species in these communities are fire sensitive— do not intentionally burn them. When burning adjacent fire-adapted communities, limit fire encroachment by burning under suitable conditions and/or using tactics such as burning away from their edges. Many of these communities are subject to weed invasion, in particular noogoora burr *Xanthium pungens* and invasive grasses, which pose a significant threat by altering the fuel loads and increasing the fire risk to these communities. Flood debris deposited at the base of riparian trees and shrubs will intensify fires and potentially result in the death or collapse of affected plants.

### Issue:

1. Limit fire encroachment into riparian, fringing and saltpan communities.

**Extent within bioregion:** 1 960 477 ha, 11 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

**Examples of this FVG:** Currawinya National Park, 21 691 ha; Culgoa Floodplain National Park, 7 748 ha; Binya National Park, 6 801 ha; Idalia National Park, 3 431 ha; Welford National Park, 1 574 ha; Hell Hole Gorge National Park, 1 053 ha; Narkoola National Park (Recovery), 15 ha.

## Issue 1: Limit fire encroachment into riparian, fringing and saltpan communities

Refer to Chapter 8 (Issue 3), regarding fire management guidelines.

Many riparian and fringing communities contain a high proportion of fire-sensitive species and/or habitat trees. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in these communities to promote structurally complex ground and mid-strata layers and retain mature habitat trees.

Patchy to low-severity burns in surrounding areas late in the wet season to early dry season (e.g. March to April) that on some occasions trickle into eucalypt-fringing river red gum *Eucalyptus camaldulensis* may be useful to reduce fuel loads and invasions of noogoora burr *Xanthium pungens* and mitigate impacts of wildfire (particularly the loss of habitat trees in these communities). Flood debris deposited around riparian trees may ultimately produce hot base-fires, resulting in fire-scar development or the loss of these critical habitat trees. Fire should be excluded from recent flood debris deposition areas at least until the majority of the debris has broken down.

The forb *Atriplex* spp. is fire-sensitive. When burning adjacent fire-adapted communities, care should be taken to avoid any fire floodplains with *Atriplex* spp.

Depressions and creeks that seasonally dry out may occur in box and river red gum woodlands.

LEFT: Chris Pennay, Queensland Herbarium, Yuleba Creek (2010).

BELOW: Chris Pennay, Queensland Herbarium, Yuleba Creek (2009).

Man-made bore-drains have developed their own fringing ecology and may be fire-sensitive.

Robert Ashdown, QPWS, Thrushton National Park (2006).

A clay-pan with sparse vegetation will not carry a fire.

Robert Ashdown, QPWS, Currawinya National Park (2006).

Flooding events can result in debris build-up at the base of trees. This makes them vulnerable to fires.

James Haig, QPWS, Bulloo River, Idalia National Park (2011).

This dried out pond and it's surrounding vegetation will generally not carry a fire.

Robert Ashdown, QPWS, Idalia National Park (2006).

Red Gums with fresh sedge growth provide habitat for many species.
Brett Roberts, QPWS, Bulloo River, Idalia National Park (2011).

River red gum or coolabah *Eucalyptus coolabah* dominate riparian areas. Following good seasonal rainfall, a dense cover of grasses may develop. Allow occasional fires to trickle in from surrounding fire-adapted communities to limit wildfire encroachment.
Bruce Wilson, Queensland Herbarium, Warrego River (2002).

# Chapter 8: Common issues

In the Mulga Lands bioregion there are some issues where the fire management approach is similar irrespective of the fire vegetation group. Rather than repeating these issues for each fire vegetation group, they are gathered in this chapter and cross-referenced where relevant in each fire vegetation group chapter.

## Fire management issues

### Issues:

1. Hazard reduction (fuel management) burns.
2. Planned burning near sensitive cultural heritage sites.
3. Limit fire encroachment into non-target fire vegetation groups.
4. Manage invasive grasses.
5. Reduce overabundant saplings/seedlings.

## Issue 1: Hazard reduction (fuel management) burns

In many cases it is important to use fire to reduce fuels. In the QPWS Fire Management System, protection zones aim to create areas of simplified vegetation structure and reduced fuel levels around key infrastructure, property and natural and cultural resources that may be damaged by fire. Protection zones should be maintained in a relatively low fuel hazard state by planned burning as often as fuel levels allow. In wildfire mitigation zones the aim of planned burning is to simplify the structure and reduce the quantity of fuel (within the ecological regime for the community) to mitigate flame height, spread and intensity of subsequent wildfires; and therefore improve their controllability.

### Awareness of the environment

#### Main indicators of where fire management is required

- The combined accumulation of all fuels (surface fuels, near-surface fuels, elevated fuels and bark hazard) exceeds a low to moderate overall fuel hazard as per the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b). Note that this is the preferred assessment method.

**Or**

- The combined accumulation of all fuels (surface fuels, near-surface fuels, elevated fuels and bark hazard) exceeds five tonnes per hectare (see Step 5 of the supporting guideline: How to assess if your burn is ready to go, for a fuel load estimation technique).

#### Descriptive indicators of where fire management is required (Not all of these indicators will apply to every fire vegetation group)

- Containment hazards (e.g. stumps, logs and stags) are present along firelines within protection zones.
- A high bark hazard is present.
- Dead material has accumulated around the base of grasses, sedges and ferns.
- There is an accumulation of continuous surface fuels that will carry a fire.
- Ground layer plants or shrubs are smothered by leaf litter in some areas.
- Shrub branches have significant dead material.
- Ribbon bark, leaf litter and fine branch material is perched in shrub and sapling foliage.
- An accumulation of coarse fuels with a diameter greater than six millimetres is present on the ground or perched in shrubs and trees.
- The mid or lower stratum is difficult to see through or walk through.

## Discussion

- To estimate fuel hazard (recommended for use in open forests and woodlands) use the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b).
- To estimate fuel load, refer to Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go.
- The terms fuel load and fuel hazard are widely used to describe fuels, often interchangeably. While they are related, they do differ significantly (refer to Photos 1a and 1b) and can be defined as:

**Fuel hazard** – the "condition of the fuel taking into consideration such factors as quantity, arrangement, current or potential flammability and the difficulty of suppression if fuel should be ignited" (Wilson 1992).

**Fuel load** – "the dry weight of combustible materials per area, usually expressed as tonnes per hectare. A quantification of fuel load does not describe how the fuel is arranged nor its state or structure" (Hines et al. 2010a).

Demonstration of the difference between **fuel load** and **fuel hazard.**

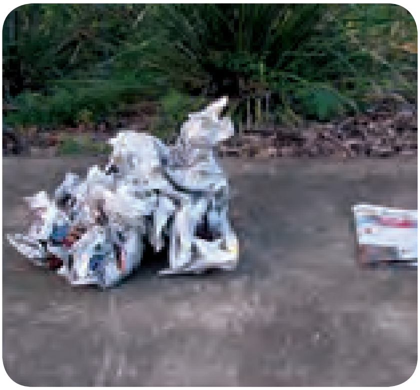


**Photo 1a:** The two samples above have the same **fuel load** (eighteen pages of newspaper) but a different fuel arrangement.

Troy Spinks, QPWS (2010).

**Photo 1b:** The fuel arrangement contributes to the difference in **fuel hazard.**

Troy Spinks, QPWS (2010).

- It is important to maintain a simplified vegetation fuel structure in protection zones and wildfire mitigation zones, which means addressing issues such as suspended and elevated fuel and overabundant saplings and seedlings.
- Fire management that favours grasses will assist in achieving an open structure suitable for wildfire management and mitigation. Moist conditions and low-severity burns that retain the bases of grasses will give them a competitive advantage over woody species.
- In wildfire mitigation zones it is essential to maintain ecosystem health. Ensure the use of appropriate conservation objectives for the fire vegetation group in addition to a fuel reduction objective (refer to fuel reduction objectives below).
- When establishing protection zones or wildfire mitigation zones favour fire vegetation groups that support a simplified vegetation fuel structure. Where possible avoid fire vegetation groups containing species that naturally produce high-severity fire during wildfire conditions (e.g. heath).
- It is not always possible to contain planned burns within the protected area due to the location of park boundaries (firelines may not exist along park boundaries as they are often in inaccessible areas and have continuous fuel levels. Cooperative fuel reduction burns with neighbours are often the only way to achieve the objectives of protection and wildfire mitigation zones. Refer to the QPWS Good neighbour policy and Notifying external parties of planned burn operations procedural guide.
- Planned burning often creates a smoke management issue particularly where burns are undertaken close to residential areas or commercial operations (e.g. agriculture, airports, major roads and high voltage power lines). Planning needs to consider factors such as fuel type, fuel hazard, temperature inversion and wind speed and direction all of which can have significant effects on the quantity of smoke generated and how it is distributed.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| **Highest** | Planned burn required to **protect life** and/or **property**, usually within **protection zones**. |
| **Very high** | Planned burn required to **mitigate hazard** or **simplify vegetation structure**, usually within **wildfire mitigation zones**. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Reduce overall fuel hazard to low or moderate.<br><br>**Or**<br><br>Reduce fuel load to <5 tonnes/ha. | **Post fire:** use the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b)<br><br>**Or**<br><br>Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations. | **Achieved:** Fuel hazard has been reduced to low or moderate<br>Or fuel load has been reduced to <5 tonnes/ha.<br><br>**Not Achieved:** Fuel hazard has not been reduced to low or moderate Or fuel load is > 5 tonnes/ha. |

| | | |
|---|---|---|
| Burn<br>90–100 %<br>(for protection zone)<br><br>60–80 %<br>(for wildfire mitigation zone). | Choose one of these options:<br>a. Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air.<br>b. Map the boundaries of burnt areas with GPS, plot on ParkInfo and thereby determine the percentage of area burnt.<br>c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating the percentage of ground burnt within visual field. | **Protection zone**<br>**Achieved:**<br>> 90 % burnt.<br><br>**Partially Achieved:**<br>80–90 % burnt, the extent and rate of spread of any subsequent wildfire would still be limited.<br><br>**Not Achieved:** < 80 % burnt. High proportion of unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be sufficiently limited).<br><br>**Wildfire mitigation zone**<br>**Achieved:** 60–80 % burnt.<br><br>**Partially Achieved:**<br>50–60 % burnt.<br><br>**Not Achieved:** < 50 % burnt. High proportion of unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be sufficiently limited). |

If the above objectives are not suitable refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

# Fire parameters

## What fire characteristics will help address this issue?

### Fire severity

- **Low** and occasionally **moderate**. Where there is a high fuel load or elevated fuels (e.g. when first establishing a protection zone) the initial fire may result in a **moderate** to **high** severity. Following this initial burn, aim to reinstate a regime that will promote **low** severity planned burns. Severity should be sufficient to reduce elevated fuels and bark hazard (i.e. allow fire to run up trunks).

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- **Protection zones:** Fuel management planned burns within protection zones are carried out as soon as possible after they can carry a fire in order to maintain a relatively low fuel hazard.
- **Wildfire mitigation zones:** Planned burns within wildfire mitigation zones are undertaken within the fire frequency recommended for the fire vegetation group but generally towards the lower end of that range.

**Mosaic** (area burnt within an individual planned burn)

- **Protection Zones:** 90 per cent burnt
- **Wildfire Mitigation Zones:** 60–80 per cent burnt

## What weather conditions should I consider?

When planning a burn it is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**Season:** January–August

- Later burning can occur in protection zones if they are well established and have no containment hazards. For wildfire mitigation zones, avoid periods of increasing fire danger when relights are more likely.

**FFDI:** < 12

**DI (KBDI):** < 120

**Wind speed:** < 15 km/hr

**Soil moisture:** While the aim of hazard reduction burning is to reduce the amount of fuel, good soil moisture is desirable to:

- reduce scorch height and limit leaf drop post fire
- reduce the likelihood of a thicket of woody species developing post fire
- favour grasses over woody species as woody species will create undesirable fuel conditions.

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Spot ignition** can be used effectively to alter the desired intensity of a fire particularly where there is a high accumulation of available and volatile fuels. Spots closer together will result in a line of a greater intensity (as spots merge and create hot junction zones) while increased spacing between spots will result in a lower intensity fire. The spacing of the spots will regularly vary throughout the burn due to changes in weather conditions, topography, fuel loads etc.
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low intensity backing fire. Depending on available fuels and the prevailing wind on the day, use either spot or strip lighting or a combination of both.
- **A low intensity backing fire** is usually slow moving, and will generally result in a more complete coverage of an area and a better consumption in continuous fuel. This tactic ensures the fire has a greater amount of residence time and reduction of available fuels, particularly fine fuels (grasses, leaf litter, twigs etc), while minimising fire severity and rate of spread.
- While a low intensity backing fire is recommended, a **running fire** of a higher intensity may be required in discontinuous or elevated fuel. Use with caution and be aware of environmental impacts that may result. To create higher intensity, contain the smoky side first, then **spot light the windward (clear) edge.** If the planned burn area is narrow, use caution when lighting the windward edge as the fire intensity may increase when the fire converges with the previously lit backing fire creating higher- intensity junction zones and the potential of fire escaping through a spot-over.

# Issue 2: Planned burning near sensitive cultural heritage sites

It is important to have knowledge of the location of significant cultural heritage sites, items and places of Indigenous or European heritage when planning fire management. The local fire strategy should identify these locations (it is important to note that some locations will be culturally sensitive and therefore their location will not be specifically identified in text or on maps). Consulting Traditional Owners, the Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA) Indigenous cultural heritage branch and the Department of Environment and Heritage Protection (EHP) European cultural heritage branch during fire strategy preparation will help to identify these places, items and issues.

## Awareness of the environment

**Key indicators of Indigenous cultural heritage sites:**

- Raised mounds (especially with visible shell debris) or the presence of shell debris scattered on the ground can indicate the presence of shell middens.
- Rock shelters, especially if they have rock paintings, stone tools, artefact bundles, wrapped material or bones inside.
- Engravings on trees or rock faces.
- Arrangements of stones or raised earth patterns on the ground, or artefacts scattered on the ground.
- The presence of trees that have been scarred or carved (e.g. a scar in the shape of a canoe).

Indigenous people scarred trees in order to make canoes, containers or temporary shelters. These trees are potentially vulnerable to fire if fuel builds up around their bases.

David Cameron, DNRM (2004).

This rock art site is potentially vulnerable to radiant heat and smoke impacts.

QPWS, Carnarvon Gorge.

Caves such as this may contain cultural material vulnerable to smoke impacts.

David Cameron, DNRM, Unspecified location.

Rocks on the ground that appear to have been purposefully arranged are likely to have cultural heritage significance.

David Cameron, DNRM, Atherton (2002).

Shell material strewn across the ground or visible in a mound structure usually indicates the presence of a midden. Middens are potentially vulnerable from radiant heat, fire line construction or vehicle or machinery operations.

David Cameron, DNRM, Bribie Island (2005).

**Key indicators of European cultural heritage sites:**

- The existence of building remains, corrugated iron shacks, wooden house stumps, old fence posts, old stock yards, tombstones, wells, graves, bottle dumps, old machinery and iron debris.
- Quarries and old mine sites (sometimes deep holes covered with corrugated iron or wood) are present.
- Forestry artefacts including marked trees (shield trees), and old machinery such as winders (timber tramways) and timber jinkers (timber lifting wagon) exist.
- Military artefacts such as old equipment and used ammunition exist.
- Survey and trig points exist.
- The presence of historic fence-lines.

Some cultural sites may require removal of fuel via mechanical means prior to a burn to protect fire-vulnerable assets.

Brett Roberts, QPWS, Idalia National Park (2011).

Sometimes early European explorers left marks, plaques, and paint on trees. These may be vulnerable to fire especially if fuel has built up around the base of the tree.

David Cameron, DNRM, Dogwood Creek (2005).



In bushland areas, forestry and timber getting operations left a number of items that are now of cultural heritage significance including from the top left: shield trees (this one marks an apiary site), road signs (and other signs), timber getting equipment such as this timber winch, springboard trees, campsite remains (and other ruins from huts and fire towers).

Because of their location in forested areas, these are often vulnerable to fire, and need to be protected from wildfire through appropriate planned burning or mechanical fuel reduction.

When planning burns, consider if particular mild weather conditions, tactics, chipped lines or mechanical fuel reduction (e.g. raking) is required prior to implementing the burn.

David Cameron, DNRM, various locations.

## Discussion

- **Do not** disturb any cultural heritage site or artefact. Leave all materials in place and treat the location with respect. If you are not sure whether the location or artefacts have been reported, consult the cultural heritage coordination units of DATSIMA (for Indigenous sites) or EHP (for European sites). Also refer to the Duty of Care Guidelines provided in the *Aboriginal Cultural Heritage Act 2003* (Queensland Government 2004).
- When planning burns in and adjacent to sensitive cultural heritage places there is a duty of care to ensure appropriate people are involved. Appropriate people may include Traditional Owners, indigenous rangers, historical societies and cultural heritage experts. If you are unsure who the appropriate people are, refer to the DATSIMA and/or EHP cultural heritage coordination units.
- Be aware of QPWS policy and procedures Management of cultural heritage places on NPRSR estate (DERM 2010a, 2010b) which recommends fire management of a heritage place involve burning only the area surrounding the place that does not contain objects or areas related to the cultural heritage place (e.g. fences or gravestones).
- Large-scale wildfires are known to damage cultural heritage values. A landscape proactively managed with mosaic burning will limit the spread and severity of wildfires giving better protection to cultural heritage artefacts and sites.
- The key risks to cultural heritage sites and artefacts from fire are direct contact with flames, radiant heat and smoke (e.g. radiant heat can exfoliate the surface of rock art sites, flame can crack or burn items and smoke can damage paintings).
- To manage impacts from flame and radiant heat, consider reducing fuel levels though manual, mechanical, or herbicide means or a combination of these. If it is not necessary to reduce fuel it is preferable to leave the site completely undisturbed.
- For larger culturally significant sites it may be necessary to create a secure burnt edge by backing fire away from these locations. Use this tactic prior to broader-scale planned burns.
- For sites that may be impacted by smoke (e.g. rock paintings and rock shelters) use wind to direct smoke away from the site.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| **Highest** | Fuel management through the implementation of planned burns within **protection zones** to protect life, property, and conservation values. |
| **Very high** | Burns protecting **significant cultural heritage sites.** |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations, walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| No impact on item or site of cultural heritage significance. | Visual inspection of site or items taking photographs before and after fire. | **Achieved:** No impact on site or item.<br><br>**Partially Achieved:** Minimal impact.<br><br>**Not Achieved:** there was significant impact on site or item. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

# Fire parameters

## What fire characteristics will help address this issue?

### Fire severity

- Burn within the parameters recommended for the fire vegetation group. **Low** severity fires will be less likely to impact on cultural heritage sites.

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Be guided by the fire zoning plan and recommendations for the specific fire vegetation group within the planned burn area.

**Mosaic** (area burnt within an individual planned burn)

- If possible, a patchy fire will give greater overall protection to cultural heritage sites and items.

### Landscape mosaic

- A landscape proactively managed with mosaic burning will help reduce fuel hazard, limit the spread and severity of wildfires and better protect cultural heritage artefacts and sites.

## What weather conditions should I consider?

When planning a burn it is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**Season:** Favour early season burning and moist conditions

**FFDI:** < 11

**DI (KBDI):** < 100 for areas where there are combustible historic sites

**Wind speed:** < 15 km/hr

**Wind direction:** Closely monitor the wind direction to avoid smoke, flame and/or radiant heat coming into contact with sensitive cultural heritage sites.

**Soil moisture:** Ensure good soil moisture exists.

Smoke directed away from rock art site during a planned burn.
Mark Parsons, QPWS, Fishers Creek (2010).

## What burn tactics should I consider?

Tactics will be site-specific and a range of burn tactics may be needed at the same location (e.g. due to changes in topography, weather and vegetation). During the planned burn tactics should be reviewed and adjusted as required to achieve the objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Manual fuel management.** Prior to undertaking planned burns near sites of cultural significance (e.g. scar trees and rock art sites), manual reduction of fuel may be required. This may include the raking, clearing (e.g. creating a rake-hoe line), trimming or leaf blowing the surface fuels away from the site to limit the potential impacts. If it is not necessary to manually reduce the fuel level it is preferable to leave the site completely undisturbed.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire particularly where there is an accumulation of available and volatile fuels next to a site of interest. Widely-spaced spot ignition is preferred around cultural heritage sites as it will promote a slow-moving and manageable low-severity fire and will limit the chances of a high-severity junction zone developing.
- **A low-severity backing fire.** A slow-moving, low-severity backing fire can help ensure fire severity and rate of spread are kept to a minimum.
- Depending on the conditions, **spot light the windward (clear) edge** to direct the active fireline and smoke away from the cultural heritage site. Use a chipped or wet line around the site so the resulting backing fire can be extinguished or self-extinguish at the chipped or wet line.

Manual removal and burning of flood debris from around the posts of a historical railroad bridge.
Mark Cant, QPWS (2002).

# Issue 3: Limit fire encroachment into non-target fire vegetation groups

Non-target fire vegetation groups include wetlands, melaleuca, springs and some cypress, riparian and acacia communities. These communities are sometimes self-protecting if fire is used under appropriately mild conditions. If suitable conditions are not available tactics such as burning away from these communities should be used to protect them.

## Awareness of the environment

**Indicators of fire encroachment risk:**

- Continuous grass leads up to the non-target community forming a fire corridor.
- There is continuous grass within the non-target community that could ignite from fires in surrounding areas.
- Wetland area without standing water or water-logged conditions.
- Invasive grasses are invading fire-sensitive communities or creating continuous fuel leading up to their edge.
- The non-target community is upslope of running fire.

Fire-sensitive species can be scorched by nearby planned burning operations, care should be taken to minimise impact on these species.

Stephen Peck, QPWS, Alton National Park (2009).

Standing water is often sufficient to limit fire encroachment and it is likely no particular tactics would therefore be required.

Martin Ambrose, QPWS, Culgoa National Park (2010).

Grassy mulga communities (below) that are not long-unburnt should be protected from fire though regular planned burning within surrounding fire-adapted communities.

Dale Richter Queensland Herbarium, 44 km south-west of Welford National Park (2012).

## Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (e.g. wetland soils may not be moist) it has the potential to damage non-target and fire-sensitive fire vegetation groups. Proactive broad-scale management of surrounding fire-adapted areas with mosaic burning is one of the best ways to reduce impacts of unplanned fire on non-target and fire-sensitive communities.
- Under suitable planned burn conditions with good soil moisture, non-target communities tend to self-protect and additional protective tactics may not be required. Sometimes where a non-target community occurs at the top of a slope it is necessary to avoid running fires upslope even in ideal conditions.
- If suitable conditions cannot be achieved specific tactics may be required to protect the non-target fire vegetation group (refer to the tactics at the end of this chapter).
- Many riparian communities contain a high proportion of fire-sensitive species and/or habitat trees. Too frequent and/or severe fire removes or inhibits the development of structurally complex ground and mid-strata vegetation. This in turn may increase the risk of weed invasion and soil erosion and lead to greater production of fine fuel (mainly grasses), and hence an increase in the potential fire hazard. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in many riparian communities in order to promote structurally complex ground and mid-strata vegetation and retain mature habitat trees—all of which are important fauna habitat.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| High | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| No scorch of margin of non-target fire vegetation group. | **After the burn** (immediately or very soon after): visual estimation of percentage of margins scorched from one or more vantage points, or from the air.<br><br>**Or**<br><br>**After the burn** (immediately or very soon after): walk the margin of the non-target community or representative sections (e.g. a 100m long section of the margin in three locations) and estimate the percentage of margin scorched. | **Achieved:** No scorch.<br><br>**Partially Achieved:** < 5 % scorched.<br><br>**Not Achieved:** > 5 % scorched. |
| Fire penetrates no further than one meter into the edge (if there is a well-defined edge). | **After the burn** (immediately or very soon after): visual assessment from one or more vantage points, or from the air.<br><br>**Or**<br><br>**After the burn** (immediately or very soon after): walk the margin of the non-target community, or representative sections (e.g. a 100m long section of the margin in three locations) and determine whether the fire has penetrated further than 1m into the edge. | **Achieved:** Fire penetrates no further than one meter into the edge.<br><br>**Not Achieved:** Fire penetrates further than one meter into the edge. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Fire parameters

### What fire characteristics will help address this issue?

The below characteristics apply to fires in areas adjacent to the non-target fire vegetation group.

#### Fire severity

- A **low**-severity fire in adjacent fire-adapted communities will help achieve the objective of limited fire encroachment. A backing fire will help ensure good coverage (refer to the mosaic section below). If there are overabundant saplings in the area being burnt a higher-severity fire may be required (in which case, appropriate tactics and moisture conditions will help limit scorch of the non-target areas).

**Mosaic** (area burnt within an individual planned burn)

- Consult the recommended mosaic for the fire vegetation group being burnt. Aim for the higher end of the recommended mosaic as this will help mitigate the movement of wildfire into fire-sensitive communities.

#### Landscape mosaic

- Proactive broad-scale management of surrounding fire-adapted areas using mosaic burning is one of the best ways to reduce impacts of unplanned fire on non-target fire vegetation groups and fire-sensitive communities.

### What weather conditions should I consider?

When planning a burn it is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**FDI:** Refer to relevant fire vegetation group

**DI (KBDI):** Refer to relevant fire vegetation group

**Wind speed:** Beaufort scale 1–3, < 15 km/hr

**Soil moisture:** If fuel moisture or other conditions (such as micro climates due to closed canopy) is insufficient to limit fire encroachment, or the fire-sensitive community is upslope from the planned burn, consider using tactics outlined below.

## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same site (e.g. due to topographical variation). During your burn, regularly review and adjust tactics as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Test burn** the site to ensure non-target communities will not be affected.
- **Do not create a running-fire.** When burning in adjacent fire adapted communities during dry conditions use a low-intensity perimeter burn from the edge of low lying communities to protect its margins.
- **Commence lighting on the leeward (smoky) edge** to establish the fire and promote a low-intensity backing fire. Depending on available fuels and the prevailing wind on the day this may require either spot or strip lighting or a combination of both.
- **Afternoon ignition**—planned burning in areas adjacent to non-target communities can be undertaken late in the afternoon. The milder conditions during this period will assist in promoting low-severity fires that trickle along the edge and generally self-extinguish, particularly during winter.
- **Limit fire encroachment into non-target communities.** Where the non-target community is present in low lying areas (e.g. sedgelands), utilise the surrounding topography to create a low-intensity backing fire that travels down the slope towards the non-target community. If conditions are unsuitable (e.g. the non-target community is too dry to ensure fire will self-extinguish on its boundary or it is upslope of a potential run of fire) use appropriate lighting patterns along the margin of the non-target community. This will promote a low-intensity backing fire that burns away from the non-target community.
- **Use strip ignition to draw** fire away from the non-target community's edge. When more than one line of ignition is used it can create micro wind conditions that can draw fire away from non-target areas. It is important to have safe refuges when undertaking this type of burning.

Semi-permanent water bodies can protect riparian communities from fire encroachment.

QPWS, Mariala National Park (1995).

# Issue 4: Manage invasive grasses

The spread of invasive grasses has resulted in significant changes to traditional fire regimes within the Mulga Lands bioregion. This is largely due to a significant increase in fuel load which in turn increases flame height and fire severity and provides fuel connectivity across the landscape, allowing fires to spread across a much greater area than previously possible (Eyre et al. 2009). This then results in greater tree death (particularly of acacias) and loss of habitat features creating flow on effects to native fauna and a cycle of damaging high severity fires. While fire can be used as a method for weed control, in most cases high biomass grasses both promote fire and are promoted by fire. It is important to be aware of the presence of high biomass grasses during planned burn operations.

## Awareness of the environment

### Key indicators

- Invasive grasses are able to form a dense single-species stand.
- Invasive grasses are starting to penetrate the edge of mulga, fringing and riparian or other fire-sensitive communities or have become established.
- Invasive grasses have a lot more biomass and/or dead material.
- Invasive grasses often first appear along fire-lines and roads.

## Discussion

- Be on the lookout for newly formed stands of invasive grasses and be especially vigilant in disturbed areas. Be particularly aware of places where disturbance is ongoing (e.g. roadsides) and areas adjacent to or downstream from existing high biomass grass infestations) (Melzer and Porter 2002). Control is often easier if their presence is detected and addressed before it become well-established.
- Prior to undertaking planned burns in areas where high biomass grasses occur, become familiar with the grasses' response to fire and its intensity (e.g. if it is promoted or killed). Take into consideration other factors such as weather conditions which may promote the grasses spread.
- The closed canopy of healthy, mature acacia stands will often suppress and prevent the encroachment and establishment of invasive grasses. Healthy eucalypt forests with a native grassy understorey that fringe acacia communities that are maintained in a healthy condition will often also act as a preventive buffer that limits the spread of invasive grasses into these areas.
- Invasive grasses cause the contraction of fire sensitive communities and also

increase the risk of wildfires (particularly during dry conditions) carrying into the canopy and causing the loss of mature trees. This contributes to the gradual decline and fragmentation of the extent and/or loss of a population of fire sensitive communities.

- Be aware of weed hygiene issues when managing invasive grasses. Vehicles, machinery and quad bikes aid their spread and should be washed down after exposure. Invasive grasses easily spread along fire breaks (usually due to machinery spreading seeds). Caution and awareness of weed hygiene issues are paramount when constructing and maintaining fire lines and roads.
- In many cases it is desirable to avoid burning invasive grasses, due to the likely increase in fire severity and further promotion of these grasses. However, the risk of wildfire later producing an even higher severity fire must be considered. In some situations, burning invasive grasses under mild conditions with planned fire may be more desirable than allowing them to burn with wildfire.
- In some instances fire may be useful as part of an integrated weed control program when implemented in conjunction with herbicide for some grass species. Fire may assist in reducing the biomass of grasses (pre or post spraying) and available seed bank stores when targeting post-fire germination before seedling can mature and set seed (Greig 2008).
- Once an area has been impacted by invasive grasses (in particular within fire sensitive communities) the aim of the land manger often becomes one of fuel management. This may involve implementing mild or 'cool' fires both within the site and in surrounding areas by using appropriate tactics to burn away from the non-target community and limit edge effects on the margin. Other techniques which may be effective include slashing, spraying with herbicide and in some instances grazing (Melzer and Porter 2002; Butler and Fairfax 2003).
- The most effective control method for invasive grasses will often be case by case and will need to be tailored to suit the site and long term management objectives of an area. For some species, the application or exclusion of fire may be an aspect of control often in combination with spraying and/or grazing.

Specific information for the control of invasive grasses is offered below:

**Buffel grass**

- Buffel grass is of particular concern to fire-sensitive communities. This species can penetrate and establish a dense sward up to several hundred metres into the acacia woodland across a front several kilometres long greatly increasing fuel loads and future impacts upon acacia communities (Butler and Fairfax 2003).
- The use of fire to control buffel grass is often debated. Buffel grass is promoted by fire disturbance and fire exclusion is the usual approach. But fire may assist in facilitating control methods such as spraying or grazing. Fire can reduce the biomass of buffel grass providing access to the remaining clumps and seedlings for herbicide treatment. Be aware that follow-up spraying of the affected site will need to be continued for some time as buffel grass will usually germinate en masse after fire and rain.
- In the dry season, buffel grass begins to store reserves for winter. Burning followed by intensive grazing is more likely to stress the plant. Continual grazing and further fires over time may eventually wear down the plant.
- The curing rate for buffel grass differs from that of native grasses—buffel grass tends to remain greener for longer periods of time. Careful consideration should be given to burning adjacent areas when there is good soil moisture and when buffel grass is green and unlikely to carry a fire. This may provide the opportunity to conduct planned burns at differing times of the year (e.g. earlier or later in the season).
- In some instances, creating a buffer through mechanical or chemical means adjacent to an area of buffel grass may be useful in limiting its spread. Creating a buffer strip between the buffel infestation and margin of unaffected communities of between 50–100 metres of may be an option where active ongoing control is required.

A close-up of the flowering head and clump mass of buffel grass.

Paul Williams, Vegetation Management Science Pty Ltd, Bald Rock (2005).

Buffel grass is fire and drought promoted and following a disturbance (such as fire) is able to rapidly invade and form dense swards within a vegetation community.

Rhonda Melzer, QPWS, Nairana National Park (2005).

Exclusion of fire from areas affected by buffel grass may be affective in allowing the canopy to recover to shade out buffel grass. Note the buffel grass has shaded out as the canopy begins to close.

Rhonda Melzer, QPWS, Albinia Conservation Park (2010).

**Other invasive grasses**

- Thatch, grader and coolatai grasses are becoming more widespread (particularly along roadsides) and are likely to influence fire management in the future.
- Grasses can produce seed in the first growth season and are often self-fertile, enabling new populations to arise from a single plant (CRC Weeds 2007). These grasses need to be actively growing (late spring to summer) for herbicide to be effective. Fire can be used to remove dead biomass and stimulate regrowth before spraying six to eight weeks after (and ideally before seeding).
- Rhodes and red natal grasses are common along roadsides and due to the comparative curing rates to native grasses can make burning surrounding areas difficult. Too-frequent fire or fires under dry conditions will promote red natal grass particularly where there are bare patches to encroach into. Due to its preferred location (predominately road edges) access for herbicide treatment is highly practical. Treat infestations early, before they become established.
- Successful fire management techniques for other species of high biomass grasses in the Mulga Lands bioregion are not yet established and will be subject to experimentation. The examples above might be useful as a starting point.

Thatch infestation adjacent to dry vine thicket (potential habitat for ooline, *Cadellia pentastylis*). Black speargrass in the foreground gives an indication of the height of thatch.

**Above:** Thatch grass seed head.

Dan Beard, QPWS, Carnarvon National Park (2009).

A monoculture of thatch has replaced native pasture and begun to encroach into adjoining communities. Note the remnant scrub within sheltered gullies.

Dan Beard, QPWS, Gladstone (2009).

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| High | It is important to be aware of the presence of invasive grasses (particularly where it is a new infestation) so that their negative effects can be managed and the potential for control can be considered. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Choose from below as appropriate:

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Distribution of invasive grass has not increased as the result of the burn. | **Before and after the burn** (after suitable germination/ establishment conditions): GPS the boundary of the invasive grass in the area or take photographs. Compare the pre and post-burn distribution of the weed species. | **Achieved:** No increase in the distribution of the weed.<br><br>**Partially Achieved:** Minor expansion of weed species distribution; will not increase fuel loads (e.g. scattered individuals spread into burn area; easily controlled).<br><br>**Not Achieved:** Significant advance in the spread of the weed; will increase fuel loads in the newly invaded areas. |

| | | |
|---|---|---|
| Significant reduction in density of invasive grasses. | Seek advice from resource staff and/or publications such as the Parks Victoria Pest Plant Mapping and Monitoring Protocol (Parks Victoria 1995). One option is given here.<br><br>**Before and after the burn** (after suitable germination/establishment conditions and growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]):<br>• Rare (0–4 % cover) = Target weed plants very rare.<br>• Light (5–24 % cover) = Native species have much greater abundance than target weed.<br>• Medium (25–75 % cover) = roughly equal proportions of target weed and native species.<br>• Dense (> 75 %) = monoculture (or nearly so) of target weed. | **Achieved:** Weed infestation 'drops' two 'density categories' (e.g. goes from dense before the fire to light after the fire).<br><br>**Partially Achieved:** Weed infestation 'drops' one 'density category' (e.g. goes from dense before the fire to light after the fire).<br><br>**Not Achieved:** No change in density category or weed density gets worse. |
| Reduction of fuels adjacent to non-target communities to low. | **Post fire:** use the Overall fuel hazard assessment guide (Hines et al. 2010b), or Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations. | **Achieved:** Fuel hazard has been reduced to low.<br><br>**Not Achieved:** Fuel hazard has not been reduced to low. |

If the above objectives are not suitable, refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

When using fire to reduce the density of invasive grasses it is important to monitor the site to ensure the objectives of the burn have been achieved and to ensure invasive grasses do not re-establish at the site.

# Fire parameters

## What fire characteristics will help address this issue?

**Fire severity**

- This will depend on the species of invasive grass being targeted. In general invasive grasses should be burnt in ways that minimise fire severity. A high-severity fire may be required to achieve specific objectives (e.g. when targeting para grass that is starting to become abundant in wetlands and swamps).

**Fire frequency / interval** (refer to Appendix 2 for a discussion)

- Dependent upon the species and the objective of the burn (see discussion above).

**Mosaic** (area burnt within an individual planned burn)

- Dependent upon the species and the objective of the burn (see discussion above).

## What weather conditions should I consider?

It is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**Season:** Late wet season to early dry season (March to April) is preferable though this will largely be dependent upon the degree of grass curing.

**GFDI:** < 7, low to moderate

**DI (KBDI):** < 100

**Wind speed:** Beaufort 1–2, < 10 km/hr. Be aware that graziers will often take advantage of hot, windy and dry conditions (during late October to December) to ensure fire will carry through their pasture grasses (for maintenance or to remove brigalow regrowth). These grazier burns may result in fires carrying into adjoining protected areas. This will often occur on a five year cycle and is largely dependent upon rainfall.

**Soil moisture:** Ensure good soil moisture to retain a duff layer (humus layer) and limit the establishment of bare ground and further encroachment of weeds.

## What burn tactics should I consider?

Tactics will be site specific and often different tactics will need to be implemented at the same location due to variations in topography, weather and vegetation. During the planned burn, review your tactics and adjust them as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **As part of a control program.** The initial over-spraying of high biomass grasses followed by a low to moderate-intensity burn into the remaining material has been shown to be a very effective control method. The successful treatment of these grasses will require monitoring and follow up treatments either by fire or herbicide if any remaining plants and new seedlings emerge.
- **Spot ignition.** Can be used to alter the desired intensity of a fire particularly where there is an invasive grass infestation. Spots further apart will result in a lower-intensity fire. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads, etc.
- **A low-intensity backing fire with good residence time.** This slow-moving fire will generally result in the more complete coverage of an area and a better reduction of available fuels. As the intensity and rate of spread are kept to a minimum the fire has a greater amount of time to burn fuels in that area. Particularly used to reduce fine fuels such as grasses, leaf litter and twigs. This tactic is also useful in reducing overabundant seedlings and saplings so care must be taken if the removal of trees is not the desired effect.
- **Running fire**. For many invasive grasses it is recommended to burn early in the season. Conditions which favour a running fire will help carry the fire though the infestation. If weather conditions are too mild or grasses are not sufficiently cured, shorten the spacing of lit spots or use line or strip ignition to increase the intensity and resulting severity of the burn.

- **Limit fire encroachment into non-target communities.** Use appropriate lighting patterns (e.g. spot lighting with matches) during favourable weather conditions along the margin of the community to promote a low-intensity backing fire that burns away from the non-target community. Undertake burning in areas adjacent to invasive grass infestations while the grass is green (not cured). Burn under mild conditions, early morning on the dew, late afternoon or at night to create a low-severity fire that burns away from the non-target community. Where the non-target community is present in low lying areas (e.g. drainage lines) utilise the surrounding topography to create a low-intensity backing fire that travels down the slope towards the non-target community. Ensure good soil moisture is present within the non-target community.
- **Fire exclusion**. Excluding fire from a buffel grass infestation may provide an opportunity for species such as mulga, brigalow or other acacias to thrive and out-compete this invasive grass. Ideally, acacia communities are left unburnt long enough to form a closed canopy that shades out the buffel grass. Note that this tactic will still require fire management in the surrounding areas to limit the chance of fire carrying into the infested area and resulting in a high-severity-fire (that potentially may have devastating impacts upon the non-target community).

## Issue 5: Reduce overabundant saplings/seedlings

Isolated thickets of saplings can result from localised hot spots or normal variations of fire severity; however a **broad-scale** overabundance of saplings in the understorey of open forest or woodland can reduce the health of the ground stratum through competition and shading. To maintain an open structure, only a very small number of canopy and mid-stratum recruits are needed to provide variety in age and for eventual replacement of mature canopy species. Knowing the fire history of an area and the individual species response to fire is important in determining if overabundance is an issue.

Species which tend to become overabundant in the Mulga Lands bioregion include doolan *Acacia salicina*, gidgee *Acacia cambagei*, *Eremophilla* spp., *Dodonoea* spp., eucalypts, white cypress pine *Callitris glaucophylla* or other trees and shrubs.

### Awareness of the environment

**Key indicators of overabundant saplings:**

- A broadscale mass germination of young acacia, cypress pine, eucalypts or other saplings emerging in the ground stratum; or a broad-scale overabundance of these species in the mid-stratum.
- Presence of a monoculture of single species (e.g. cypress pine) in the understorey.
- Understorey or mid-stratum is difficult to see through or walk through.
- Grasses are continuous or near continuous but starting to collapse. Other ground layer plants are reduced in health and abundance.
- Shrubs where present, have dead or dying branches and are declining in diversity and abundance.

## Discussion

### Why are saplings and seedlings overabundant?

An overabundance of saplings in the understorey may be triggered in response to:

- a lack of, or a long absence of fire
- heavy grazing
- a high rainfall event or severe fire event which has exacerbated thickening (due to one of the above causes).

### Potential impacts of overabundant saplings

- A thickening of trees will result in a lower diversity in the ground stratum due to shading and less fine fuel to carry future fires.
- Once thickets have developed it may be difficult to re-introduce fire into that area if left too long.
- The fire intensity will often be higher and reach into the canopy when the community does burn. This may promote the regeneration of woody species rather than grasses and herbs.

### Other considerations

- Small isolated flushes of saplings can result from localised hot spots or normal variations of fire severity and should not be confused with the broad-scale issue.
- Some shrubs and trees may thicken in response to an occasional high-severity fire or high rainfall years. In healthy country (where fire has been maintained and in the absence of heavy grazing) providing appropriate fire continues to be applied within and around these areas, they will thin with time maintaining a balance of open and woodland areas across the landscape.
- Certain wattles and other tree species build up large seed banks in the absence of fire, which is likely to lead to a mass germination event after wildfire (which tends to be a higher severity fire). Post-fire observations and monitoring will help determine whether this is a broad-scale issue which requires follow-up fire.
- Be aware that some overabundant eucalypt species will re-sprout from the base and while fire will not kill them, it will keep them low in profile, so that other species can compete.
- Where grasses are scattered, poorly formed and collapsing, forest health will be more difficult to recover and the area becomes a lower priority for planned burning.

## What is the priority for this issue?

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**. |
| **Medium** | Planned burn in areas where **ecosystem health** is **poor** but recoverable. |
| **Low** | Planned burn in areas where **ecosystem** structure and function has been **significantly disrupted**. Ground stratum is absent or sparse and fire is no longer viable. |

## Assessing outcomes

### Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Select from below as appropriate for the site:

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| > 75 % of overabundant saplings are scorched. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity), estimate the percentage of overabundant saplings (above ground components) scorched. | **Achieved:** > 75 %.<br>**Partially Achieved:** 25–75 %.<br>**Not Achieved:** < 25 %. |
| > 90 % of the clumping grass bases remain as stubble. | Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate clumping grass bases remaining after fire. | **Achieved:** > 90 % bases remain.<br>**Partially Achieved:** 75–90 % bases remain.<br>**Not Achieved:** < 75 % bases remain. |

If the above objectives are not suitable refer to the compendium of planned burn objectives found in the monitoring section of the QPWS Fire Management System or consider formulating your own.

## Monitoring the issue over time

Many issues are not resolved with a single planned burn and it is important to keep observing the land. To support this, it is recommended that observation points be established. Observation points are usually supported by photographs and by recording observations. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

## Fire parameters

### What fire characteristics will help address this issue?

#### Fire severity

- **Low** to **moderate** (small areas of **high** may occur)

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity ($kWm^{-1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | < 150 | < 0.5 | < 2.5 | Some patchiness. Litter may be retained but charred. Humus layer retained. Nearly all canopy trees and clumping grass stubble retained. Some scorching of mid stratum. Little or no canopy scorch. |
| **Moderate (M)** | 150–500 | 0.5–1.5 | 2.5–7.5 | Limited patchiness. Some scorched litter remains. Some of humus layer, clumping grass stubble and fallen logs remain. Most of canopy trees retained. Scorching of mid stratum. Small amount of canopy scorch. |
| **High (H)** | 500–1000 | 1.5–3.0 | 7.5–15.0 | Little or no patchiness. Limited humus remains. At least some canopy scorch in moderate < 20m height canopy, mid stratum burnt completely (or nearly so). |

Note: This table assumes good soil moisture and optimal planned burn conditions.

**Scorch height:**

- Scorch height required to reduce overabundant saplings will be variable depending on target species.

**Other considerations:**

- It is possible that more than one planned burn will be required to manage this issue. If the initial fire triggers a flush of new seedlings, follow-up planned burn as fuel allows for **low** to **moderate** severity fire.
- Try to carry out planned burns before significant seeding of overabundant saplings occurs. This may require a shorter fire frequency than normally recommended for this community.
- For medium priority planned burns (planned burns in degraded areas), be aware that a low-severity fire may do more harm than good, by reducing available ground fuel but not scorching the targeted saplings.
- Once the area has recovered, the recommended regime for healthy open forest and woodland should be resumed.

## What weather conditions should I consider?

When planning a burn it is important to be aware of weather predictions prior to and following burns so that undesirable conditions and weather changes can be avoided.

**Season:** Depends on accumulation of fuel and sufficient moisture to favour regeneration of grasses. In general late summer burning is preferable to provide higher scorch and better conditions for grass recovery.

**FFDI:** < 11

**Wind speed:** < 15 km/hr

Cypress pine can invade shrublands.
Stephen Peck, QPWS, Thrushton National Park (2007).

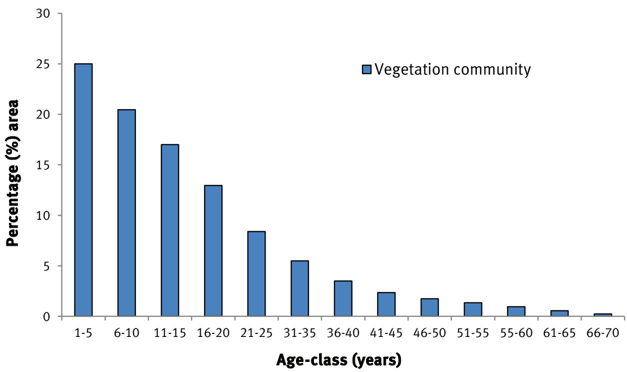
## What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics (refer to Issue 1 for additional tactics).

- While a **low to moderate-severity** fire is recommended to address this issue, the scorch height required to achieve burn objectives is dependent on the target species and their height.
- A **backing fire** with good residence time. A slow moving backing fire lit against the wind on the smoky edge or fire running down-slope, will ensure the fire has a greater amount of residence time, while ensuring fire severity and rate of spread are kept to a minimum. Greater residence time is useful in reducing overabundant seedlings/saplings.
- A running fire of a higher severity (e.g. a fire lit along the mid-ridge running uphill), may be required initially where there is a lack of surface and near surface fuels due to shading-out or the thicket is well developed. In this instance a follow-up planned burn will be required to thin surviving saplings and any new seedlings.

# Glossary of fire terminology

(**Primary source:** Australasian Fire Authorities Council 2012).

| Terminology | Definition |
|---|---|
| **Aerial ignition** | The lighting of fine fuels for planned burning by dropping incendiary devices or materials from aircraft. |
| **Available fuel** | The portion of the total fuel that would actually burn under current or specified conditions. |
| **Age-class distribution** | The distribution of groups of similar aged vegetation (age-class) of a particular vegetation community after fire. In fire ecology this is used to indicate the success of mosaic burning in achieving varied habitat conditions. This is usually represented as a plot of areas (y-axis) versus age-class (x-axis) (e.g. 25 per cent of a fire vegetation group burnt between one and five years ago) (refer to Figure 1).<br>**Figure 1: Idealised age-class distribution (concept only)**<br> |
| **Burn severity** | Relates to the amount of time necessary to return to pre-fire levels of biomass or ecological function. |
| **Backing-fire** | The part of a fire which is burning back against the wind or down slope, where the flame height and rate of spread is minimal. |

| Terminology | Definition |
|---|---|
| **Beaufort scale** | A system of estimating and reporting wind speeds, invented in the early nineteenth century by Admiral Beaufort of the Royal Navy. It is useful in fire management to indicate wind speed and relies on visual indicators rather than instruments. It equates to:<br>• Beaufort force (or Beaufort number)<br>• wind speed<br>• visible effects upon land objects or seas surface. |
| **BOM** | Bureau of Meteorology. |
| **Crown scorch** | Browning of the needles or leaves in the crown of a tree or shrub caused by heat from a fire. |
| **Char height** | The height to which former green leaves still suspended on plants that are turned black by the flame of the fire. NB: This cannot be measured on the stems of plants as fire ‘climbs’ the bark. |
| **Dew point temperature** | This is a measure of the moisture content of the air and is the temperature to which air must be cooled in order for dew to form. The dew-point is generally derived theoretically from dry and wet-bulb temperatures, with a correction for the site’s elevation (BOM). |
| **Drought** | A **drought** is defined by the Bureau of Meteorology (BOM) as an ‘acute rainfall deficiency’. For the purpose of quantifying the severity of a drought, the BOM describe rainfall deficiency in two categories: **‘Serious** rainfall deficiency—rainfall lies above the lowest five per cent of recorded rainfall but below the lowest 10 per cent (decile 1 value) for the period in question, **Severe** rainfall deficiency—rainfall is among the lowest five per cent for the period in question.’ For more information, refer to <www.bom.gov.au/climate/glossary/drought.shtml> |
| **Drought index (DI)** | A numerical value (e.g. the Byram-Keetch Drought Index), reflecting the dryness of soils, deep forest litter, logs and living vegetation. |
| **Duff layer** | Refer to ‘humus layer’. |

| Terminology | Definition |
|---|---|
| **Fire behaviour** | The manner in which a fire reacts to variables of fuel, weather and topography. |
| **Fire Danger Index (FDI)/ Fire Danger Rating (FDR)** | A relative number and rating denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of fuel moisture and wind speed. |
| **FFDI/FFDR** | Forest Fire Danger Index/Danger Rating. |
| **Fire frequency** | The frequency of successive fires for a vegetation community in the same point of the landscape (refer to fire interval). |
| **Fire extent** | Refer to patchiness. |
| **Fire intensity** | The amount of energy released per unit length of fire front, in units of kilowatts per metre of the fireline (also known as the Byram fire-line intensity). |
| **Fire interval** | The interval between successive fires for a vegetation community in the same point of the landscape. Often expressed as a range indicating a minimum and maximum number of years that an area should be left between fire events (refer to Appendix 2). |
| **Fireline** | Constructed or treated lines/trails (sometimes referred to as fire trails or control lines) or environmental features that can be used in the management of a fire. Permanent firelines should (usually) have a primary purpose other than that of a control line (e.g. access track to a campground). Firelines are **NOT** fire breaks. Although the term ‘fireline’ is not without its shortcomings it should be used in preference to ‘firebreak’ to avoid the perception that a fire will stop at a break. |

<table>
<tr><th>Terminology</th><th>Definition</th></tr>
<tr><td>Clarification over the terms<br><br>‘fire vegetation group’ and ‘fire management zone’.</td><td>The fire management requirements within a conservation fire management zone are based on the fire vegetation groups (FVGs)—groups of related ecosystems that share common fire management requirements. Fire regimes for FVGs are identified in the Bioregional Planned Burn Guidelines and are reflected in fire strategies. Other fire management zones (e.g. protection, wildfire mitigation, special conservation, sustainable production, rehabilitation, exclusion, and reference) will have specific management objectives that override the FVG fire regime requirements. Further, if there are a number of these other zones within a strategy they are identified as fire management subzones (FMSz) (e.g. P1, P2, P3, WM1, WM2, etc) each with specific fire management requirements.<br><br>
<table>
<tr><th>Fire management zone</th><th>Fire management sub-zone or Fire vegetation group</th></tr>
<tr><td rowspan="2">Conservation</td><td>FVG1</td></tr>
<tr><td>FVG2</td></tr>
<tr><td rowspan="2">Protection</td><td>P1</td></tr>
<tr><td>P2</td></tr>
<tr><td rowspan="2">Wildfire mitigation, etc</td><td>W1</td></tr>
<tr><td>W2</td></tr>
</table>
</td></tr>
<tr><td>Fire perimeter</td><td>The outer containment boundary in which fire is being applied.</td></tr>
<tr><td>Fire regime</td><td>The recommended use of fire for a particular vegetation type or area including the frequency, intensity, extent, severity, type and season of burning.</td></tr>
<tr><td>Fire regime group (FRG)</td><td>A group of related ecosystems that share a common fire management regime including season, severity, recommended mosaic etc. These are a sub-grouping of the fire vegetation groups to provide more detail about specific fire management requirements. Fire regime groups are provided as a more detailed alternative for use with fire strategies or in mapping.</td></tr>
</table>

| Terminology | Definition |
|---|---|
| **Fire season** | The period(s) of the year during which fires are likely to occur, spread and cause sufficient damage to warrant organised fire control. |
| **Fire severity** | A measure of the effect of fire on vegetation and soil immediately after the fire (e.g. vegetation consumption, vegetation mortality, soil alteration). Can be used to indicate fire intensity. |
| **Fire vegetation group (FVG)** | A group of related ecosystems that share common fire management requirements. For the purpose of practical fire management, these ecosystems are treated as a group. |
| **Flame height** | The vertical distance between the average tip of the flame and ground level, excluding higher flares. |
| **Fuel** | Any material such as grass, leaf litter and live vegetation, which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare. |
| **Fuel hazard** | The condition of the fuel and takes into consideration such factors as quantity, arrangement, current or potential flammability and the difficulty of suppression if fuel should be ignited. |
| **Fuel load** | The dry weight of combustible materials per area, usually expressed as tonnes per hectare. A quantification of fuel load does not describe how the fuel is arranged, nor its state or structure. |
| **Fuel moisture content** | The water content of a fuel particle expressed as a percentage of the oven dry weight of the fuel particle (% ODW). |
| **Grid ignition** | A method of lighting prescribed fires where ignition points are set at a predetermined grid-like spacing through an area. |
| **GFDI/GFDR** | Grassland Fire Danger Index/Danger Rating. |

| Terminology | Definition |
|---|---|
| **High biomass grasses** | Tend to be exotic species of grasses which can out-compete native species to form dense mono-specific stands. They:<br>• are generally taller than native species<br>• can lead to decreased biodiversity<br>• increase biomass<br>• increase fire severity<br>• increase threat to life and property. |
| **Humus (or duff layer)** | The mat of partly decomposed vegetation matter on the forest floor, the original vegetative structures still being recognisable. |
| **Junction zone** | An area of greatly increased fire intensity caused by two fire fronts (or flanks) burning towards one another. |
| **Keetch-Byram Drought Index (KBDI)** | A numerical value reflecting the dryness of soils, deep forest litter, and heavy fuels and expressed as a scale from 0–203. |
| **Landscape mosaic** | A mosaic burn at a landscape level, usually achieved by planning a series of fires across a reserve, a bioregion or broader area. |
| **Lighting pattern** | The lighting pattern adopted by fire fighters during planned burning operations, or indirect attack. |
| **Litter** | The top layer of the forest floor composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves and needles, little altered in structure by decomposition. (The litter layer of the forest floor). |
| **Mesophyll pioneers** | Large-leaved (12.5–20 cm long) rainforest tree species able to establish in neighbouring communities. |
| **Mineral earth** | Being completely free of any vegetation or other combustible material. |

| Terminology | Definition |
|---|---|
| **Mosaic burn** | An approach which aims to create spatial and temporal variation in fire regimes. This can occur within an individual burn and at a landscape level (refer to Appendix 2). |
| **Obligate seeders (obligate seed regenerating species)** | Shrubs that are killed by fire and rely on soil-stored seed bank to regenerate. In fire ecology, the time it takes obligate seeders to mature and establish a seed bank often indicates the minimum frequency with which a vegetation community should be burnt in order to avoid the local extinction of these species. |
| **Patchiness** | A percentage or proportion of the ground layer vegetation (grasses, herbs and trees/shrubs less than one metre) not affected by fire (i.e. 20 per cent patchiness = 80 per cent burnt). |
| **Perennial plants** | Plants that last for more than two growing seasons, either dying back after each season as some herbaceous plants do, or growing continuously like many shrubs. |
| **Planned burn** | The controlled application of fire under specified environmental conditions to a pre-determined area and at the time, intensity, and rate of spread required to attain planned resource management objectives. In the context of QPWS operations: a fire that is deliberately and legally lit for the purposes of managing the natural and/or cultural and/or production resources of the area (e.g. reducing fire hazard, ecological manipulation), and protecting life and property. |

| Terminology | Definition |
|---|---|
| **Progressive burning** | Progressive burning is an approach to planned burning where ignition is carried out throughout much of the year as conditions allow. In northern Queensland, ignition can begin early in the year after heavy seasonal rain, with numerous small ignitions creating a fine scale mosaic. These burnt areas can provide opportunistic barriers to fire for burning later in the year. They also provide fauna refuge areas. Progressive burning helps create a rich mosaic of intensities, burnt/ unburnt areas, and seasonal variability. Be aware of how fire behaves differently in different seasons. Depending on local climatic conditions, there can be up to four seasons in the wet tropics (this will vary from moister to drier climatic areas): The **early burn period** following seasonal heavy rain where fire self extinguishes overnight and will not burn through areas burnt the year before. **Secondary burn season** where fires will burn through the night and will extinguish within areas burnt the year before. **Falling leaf season**, where a blanket of leaves often crosses natural water features. This is the dry season and fires will not go out. Fires in dry conditions will often favour woody species over grasses. **Storm burning**, where climatic conditions allow, from December through to January, is a useful way to achieve intense, wind supported fire where rain can be reliably expected to follow; providing good conditions for regeneration (Mick Blackman pers. comm., 10 September 2011). |
| **Rate of spread (ROS)** | The forward progress per unit time of the head fire or another specified part of the fire perimeter, defined as metres per hour. |
| **Relative humidity (RH)** | The amount of water vapour in a given volume of air, expressed as a percentage of the maximum amount of water vapour the air can hold at that temperature. |
| **Scorch height** | Is the height to which former green leaves still suspended on plants are turned brown by the heat of a fire. |
| **Strip burning** | Setting fire to a narrow strip of fuel adjacent to a fire-line and then burning successively wider adjacent strips as the preceding strip bums out. |
| **Test fire** | A controlled fire of limited extent ignited to evaluate fire behaviour. |

# References

Australasian Fire Authorities Council (AFAC) 2012, *Glossary of rural fire terminology*, Australasian Fire Authorities Council, Canberra.

Butler DW and Fairfax RJ 2003, 'Buffel grass and fire in a gidgee and brigalow woodland: a case study from central Queensland', *Ecological Management and Restoration,* vol. 4, pp. 120–125.

Commonwealth of Australia 1999, E*nvironment Protection and Biodiversity Conservation Act 1999*, Sustainability, Environment, Water, Population and Communities, Attorney-General's Department, Canberra.

Crowley G 2003, *Brigalow Belt north recommendations for ecological fire management based regional ecosystems - draft for comment*, Queensland Parks and Wildlife, Queensland Government, Brisbane, unpublished work.

Department of Environment and Resource Management (DERM) 2002, *Draft-Currawinya National Park fire strategy*', Queensland Government, Brisbane.

Department of Environment and Resource Management (DERM) 2010a, *Operational policy –Management of cultural heritage places on QPWS estate*, Queensland Government, Brisbane.

Department of Environment and Resource Management (DERM) 2010b, *Procedural guide–Management of cultural heritage places on QPWS estate*, Queensland Government, Brisbane.

Department of Natural Resources and Mines (DNRM) 2002, *The mulga lands bioregion regional vegetation management plan,* Queensland Government, Brisbane.

Eyre TJ, Wang J, Venz MF, Chilcott C and Whish G 2009, 'Buffel grass in Queensland's semi-arid woodlands: response to local and landscape scale variables, and relationship with grass, forb and reptile species', *The Rangeland Journal,* vol. 31, pp. 293–305.

Greig C 2008, 'Lion's tail control at Boodjamulla National Park', *Proceedings of the 16th Australian Weed Conference*, Queensland Weeds Society, Brisbane, pp. 491–3.

Hines F, Tolhurst KG, Wilson AAG and McCarthy GJ 2010a, *Fuel hazard assessment guide*, 1st edition April 2010, Fire and adaptive management report no. 82. Fire Management Branch, Department of Sustainability and Environment, Victoria.

Hines F, Tolhurst KG, Wilson AAG and McCarthy GJ 2010b, *Overall fuel hazard assessment guide*, 4th edition July 2010, Fire and adaptive management report no. 82, Fire Management Branch, Department of Sustainability and Environment, Victoria.

Hodgkinson K 2002, 'Fire regimes in Acacia wooded landscapes: effects on functional processes and biological diversity', pp. 351–372, in RA Bradstock, JE Williams and AM Gill (eds.), *Flammable Australia: the fire regimes and biodiversity of a continent*, Cambridge University Press, Cambridge.

Lucas C 2010, 'On developing a historical fire weather data-set for Australia', *Australian Meteorological and Oceanographic Journal*, vol. 60, pp. 1–14.

Melzer R and Porter G 2002, *Guidelines for the management of buffel grass on conservation reserves*, Queensland Parks and Wildlife Service, Brisbane, unpublished work.

Myers B, Allan G, Bradstock R, Dias L, Duff G, Jacklyn P, Landsberg J, Morrison J, Russell-Smith J and Williams R 2004, *Fire management in the rangelands*, Tropical Savannas CRC, Darwin.

Neldner VJ (1984), 'Vegetation survey of Queensland – south central Queensland', *Queensland Botany Bulletin No. 3 1984*, Queensland Department of Primary Industries.

Parks Victoria 1995, *Parks Victoria pest plant mapping and monitoring protocol,* Parks Victoria.

Price O and Bowman DM 1994, 'Fire-stick forestry: a matrix model in support of skilful fire management of Callitris intratropica R.T. Baker by north Australian Aborigines', *Journal of Biogeography*, vol. 21, pp. 573–580.

Queensland Government, 1999, *Queensland Vegetation Management Act 1999*, Queensland Government, Brisbane.

Queensland Government 2004, *Aboriginal Cultural Heritage Act 2003*, Queensland Government, Brisbane.

Queensland Herbarium 2011a, *Regional ecosystem description database (REDD)*, version 6.0b, Department of Environment and Resource Management, Brisbane.

Queensland Herbarium 2011b (16 September), *Survey and mapping of 2006 remnant vegetation communities and regional ecosystems of Queensland spatial layer, version 6.1*, Queensland Government, Brisbane.

Sattler P and Williams R (eds.) 1999, *The conservation status of Queensland's bioregional ecosystems*, Environmental Protection Agency, Queensland.

Scanlan JC 1980, 'Effects of spring wildfires on Astrebla (Mitchell grass) grasslands in north-west Queensland under varying levels of growing season rainfall', *Australian Rangelands Journal*, vol. 2, pp. 162–168.

Taylor D and Swift S 2003, *Prescribed burning guidelines and post burning assessment*, Department of Primary Industry and Forestry, Queensland Government, Brisbane, unpublished work.

Williams P 2008, 'Weedy fire regimes: incorporating weed issues into fire programs', *Proceedings of the 16th Australian Weed Conference*, Queensland Weeds Society, Brisbane, pp. 454–56.

Wilson AAG 1992, *Assessing the fire hazard on public lands in Victoria: fire management needs and practical research objectives*, research report no. 31, Fire Management Branch, Department of Conservation and Environment, Victoria. In: Hines F, Tolhurst K, Wilson A and McCarthy G 2010a, Fuel hazard assessment guide, 1st edition April 2010, Fire and adaptive management report no. 82. Fire Management Branch, Department of Sustainability and Environment, Victoria.

Wright BR and Clarke PJ 2008, 'Relationships between soil temperatures and properties of fire in feathertop spinifex *Triodia schinzii* (Henrard) Lazarides sandridge desert in central Australia', *The Rangeland Journal*, vol. 30, pp. 317–325.

# Appendix 1: List of regional ecosystems

A fire vegetation group is a group of related regional ecosystems that share common fire management intent for the purpose of practical fire management.

| Fire vegetation group | Hectares within the Mulga Lands bioregion | Percentage |
|---|---:|---:|
| Eucalypt forest and woodland | 783 201 | 4.2 |
| Grasslands | 717 687 | 3.9 |
| Melaleuca and wetlands communities | 131 571 | 0.7 |
| Cypress pine and bull oak communities | 78 127 | 0.4 |
| Mulga dominated communities | 7 219 145 | 38.8 |
| Acacia dominated communities | 3 071 141 | 16.5 |
| Riparian, fringing and salt-pan communities | 1 960 477 | 10.5 |
| Non-remnant | 4 642 555 | 25.0 |
| **TOTAL** | **18 603 904** | **100** |

| Chapter | Issues | Fire vegetation group | Fire regime group | Map label (if required) | **Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b). |
|---|---|---|---|---|---|
| 1 | 1 | Eucalypt forest and woodland | Eucalypt forest and woodland-grassy | | 6.3.24a, 6.5.3a, 6.5.5, 6.5.17, 6.5.17a, 6.5.19a, 6.7.6. |
| | 2 | | Eucalypt forest and woodland-shrubby | | 6.3.4, 6.3.8, 6.3.18, 6.3.18a, 6.7.5, 6.7.16. |
| 2 | 1 | Grasslands | Spinifex grasslands | | 6.6.2. |
| | 2 | | Tussock grasslands | | 6.3.14, 6.3.15, 6.7.17. |

| Chapter | Issues | Fire vegetation group | Fire regime group | Map label (if required) | **Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b). |
|---|---|---|---|---|---|
| **3** | 1 | **Melaleuca and wetlands communities** | Melaleuca shrublands | | 6.3.11d. |
| | 2 | | Wetlands and/or wetland associated communities/ sedgelands (including mound springs) | | 6.3.1a, 6.3.3a, 6.3.10, 6.3.10a, 6.3.10b, 6.3.11, 6.3.11a, 6.3.11b, 6.3.11c, 6.3.11e, 6.3.11f, 6.3.13b, 6.3.23, 6.7.18. |
| **4** | 1 | **Cypress pine and casuarina communities** | Cypress pine and casuarina communities | | 6.3.16, 6.3.17, 6.5.19. |

| Chapter | Issues | Fire vegetation group | Fire regime group | Map label (if required) | **Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b). |
|---|---|---|---|---|---|
| 5 | 1 | **Mulga dominated communities** | Mulga dominant community | | 6.3.21, 6.5.1, 6.5.2, 6.5.3, 6.5.6, 6.5.7, 6.5.8, 6.5.9, 6.5.10, 6.5.11, 6.5.13, 6.5.14, 6.5.15, 6.5.15a, 6.5.15b, 6.5.16, 6.5.16a, 6.5.18, 6.6.1b, 6.7.9, 6.7.10, 6.7.11, 6.7.12, 6.6.1, 6.12.1. |
| 6 | 2 | **Acacia communities** | Acacia shrubland | | 6.3.22, 6.6.1a, 6.7.1, 6.7.2, 6.7.7, 6.7.7a, 6.7.13. |
| | 3 | | Acacia fire-sensitive | | 6.3.25, 6.3.25a, 6.4.4, 6.9.3, 6.4.1, 6.4.2, 6.4.3, 6.3.6, 6.7.14, 6.7.15, 6.9.2, 6.9.4. |
| 7 | 1 | **Riparian, fringing and salt-pan communities** | Fringing, riparian and saltpan communities | | 6.3.1, 6.3.2, 6.3.2a, 6.3.2b, 6.3.3, 6.3.5, 6.3.5a, 6.3.7, 6.3.9, 6.3.12, 6.3.24, 6.3.13, 6.3.13a. |

The spatial data is based on version 6.1 of the "Queensland Remnant Vegetation Cover 2006" layer (16 September 2011) data (refer to Figure 1).

Some of the Regional Ecosystems (RE) listed above will not be matched in the spatial data. This may be because the RE is 'not of a mappable size', the RE 'has been moved' (i.e. it has been reclassified into a new RE code), the RE exists only as a sub-dominant RE within the spatial data or the RE has not yet been mapped. In the Regional Ecosystem Description Database (REDD) system, the comments section indicates if the RE is not of a mappable size or if it has been moved.

The RE's listed below are those RE's from the classifications listed above that do not have any matching records in version 6.1 of the Survey and Mapping of 2006 Remnant Vegetation Communities and Regional Ecosystems of Queensland spatial layer (16 September 2011).

| | |
|---|---|
| **Unmatched regional ecosystems** | 6.3.11c, 6.3.11d, 6.3.11e, 6.3.18a, 6.3.25a, 6.5.15b, 6.5.3a, 6.6.1a, 6.7.18, 6.7.7a. |

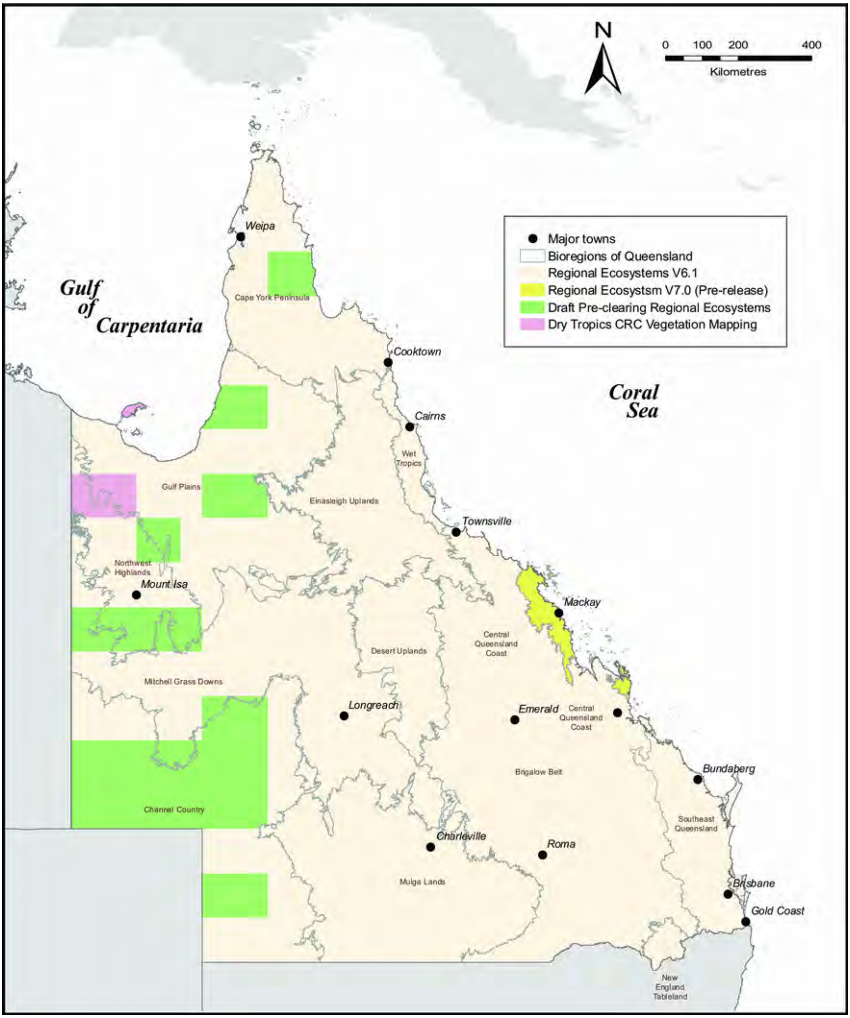



**Figure 1:** Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

# Appendix 2: Mosaic burning

Mosaic burning is an approach to planned burning which aims to maintain and maximise diversity within fire-adapted vegetation communities. At various scales, a mosaic of vegetation in different stages of post-fire response can provide a greater range of habitats for plants and animals including those that prefer open country, those that need dense vegetation or the presence of a particular food source and all ecological requirements in between.

In practice, mosaic burning is achieved through the use of appropriate weather conditions, variation in topography, frequency, intensity, season and ignition patterns to create a patchwork of burnt and unburnt areas. Over time the patches overlay to build a more complex mosaic of vegetation at various stages of response from fire (Figures 1–5 provide a simplified example). This practice can apply to burning at a **landscape scale**—how much of a particular fire vegetation group is targeted within a given year (across a bioregion or management area) or can refer to the area burnt within an individual fire event. Both are important.

The land manager should apply mosaic burning and be guided by the recommended fire frequency. **Note that it is a common mistake to interpret the fire interval as a formula for applying fire.** Consider the following example: A fire strategy might recommend burning with a fire interval of between 8–12 years. In this case the land manager would apply mosaic burning (as often as required) but generally not burning any single patch more frequently than the minimum fire interval (e.g. eight years), or less frequently than the maximum fire interval (e.g. 12 years) (refer to Figures 1–5).

This is relevant because the minimum fire interval represents the amount of time it takes for each species to regenerate sufficiently to tolerate a second fire, and the maximum fire interval represents the amount of time an ecosystem can be left without fire before it begins to decline in health and species might be lost.

As ParkInfo/geographic information systems (GIS) and monitoring tools evolve it will become easier to evaluate if the fire vegetation groups are on track in terms of maintaining an age class distribution and conforming to recommended fire frequencies. Irrespective of monitoring and GIS tools it is important to learn to observe the health of the country and to understand its fire management needs to appropriately apply fire in a way that maintains a healthy ecosystem. This planned burn guideline provides key indicators supported by photographs to help you assess the health of the ecosystems and their fire management needs.

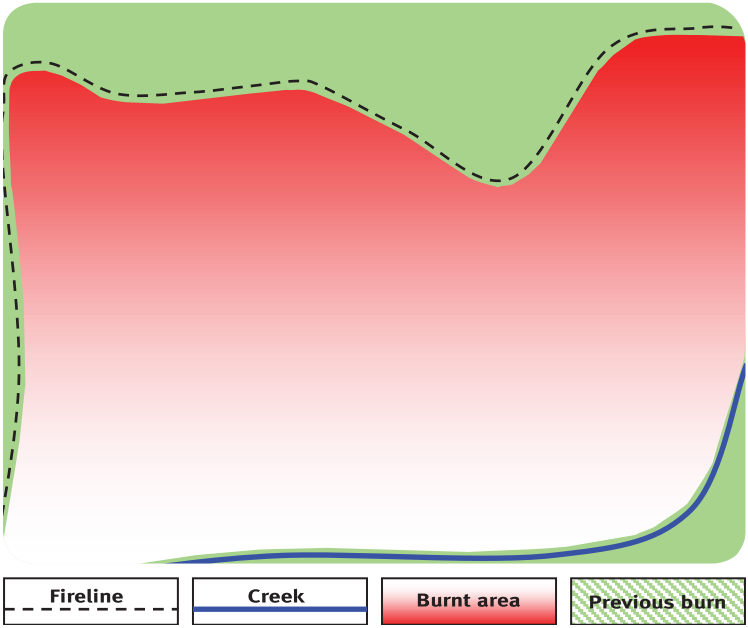



**Figure 1:** Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

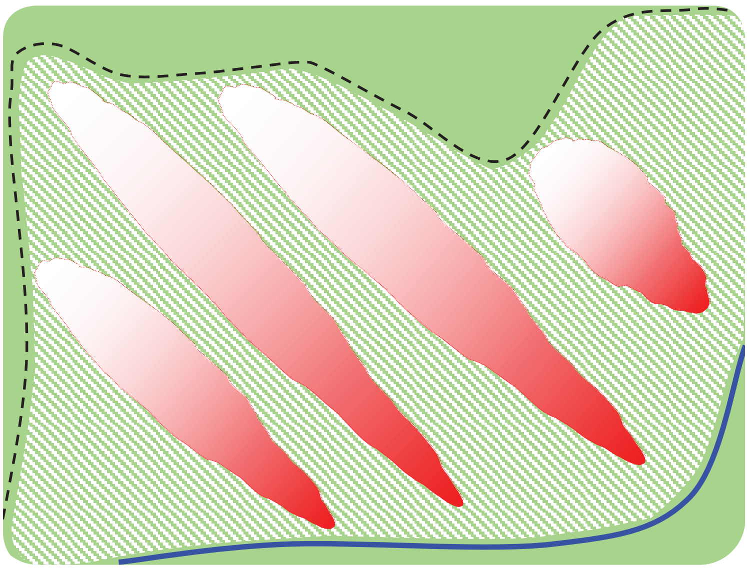


**Figure 2:** Planned mosaic burn—year 8.

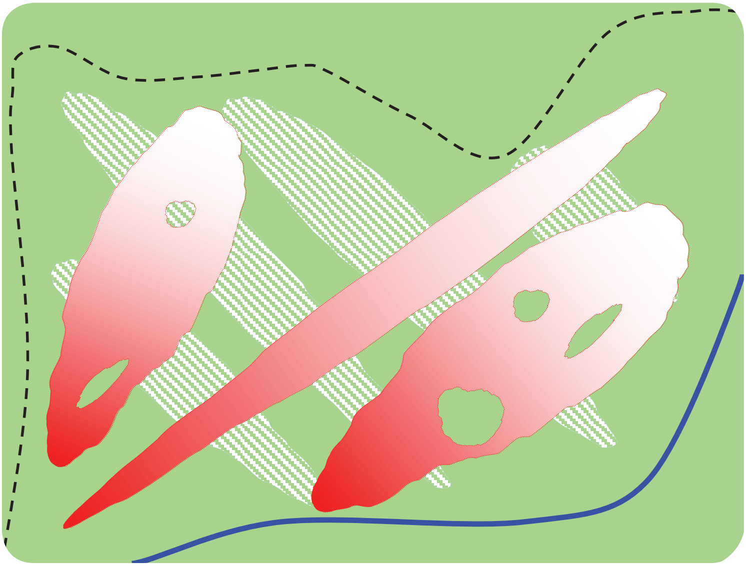


**Figure 3:** Planned mosaic burn—year 20.

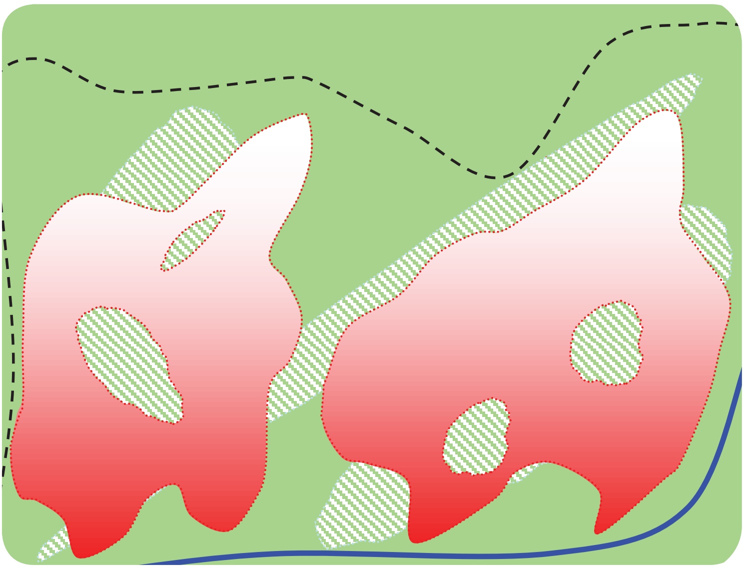


**Figure 4:** Planned mosaic burn—year 28.

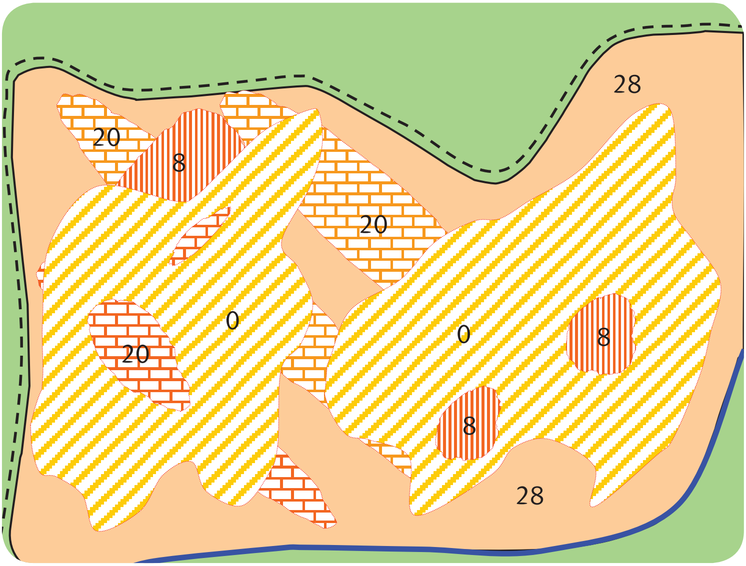



**Figure 5:** Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

Mosaic burn on Idalia National Park showing ~ 30 per cent coverage across the landscape.

QPWS, Idalia National Park (2010).