Department of National Parks, Recreation, Sport and Racing

Planned Burn Guidelines

Brigalow Belt 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).

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Front cover photograph: Carnarvon National Park, Moolayember section, Bernice Sigley, QPWS (2010).

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Foreword

The Brigalow Belt bioregion contains a diversity of landscapes from the highlands and foothills of the great divide to fertile woodlands and grasslands. Although the bioregion is characterised by brigalow forests and woodlands they are not predominant through the entire region. Other ecosystems include eucalypt forest and woodlands, grasslands, dry rainforest, cypress pine forest and woodland and riparian communities.

Many of the ecosystems, in particular the woodlands and grassy plains, have been impacted through broad-scale clearing, altered fire regimes and the introduction of exotic species. They persist as fragmented, often highly modified remnants surrounded by intensive agriculture. The challenges are not only to protect current biodiversity values and halt further decline but also to resolve the issues between burning for hazard reduction and burning to maintain ecosystem diversity.

We believe that fire is the single most effective management tool available to us for those fire-adapted communities. The challenge is to determine the fire regime that will provide the best opportunities to maintain ecosystem diversity within the Brigalow Belt bioregion. The aim of these planned burn guidelines is not only to provide guidance and assistance in understanding the role and application of fire but also to promote fire as a legitimate conservation tool.

Michael Koch
Senior Ranger
Central Region
Queensland Parks and Wildlife Service.

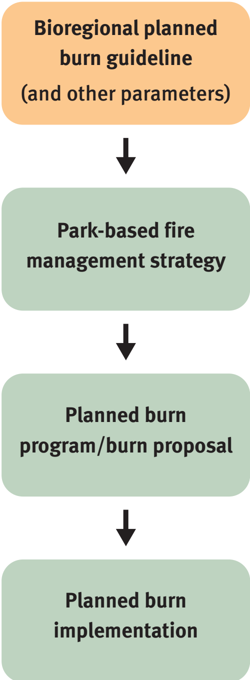
Table of contents

A low-intensity, mosaic fire in this brigalow and mountain yapunyah community with a grassy understorey will help managing fuel loads and maximise species diversity. Be aware of buffel grass in surrounding areas.

Bill McDonald, Queensland Herbarium, Roundstone Conservation Park (2002).

Brigalow regrowth with a dense grassy understorey.

Bill McDonald, Queensland Herbarium, Castlevale (2009).



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 Brigalow Belt bioregion (refer to Figure 1) and covers the following fire vegetation groups: eucalypt forests and woodlands, grasslands, heaths and shrublands, melaleuca communities, wetlands and swamps, cypress and bull oak communities, acacia dominated communities, brigalow dominated communities, riparian, springs, fringing and foredune communities, rainforests and vine thickets, mangroves and saltpans (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Brigalow Belt. 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.

Paul Williams, Vegetation Management Science Pty Ltd, Carnarvon National Park (2009).

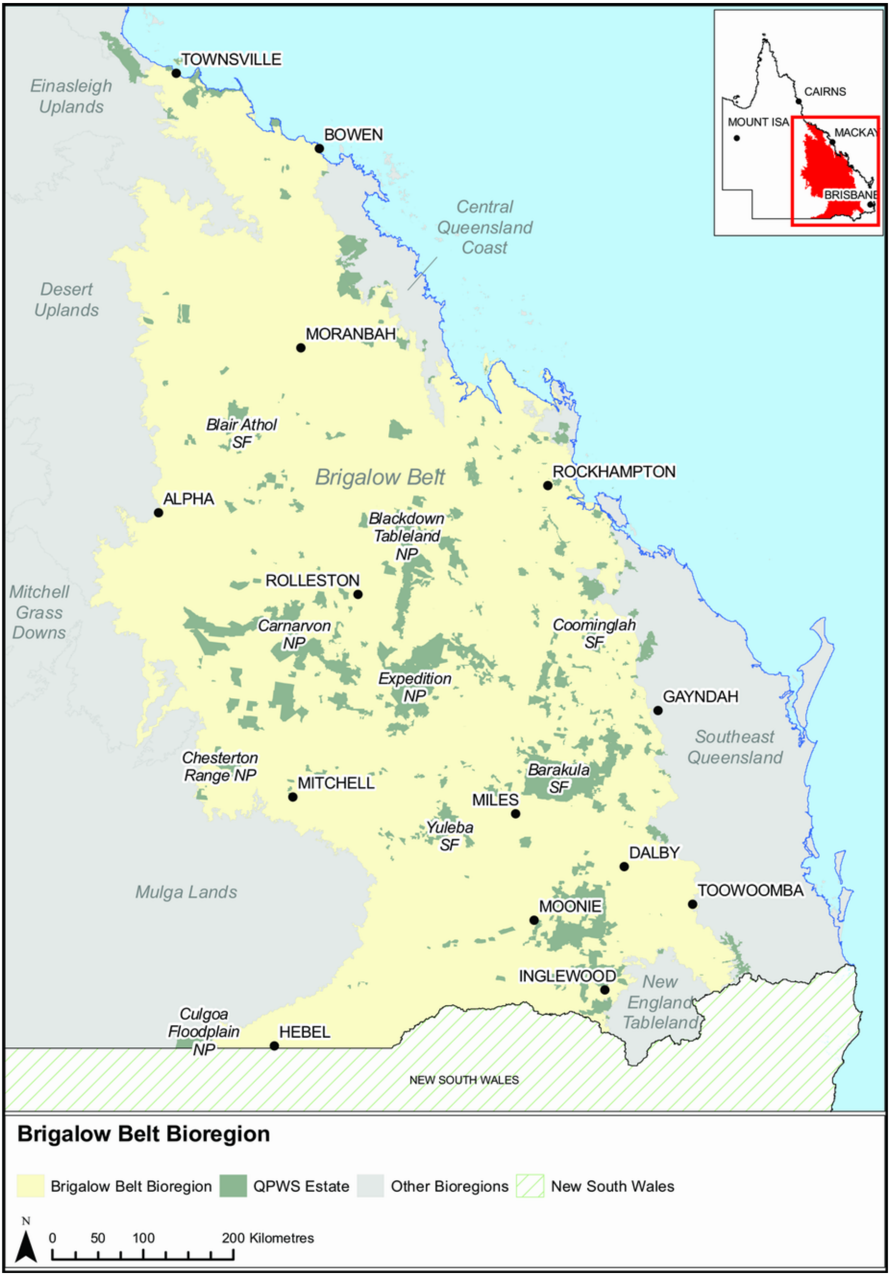


Figure 1: Map of Brigalow Belt bioregion of Queensland.

Fire and climate in the Brigalow Belt bioregion

The Brigalow Belt (BB) bioregion contains significant climatic variability as it stretches from the New South Wales border in the south to Townsville in the north.

Northern areas of the bioregion range from semi-arid to tropical with the majority of rain falling in the summer (average 590 mm per year). Rainfall decreases towards the south-west (400 mm) and increases considerably near the coast (1200 mm), demonstrating considerable variation across region. Tropical cyclones and flooding can occur in the summer months however winters are normally dry and cool. Alluvial plains and rugged ranges characterise the landscape with rangelands to the west. Wildfires can occur in the spring and early summer.

Although still relatively variable, **southern** areas within the bioregion have a climate that is generally cooler than the rest of Queensland with frosts experienced from mid-autumn to mid-spring, restricting the hours available for planned burns but also providing another tactic for containment. The majority of rainfall occurs during summer either as heavy thunderstorms or from tropical rain depressions. Eastern parts receive higher rainfall than western parts. Autumn and winter can experience seasonal rain events which may impede planned burn operations. The majority of wildfires occur in spring after dry storms or from escaped burns as a result of dramatic wind changes due to the passage of pressure troughs.

Fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). In northern areas of the BB bioregion these days have an average temperature around 30˚C, low humidity (around 17 per cent) and sustained winds of more than 20 km/hr. In southern areas of the BB bioregion these days have a slightly higher average temperature (around 33˚C), slightly lower humidity (around 16 per cent) and sustained winds of more than 18 km/hr (refer to Figures 2a and 2b).

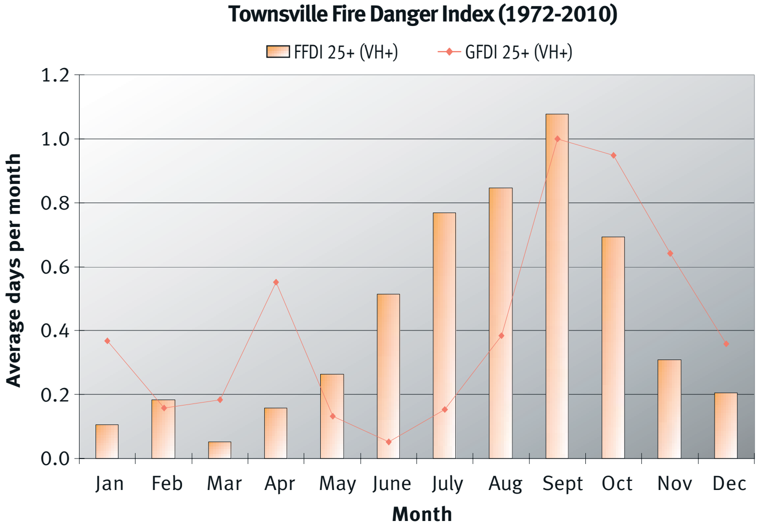


Figure 2a: Fire weather risk in the northern Brigalow Belt bioregion.

The likelihood of a fire weather day or sequence of days (FDI 25+) gradually increases from the start of the dry season, peaking around September and decreasing into the wet season. Data (Lucas 2010).

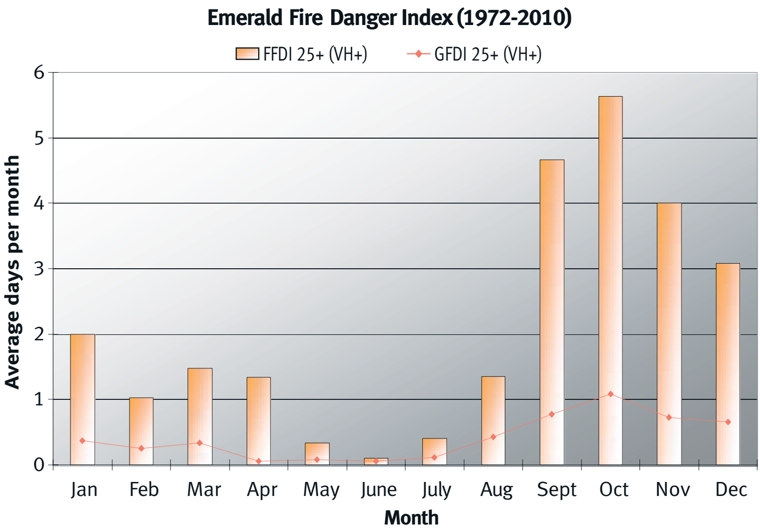
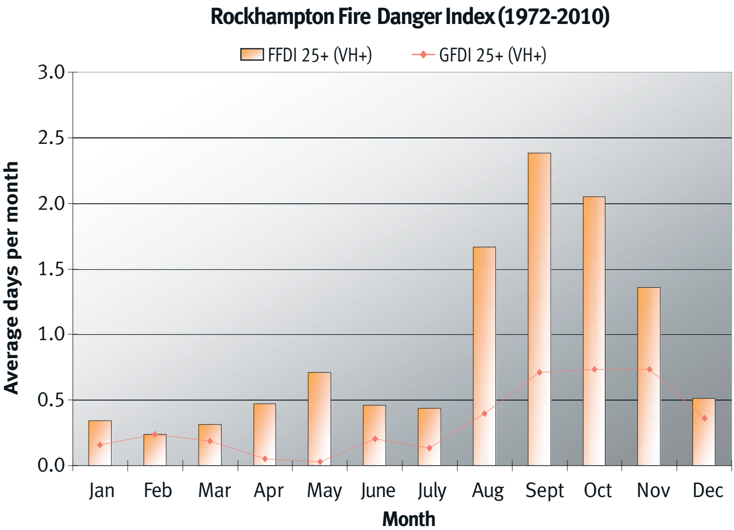
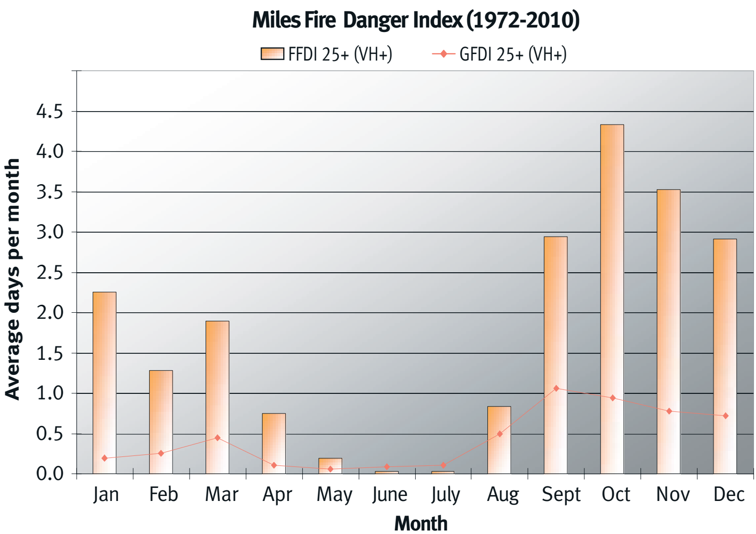


Figure 2b: Fire weather risk in the southern Brigalow Belt bioregion.





The likelihood of a fire weather day or sequence of days (FDI 25+) increases significantly after September and persists until December but variation occurs within the southern half of the bioregion. Data (Lucas 2010).

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>.

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 Brigalow Belt bioregion and contains a variety of communities that vary with annual rainfall, landform and soil type. The canopy is generally between 12 to 25 metres, and dominated by one or a few eucalypt species. In drier areas the most common species include ironbark, spotted gum, bloodwood and box species with an understorey of smaller trees, shrubs, grasses and herbs. Tall eucalypt forests of smoothed barked blue gums, stringy barks and messmates occur on elevated areas, lower slopes and moist sheltered areas. These taller forests can have an open or closed structure with a predominant grassy understorey with a canopy of between 20 to 30 metres.

Fire management issues

A key management concern for this fire vegetation group (particularly where it occurs on sandstone) are frequent and extensive wildfires that impact on its ecological values, nearby fire-sensitive communities and properties. This is exacerbated by large tracts of inaccessible land, long dry spring periods and extended periods of very high fire danger. An issue threatening the structure of this community in some areas is overabundant saplings in the mid-stratum. These include cypress, bull oaks, eucalypts and wattles and are associated with an absence of fire or a mass germination event after severe fire. Weed species such as rubber vine *Cryptostegia grandiflora* and in particular, invasive grasses, pose a significant threat to eucalypt community health.

Issues:

1. Maintain healthy grassy eucalypt forest and woodland.
2. Maintain healthy shrubby eucalypt forest and woodland.
3. Maintain healthy tall eucalypt forest.
4. Maintain healthy eucalypt open woodland with an understorey of spinifex.
5. Manage eucalypt forests where understorey fuels are not usually continuous.
6. Reduce overabundant saplings.
7. Manage forests and woodlands that are prone to frequent, extensive wildfires.
8. Manage invasive grasses.
9. Manage lantana.
10. Manage rubber vine.

Extent within bioregion: 9 394 566 hectares (ha), 26 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Barakula State Forest, 178 278 ha; Carnarvon National Park, 175 414 ha; Expedition State Forest, 99 711 ha; Belington Hut State Forest, 87 244 ha; Expedition (Limited Depth) National Park, 77 611 ha; Dawson Range State Forest, 65 216 ha; Theodore State Forest, 65 068 ha; Presho Forest Reserve, 63 324 ha; Allies Creek State Forest, 55 773 ha; Blackdown Tableland National Park, 45 885 ha; Oakvale State Forest, 30 968 ha; Coominglah State Forest, 30 948 ha; Bowling Green Bay National Park, 24 231 ha; Kumbarilla State Forest, 24 061 ha; Western Creek State Forest, 21 048 ha; Boondandilla State Forest, 19 449 ha; Rockybar State Forest, 19 265 ha; Boxvale State Forest, 18,960 ha; Forrest State Forest, 18 035 ha; Koko State Forest, 16 806 ha; Palmgrove National Park, (Scientific) 16 720 ha; Shotover State Forest, 16 392 ha; Junee State Forest, 16 185 ha; Calrossie State Forest, 15 102 ha; Borania State Forest, 14 664 ha; Bringalily State Forest, 14 503 ha; Blair Athol State Forest, 12,954 ha; Lonesome proposed NP 12 652 ha; Pluto Timber Reserve, 12 646 ha; Homevale National Park, 12 403 ha; Don River State Forest, 11 811 ha; Diamondy State Forest, 11 720 ha; Mount Hope State Forest, 11 593 ha; Sunnyside State Forest, 11 532 ha; Homevale Resources Reserve, 10 962 ha.

Issue 1: Maintain healthy grassy eucalypt forest and woodland

Maintain healthy grassy eucalypt forest or woodland with mosaic burning.

Awareness of the environment

Key indicators of a healthy grassy eucalypt forest and woodland

- The canopy is characterised by trees of various heights and ages and trees appear healthy. Hollow bearing habitat trees may be present.
- 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 and may be continuous and/or clumps are well-formed.
- The ground-layer, though dominated by grasses, has a diversity of other ground layer 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 through and walk through.

A healthy open woodland with a grassy understorey. Although few canopy species are recruiting, this is sufficient to eventually replace the canopy.

Bill McDonald, Queensland Herbarium, Mount Moffat (2010).

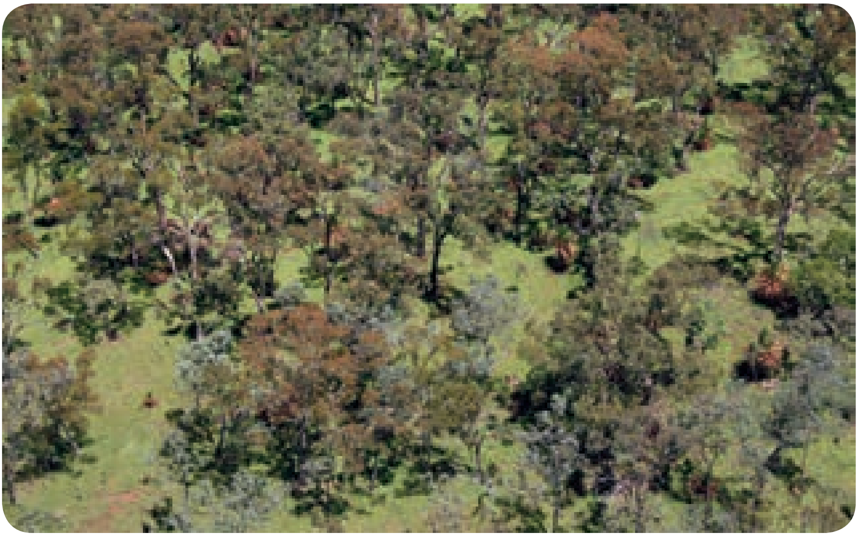
Poplar box woodland with a healthy grass-layer on flood plains. There is a good mix of trees of different ages, from saplings to habitat trees.

Teresa Eyre, DSITIA, Carnarvon Station (2005).

Eucalypt open woodland with a mixed grassy understorey.

Don Butler, Queensland Herbarium.

An open ironbark woodland with a healthy grassy understorey.
Paul Williams, Vegetation Management Science Pty Ltd, Mount Elliot (2008).



Aerial view of an open woodland with a grassy understorey.
Bernice Sigley, QPWS, Carnarvon Gorge National Park (2010).

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 or hop bush are beginning to emerge in abundance above the ground-layer (up to around waist height. If they are higher, refer to Issue 6) and are shading-out the ground-layer.
- Where present, the new leaves of xanthorrhoea are starting to appear ‘yellowish’ or ‘brownish’ and are beginning to form a ‘skirt’ of dead material.
- Ground-layer diversity is declining.
- There is a build up of fine fuels such as dead grass material, leaf litter, suspended leaf litter, bark and twigs.
- Where giant speargrass *Heteropogon triticeus* is a dominant understorey plant (e.g. occurred in areas of the northern coastal Brigalow belt), and begins to steeply decline (four to five years after a fire), this indicates fire is due (Williams 2009).
- Where grasses were once common, they are becoming sparse.

The build-up of skirts on grass trees and rank, matted grass indicate the need for fire in this area.

Nathan Willis, QPWS, MIsla Gorge National Park (2009).

Two years post-fire and a flush of ironbark saplings are beginning to emerge above the understorey. Maintaining appropriate fire in this community will ensure that some saplings are thinned and others are retained for canopy recruitment.

Paul Williams, Vegetation Management Science Pty Ltd.

Discussion

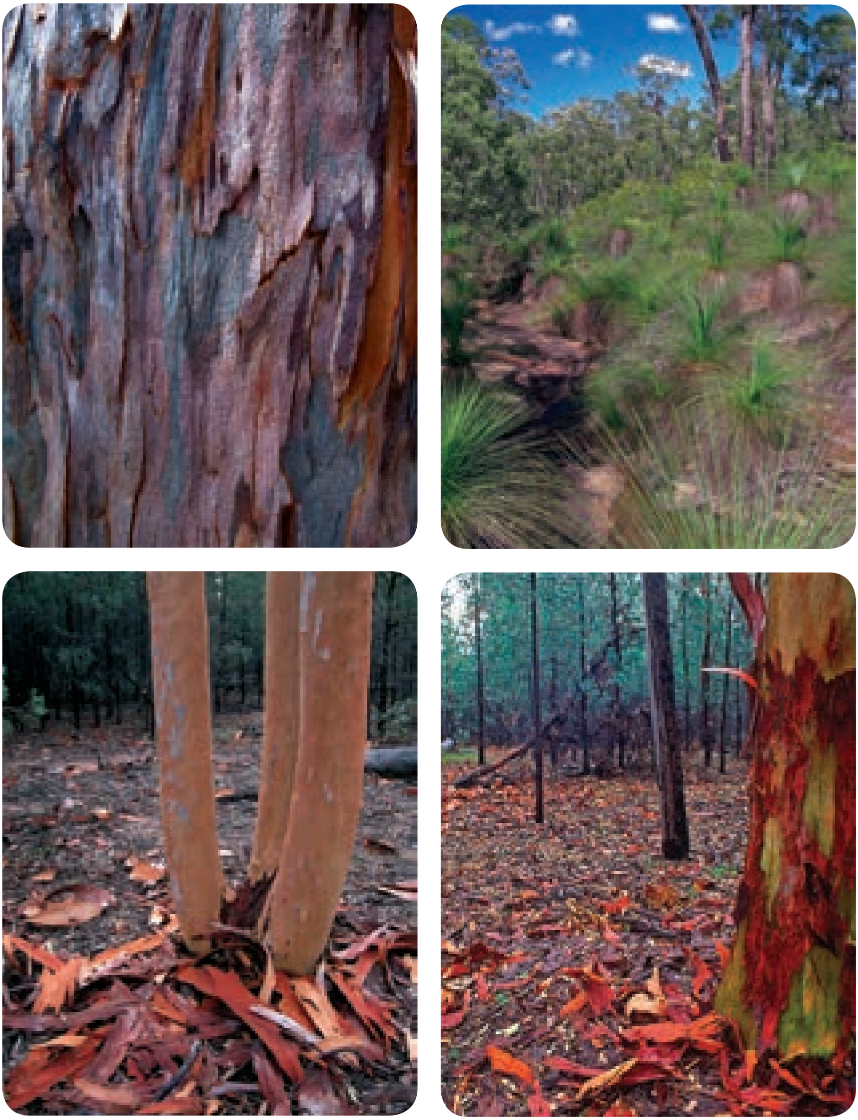
- Some protected areas contain disturbed systems that may be recovering from previous land management (e.g. clearing, logging and grazing). In these systems, the canopy may be understocked and have fewer larger trees (including habitat trees), overstocked or not contain sufficient recruiting canopy species of various ages. 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 communities with a grassy understorey can result in the loss of perennial grasses. In some areas this 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. Cattle paths and pads will break up the continuity of fuels affecting the extent to which burns will carry.
- Communications between the land manager and stakeholders is important. Be aware of stakeholder requirements. A lessee may require the use of fire to promote grass for stock or apiarists may have specific times of the year when burning should be avoided (i.e. during key nectar/flowering periods).
- The increased usage of state forests for the rapidly expanding coal seam gas industry has implications for fire management due to cleared production pads and extensive road networks fragmenting the coverage of planned burns. There is also an increased presence of staff associated with coal seam gas companies on the ground. Consultation with company representatives is important prior to burning.
- Many Eucalypt floodplain communities are more influenced by rainfall and flooding events than fires (e.g. a flush of coolabah saplings will often be in response to flood and associated silt deposition rather than fire). See photographs below.
- High-severity fires during the mid to late dry season or during extended dry periods in floodplain communities can be detrimental to species such as Queensland blue gum and river red gums *Eucalyptus camaldulensis*, as these species will be in winter dormancy and less likely to recover.

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 impacts of wildfire.

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

On the other hand, where floodplains have a *tall grassy* understorey, planned burning within them will ensure the health, diversity and structure of the community and control shrubby invasive species (e.g. *Eremophila* spp. and *Acacia stenophylla*) in the red soil country in particular, and cypress pine.

V.J. Neldner, Queensland Herbarium, south-west of Dirranbandi.



Microhabitat features such as grasstree skirts, bark fissures, fallen material, leaf litter and dense ground cover provide habitat for invertebrates and skinks, and will develop over time. Planned burning may temporarily affect some of these features but at the same time will ensure their persistence over time. Burning under appropriate conditions will ensure a variety of these features in differing stages will persist in an area by minimises the risk of widespread wildfire and loss of these features over large areas. It is important to ensure that planned fire is patchy enough to ensure a good representation of these critical habitat features across the landscape at any one time.

Robert Ashdown, QPWS.

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**.

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: 1. Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air. 2. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. 3. 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:** 40–70 % burnt **Partially Achieved:** between 30–40 % **Or** 70–80 % burnt **Not Achieved:** < 30 % or > 80 % burnt.

Minimal canopy scorch.	In the days post fire, walk through planned burn area in three locations (that take account of the variability of landform and ecosystems within burn area), estimating percentage of canopy scorch within visual field.	**Achieved:** < 10 % of the crown of the dominant tree layer scorched. **Partially Achieved:** 10–25 % of the crown of the dominant tree layer scorched. **Not Achieved:** > 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:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 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.100 metre 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.
> 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. **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.

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

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

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 fire helps 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 response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between four to eight years for grassy understorey.
- Where they occur in some coastal areas of the northern Brigalow Belt, this community can tolerate very frequent fires (e.g. annually) providing it is of a low severity with good soil moisture in the early dry season (March–April).

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 40–70 per cent burnt within the target communities.
- In more moist areas (e.g. near gullies and rocky creek beds along the bases of sheltered gorges) unburnt areas tend to remain. This helps retain habitat features such as ground epiphytes and denser pockets of vegetation.

Post-burn in eucalypt woodland with a grassy understorey showing a mosaic of burnt and unburnt patches resulting in a flush of "green pick" favoured by macropods.
Paul Williams, Vegetation Management Science Pty Ltd (2005).

Landscape Mosaic

- In general, no more than 30 per cent of eucalypt forests and woodlands with a grassy understorey should be burnt within the same year in a management area.
- In the northern Brigalow Belt, there are often a greater percentage of larger burns in this community than in the south. Though these tend to be patchier.

Other considerations

- Where relevant, alleviate grazing pressure in the year prior to burning to allow the accumulation of fuel for fire to carry.
- After a wildfire, to prevent a cycle of wildfire promoted by single-aged fuel, attempt to break up the area with planned burns.
- Ground-layer species diversity has been shown to decline in eucalypt forest and woodlands with a grassy understorey in coastal areas of the northern Brigalow Belt after three years without fire (Williams et al. 2003). However this does not mean burn all areas every three years, rather implement the fire frequencies recommended above.

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.

Southern Brigalow	Northern Brigalow
Season: Autumn to early spring **FFDI:** < 13 **DI (KBDI):** Ideally 60–90, but < 120 **Wind speed:** Beaufort scale 1–4, < 23 km/hr (ideally between 10–23 km/hr in forests)	**Season:** Late wet season to early dry season (e.g. March to April) **FFDI:** < 13 **DI (KBDI):** Ideally 40–80, but < 100 **Wind speed:** Beaufort scale 1–4, < 23 km/hr (ideally between 10–23 km/hr in forests)
Aim to implement burns at varying times of the year (e.g. late in the dry season, or early storm season or after good spring rains) to maximise species diversity. Good soil moisture at the time of burning is the critical factor.	

Soil moisture

Good soil moisture is critical for a range of aspects to:

- Protect and retain the bases of grasses, ensuring they are given a competitive advantage over invasive grasses and woody weeds.
- Minimise loss of habitat features such as hollow bearing trees and fallen logs.
- Limit the opening of bare ground, erosion, and encroachment of weeds.
- Encourage species regeneration soon after fire.
- Promote a mosaic of burnt and unburnt patches.
- Facilitate further later burning by creating a mosaic of burnt areas.

Other considerations

- During winter in the **Southern Brigalow Belt** (particularly from Inglewood to Dalby) the effective burn period is generally around two to five hours maximum (between 10.00 am and 3.00 pm). In some instances burning at this time may be preferable as the fire is likely to self-extinguish overnight due to low temperatures, fuel moisture, south easterly winds and heavy overnight dew.
- **Ironbark/cypress communities** require drier conditions to burn and in the southern Brigalow Belt are generally burnt **late autumn**. This is due largely to fuels in this community being sparse and discontinuous, and a more closed canopy. Some wind will generally be required. Be aware that following a landscape mosaic burn, ridgelines of these communities may burn as conditions dry out causing re-ignitions. Progressive burning may have to be planned to counter any such issues.
- Avoid burning when there is an increasing fire danger to avoid re-ignitions. Be aware that there is a high risk of **re-ignition in ironbark and spotted gum** communities sometimes weeks post-fire.

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** from a fixed wing aircraft or helicopter is often used in the Brigalow Belt 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. This creates a backing fire that travels downhill away from the edge of non-target communities. 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 aerial incendiaries, as smoke from fires lit by ground crews may impair the vision of the pilot and hamper lighting efforts. Use of aerial photographs is recommended (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 lighting crews are well aware of this plan prior to ignition.
- **Progressive burning.** Fires (of varying extents, severity and at various times) are lit in fire-adapted communities from early in the year as conditions allow. 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 grasses (Williams 2009). Burning should begin in March/April—very soon after the wet season. This will 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 to produce 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. This will promote the availability and diversity of grass and herb seed which is an important food source for birds and mammals.

- **Commencing lighting on the leeward (smoky) edge** can be a useful way to create a low-intensity backing fire that trickles into the burn area or to create a containment edge for a higher-severity fire that is ignited inside the burn area.
- **A low-intensity backing fire with good residence time.** This slow-moving fire will generally result in a more complete coverage of an area and a better reduction of available fuels. The severity is kept to a minimum and 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.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire particularly where there is an accumulation of volatile fuels.
- **Afternoon or evening ignition.** If conditions are not ideal (e.g. prolonged drought), but fire management is required, implement suitable tactics such as afternoon or night ignition to reduce the potential impacts. Be aware of any containment issues, the current DI, soil moisture and signs of poor health (e.g. tree death from drought stress) and the potential for fire to compound these issues.
- **Flooding events** can remove fuel from a site (including heavy, coarse fuels) and can also deposit it. Often following a flood there will be a large amount 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. Raking debris away from the base of large trees will further assist in limiting the loss of habitat features but this may not always be practical—in which case burning when the fuels are moist and trees are actively growing is important. 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 flooding events.

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 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.

Planned burning in Angophora woodland at dusk.
Bernice Sigley, QPWS, Mount Moffat (2009).

Issue 2: Maintain healthy shrubby eucalypt forest and woodland

Maintain healthy shrubby eucalypt forest or woodland with mosaic burning.

Awareness of the environment

Key indicators of a healthy shrubby eucalypt forest and woodland:

- The soil is typically poorer than communities with a grassy understorey.
- The canopy is characterised by trees of various height and ages and trees appear healthy. 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.
- The understorey is dominated by a diversity of shrubs (not juvenile trees) often including small *Acacia* spp., hop bush and dogwood less than four metres high.
- The shrub layer can vary from dense to patchy.
- Where the shrub layer is patchy the ground layer may have a mix of grasses and/or patches of bare earth.
- Scattered fire-sensitive shrubs including legumes and grevilleas are present and are of a flowering age.
- Scattered sedges, grasses and ferns may be present.

Eucalypt woodland with a scattered shrubby understorey. Shrubby communities usually occur as small islands amongst grassy communities.

L.P. Bailey, Queensland Herbarium.

Spotted gum open-forest with a healthy mixed grassy/ shrubby understorey.
Bill McDonald, Queensland Herbarium, Coominglah State Forest (2010).

Eucalypt woodland with a dense shrubby understorey. Shrubby communities have longer fire frequencies than grassy communities largely due to the increased presence of obligate seeders.
Paul Williams, Vegetation Management Science Pty Ltd, Carnarvon National Park (2009).

The following may indicate that fire is required to maintain a shrubby understorey:

- Shrubs are looking unhealthy (e.g. beginning to lose lower level leaves, spindly branches are present or some ends of branches (crowns) are dying). There is an accumulation of dead branches and leaves on shrubs.
- Scrub and tree species (such as she-oak, cypress or acacia) may be emerging among the shrubs and beginning to dominate.
- Vines including legumes and dodder (*Cuscuta* spp.) may be growing over and/or smothering some of the shrubs.
- Weeds may be beginning to establish.
- Suspended litter and bark may be perched in shrubs.

Acacias and red ash are starting to become overabundant within the understorey.
Mark Cant, QPWS, Allies Creek State Forest.

The vulnerable *Acacia handonis* where present, requires two seeding cycles prior to burning (look for evidence of previous seeding bodies).
Mark Cant, QPWS, Barakula State Forest (2002).

The build-up of heavy-fuels in a eucalypt forest with a shrubby understorey.
Mark Cant,QPWS, Wondul State Forest (2002).

Discussion

- The relative abundance of grasses and shrubs may result from soil nutrients as well as the frequency of past fires. Drier, deficient soils tend to favour a shrubby understorey (Christensen et al. 1981).
- It is important to distinguish 'shrubs' from juvenile trees or saplings. Shrubs are typically multi stemmed, remain as small plants when mature and certain types of forests are characterised by an abundance of shrubs in the lower stratum.
- The vulnerable Hando's wattle *Acacia handonis* at Barakula would benefit from implementing these guidelines, to avoid wildfire events impacting on the restricted populations. Allow at least two seeding cycles prior to burning.
- 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 conesticks *Petrophile canescens* and the generations of seed capsules on bottlebrushes, hakeas and melaleucas.

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**.

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: 1. Visual estimation of percentage of vegetation burnt from one or more vantage points or from the air. 2. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. 3. 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 the percentage of ground burnt within visual field.	**Achieved:** 40–70 % burnt. **Partially Achieved:** between 30–40 % and 70–80 % burnt. **Not Achieved:** < 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. **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 metres long however the 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.
Obligate seeders have germinated at a greater density than dead adults.	Before the burn: select three sites (taking into account the variability of landform and likely fire intensity) in which fire-killed shrubs are present. After the burn (can be 6–12 months later to allow recruitment to be visible) return to the sites and count the fire-killed shrub recruitment.	**Achieved:** Recruitment of seedlings ≥ 5 times number of adults before burn. **Partially Achieved:** Recruitment of seedlings ≥ 3 times number of adults before burn. **Not Achieved:** Recruitment of seedlings ≤ 3 times number of adults before burn.

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 fire will be useful 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 o**n-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.

Southern Brigalow	Northern Brigalow
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). Consider a broad fire interval of between 7–12 years. Climate extremes such as drought may result in slower fuel accumulation and may necessitate the need for longer intervals of 15 years.	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). Consider a broad fire interval of between 5–10 years. Climate extremes such as drought may result in slower fuel accumulation and may necessitate the need for longer intervals.

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 40–70 per cent burnt within the target communities.
- In more moist areas (e.g. near gullies and rocky creek beds along the bases of sheltered gorges), unburnt areas tend to remain. Unburnt areas retain features such as ground epiphytes and dense pockets of vegetation.

Landscape Mosaic

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

Other considerations

- Where they occur within a broader grassy landscape, planned burn programs may be designed to avoid the shrubby component. For example, every second burn target surrounding grassy areas early in the dry season. This can create a buffer around shrubby areas limiting too frequent fire (Williams 2009).
- **Ironbark/cypress shrubby communities** require drier conditions to burn and in the southern Brigalow Belt are generally burnt **late autumn**. This is due largely to fuels in this community being sparse and discontinuous, and a more closed canopy. Some wind will generally be required. Be aware that following a landscape mosaic burn, ridgelines of these communities may re-ignite as conditions dry out causing fresh fire fronts. Progressive burning may have to be planned to counter this.
- Following a wildfire, reassess the area and attempt to break up the area with planned burns to prevent a cycle of wildfires and to prevent 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.

Southern Brigalow	Northern Brigalow
Season: Autumn to early spring. **FFDI:** < 13.	**Season:** Late wet season to early dry season (e.g. March to April). **FFDI:** < 13.
DI (KBDI): Ideally 60–90, but < 120.	**DI (KBDI):** Ideally 40–80, but < 100.
Wind speed: Beaufort scale 1–4, < 23 km/hr (ideally between 10–23 km/hr in forests).	**Wind speed:** Beaufort scale 1–4, < 23 km/hr (ideally between 10–23 km/hr in forests).
Aim to implement burns at varying times of the year (e.g. late in the dry season, early storm season or after good spring rains) to maximise species diversity. Good soil moisture at the time of burning is the critical factor.	

Soil moisture

- Good moisture conditions are required to protect hollow bearing trees and fallen logs and promote a good mosaic of burnt and unburnt patches.
- Early dry season burns with good soil moisture are useful for conservation and hazard reduction (fuel management) and when burning areas that adjoin fire-sensitive vegetation (Williams 2009).

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** with incendiaries from a fixed wing aircraft or helicopter is often used in the brigalow bioregion, due to the large size of areas being managed. Aerial burning is efficient and allows a greater ability to respond to burn opportunities as they arise. Helicopters provide the opportunity to directly target topographical features such as peaks, ridges and spurs (which creates a backing fire downhill and burns away from the edges of the non-target communities). Aerial ignition may be implemented in conjunction with ground ignition which secures 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 or helicopter and the spacing of aerial incendiaries, as smoke from fires lit by ground crews may impair the vision of the pilot and hamper lighting efforts. Use of aerial photographs is recommended (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 lighting crews are well aware of the plan prior to ignition. Aerial ignition is useful to limit scorch and fire severity on upper slopes, cater for the varying needs of fire vegetation groups, create variability in fire severity and promote a rich landscape mosaic.
- **Commencing lighting on the leeward (smoky) edge** can be a useful way to create a low-intensity backing fire into the burn area. This tactic can also be used to create a containment edge for a higher severity fire ignited inside the burn area.
- **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.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire, particularly where there is an accumulation of 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.
- **Afternoon or evening ignition.** If conditions are not ideal (e.g. prolonged drought) but fire management is required, implement suitable tactics such as afternoon or night ignition to reduce environmental impacts. Be aware of any containment issues, the current DI, soil moisture, signs of poor health (e.g. tree death from drought stress) and the potential for fire to compound these issues.

Issue 3: Maintain healthy tall eucalypt forest

Maintain healthy tall eucalypt forest with mosaic burning.

Awareness of the environment

Key indicators of a healthy tall eucalypt forest:

- They tend to occur on elevated plateaus or in protected gorges.
- The community is dominated by eucalypts with a canopy height that is greater than 20 metres.
- Canopy branches can be touching, often forming a continuous unbroken canopy.
- The canopy can be dominated by one or several species of eucalypt such as stringybarks, white mahogany *Eucalyptus acmenoides*, Queensland blue gum *Eucalyptus tereticornis*, Blackdown stringybark *Eucalyptus sphaerocarpa* and spotted gum *Corymbia citriodora*.
- The forest may have a mid-stratum of fire-promoted small trees and shrubs such as tea trees, brush boxes, boxes, mahoganies, turpentines and cheese trees.
- Where they occur in gorges they may have pockets of rainforest species such red kamala *Mallotus philippensis*, whalebone tree *Streblus brunonianus* and white cedar *Melia azedarach*.

Tall eucalypt forest with a grassy understorey.
Bernice Sigley, QPWS, Conseulo Tableland (2011).

On plateaus the ground-layer is generally dominated by grasses, bracken, *Lomandra* spp., and *Zamia* spp., and often lacks a distinct shrub layer.

Bernice Sigley, QPWS, Carnarvon Gorge National Park (2010).

The following may indicate that fire is required to maintain a tall eucalypt forest:

- There is a build-up of fine fuel in the ground-layer or mid-stratum.
- Grasses have thickened and become tangled and matted.
- There is accumulation of dead fronds on zamia plants.
- In more moist communities (e.g. Blackdown Tableland National Park and Carnarvon National Park) acacia tree species, whipstick swamp box or supple jack saplings or seedlings are becoming abundant and beginning to emerge above the ground stratum.
- There is a build up of fine fuels such as dead grass material, leaf litter, suspended leaf litter, bark and twigs.
- Fuel loads > 10 t/ha.

Discussion

- Tall forests on elevated plateaus and in sheltered gullies will usually be more moist and cooler, and windows of opportunity for planned burns are limited. Preparation (e.g. fire-line repairs, raking around habitat trees and infrastructure, etc) and notifying stakeholders (including neighbours) will allow the land manager the flexibility to respond to the limited opportunities as they arise.
- A dominance of blady grass *Imperata cylindrica* or bracken fern *Pteridium esculentum* may indicate too frequent dry season fires (e.g. winter or a dry spring).

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.

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: 1. Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air. 2. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. **Or** 3. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through the planned burn area estimating the percentage of ground burnt within the visual field.	**Achieved:** 40–70 % burnt. **Partially Achieved:** between 30–40 %. **Or** 70–80 % burnt. **Not Achieved:** < 30 % or > 80 % burnt.

> 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:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 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.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.
> 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 the number of habitat trees. Determine the percentage retained after fire.	**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.

Objectives achieved—the planned burn has promoted grasses, removed dead fronds from zamias, retained habitat trees and ensured the community remains open.
Bernice Sigley, QPWS, Carnarvon Gorge National Park (2005).

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** and with the occasional **moderate**. An occasional moderate-severity fire helps 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.

Post low-severity fire. Humus and grass stubble have been retained and there is a good mosaic of burnt and unburnt patches.

Robert Ashdown, QPWS, Carnarvon National Park.

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

- Fire frequency should primarily be determined through the **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 four to twelve years.
- Climate extremes such as drought may result in slower fuel accumulation and may necessitate the need for longer fire intervals of 15 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 more moist areas (e.g. near gullies and along rocky creek beds and sheltered gorges) unburnt areas tend to remain. This retains features such as ground epiphytes and dense pockets of vegetation.

Landscape Mosaic

- Do not burn more than 30 per cent of tall closed eucalypt forests within the same year in the same management area.

Other considerations

- Following a wildfire, reassess the area and attempt to break up the area with planned burns to prevent a cycle of wildfires. This will help mitigate 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 60–80, but < 100 maximum

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

Soil moisture: Good moisture conditions will protect the bases of grasses, hollow-bearing trees and fallen logs and promote a good mosaic of burnt and unburnt patches. Early dry season burns with good soil moisture are useful for hazard reduction (fuel management) and when burning in areas adjoining fire-sensitive vegetation (Williams 2009).

Other considerations

- It is important to understand local weather conditions (particularly where these communities occur on elevated plateaus) rather than rely on information from nearby lowland centres as the plateaus are generally three to four degrees Celsius cooler with a RH generally 10–20 per cent higher.
- Tall, closed forests at altitude are usually significantly wetter than eucalypt forests and woodlands on the lowlands as they are often covered in mist or ‘cloud rain’ for extended periods. This has a significant effect on timing and curing rates compared to other areas.
- Test burns are particularly useful in these communities as they ensure conditions are suitable to meet the objective of the burn and assess the influence altitude will have on fire behaviour.
- Adjoining angophora/spotted gum communities burn easily and are generally burnt early in the dry season.

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** is a tactic used to limit scorch and fire severity on upper slopes. It caters for the varying needs of the fire vegetation groups by creating variability in fire severity and promoting a rich landscape mosaic.
- 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. Use of aerial photographs is recommended (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 lighting crews are well aware of the plan prior to ignition.
- **Progressive burning.** Fires (of varying extents, severity and at various times) are lit in fire-adapted communities from early in the year when conditions allow. Progressive burning in lower lying open forests will help create barriers to fire movement allowing greater flexibility when targeting the higher altitude tall open forests. 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 2009).

Aerial incendiary ignition. Consider the lighting pattern and the spacing of incendiaries carefully and alter these to suit the objectives of the burn.

Bernice Sigley, QPWS, Carnarvon Gorge National Park (2007).

Helicopters provide the opportunity to directly target topographical features such as peaks, ridges and spurs.

Bernice Sigley, QPWS, Carnarvon Gorge National Park (2007).

Issue 4: Maintain healthy eucalypt open woodland with an understorey of spinifex

This vegetation group is characterised by a very discontinuous cover of spinifex *Triodia* spp. clumps with scattered isolated shrubs (wattles) and trees such as silver-leafed ironbark *Eucalyptus melanophloia*, Queensland peppermint *Eucalyptus exserta* and bloodwoods. Forbs, legumes, and grasses can also be found between the spinifex clumps. Whilst only small in area these 'of-concern' communities require special burn consideration.

Ironbark woodland with a healthy discontinuous spinifex understorey.
Robert Ashdown, QPWS, Yelarbon (2006).

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

Bull oak saplings are overabundant in the understorey and grasses are becoming sparse.
Jenise Blaik, QPWS, Talgai State Forest (2010).

The following may indicate that fire is required to maintain spinifex woodlands

Fires within this community are generally infrequent as it takes many years (in general ten years) for clumps to accumulate the biomass, dead material and continuity required to sustain a running fire. It is important to keep observing the land and implement fire where sufficient continuity of fuels between clumps has accumulated or where woody thickening may have become an issue. Other useful indicators include:

- Spinifex clumps are beginning to collapse. There is an accumulation of dead material in the centre with the younger leaves remaining green around the outside, forming a distinctive ring-like structure that eventually breaks-up (QMDC 2006) or collapses.
- The clumps have become connected (there is no space between the clumps).
- Wattles that germinated after a previous fire are beginning to die or are dead. Often this is associated with a 10 year cycle.
- Woody species such as cypress pine *Callitris glaucophylla* may be establishing or are frequent in the area.

Discussion

- Planned burns in this community are best undertaken in the wet season, (and can be done so in light showers), due to the volatility of the clumps. Fires which are too severe and occur without sufficient soil moisture result in the death of grass bases/roots. Soil moisture 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.
- By selectively targeting areas where spinifex clumps have accumulated enough fuel to carry a fire, a mosaic of varying clump ages can be created. This allows small areas of spinifex to be targeted over time and can also be used to create breaks between this community and adjacent fire-adapted communities when burning later in the year.

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 its growth post-rainfall.

Priority	Priority assessment
Very high	Planned burn required to maintain areas of **special conservation significance**.

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 two or more sites (taking into account the variability of landform and likely fire intensity) and estimate cover of spinifex that recover one to three months after fire.	**Achieved:** > 95 % recovered. **Partially Achieved:** 90–95 % recovered. **Not Achieved:** < 90 % recovered.
> 75 % of woody saplings/ seedlings. <1 m in height is 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); estimate the percentage of saplings/seedlings scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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.

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)	50–100	0.3–0.5	≤ 2.0	Some patchiness. Most of the surface and near surface fuels have burnt. Stubble still evident.
Moderate (M)	100–1500	0.5–1.5	2.0–6.0	All surface and near surface fuels burnt. Stubble burnt to blackened remnants. Invasive saplings scorched to tips.

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 10–15 years.

Mosaic (area burnt within an individual planned burn)

- Use appropriate tactics and burn with good soil moisture to assist in creating a mosaic.

Landscape Mosaic

- At least 20 per cent of these communities in the Brigalow Belt should be burnt at a time, as seasons dictate.

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.

Season:

- Wet season to early dry season and concentrate efforts after years of good rainfall. It is important to regularly monitor spinifex woodlands 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 fire killed when young.
- A mosaic of storm season fires will limit the chance of extensive wildfires later in the dry season (Crowley 2003).

Soil moisture:

- Good soil moisture is critical when burning spinifex woodlands. Burning with good soil moisture, high temperatures and before storm rainfall is a good strategy to assist in encouraging regeneration of grasses and retain grass bases. Timing burns to coincide with follow-up rain will further assist in promoting regrowth. Soil moisture also promotes rapid post-fire spinifex seedling establishment.

FFDI: < 13

DI (KBDI): < 80

Wind speed: Beaufort 1–2, < 10 km/hr. Some wind will be required to help carry the fire through the spinifex.

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** 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). Spots further apart (or alternatively a single spot ignition) will result in a lower-intensity fire and greatly varied mosaic of unburnt and burnt patches. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- 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 the early wet season to mid dry season following sufficient rain. This will ensure good soil moisture throughout the site (including drainage lines). Good soil moisture indicators include moist sub-soil, visible surface water and the high likelihood of rain in the days post burn.

Issue 5: Manage eucalypt forests where understorey fuels are not usually continuous

This fire vegetation group contains two communities which naturally have very sparse understoreys—gum-topped box and mugga/ironbark forests.

Fire management issues

The condition of the understorey in these communities prior to historical clearing, grazing and altered fire regimes is unknown however these forests have extremely sparse and slow growing understorey vegetation which limits availability of ground fuel for carrying fire during planned burns. Getting fire to carry during a planned burn in these communities is not likely to be feasible. These communities may only burn with occasional wildfires under drier conditions.

Issue 6: Reduce overabundant saplings

In forests and woodlands an overabundance of saplings may reduce the health of the grasses through competition and shading. This may create a situation where fire becomes more difficult to reintroduce and/or grass species are lost from the system through prolonged absence of fire. This leads to system transition where planned fire can no longer be introduced.

Awareness of the environment

Key indicators of where fire management is required:

- A density of woody species such as acacias, cypress pine, eucalypts and hop bushes are beginning to emerge in abundance above the ground (up to about waist height) and are shading out the ground-layer.
- In moister communities (e.g. Blackdown Tableland National Park), acacia tree species, swamp box and supple jack *Lophostemon confertus* saplings or seedlings are becoming abundant and beginning to emerge above the ground stratum.
- The diversity of mid/ground stratum species (such as grasses, herbs, sedges and shrubs) has declined.
- Where grasses were once common they are becoming very sparse, are poorly formed or have collapsed due to shading.
- Where present, mature shrubs have sparse crowns or are beginning to die with little or no new recruitment of young shrubs in the ground-layer.
- Heavy fuels (e.g. fallen trees and branches), are smothering the ground-layer with a thick blanket of leaf litter from species above (such as she oak or cypress pine). Large amounts of suspended and elevated fuels are also present.
- Where it was once easy to see and walk through it is now difficult to do so unimpeded.

Discussion

Why are saplings overabundant?

- An overabundance of saplings/young trees in the understorey may be triggered in response to:
- prolonged absence of fire from an area
- lighting patterns that favour a hot running fire (e.g. line lighting at the bottom of a slope) and flush of woody species
- a fire regime which as not been varied and has favoured one species.

A high severity fire event has resulted in the germination of a flush of spotted gums without any follow up fire in the following years (e.g. 3–4) to thin out the overabundant trees.
Mark Cant, QPWS, Barakula State Forest (2011).

Potential impacts of overabundant saplings

- Too many saplings/young trees in the understorey may indicate the beginning of a transition from an open structure to a closed one.
- Some canopy species in the understorey are necessary for the eventual replacement of canopy. However this must be balanced against shading of the understorey.
- Once a thicket has developed it may be difficult to re-introduce fire into that area if left too long.
- A thickening of trees or shrubs will result in a lower diversity in the understorey due to shading, and potentially less fuels to carry future fires.

Other considerations

- Grassy forest and woodlands in some areas are susceptible to acacia, bull oak or cypress pine thickening. In the absence of fire, seed stock from these species accumulates which generally results in a mass germination event after wildfire (particularly those of a high severity). It is particularly important to observe post-fire germination as it is likely that more than one planned burn will be required to return the community to a grassy or more open understorey.
- Be aware that following a wildfire there may be a need to implement a planned burn to address issues which may arise (e.g. a flush of saplings).

A flush of acacia saplings post-wildfire can be addressed with a follow up burn implemented as soon as a fire will carry again. Use good soil moisture and appropriate weather conditions to promote native legumes and grasses and give them competitive advantage over woody species.
Mark Cant, QPWS, Barakula State Forest (2011).

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)
>75 % of saplings < 2 m 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 intensity), estimate the percentage of overabundant saplings (above ground components) scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.
> 50 % fallen logs (with a diameter ≥ 20 cm) retained.	Before and after fire, select three or more sites of a 20 metre radius (taking into account the variability of landform and likely fire intensity) and estimate the percentage of fallen logs retained after fire.	**Achieved:** > 50 % retained. **Partially Achieved:** 35–50 % retained. **Not Achieved:** < 35 % retained.
> 90 % of standing live canopy trees retained.	After fire, select three or more sites (taking into account the variability of landform and likely fire intensity) and estimate number of live trees burnt down.	**Achieved:** > 95 % retained. **Not Achieved:** < 95 % retained.
> 90 % of the grass clumps 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:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **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.

These two photos show pre and post-burn in woodland with an objective to reduce overabundant saplings.

Paul Williams, Vegetation Management Science Pty Ltd.

Objective achieved with >75 per cent reduction of saplings and seedlings, while at the same time retaining mature trees fallen logs, and allowing grass recovery.

Paul Williams, Vegetation Management Science Pty Ltd.

Fire parameters

What fire characteristics will help address this issue?

Fire severity:

- **Moderate** to **high**. Once mid-stratum overabundance is controlled return to a low to moderate severity regime (refer to Issue 1).
- Aim to scorch to the top of mid-stratum saplings so that all the leaves of undesired saplings are brown after fire. The target scorch height (see table below) should be as high as the tip of the mid-stratum trees that you wish to control.

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)
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.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate < 20 m height canopy, mid stratum burnt completely (or nearly so).

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

Mosaic (area burnt within an individual planned burn)

- Burn as much of the area dominated by saplings or targeted shrubs as possible.

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 so that undesirable conditions and weather changes can be avoided.

Season: The season is dependent on the accumulation of fuel and sufficient moisture to favour the regeneration of grasses. Caution is required if burning at moderate-high severity in late autumn as this is when plant growth slows and soils are exposed to erosion during winter rains.

DI (KBDI): < 75

FFDI: 5 to 11

Wind speed: Beaufort scale 1–4, < 23 km/hr

Other considerations:

- Being available to implement burns as the priority when windows of opportunity arise, is one of the key factors for this issue.
- If using high severity fire, be aware of the potential for impacts on grasses, mature trees, habitat trees and fallen logs.
- A low to moderate severity backing fire, with a high residence time around the base of overabundant saplings in some instances may be sufficient to brown off the leaves and kill the above ground component of the plant.
- Be aware that when used as an initial burn, a fire of a lower severity may exhaust available fuels without achieving the desired scorch and objectives of the burn and also possibly limit the opportunities for subsequent burns. Following a low severity burn it will take a greater amount of time for sufficient fuel to accumulate to carry a fire at which point the saplings may be well established and difficult to manage with planned burns.
- If the initial fire triggers a flush of new seedlings or you have not achieved the objectives of the planned burn, a follow-up planned burn should be implemented when a fire will again carry within the area. Often this will be promoted if there has been good grass growth post the initial fire.

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.

- While a **moderate**-severity fire is recommended to address this issue, this is dependent upon the height of the saplings (refer to severity table for scorch heights).
- A **running fire** of a **higher** severity may be required where there is a lack of surface and near-surface fuels (due to shading-out or a well-developed thicket). In this instance a follow-up planned burn will be required to kill the surviving saplings and any new seedlings.
- **Line or strip ignition** is used to create a fire of higher-intensity which is useful to reduce overabundant trees (through scorching).
- **Commence lighting on the leeward (smoky) edge** to create a containment edge for a higher-severity fire ignited inside the burn area.
- **A backing fire with good residence time.** A slow moving backing fire (lit against the wind on the smoky edge or down slope) will ensure the fire has a greater amount of residence time, while ensuring fire intensity and rate of spread are kept to a minimum. Greater residence time is useful in reducing overabundant seedlings/saplings.

Issue 7: Manage forests and woodlands that are prone to frequent, extensive wildfires

Some eucalypt forests and woodland communities (in particular those which occur on sandstone and on hill slopes) are susceptible to high-intensity wildfires that affect large areas. Long-term effects of these high-intensity wildfires include a general reduction in diversity, loss of mature canopy trees and recruitment of canopy saplings and impacts on floral and faunal habitat features. These systems are slow to recover often due to their low nutrient soils and periods of low rainfall. Wildfires generate an even-age vegetation structure and fuel level which can further promote the cycle. There may also be one or two shrubby species dominating post-fire regrowth (e.g. wattle). The main wildfire mitigation strategy is to reduce the fuel load in wildfire corridors and maintain a landscape mosaic.

Awareness of the environment

Key indicators:

- There are a significant number of dead trees and/or reduced frames of trees (the tree has been reduced mostly to its trunk).
- A high proportion of charred branches exist in the canopy (often referred to as 'antlering').
- There is a lack of standing, hollowed habitat trees.
- Tree stems are charred up to the canopy (particularly stringybarks).
- A high proportion of fire scars exist on trees.
- Trees have dense coppicing.
- There may be a dominance of wattles in the understorey.
- There may be a deficiency of ground plants or a dominance of fire-promoted grasses (e.g. blady grass).
- Patches of bare earth are common.
- Skeletal frames of shrubs remaining.
- Ash beds and charcoal from heavy fuels such as logs.

Also, utilise good fire history maps and associated reports.

Post-wildfire showing dense coppicing of trees and removal of ground fuels exposing patches of bare earth.

Bernice Sigley, QPWS, Moolayember National Park (2010).

Communities on sandstone are particularly vulnerable to frequent and extensive wildfires. Aim to create a patchy mosaic of burnt and unburnt patches within the community and in surrounding areas. This limits the extent and severity of wildfires.

Robert Ashdown, QPWS, Isla Gorge (2009).

Antlering effects on trees post-wildfire on a hill slope in a eucalypt woodland. Typically theses communities are prone to extensive, high-severity wildfires.

Mark Cant, QPWS, Bunya Mountains National Park (2009).

Epicormic growth and damage to the crowns of gum-topped ironbarks post high-severity fire.

Bill McDonald, Queensland Herbarium, Dooloogarah (2010).

Post high-severity fire showing a flush of dense trees in the understorey. Note the remaining frames of dead trees.

Peter Leeson, QPWS, Blackdown Tableland National Park (2009).

Discussion

- Wildfires usually occur under dry or otherwise unsuitable conditions and combined with predominantly low-nutrient soils of the tablelands, results in severe long-term impacts on communities. Fuel-reduction burning in strategic wildfire corridors (e.g. along ridge tops) and mosaic burning of remaining healthy communities is the key strategy to mitigate impacts of unplanned fire.
- If blady grass begins to dominate and out competes other native grasses it may indicate that the current fire regime is undesirable (e.g. too hot and/or too frequent with lack of soil moisture). This is most common in communities with a grassy understorey and is of particular concern where it occurs on the edge of communities with a shrubby understorey.
- An overabundance of tree species in the mid-stratum such as supple jacks *Lophostemon confertus* can result in high severity fires. These also form a continuous layer of fuels from the mid-stratum to the canopy that has in the past resulted in damaging crown fires within Blackdown Tableland National Park affecting local populations of Blackdown stringybark *Eucalyptus sphaerocarpa*.
- Where possible, placement of wildfire mitigation zones along park boundaries is a useful strategy to help limit the severity and extent of wildfires entering or leaving the park. This will require liaison and cooperation with park neighbours.
- Wildfires will happen from time to time in severe conditions even if planned burning has been undertaken—the latter may however help to mitigate effects.
- Too frequent and/or severe fire removes the structurally complex ground and mid-strata layers, resulting in an even age structure.
- Post wildfire, planned burning needs to strike a balance between allowing time for recovery and mitigating against a continual cycle of wildfires.
- Under drought or prolonged dry conditions, recovery from wildfire will be extremely slow.
- Note that drought conditions can also cause canopy tree deaths. Obvious charring of branches in the canopy will help differentiate death from wildfire.

What is the priority for mitigating 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.

Select from below as most appropriate for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Overall fuel hazard has been reduced 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:** Overall fuel hazard has been reduced to low. **Not Achieved:** Overall fuel hazard has not been reduced to low.
In wildfire corridors, fire mosaic 60–80 % burnt.	There are three options: 1. From one or more vantage points, estimate aerial extent of ground burnt. 2. In three locations (that take account of the variability of landform within burn area), walk 300 or more metres through the planned burn area estimating the percentage of ground burnt within visual field. 3. Walk into one or more gully heads, and down one or more ridges and estimate the percentage of ground burnt within visual field.	**Achieved:** Mosaic 60–80 %. **Partially Achieved:** Mosaic 50–60 %. **Not Achieved:** Mosaic < 50 %. High proportion of patchiness, unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be 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.

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

- **Moderate** – aim to scorch the mid-stratum of shrubby fuel (see table below).

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)
Moderate (M)	150–500	0.5–1.5	2.5–7.5	Moderate patchiness. Some scorched litter remains. About half the humus layer retained. Some fleshy sedge bases remain though show charring. General charring of shrubs but some frames 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.
- In strategic wildfire mitigation areas, use the lower end of the recommended fire frequency (as appropriate for wildfire mitigation zones).
- Where there are areas of eucalypt forests and woodlands subject to frequent wildfires a regime of strategically located low severity, early dry season burning every three to four years will create a mosaic of burnt and unburnt areas and may limit the extent of large scale wildfires. While this may challenge the normal recommended fire frequency, low severity, early dry season fires will create a greater variety of unburnt patches within the broader landscape and provide refuge for fire killed shrubs of varying ages (Price et al. 2003).

Mosaic (area burnt within an individual planned burn)

Good fire coverage with no fuel corridors.

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.

Season: March to August

FFDI: 6–11

DI (KBDI): < 120

Wind speed: Beaufort scale 1–4, < 23 km/hr

Other considerations

- In areas with a shrubby understorey that have a history of frequent, repeated wildfires, efforts should be on creating a patchy mosaic of burnt and unburnt patches. Alternatively, introduce shorter fire intervals within strategic locations that aim to limit the extent of wildfires while ensuring some area remain long unburnt (Williams 2009).

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.

- In wildfire **mitigation zones**, select tactics that will reduce elevated fuel and ensure a good coverage of fire with no fuel corridors. Also consider re-ignition of any large unburnt areas.
- **Aerial ignition**. Use of aerial incendiaries is essential to cover large or inaccessible burn areas and to maximise efficiency of resources, particularly in winter when the burning times are reduced to two to four hours between 11:00 am and 3:00 pm. Reduced burning times are an important tactic for creating landscape mosaics in the absence of fire lines. Morning frosts and dew which remain longer in shaded areas are also useful to create patchy burns. Lighting patterns will need to be adjusted to achieve greater fire coverage for wildfire mitigation zones. Lighting along strategic ridgelines will reduce fuel in wildfire corridors and allow fire to trickle down slopes and extinguish in more moist areas.
- **Spot ignition.** Applies to aerial and ground ignition and can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of 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 and fuel loads. In the flatter country of northern and western parts of the bioregion, spacing is more easily regulated whereas rugged or hilly areas will require continual adjustment of intervals.
- **Create a running fire** where you need fire to carry due to cooler conditions, high moisture levels or lack of fuels.
- C**ommence lighting on the leeward (smoky) edge** to create a containment edge for a higher severity fire ignited inside the burn area.

Issue 8: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses, as they can dramatically increase fire-severity and can be promoted by disturbances such as fire. Invasive grasses can result in significant impacts upon native vegetation. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires gradually resulting in the overall decline of eucalypt community health and diversity.

Issue 9: Manage lantana

Refer to Chapter 12 (Issue 6), regarding fire management guidelines.

The presence of weeds such as lantana *Lantana camara*, mother of millions *Bryophyllum* spp. and parthenium weed *Parthenium hysterophorus* may require an altered approach to fire management (for well-established infestations this may include the integrated use of fire and herbicide).

Issue 10: Manage rubber vine

Refer to Chapter 12 (Issue 7), regarding fire management guidelines.

Rubber vine *Cryptostegia grandiflora* is an aggressive, vigorous climber that can rapidly spread and smother a range of vegetation communities, most notably riparian zones and waterways. Fire has been proven to be an effective control measure for rubber vine as well as being an effective follow-up to other control methods such as mechanical and herbicide control.

Chapter 2: Grasslands

The grasslands of the Brigalow Belt bioregion occur on rocky islands, coastal hills and floodplains, flats, plains and undulating hills throughout the bioregion. These communities are diverse and their composition varies greatly depending upon climatic zone, annual rainfall, geology/soil type and topography. Grasslands generally grow to one metre in height and are characterised by a single grass layer. However, legumes and other herbs, scattered shrubs and trees such as Moreton Bay ash, bloodwood, mountain coolabah, coolabah and brigalow may also be present (QPWS nd.). Grassland communities of the Brigalow Belt bioregion include kangaroo grass *Themeda triandra*, spinifex *Triodia* spp., Mitchell grass *Astrebla* spp. and bluegrass *Dichanthium* spp. Of these grasslands, Mitchell and bluegrass grasslands are the most common.

Fire management issues

While fire plays an important role in maintaining these communities, any sort of disturbance (including inappropriate fire) facilitates the spread of exotic species into grasslands and poses a significant threat to these communities. The occurrence of invasive grasses such as buffel grass significantly increases available fuel loads in some grasslands and in-turn the potential frequency and intensity of fires. Post-fire, these invasive grasses can rapidly form dense swards, displacing native grass species—which also require fire but respond more slowly.

Issues:

1. Maintain tussock grasslands.
2. Maintain spinifex grasslands.
3. Manage invasive grasses.

Extent within bioregion: 516 922 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Albinia National Park, 4 023 ha; Ula Ula State Forest, 1 886 ha; Albinia (Rolleston - Springsure Rd, Proposed National Park), 1 368 ha; Culgoa Floodplain National Park, 1 349 ha; Peak Range National Park, 716 ha; Moranbah Quarry Reserve, 351 ha; Mazeppa National Park, 250 ha; Townsville Town Common Conservation Park, 247 ha; Carnarvon National Park, 191 ha; Bowling Green Bay National Park, 155 ha; Magnetic Island National Park, 140 ha; Albinia Conservation Park, 140 ha; Mount Hope State Forest, 82 ha; Tregole National Park, 55 ha; Albinia Resources Reserve, 37 ha; Pluto Timber Reserve, 37 ha; Bowling Green Bay Conservation Park, 30 ha; Nogoa River Proposed National Park, 22 ha; Blair Athol State Forest, 19 ha; Cape Pallarenda Conservation Park, 14 ha; Fairbairn State Forest, 11 ha; Theodore State Forest, 9 ha; Roundstone State Forest, 8 ha; Dawson Range State Forest, 5 ha; Gloucester Island National Park, 4 ha; Vandyke Creek Conservation Park, 3 ha; Sandfly Creek (South Bank of Ross River), 1 ha.

Issue 1: Maintain tussock grasslands

Use regular low severity mosaic fires to maintain tussock grasslands.

Awareness of the environment

Key indicators of healthy tussock grasslands:

- The ground-layer is characterised by a continuous stand of bluegrass *Dichanthium* spp. or Mitchell grass *Astrebla* spp. These grasses grow as tussocks and can vary greatly in diameter.
- Other grasses including wiregrasses *Aristida* spp., kangaroo grass *Themeda* spp. and forbs are present particularly after good seasonal rains.
- Scattered eucalypts, acacia and a mix of shrubs including *Eremophila* spp. may be common.
- Native perennial grasses dominate the environment.

Mitchell grasslands tend to be a self-mulching community. While some dead material is present in the tussock there is not as much as grasses such as kangaroo grass.
Paul Williams, Vegetation Management Science Pty Ltd (2008).

Healthy Bluegrass downs.
Rhonda Melzer, QPWS, Albinia National Park (2009).

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

The following may indicate that fire is required to maintain tussock grasslands

- There is some dead material in the tussock.
- Gidgee, *Eremophila* spp. has become common.
- The diversity and abundance of forbs and herbs has declined.
- The crowns of satin top *Bothriochloa erianthoides* grasses are dead.
- It is difficult to walk through unimpeded.
- Fuel loads have reached more than 1200 kilograms per hectare (in some cases this may take up to 15 years to accumulate). It is unlikely that fires would carry prior to this time. It may take a series of wet years for this fuel level to occur.

Healthy Mitchell grassland. This area could be considered for a planned burn.

Don Butler, Queensland Herbarium.

Native perennial grasses such as black speargrass (foreground) are often abundant in bluegrass downs. This area could be considered for a planned burn.

Rhonda Melzer, QPWS, Albinia National Park (2007).

Discussion

- The structure of tussock grasslands can vary and will depend upon past fire and grazing history, soil type, local drainage conditions and levels of seasonal rainfall (winter and summer). For example, Mitchell grasslands in the north of the Brigalow Belt bioregion are likely to be more influenced by summer rains which produce a wide variety of both annual and perennial grasses and forbs between the tussocks while communities with significant winter rainfall generally contain a higher proportion of shrubs and trees (Orr 1975).
- Altered land use has largely confined grassland communities to protected areas, roadside verges and the corners of cropped paddocks (QPWS nd.). Surrounding land use and fragmentation has also had a significant impact on use of fire and therefore conservation of grasslands (Myers et al. 2004).
- Flinders grass *Iseilema* spp. is a native annual grass commonly occurring within Mitchell grasslands and turns orange when it is beginning to die off in the late wet season. Where Flinders grass is the dominating grass, it may indicate that other tussock grasses and other native perennials have declined in abundance, possibly as a result of significant disturbance (e.g. overgrazing) in the past. Allow the community to recover (which will generally require several good rainfall seasons) prior to introducing fire.
- A too severe or too dry fire that causes the removal of grass bases will often kill the grass tussock and gives a competitive advantage to weeds and woody species.
- Two fires in quick succession can assist in controlling some species such as *Eremophila* spp. from tussock grasslands where overabundance may be becoming an issue.
- Post fire, it is important to keep stock off tussock grasslands for a minimum of six months to allow native grasses to seed.
- Be aware that some tussock grasslands may exist as a result of historic clearing practices. The land manager, when considering management of their reserve, must judge the relative merit of retaining its value as grassland using fire, or let it transition into a woody community especially if the latter is an endangered ecosystem.

What is the priority for this issue?

An endangered community, maintaining healthy Mitchell and bluegrass is a **very high** priority, however burning this community is reliant upon seasonal rainfall and growth post rainfall. Therefore planned burns in these communities may be a **medium** priority until the desired rainfall levels and resulting growth are observed.

Priority	Priority assessment
Very high	Planned burn required to maintain areas of **special conservation significance**.
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**.

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 the following as appropriate for the site:

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:** > 95 % recover. **Partially Achieved:** 90–95 % recovers. **Not Achieved:** < 90 % recovers. **Or** Exotic grasses were promoted.
> 75 % of woody saplings/ seedlings. < 1 m in height is 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); estimate the percentage of saplings/seedlings scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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 grasslands it is important to maintain the mix and diversity of native perennial grasses (including endangered species such as *Dichanthium queenslandicum*). Consider monitoring woody thickening in areas where it can potentially become an issue. This is easy to achieve in grasslands by using satellite imagery or establishing observation points.

Bluegrass downs often occur amongst other communities such as open eucalypt forests.
Rhonda Melzer, QPWS, Buckland (2011).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Patchy** to **low** with the occasional **moderate.** An occasional moderate-severity fire helps to ensure emerging overabundant trees are managed.

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 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 three to 15 years for **Mitchell** grasslands and between five to 10 years for **bluegrass** and other tussock communities.
- Be aware that some years will be wetter or drier than normal. If poor seasons continue a fire interval of up to 20 years may be required.

Mosaic (area burnt within an individual planned burn)

- Use appropriate tactics and burn with good soil moisture to assist in creating a mosaic. Due to the contiguous nature of fuel, the entire planned burn area can burn with little or no internal unburnt patches. As such, a mosaic may only be possible if planned at a landscape level (by targeting different areas in different years).

Landscape Mosaic

- In general, within the management area, do not burn more than 20 per cent of grasslands within the same year. In particularly good seasons, it may be beneficial to burn more than 20 per cent and in very poor seasons it may be necessary to minimise the amount of planned burning.

Black wattle encroachment into bluegrass/ Mitchell grassland. An occasional moderate-severity fire helps to ensure emerging overabundant trees are managed.

Paul Lawless-Pyne, QPWS, Peak Range National Park (2010).

Due to the contiguous nature of fuel associated with some grasslands, the entire planned burn area can burn with little or no internal patchiness, especially as a result of wildfires. A mosaic is often only possible at a landscape level by targeting different areas in different years.

Bernice Sigley, QPWS, Marlong Plain (2006).

Other issues

- A moderate severity fire may be required when targeting woody species that are starting to become abundant. Ensure good soil moisture at the time of burning so as not to exacerbate the issue, and to promote rapid regeneration of native species.
- In areas that are being grazed, a reduction in cattle grazing in the months prior to undertaking a planned burn may be required in order to achieve the desired fire severity (Crowley 2003).
- Grazing should be excluded after a fire to permit recovery and seeding of grasslands to occur.
- Grassland fires can produce a lot of smoke. Be aware of the need to plan to minimise smoke impacts on urban settlements and roads.

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.

Season

- Late wet season to early dry season (e.g. March to April) and concentrate efforts after years of good rainfall. It is important to regularly monitor tussock grasslands to ensure encroachment and establishment of woody species is minimised. Be prepared to implement fire to address this issue when possible, as conditions allow.
- 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 to carry a fire. Often this will be dependant upon the objectives of the burn and the curing percentage required to achieve this.
- Avoid burning following frosts and during drought or periods of low soil moisture.

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 encouraging regeneration of grasses and retain grass bases. Timing burns to coincide with follow up rain will further assist in promoting grasses.
- Heavy dew at night is preferred when burning bluegrass downs as often this will cause the fire to extinguish overnight. It is important to have a good understanding of local and forecasted conditions. Align burns with expected rain events and be aware that often a number of consecutive heavy dew events may signal rain.

Temperature: Be aware that grass growth and recovery post fire is slower in winter which may result patches of bare ground for longer periods and provide the opportunity for erosion or encroachment of weeds.

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

GFDI: < 7.

DI (KBDI): < 100.

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** 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 and create hot junction zones) while increased spacing between spots or alternatively a single spot ignition will result in a lower intensity fire and greatly varied mosaic of unburnt and burnt patches. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **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.
- **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 in addressing the issue of encroachment of woody species.

Spot lighting using matches spaced every 50–100 m 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 2: Maintain spinifex grasslands

Use regular low-severity mosaic fires to maintain spinifex grasslands.

This vegetation group is characterised by a continuous cover of dense spinifex *Triodia* spp. clumps with some scattered isolated shrubs (wattles). Forbs, legumes, grasses and sand patches may also be found within the interspaces between spinifex clumps.

Awareness of the environment

Key indicators of healthy Spinifex grasslands:

- Ground layer is characterised by a continuous stand of spinifex grass *Triodia* spp. that grow as hummock clumps and can vary greatly in diameter.
- Other grasses including wiregrasses *Astrida* spp., Mitchell grass *Astrebla* spp. and forbs will also be present, particularly after good seasonal rains.
- Scattered eucalypts, acacia and a mix of shrubs may be common.
- Often there will be an abundance of native perennial grasses.

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.
- Spinifex hummocks are contiguous and able to carry even a low-severity fire.
- It may be difficult to walk through the grassland unimpeded.

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

Discussion

- The hummock structure of spinifex grasslands can vary and will depend upon past fire and grazing history, soil type, local drainage conditions and levels of seasonal rainfall (winter and summer).
- 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 promotes rapid post-fire spinifex seedling establishment. Burning without soil moisture will often kill the spinifex hummock and/or slow seedling establishment and give a competitive advantage to weeds and woody species.
- Even though spinifex communities are the most fire prone vegetation community in the Brigalow Belt, fauna diversity is often dependant on creating a mosaic of habitats using fire (Wilson 1992).
- Two fires in quick succession (if climactic conditions permit) can assist in controlling some species such as *Callitris* spp. and *Eremophila* spp., in Spinifex grasslands where overabundance may be becoming an issue.

Strip burning spinifex to generate a long backing fire.
QPWS, Welford National Park (1993).

What is the priority for this issue?

Maintaining healthy spinifex grasslands is a very high priority; however the burning of this community is reliant upon seasonal rainfall and grass 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:** > 95 % recovery. **Partially Achieved:** 90–95 % recovery. **Not Achieved:** < 90 % recovery. **Or** Exotic grasses were promoted.
> 75 % of woody saplings/ seedlings. < 1 m in height is 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); estimate the percentage of saplings/seedlings scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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.

It is important to maintain the mix and diversity of age classes and native herbaceous species within spinifex grasslands. Monitor woody thickening where it can become an issue. This is easy to achieve in grasslands by using satellite imagery and/or establishing observation points.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Patchy** to **low** and with the occasional **moderate**-severity fire.

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.

Spinifex recovering after a high intensity fire used to reduce overstorey vegetation thickening.
Stephen Peck, QPWS, Alton National Park (2009).

Strip burn lighting in areas of discontinuous spinifex hummocks may be required to carry fire.
Robert Murphy, QPWS, Craven Peak Nature refuge (2011).

Fire frequency / interval (refer to Appendix 2 for 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). This may be dependent upon growth post-wet season. Consider a broad fire interval range of between 10–20 years.

Mosaic (area burnt within an individual planned burn)

- Use appropriate tactics and burn with good soil moisture to assist in creating a mosaic.

Landscape Mosaic

- In general, within the management area, do not burn more than 20 per cent of spinifex community within the same year. In particularly good seasons, it may be beneficial to burn more than 20 per cent and in very poor seasons it may be necessary to minimise the amount of planned burning.

Other issues

- A moderate severity fire may be required when targeting woody species that are starting to become overabundant (DERM 2002). 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.

In areas of discontinuous spinifex hummocks, it may be difficult to get the desired coverage during low wind conditions.

QPWS, Welford National Park (1993).

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.

Season:

- Burn during the wet season to early dry season and concentrate efforts after years of good rainfall. It is important to regularly monitor spinifex grasslands to ensure they are maintained, remain open and avoid the encroachment and establishment of woody species. Implement fire to address woody species establishment as soon as sufficient fuels are available, as woody species are more likely to be fire killed when young.
- A mosaic of storm season fires will limit the chance of extensive wildfires occurring later in the dry season (Crowley 2003).
- Spinifex has highly volatile resin content and for this reason is not reliant upon complete curing to carry a fire. Moisture and wind are the primary factors in determining how effectively a burn will carry across the landscape.

GFDI: < 7

DI (KBDI): < 100

Temperature: Be aware that grass growth and recovery post fire is slower in winter which may result patches of bare ground for longer periods and provide the opportunity for encroachment.

Wind speed: Beaufort 1–2, or < 10 km/hr. Some wind is required to help carry the fire through the grasslands.

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

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). 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** 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 and create hot junction zones) while increased spacing between spots or alternatively a single spot ignition will result in a lower intensity fire and greatly varied mosaic of unburnt and burnt patches. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low-intensity backing fire. Depending on the available fuels and prevailing wind on the day this may require either spot or strip lighting or a combination of both.
- **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 in addressing the issue of encroachment of woody species.
- **Storm burning.** When possible, aim to conduct planned burns from the early wet season to mid dry season following sufficient rain to ensure good soil moisture throughout the site (including drainage lines). Good soil moisture indicators are moist peat, visible surface water and the likelihood of rain in the day's post burn is high.

Issue 3: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses. These grasses can dramatically increase fire severity and are promoted by disturbances such as fire. The establishment of these grasses often results in significant damaging impacts upon 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. This gradually results in the fragmentation and overall decline of grasslands.

Chapter 3: Heath and shrublands

Heaths are shrubby communities (typically up to two metres) that are treeless or contain only scattered trees (Keith et al. 2001). Within the Brigalow Belt bioregion, heath and shrublands are found on coastal hills and headlands and inland on sandy plains, ridges, slopes, sheltered rocky gullies and mountain tops. In shrublands on coastal ranges brush box *Lophostemon confertus* is common in the canopy with understorey species such as grass trees *Xanthorrhoea* spp. and *Acacia* spp., and sparse ground layer species such as grasses and mat rushes *Lomandra* spp. The structure of the understorey and groundcover may differ where this community occurs in gullies and margins mixed with rainforest species (Lynn 2009). Shrublands on inland sandy plains may be dominated by *Melaleuca tamarscina* with a spinifex ground layer. The vulnerable shrubs *Babingtonia papillosa* and *Leucopogon cuspidatus* (Queensland *Nature Conservation Act 1992; Commonwealth Environment Protection and Biodiversity Conservation Act 1999*) are also found within the montane shrublands. Pumpkin Gum *Eucalyptus pachycalyx* subsp. *Waajensis* is listed as endangered and occurs as an isolated patch on Barakula. It is particularly vulnerable to extinction when inappropriate fire regimes in the surrounding heaths impede regeneration events.

Fire management issues

Burning of heath and shrublands is usually planned in association with the surrounding fire-adapted communities. Implementation of mosaic burning in and around these communities helps achieve a sufficient patchiness to mitigate against the effects of too frequent and extensive wildfires on heath and shrublands particularly where they occur as isolated pockets (e.g. montane), while also promoting a good diversity of flora of differing ages.

Issues:

1. Maintain healthy heath and shrubland communities.
2. Manage lantana.

Extent within bioregion: 43 999 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Gurulmundi State Forest, 3 694 ha; Condamine State Forest, 1 931 ha; Barakula State Forest, 1 828 ha; Diamondy State Forest, 1 659 ha; Minerva Hills National Park, 996 ha; Mount Abbot National Park (Scientific), 602 ha; Bowling Green Bay National Park, 483 ha; Rose Lea Land, 441 ha; Cape Upstart National Park, 414 ha; Baywulla State Forest, 395 ha; Yule State Forest, 383 ha; Amaroo State Forest, 289 ha; Humboldt State Forest, 277 ha; Camboon State Forest, 190 ha; Humboldt National Park, 140 ha; Trevethan State Forest, 137 ha; Mundowran State Forest.

Issue 1: Maintain healthy heath and shrubland communities

Maintain heath and shrubland communities by burning in association with the surrounding fire-adapted landscape.

Awareness of the environment

Key indicators of healthy heath and shrubland communities
Coastal heaths and shrublands on rocky outcrops:

- The canopy is characterised by trees and shrubs including Queensland peppermint *Eucalyptus exserta*, brush box, *Leptospermum* spp., and acacias.
- The ground layer is often sparse and includes a mix of *Xanthorrhoea* spp., grasses such as kangaroo grass *Themeda triandra*, lomandra and/or sedges.

Inland heath and shrublands:

- On sand plains the canopy is characterised by *Melaleuca tamarascina*. On sandstone plateaus *Calytrix* spp., *Kunzea* spp., and *Micromyrtus* spp. are common.
- Some fire-killed shrubs (obligate seeders), including *Acacia tenuissima* are present.

Inland heath and shrublands. Commonly occurring shrubs in the canopy include *Acacia complanata* and *Acacia julifera*. A very common low shrub is *Keraudrenia collina*.
Andrew Dinwoodie, QPWS, Minerva Hills (2011).

Signs of where fire management is required:

- Post fire, the sucker regrowth of shrubs has returned to pre fire height as indicated by the remaining dead stems.
- Where present, the new leaves of grass trees are starting to appear 'yellowish' or 'brownish' or (in longer unburnt areas) grass trees are beginning to form a thick 'skirt' of dead material around them and/or the canopy in general appears to have closed over.
- Shrubs have lost a significant amount of lower level leaves, or crowns of shrubs are dying. Dead material is accumulating on shrubs.
- There is a noticeable loss of diversity in the shrub layer.

Spinifex is often present where this community occurs on hill slopes on trachyte. If the majority of clumps have begun to join it may indicate a need for fire.
Andrew Dinwoodie, QPWS, Minerva Hills (2011).

Discussion

- The fire management requirements of some of these communities and species are not well understood. Prior to implementing burns take time to familiarise with how these communities recover post fire (e.g. seed or re-sprouting) and their rate of recovery (e.g. seed-set time of obligate seeders). By continuing to observe the recovery of the area post fire our knowledge of fire management in these communities will improve.
- Obligate seeders are common in heath and shrublands. It is important to allow seedlings sufficient time to mature and set seed (more than once) prior to fire exposure.
- The communities can be prone to frequent and extensive wildfires. Fuel reduction burning in strategic wildfire corridors (e.g. along ridge tops) and mosaic burning both within this community and in the surrounding area is key to mitigating the impacts of unplanned fire.
- These communities are generally self-protecting where they occur in moist gullies—it is unlikely that fires undertaken in surrounding areas will carry into these areas.
- Implementing fire during drought conditions is not recommended as in most instances plants will be drought 'stressed' and this will impact upon post fire recovery of the plants and community generally. The resulting fire can also be expected to be more damaging and extensive and may also encourage the invasion of undesirable species.
- Inland heath and shrublands are often heavily broken with natural features such as rocky areas and creek lines. Fires in these areas tend to be limited in extent (except in dry conditions) which helps to create a finer scale mosaic.
- Shrubby communities usually occur as small islands amongst grassy communities. Shrubs in heath and shrublands often have very slow growth rates and require longer fire frequency to mature and commence seed production.
- Pumpkin Gum *Eucalyptus pachycalyx* subsp. *Waajensis* occurs within heathlands in Waaje Scientific Area on Barakula State forest. Extensive history of wildfires has adversely impacted on the health, and retention and recruitment of species. Using these burn guidelines will reduce the incidence of wildfires and encourage future regeneration.

Post wildfire, this photo shows how rocky outcrops can break up the extent of fires, ensuring some unburnt areas remain. This is particularly important to ensure survival of species such as the vulnerable shrub *Babingtonia papillose* (inset) which is found in these areas.

Paul Williams, Vegetation Management Science Pty Ltd.

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**.

Fires that pose the greatest threat to heath and shrublands are those that originate from lowland fire-adapted communities and at drier times when natural barriers are less likely to break up the run of the fire.

Rhonda Melzer, QPWS, Mount Wheeler (2011).

The post-fire coppice shoots of *Melaleuca tamarascina* may take six to nine years to return to mature heights (depending on rainfall).

The photo left shows *Melaleuca tamarascina* prior to being burnt. The photo below shows the height of the coppice growth three years post-fire at the same site.

Once sucker regrowth has reached the height of the dead stems that persisted after the previous fire, and has seeded, it is an indicator that fire can be implemented into the area.

Paul Williams, Vegetation Management Science Pty Ltd, Blackwood National Park (1999 and 2006).

Assessing outcomes

Formulating objectives for burn proposals

Measurable objectives	How to be assessed	How to be reported (in fire report)
A mosaic pattern of burnt and unburnt areas is achieved, within the aerial ignition footprint, reflecting topographical features that break up the burn.	Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air.	**Achieved:** Mosaic achieved within aerial ignition footprint. **Not Achieved:** Fire extended beyond aerial ignition footprint.

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.

Some locations, such as where endangered pumpkin gum *Eucalyptus pachycalyx* subsp. *Waajensis* exists in Barakula State Forest, have photo points and tagged trees to assist with long term monitoring.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Various** – moisture, topography, and natural barriers (e.g. rocky outcrops) will influence the severity and coverage of fire in this community.

Fire severity class	Fire intensity (during the fire)	Fire severity (post-fire)
	Average flame height (m)	Description (loss of biomass)
Patchy (P) to Low (L)	< 1.0	40–60 % vegetation burnt. Unburnt vegetation (green patches) in the ground and shrub layer. Does not remove all the surface fuels (litter) and near surface fuels. Can create distinct 'holes' in closed heath. Overall little canopy scorch. Some scorching of shrubs and small trees.
Moderate (M) to Extreme (E)	> 1.0	Greater than 60 % vegetation burnt. Understorey burnt to mineral earth. Extensive to total foliage burnt. Minimal evidence of green vegetation remaining. Skeletal frames of shrubs.

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

Fire frequency / interval (refer to Appendix 2 for 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 seven to fifteen years.
- Repeated fire intervals of less than seven years are believed to be too short to replenish seed reserves of most fire-killed species in heath and shrublands. This leads to the gradual decline in extent and/or loss of local populations (Williams et al. 2006).

Landscape Mosaic

- The main concern for these communities is repeated fire events of too short an interval that burn extensive areas during the one event.
- Aim to maintain appropriate mosaic burning in surrounding fire-adapted areas to minimise the risk of these communities burning too frequently and extensively by unplanned fires.

Other considerations

- Use good soil moisture, appropriate weather conditions and tactics that utilise landscape features (e.g. drainage lines and rocky outcrops) to ensure the resulting fire is patchy and of a low severity.

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.

Season: Aim to target surrounding areas in late wet season to early dry season (March to May)

FDI: As per the requirements of surrounding communities

DI (KBDI): As per the requirements of surrounding communities

Wind speed: Near-stable conditions to enable aerial operations

Relative humidity: Burning in high humidity conditions (such as before rain, during low cloud cover or during the evening) is a tactic used to limit spread of fire into these communities (it also ensures the resulting fire is of a low severity and has a high chance of extinguishing overnight).

Soil moisture: Health and shrubland communities are influenced by local conditions (e.g. coastal heaths and shrublands on rocky outcrops can receive regular moisture or rain but are also exposed to strong winds and can dry out very quickly—particularly where they occur on granitic soils). Banks of orchids and basket ferns can be common on rock faces and in rocky shelters. Ensure good soil moisture exists to avoid burning these.

Other considerations:

- The key fire management approach in this fire vegetation group is aerial ignition early in the season before the community dries out. The moist conditions and natural barriers help control the spread of fire and create a natural mosaic of burnt and unburnt areas. This helps address the issue of unplanned fire repeatedly burning extensive areas in dry conditions, and therefore helps to maintain fire frequencies and species diversity.
- Burning can be effectively undertaken in the rain in some of these communities.
- Late wet to early dry season fires in surrounding communities are usually preferable as they will usually not carry far into ecosystems on rocky outcrops.
- Plan to avoid dry conditions in which the fire will carry beyond planned burn footprints in surrounding fire-adapted communities.

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.

- **Burn in association with the surrounding landscape**. Heath and shrubland communities generally require much longer fire frequencies than the communities that surround them. Therefore burning of adjacent fire-adapted communities has to be planned with montane communities in mind.
- Burning is usually done by **aerial ignition mostly in adjoining areas** - with ignition initially along peaks, ridges and spurs to break up the fuel in and around the heath to control future unplanned fire emerging from lower areas. This provides some level of control with regard to how much of the heath burns at one time, creating the required longer fire frequencies as well as a landscape mosaic. This also helps to protect against wildfire. Inappropriate fire usually occurs in dry conditions where wildfire will carry over landscape features that would usually prevent fire entering heath communities.
- **Progressive burning** – commence burning in late wet season to early dry season to assist in creating a landscape mosaic and provide the opportunity to conduct later burns in surrounding areas throughout the year where conditions allow.

Pumpkin gum following a planned burn within a heath community. Note the old fire scars and fire-killed trees from earlier wildfire events.

Mark Cant, QPWS, Waaje Scientific area, Barakula State Forest (2008).

Issue 2: Manage lantana

Refer to Chapter 12 (Issue 6), regarding fire management guidelines.

Lantana can invade the edges of heath and shrublands increasing fuel loads and drawing fire into heath and shrubland communities.

Chapter 4: Melaleuca communities

This fire vegetation group includes melaleuca woodlands and open woodlands generally characterised by a mix of *Melaleuca* spp. including broad-leaved paperbark *Melaleuca viridiflora* on seasonally inundated flats and *Melaleuca dealbata* in dune swales with a canopy between eight to 15 metres often with Moreton bay ash *Corymbia tessellaris* co-dominating and scattered Queensland blue gum *Eucalyptus tereticornis*. Due to the differences in soil type and site drainage, there is often considerable variation in the mid to ground stratum. In general, wetter sites support an understorey of smaller trees including *Acacia crassicarpa*, *Livistona decora*, and sedges and herbs.

Fire management issues

There are considerable differences in where melaleuca communities occur in the landscape and in the types of vegetation communities that surround them. Approaches to fire management differ as a result. Where they occur as isolated stands within a broader fire-adapted community, the focus becomes the appropriate fire management of surrounding areas, allowing fire to carry into the community on some occasions. Where they occur as an extensive forest, a more direct approach to fire management may be required.

Melaleuca dealbata woodlands on dune swales are often heavily infested by invasive grasses such as guinea grass *Megathyrsus maximus* var. *maximus* and green panic Megathyrsus *maximus* var. *pubiglumis* and other weeds including lantana *Lantana camara*, rubber vine *Cryptostegia grandiflora* and Chinese apple *Ziziphus mauritiana* that may require an altered approach to fire management.

Issues:

1. Maintain healthy melaleuca communities.
2. Manage rubber vine.
3. Manage invasive grasses.
4. Manage lantana.

Extent within bioregion: 80 936 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Bowling Green Bay National Park, 1 365 ha; Broad Sound Islands National Park, 716 ha; Townsville Town Common Conservation Park, 447 ha; Bowling Green Bay Conservation Park, 146 ha; Sandfly Creek (South Bank of Ross River), 139 ha; Cape Upstart Reserve for Env Purp (Adj to Cape Upstart NP), 121 ha; Cape Upstart National Park 96 ha; Abbott Bay Resources Reserve, 79 ha; Proposed Cromarty Wetlands Conservation Park, 49 ha; Charon Point Conservation Park, 43 ha; Keppel Sands Conservation Park, 8 ha; Capricorn Coast National Park, 4 ha; Horseshoe Bay Lagoon Conservation Park, 4 ha; Causeway Lake Conservation Park, 3 ha.

Issue 1: Maintain healthy melaleuca communities

Use fire within melaleuca communities and surrounding fire-adapted communities.

Awareness of your environment

Key indicators of a healthy melaleuca community

Melaleuca/eucalypt woodland on beach ridge and swales:

- Beach ridge woodland is often dominated by *Melaleuca dealbata* (and sometimes *Melaleuca leucadendra* or *Melaleuca Viridiflora*), with Moreton Bay ash *Corymbia tessellaris* commonly present.
- The understorey may be dominated by *Acacia* spp., with a sparse to dense shrub layer of species such as *Pandanus spiralis*, grasses, shrubs, sedges, vines or a mixture of plants that can vary depending on the previous fire regimes.
- Melaleuca trees of varying ages and sizes are scattered among the understorey—enough to eventually replace the canopy.
- Weed species are uncommon.

Melaleuca on poorly drained soils:

- Melaleuca communities that occur on poorly drained soils in low lying areas are generally dominated by *Melaleuca viridiflora*.
- *Melaleuca* spp. have on average reached their maximum height (this is a mature forest of melaleuca and is not a regenerating stand). In most cases the trees will be between five and eight metres in height.
- The understorey is often diverse and will typically include *Xanthorrhoea* spp., grasses, shrubs and sedges.
- Melaleuca trees of varying ages and sizes are scattered among the understorey—enough to eventually replace the canopy.

A melaleuca woodland with a mixed understorey.
Paul Williams, Vegetation Management Science Pty Ltd.

The following may indicate that fire is required to maintain a melaleuca community

Melaleuca/eucalypt woodland on beach ridge and swales:

- Large skirts of dead material have formed on pandanus trees.
- Fuels such as leaf litter, dead grass, suspended leaf litter, bark and twigs are beginning to accumulate.
- Weeds are beginning to dominate.
- Rainforest and woodland pioneers are starting to colonise the understorey, and shade-out ground-layer plants.

Melaleuca on beach ridge and swales. Grasses are declining in health, weeds are starting to dominate and there is a high accumulation of fuels.
Paul Williams, Vegetation Management Science Pty Ltd.

Melaleuca on poorly drained soils:

- Melaleuca regrowth has reached a height greater than five metres.
- Where they are present, shrubs have a build-up of dead leaves and/or dying branches.
- Ground-layer plants such as sedges are becoming sparse and/or are beginning to decline in vigour and abundance due to shading.
- Where once abundant, grasses are becoming sparse or grass clumps are poorly formed. There is an accumulation of dead material and grasses are beginning to collapse (no longer erect).
- Large skirts of dead material have formed on xanthorrhoea and pandanus.

Discussion

- *Melaleuca dealbata* communities are very sensitive to fire and can be easily damaged. Avoid burning or use only low intensity fire.
- For other melaleuca species fire poses little threat to mature trees. However, where a thicket of young melaleucas has developed the resulting fire can be of a much greater severity due to their proximity and fuel arrangement which can result in a much greater mortality of melaleuca.
- Where there is a peat substrate it is critical to burn with at least saturated soil, and preferably standing water, to prevent a peat fire which can in turn result in the death of even mature melaleucas.
- In most instances melaleuca/eucalypt woodland on beach ridge and swales is heavily disturbed and weed infested.
- The thick papery bark of melaleuca can promote ladder fires which will quickly run from the base to the top of the tree. Often these fires will self-extinguish without causing any damage particularly to mature trees (depending upon weather conditions and fire severity). Younger melaleuca trees will often respond post fire with a flush of regrowth from epicormic buds.

What is the priority for this issue?

Priority	Priority assessment
Very high	Planned burn required to maintain areas of **special conservation significance.**
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**.

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 the following as most appropriate for your site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Combined surface and near-surface fine fuel reduced to moderate.	**Post fire:** use the Overall Fuel Hazard Guide, to visually assess the remaining fuel in at least three locations.	**Achieved:** fine fuel reduced to Moderate. **Not Achieved:** fine fuel still High.
< 5 % mortality of mature melaleuca.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity); estimate the percentage of mature dead trees (approximately six months after the fire).	**Achieved:** < 5 %. **Not Achieved:** > 5 %.
	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 pandanus skirts remaining after fire.	**Achieved:** > 50 % retained. **Partially Achieved:** 25–50 % retained. **Not Achieved:** < 25 % retained.
The planned burn does not result in a peat fire.	Ongoing visual assessment during and post burn to ensure the fire has not carried into peat layer and developed into a peat fire.	**Achieved:** Fire did not carry into peat layer and develop into a peat fire. **Not Achieved:** Fire carried into peat layer and developed into a peat fire.

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** and occasionally **moderate** (particularly for weed control or overabundance issues).

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 (up to 8 m on melaleuca trees)	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 (up to 20 m on melaleuca trees)	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.

Melaleuca/eucalypt woodland with a mixed shrubby understorey on beach ridge and swales:

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

- *Melaleuca dealbata* can be killed by fire. Avoid burning healthy beach ridge systems or if fire is allowed to enter this community ensure it is of **low severity**. This will limit any potential impacts on trees (resulting in further disturbances to the canopy and greater opportunity for invasive grasses to spread) (Williams 2009).

Melaleuca on poorly drained soils:

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

- Planned burns in this community are usually conducted as part of burns in surrounding eucalypt woodlands.
- 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.
- Consider a broad fire interval of between three to seven years. Where areas have obligate seeders such as *Grevillea pteridifolia* or other fire-killed shrubs, leave longer intervals to allow post-fire seedlings to mature and set seed at least twice, before burning again.

Season: Early dry season (April to May)

FFDI: < 13

DI (KBDI): < 80

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

Soil moisture: Burn as early in the dry season as possible, when the surface material is dry enough to carry a fire but soil moisture and water retained in the melaleuca bark is high.

Other considerations

- If the substrate is organic/peaty, burning should only be carried out when the peat is saturated (can squeeze water from it) or covered by standing water.
- Planned burns following rain will help protect melaleuca trees and reduce ember spotting (due to the moisture retained in the bark).
- Several fires in quick succession have proven to be an effective treatment of rubber vine. However, where rubber vine is absent and exotic grasses dominate the ground layer, fire should be implemented only occasionally and strictly under mild conditions to produce a low-severity fire, as these grasses are fire promoted (Williams 2009). See issues two, three and four in this chapter for more information.
- The successful treatment of the weeds common within this community will require monitoring of the site and often follow-up herbicide treatment of any remaining plants and new seedlings.
- Some moderate severity fires may have to be planned to mitigate weed problems and overabundant saplings (sometimes forming whip stands of closely packed narrow trees).

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). 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.

- **Limit fire encroachment into non-target communities.** When burning in surrounding fire-adapted areas (and to limit fire penetration into melaleuca), appropriate lighting patterns along the margin of the melaleuca community may assist in creating a low-intensity backing fire that burns away from the non-target area. Or, where the melaleuca is low-lying (e.g. drainage lines), utilise the surrounding topography to create a low intensity backing fire that travels down slope towards the melaleuca community. In both instances ensure good soil moisture is present within the melaleuca community.
- **Spot ignition** is used to alter the desired severity of a fire. Well-spaced spot lighting adjacent to melaleuca stands is preferred to limit the chance of hot damaging junction zones forming within this community.
- A **low-severity backing fire with good residence time** (lit against the wind on the smoky edge or down slope) 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.
- **Commence lighting on the leeward (smoky) edge** to establish the initial fire-line, a safe perimeter and promote a low severity 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.
- **Line or strip ignition** can be used to create a fire of higher-intensity or to help carry fire through moist or inconsistent fuels. This tactic is also useful to reduce overabundant trees (through scorching).
- **Progressive burning** is a useful tactic to create variation, mosaics and take advantage of different conditions. This may also assist with fuel load management and reduce the severity and extent of wildfires. Fires (of varying extents, severity and at various times) are lit in fire-adapted communities from early in the year when conditions allow.

Issue 2: Manage rubber vine

Refer to Chapter 12 (Issue 7), for fire management guidelines.

Rubber vine *Cryptostegia grandiflora* is an aggressive, vigorous climber that can rapidly spread and smother a range of vegetation communities, most notably riparian zones and waterways. Fire has proven to be an effective control measure for rubber vine as well as an effective follow-up to other control methods such as mechanical and herbicide control (DEEDI 2011).

Issue 3: Manage invasive grasses

Refer to Chapter 12 (Issue 5), for fire management guidelines.

It is important to be aware of the presence of invasive grasses as they can dramatically increase fire severity, are often promoted by fire and may significantly damage vegetation communities. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires.

Issue 4: Manage lantana

Refer to Chapter 12 (Issue 6), for fire management guidelines.

The presence of weeds such as lantana *Lantana camara*, mother of millions *Bryophyllum* spp. and parthenium weed *Parthenium hysterophorus* may require an altered approach to fire management. For well-established infestations this may require the integrated use of both fire and herbicide.

Chapter 5: Wetlands and swamps

This fire vegetation group includes lagoons within beach dunes, freshwater wetlands and swamps. These communities are generally fringed by melaleuca and/or eucalypts often with a mix of sedges, forbs, and grasses. These may retain water permanently or dry out seasonally.

Fire management issues

Seasonal wetland and swamps with native grasses and sedges can benefit from occasional fires. Fire management within wetlands and swamps is usually planned in association with the surrounding fire-adapted landscape as these communities often occur as isolated areas surrounded by a mix of communities that require fire. Permanent wetlands will only burn when they are stressed by drought. Avoid burning permanent wetlands.

Most of the communities within this fire vegetation group are listed as either **'of concern'** or **'endangered'**, therefore maintaining healthy remaining examples of wetlands and swamps is a key conservation issue in the Brigalow Belt bioregion. The encroachment of aggressive exotic wetland pasture species such as para grass *Urochloa mutica* and olive hymenachne *Hymenachne amplexicaulis* pose a significant threat to wetlands and swamps and require an altered approach to fire management (see issue 2). These weeds can alter hydrology, increase fuel loads and out-compete native species such as bulkuru *Eleocharis dulcis* and the **'vulnerable'** *Paspalidium udum* (Williams and Collett 2009). Wetlands and swamps often have a well-developed peat layer, the burning of which must be avoided when undertaking planned burns both within these communities and in surrounding fire-adapted communities.

Issues:

1. Maintain healthy wetlands and swamps.
2. Manage invasive grasses.
3. Avoid peat fires.

Extent within bioregion: 44 917 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Bowling Green Bay Conservation Park, 591 ha; Bowling Green Bay National Park, 419 ha; Townsville Town Common Conservation Park, 299 ha; Lake Murphy Conservation Park, 285 ha; Culgoa Floodplain National Park, 269 ha; Lake Broadwater Conservation Park, 255 ha; Proposed Cromarty Wetlands Conservation Park, 159 ha; Carnarvon National Park, 147 ha; Kaiuroo Reserve 136 ha; Dawson Range State Forest, 79 ha; and other areas.

Issue 1: Maintain healthy wetlands and swamps

Use fire to maintain wetlands and swamps.

Awareness of the environment

Key indicators of healthy wetlands and swamps:

- A high diversity of mixed ground-layer plants exist in these areas and includes grasses such as swamp rice-grass *Leersia hexandra*, native rice *Oryza meridionalis*, and sedges such as bulkaru *Eleocharis dulcis*.
- Standing water is present but may also seasonally dry out.

Scattered trees such as eucalypts, swamp mahogany and melaleucas are present and in most instances will be restricted to the fringe of the wetland.

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

Depressions that seasonally dry out may occur in poplar box and blue gum woodlands.

Left: Chris Pennay, Queensland Herbarium, Yuleba Creek (2010). **Right:** Chris Pennay, Queensland Herbarium, Yuleba Creek (2009).

A dense cover of bulkuru is common in most swamps.
Chris Pennay, Queensland Herbarium, Menima swamp (2005).

Signs of where fire may be required:

- The wetlands seasonally dry out.
- There is a large accumulation of old paperbark on trees.
- A build-up of fuel around the bases of grasses and sedges. Grasses and sedges no longer erect, rather, they are beginning to collapse.
- Fuel perched on sedges and grasses.
- Melaleuca seedlings are present.
- Exotic pasture grasses such as para grass *Urochloa mutica,* olive *hymenachne Hymenachne amplexicaulis* are beginning to establish.

Discussion

- Avoid burning permanent wetlands that have temporarily dried out due to drought. Permanent wetlands do not require fire and may be damaged by fire.
- It is important to observe surrounding vegetation communities. If surrounding areas are showing signs of needing a fire, it may also indicate the need for a fire in seasonal wetlands and swamps.
- Wetlands play an important role in maintaining hydrological movement within the landscape. In long-unburnt areas, wetlands can accumulate very high fuel loads that can impede groundwater and surface-water flows and increase the risk of a peat fire developing. Peat fires should be avoided; however, some peat may unintentionally burn on occasion.
- Para grass can aggressively out-compete native species and can choke waterways and disrupt hydrological flows. A high-severity burn in the dry season may be useful to target para grass and open up waterways.

Be aware that swamps and lagoons that are too dry may result in a greater amount of area being burnt and potentially carry into surrounding areas and also impact upon swamp and wetland species.

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

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**.

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 the following as appropriate for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
The planned burn does not result in a peat fire.	Ongoing visual assessment during and post burn to determine if the fire has carried into peat layer and developed into a peat fire.	**Achieved:** Fire did not carry into peat layer and develop into a peat fire. **Not Achieved:** Fire carried into peat layer and developed into a peat fire.

Significant reduction in para grass.	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. Before fire and after suitable germination and establishment conditions (taking into account the variability of landform and likely fire intensity), define the density of the infestation using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater. abundance than target weed. • Medium (25–75 % cover) = roughly equal proportions of target weed and native species. • Dense (> 75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation drops two 'density categories' (e.g. from 'dense' before fire, to 'light' after fire). **Partially Achieved:** Weed infestation 'drops' one 'density category' (e.g. from dense before fire to light after fire). **Not Achieved:** No change in density category or weed density gets worse.

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

- Aim for a range of fire severities of between **Patchy** to **Low**. Ensure good soil moisture exists at the time of burning.
- A **high** severity fire may be required for specific objectives (e.g. when targeting para grass that is starting to become abundant).

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

- **Permanently inundated wetlands:** Avoid burning permanently inundated wetlands (they will not usually burn unless drought stressed).
- **Seasonally inundated wetlands:** Occasional fires. Protection relies on mosaic burning in surrounding country, with numerous small fires throughout the year so that wildfires will be very limited in extent.
- Where exotic grass weeds (such as para grass) have formed dense infestations in a wetland, consider a fire interval of between two to five years with the application of herbicide post-fire.

Mosaic (area burnt within an individual planned burn)

- The contiguous nature of fuel within some wetlands may result in the entire planned burn area burning with no internal patchiness. Good soil moisture may improve patchiness.
- Using good soil moisture (e.g. when sites are waterlogged or surface water is present) and variations in topography will assist in promoting a mosaic of burnt and unburnt areas.

Other issues

- It may only be possible to burn some wetlands when they dry-out seasonally, as they may be inaccessible or not flammable, at other times of the year. It is still important to ensure sufficient water is present to protect the bases of aquatic plants and avoid peat fires.
- Fires within wetlands and swamps can produce a lot of smoke—plan to minimise smoke impacts on urban settlements and roads.

Be aware that invasive grasses such as para grass will greatly increase fuel loads, fire severity and flame height. The photo above (taken pre-fire) and the photo below (taken post-fire) illustrate Melaleuca dealbata death as a result of para grass-caused high-severity fire.

Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common Conservation Park.

Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common Conservation Park.

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.

Season:

- Burning can begin very soon after the wet season (March to April). This will secure boundaries particularly when burning areas adjacent to fire-sensitive vegetation and will allow late dry-season burns to be implemented safely.
- Burn from mid to late dry season (August to November) to effectively target para grass.

FDI and DI (KBDI): As per the requirements of surrounding communities.

Wind speed: Beaufort scale 1–4, or < 23 km/hr. Some wind is usually required to ensure the fire will carry.

Soil moisture: standing water or waterlogged soil or peat should be present in order to avoid peat fires and protect bases of aquatic plants.

Bulkuru and *Paspalidium udum*. Burning early in the dry season when there is free standing water is often useful to create natural barriers and a greater mosaic of burnt and unburnt patches, and to support burning later in the year.

Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common Conservation Park (2009).

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.

- **Progressive burning.** Fires (of varying extents, severity and at various times) that are lit within swamps, wetlands and in surrounding fire-adapted communities will create burnt-out areas that will help to contain fires implemented in the mid to late dry season.
- **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.
- **Line or strip ignition** can be used to create a fire of higher intensity or to help carry fire through moist or inconsistent fuels.
- Creating a **running** fire (through closely spaced spot ignition or line ignition with the wind) may be a useful tactic in the control of para grass. Use with caution and an understanding of fire containment issues.

Progressive burning in the area surrounding a para grass infestation earlier in the year or timing burns when there is free standing water is often useful to support implementing a high severity burn later in the year (by providing barriers to fire movement).
Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common Conservation Park.

Issue 2: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

In the Townsville Town Common Conservation Park and in Horseshoe Bay Lagoon Conservation Park on Magnetic Island, fire has been used with success in combination with herbicide application to control aggressive, exotic wetland pasture species such as para grass *Urochloa mutica* and olive hymenachne *Hymenachne amplexicaulis*.

A sequence showing recruitment of native rice *Oryza meridionalis* post fire/herbicide treatment of para grass.

Spraying para grass during post-fire regrowth reduces its cover and promotes the spread of native grasses such as *Paspalidium udum*. Native grasses take advantage of gaps created in the groundcover (Williams and Collet 2009).

Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common Conservation Park.

Issue 3: Avoid peat fires

Refer to Chapter 12 (Issue 4), regarding fire management guidelines.

Often low lying communities such as wetlands and swamps gradually accumulate partially decayed, densely packed vegetation known as peat. In the absence of good soil moisture the peat is easily ignited resulting in a peat fire. Peat fires can burn for months, and can have very negative impacts on the vegetation community. Peat can take hundreds of years to re-form.

Chapter 6: Cypress and bull oak communities

Cypress and bull oak communities occur on a variety of landforms within the Brigalow Belt bioregion, predominately on plains and undulating hills. White cypress pine *Callitris glaucophylla* is the most common species and is widespread particularly throughout the south, and is also an economic (silviculture) resource. The structure of cypress stands varies, depending upon landscape features, the community's exposure to forestry practices and fire. Cypress stands may occur as open forests with associated eucalypts, as fragmented clumps (containing mature and young trees) or as a dense ('locked') stands of very large numbers of regenerating trees with few mature trees. Cypress and bull oak also occur as canopy or understorey trees within other fire vegetation groups. One of Australia's most threatened butterflies, the endangered bull oak jewel butterfly *Hypochrysops piceatus*, is reliant upon dense leaf litter and mature bull oaks as a host tree for the ant species *Anonychomyrma* spp., which attend the butterfly larvae (Lundie-Jenkins and Payne 2000). Maintaining bull oak forests and minimising excessive fire impacts are critical to the survival of the species.

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 bull oak community with fire. While cypress pine is a fire-sensitive species, low-severity fire plays a role in maintaining other elements of the community, especially in more open stands. Historically, fire was excluded in cypress production areas, particularly within areas subject to intensive silvicultural management (Taylor and Swift 2003). Absence of fire has promoted the formation of immature 'locked' stands, and has left cypress resources vulnerable to wildfire impacts. Planned burning to protect core cypress resources either directly (through fuel management burns within the site) or indirectly (by conducting burns within the surrounding area) is important to limit loss of production timber. Where cypress pine forests are removed from production and included within protected area estate there will be a need for the land manager to reassess fire management objectives and arrangements.

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 intensity.

Issues:

1. White cypress pine production forests.
2. Maintain open cypress pine forests.
3. Transition production stands to open forest.
4. Manage invasive grasses.

Extent within bioregion: 1 435 480 ha, 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Barakula State Forest, 95 114 ha; Kumbarilla State Forest, 55 512 ha; Yuleba State Forest, 55 178 ha; Western Creek State Forest, 53 746 ha; Oakvale State Forest, 40 196 ha; Whetstone State Forest, 29 298 ha; Pluto Timber Reserve 27 778 ha; Boondandilla State Forest, 23 935 ha; Yelarbon State Forest, 21 766 ha; Carnarvon National Park, 21 582 ha; Bringalily State Forest, 18 493 ha; Dunmore State Forest, 12 040 ha; Sunnyside State Forest, 11 970 ha; Hallett State Forest, 9 226 ha; Booroondoo State Forest, 7 549 ha; Koolbellup State Forest, 7 505 ha; Attica State Forest, 6 612 ha; Belington Hut State Forest, 6 480 ha; Braemar State Forest, 5 853 ha; Doonkuna State Forest, 5 777 ha; Chesterton Range National Park, 5 443 ha; Forrest State Forest, 5 046 ha; Ula Ula State Forest, 4 580 ha; Allies Creek State Forest, 4 461 ha; Kinkora State Forest, 4 329 ha; Combabula State Forest, 4 267 ha; Calrossie State Forest, 3 895 ha; Bendidee State Forest, 3838 ha; Bulli State Forest, 3 751 ha; Squire State Forest, 3 393 ha; Borania State Forest, 3 286 ha; Orkadilla State Forest, 2 892 ha; McLeay State Forest, 2 887 ha; Hillside State Forest, 2 500 ha; Currajong State Forest, 2 405 ha; Brucedale State Forest, 2 307 ha; Dawson Range State Forest, 2 107 ha; Woodduck State Forest, 2 002 ha; Kerimbilla State Forest 1, 1 926 ha; Kettle State Forest, 1 872 ha.

Issue 1: White cypress pine production forests

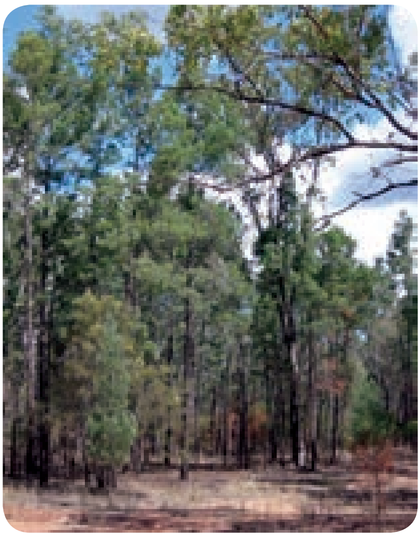
Use fire in adjoining areas to protect white cypress pine production forests.

Awareness of the environment

Indicators of a white cypress pine forest where fire exclusion is necessary:

- 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.
- The increased usage of state forests for the rapidly expanding coal seam gas industry has implications for fire management in these areas. Cleared production pads and extensive road networks limit the coverage of planned burns. There is also an increased presence of employees on the ground associated with the coal seam gas company. It is important to consult with representatives responsible for the company's activities when a burn is being planned.

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. **Or** Reduce fuel load to < 5 tonnes/ha.	**After the burn:** 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 Or fuel load has been reduced to less than five tonnes/ha. **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. **Or** **After the burn:** Walk through the site or representative sections (e.g. a 100m 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. **Partially Achieved:** 5–15 % of the area is scorched. **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. **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. **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 in 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 ten 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

- It is common 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 noon 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 2: Maintain open cypress pine forests

Use low-severity burning to maintain open cypress pine forests

Awareness of the environment

Indicators of healthy open cypress pine forests:

- Cypress (where it occurs as an open forest) may exist as a pure stand or can be associated with other species such as smooth barked apple *Angophora leiocarpa*, ironbark, bull oak *Allocasuarina luehmannii* or Moreton Bay ash *Corymbia tessellaris*.
- Some evidence of past fires (e.g. charring on trees) is present.
- Mature cypress trees often occur in distinct age classes through a number of germination events but not as a 'locked' stand of narrow immature cypress.
- Bull oak mistletoe *Amyema linophyllum* may be present on the branches of older bull oak trees.
- The mid and lower stratums are often sparse with a mix of smaller trees and shrubs, such as *Acacia* spp. and *Dodonaea* spp. with some young canopy species present (enough to eventually replace the canopy).
- Ground-layer vegetation can vary from sparse to dense and is often dominated by grasses such as hairy panic *Panicum effusum*, kangaroo grass *Themeda triandra*. Occasional forbs may be present.
- The leaf-litter may be thick and compact, discontinuous or sparse.
- Logs and branches are scattered.
- Overall, it is easy to see through and walk through.

A healthy open cypress pine forest with a shrubby understorey. In this photo young trees and shrubs are scattered and the ground-layer is sparse.

Mark Cant, QPWS, Wondul National Park.

A healthy open cypress pine forest with a mixed understorey. There is a good mix of young trees of varying species and ages.

Mark Cant, QPWS, Barakula State Forest.

Cypress and eucalypt co-dominant forest.
V.J. Neldner, Queensland Herbarium.

The following may indicate that fire is required to maintain open cypress pine forests

- A lack of diversity with cypress starting to dominate forming dense, 'locked' stands of young cypress trees usually of a height between one and three metres.
- An abundance of single age cypress of one to three metres.
- Cypress pines are beginning to shade-out understorey diversity and out-compete recruiting juvenile trees.
- The lower stratum has been shaded-out and ground-layer diversity has declined and/or is sparse.
- Where grasses were once common they are becoming sparser or for clumping grass species, the 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.

Young cypress pines have formed a dense 'locked' stand and have almost completely shaded-out the understorey. It would be difficult to introduce a planned burn into this site.

Mark Cant, QPWS, Gubbermunda State Forest.

Post clearing and grazing, young cypress have formed a dense stand and have almost completely shaded-out the understorey. It would be difficult for a planned burn to carry through this site.

A.R. Bean, Queensland Herbarium.

Discussion

- Protection of open cypress pine forests relies on low severity fire in and around the community, to mitigate impacts of wildfire.
- Appropriate fire management within open cypress pine forests avoids the formation of 'locked' stands. Mature and intermediate cypress trees will survive low-severity fires however, young trees and seedlings will not (Price and Bowman 1994). Applied in this manner, fire can be used to maintain the health of the cypress pine forest.
- One of Australia's most threatened butterflies, the 'endangered' bull oak jewel butterfly *Hypochrysops piceatus*, is reliant upon mature bull oaks as a host tree (Lundie-Jenkins and Payne 2000) and a thick leaf litter for its survival. Highs severity fires may remove leaf litter (disrupting the attendee ants) and burn mature bull oaks, impacting upon the survival of the bull oak jewel butterfly.
- Bull oak is an important food tree for the glossy black cockatoo.
- Cypress is particularly vulnerable to fire where there has been flame residence time at the base of the tree and complete charring or 'collaring' of the bark (some wind is advisable to avoid this).
- Dense 'locked' cypress stands will naturally exclude fire as they create a thick blanket of pine leaf litter and act as a 'wind break' that generally will impede fire spread and hamper planned burn efforts. Despite this, under severe weather conditions, they will burn with a very high to extreme severity with significant ecological impacts, including neighbouring areas (Taylor and Swift 2003).
- Cypress pine forests are an economic resource and are often managed in cooperation with other agencies including the DAFF. As part of the Western Hardwoods Process, a number of state forests and timber reserves that have retained some conservation values (some containing significant cypress communities) are progressively being transferred to protected area estate managed by the QPWS. Other areas of core cypress pine on State Forests are still currently available for timber harvesting.
- It will often be necessary to undertake cooperative planned burns in conjunction with other agencies (e.g. DAFF) to protect core cypress pine timber production forests.

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.

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: 1. Visual estimation of percentage of vegetation burnt, from one or more vantage points or from the air. 2. Map the boundaries of burnt areas with a GPS, plot on a GIS and thereby determine the percentage of area burnt. 3. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating the percentage of ground burnt within visual field.	**Achieved:** 40–60 % burnt. **Partially Achieved:** between 30–40 % and 60–80 % burnt. **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. **Partially Achieved:** 25–75 %. **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-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

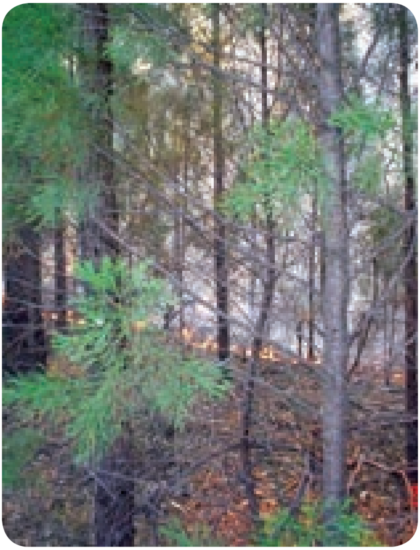
What fire characteristics will help address this issue?

Fire severity

- In general **low**, but vary with occasionally **moderate** to ensure the density of young cypress pines is 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.

Examples of low severity fires within cypress pine forests.

Stephen Berlin, DAFF.

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

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

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

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation, cypress flush** 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 eight years.

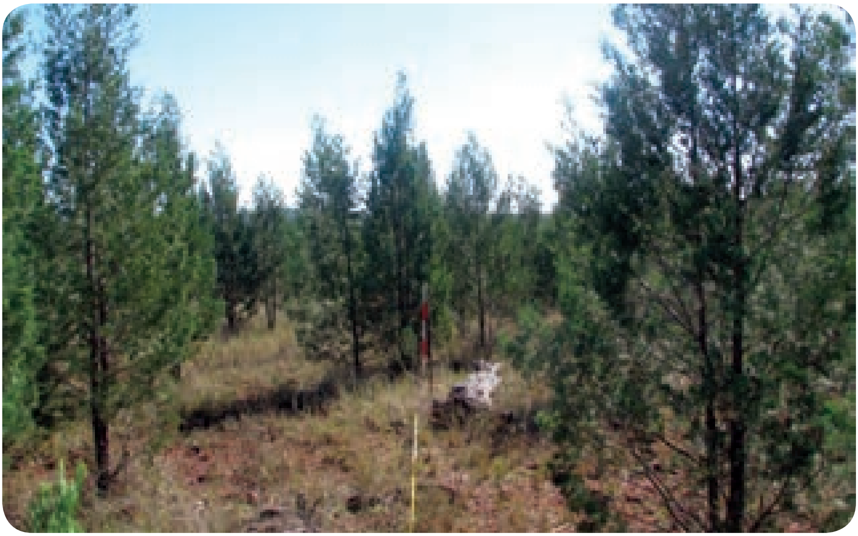
Mosaic (area burnt within an individual planned burn)

A mosaic is achieved with generally 40–60 per cent 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 has resulted in a flush of young trees, a fire frequency of less than six to eight years may be necessary (to reduce their number and assist in maintaining a diversity of cypress pine of varying ages).
- Long fire free intervals will ultimately lead to cypress dominance at the expense of other species, reduce the capacity to implement 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 pine forests.

Young cypress pines are encroaching and beginning to dominate—they will eventually shade-out the grasses. This site is still recoverable as the grass cover will still carry a fire.
Mark Cant, QPWS, Yeralbon State Forest (2005).



This photo depicts the same site four years later with no fire management. Young cypress trees have become established and grasses have become sparse. It would be difficult to recover this site due to the height of cypress pines and lack of fuel to carry a fire.
Mark Cant, QPWS Yeralbon State Forest (2009).

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).

Post high-severity fire. This fire has killed the mature cypress and bull oak trees and has resulted in the mass germination of acacia.

Bernice Sigley QPWS (2011).

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.

Season: Burn 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 1–4, or < 20 km/hr

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

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** is used to create variability in fire severity (which promotes a rich landscape mosaic) and limit the scorch and severity of the fire on upper slopes. Aerial ignition using aerial incendiaries from a fixed-wing aircraft or helicopter is often used in the Brigalow Belt bioregion due to the extensive areas requiring burns. It is important to respond to opportunities to burn as they become available. Gridding with a fixed wing aircraft allows a greater coverage of large, flatter areas while helicopters provide the opportunity to directly target topographical features such as peaks, ridges and spurs to create a backing fire downhill. 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. 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.
- **Smoke issues.** Cypress pine litter retains a high level of moisture and often low severity planned burns will carry across it removing only approximately the first 10 millimetres off of the top layer of litter. Fires in cypress pine litter will often smoulder for long periods of time and create abundant smoke. Be aware of potential smoke impacts on urban settlements. Planned burns in adjoining areas should avoid periods when the atmosphere is stable and likely to create an inversion layer when smoke is likely to persist. Rather burns should be undertaken when the prevailing weather conditions (in particular wind direction) will direct the resulting smoke away from settled areas. Standard neighbour notification protocols should be followed. Be aware that smoke issues will also impact on apiary sites which have bees on them. Consideration should be given to these users when planning to burn as smoke and heat will impact on honey production at the time.
- **Progressive burning** can be implemented in surrounding fire-adapted communities (e.g. eucalypt forests and woodlands) where there is often a greater available fuel load under mild conditions and the fire is unlikely to carry into the cypress pine forest. Planned burns can then be implemented into the cypress pine forest at a later date under conditions that will achieve the desired severity and objective of the planned burn.

- Be aware that **fuel loads** (in particularly the presence of 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 sufficient fuel on casual aerial observation, it is common in cypress to have some areas where there is an accumulation of elevated fuels and lack of ground fuels. Attempting planned burns where there is a lack of ground fuel may exhaust fuels limiting later planned burn efforts.
- **Commence lighting on the leeward (smoky) edge** 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 to effectively alter the desired intensity of a fire (particularly where there is an accumulation of elevated or volatile fuels). Spots close 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 may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- A **running fire** (closely spaced spot ignition or strip/line ignition with the wind) is often favoured within cypress pine production areas to ensure the fire carries across the available leaf litter (which is often heavily compacted in these areas) and limit flame residence time around the bases of cypress pines. 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 cypress pine.

A spot fire from an incendiary in cypress pine forest approximately 10 minutes after being dropped. Widely spaced spots in mild conditions will promote a low severity fire such as that shown here.
Stephen Berlin DAFF (2001).

Issue 3: Transition production stands to open forest

Use fire to transition areas that were previously managed for production in order to manage them for conservation objectives.

Awareness of the environment

Indicators of previously managed production stands of white cypress pine:

- The area was previously zoned Natural Resource Management–Forest Products as a production forest.
- The leaf litter is predominately thick and compacted cypress pine litter.
- More than 75 per cent of the canopy is dominated by cypress pine.
- Often there are no signs of fire history at the site (e.g. charring of trees).
- Logs and limbs are lying on the ground and there is a general build-up of coarse or heavy fuels.
- The site lacks an understorey.

Discussion

- As management of these areas changes from one of silviculture to that of conservation, there will be a need for the land manager to determine future management objectives. Often this will be a decision to either retain monoculture stands of white cypress pines or to transition them to open stands that can be maintained more easily for conservation managed intent by using fire and other methods such as the thinning of regeneration by mechanical means.
- The harvest regime of the area preceding transition will greatly influence fire management and favoured outcomes in these areas. This is due largely to the potential removal of 50 per cent to 95 per cent of mature trees with a DBH of between 23 to 38 centimetres prior to handover to the QPWS.
- Due to the change in the vegetation structure post harvest, fuel loads at the site may be significant. Often the crowns or 'heads' of trees and other material such as bark and tree limbs will remain on the ground. This also opens the canopy allowing woody weeds such as lantana, acacias, canopy tree saplings and grasses to establish. In cypress forests, FP may conduct a 'top disposal burn' in the years following harvesting operations as the structure of the remaining material begins to change and breakdown and is more likely to result in a fire of a low severity. There is opportunity to undertake co-operative burns between FP and the QPWS to facilitate the transition.
- A dense acacia thicket may develop at harvested sites following a wildfire or a fire with an average flame height that is greater than 30 centimetres. It is important to take the opportunity to conduct planned plans (under favourable conditions with good soil moisture) at the site following a wildfire to limit the occurrence of acacia thickets and to promote grasses. If there are grasses remaining post wildfire it is often a good indication that the site is likely to recover in the long term.

What is the priority for this issue?

Priority	Priority assessment
Medium	Planned burn in areas where **ecosystem health** is **poor** but recoverable.
Very low	Ecosystem is **extremely difficult to recover**.

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)
To reduce mature cypress trees by > 50 % and create an open structure.	Choose one of these options: Visual estimation of percentage of cypress trees burnt – from one or more vantage points, or from the air. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating the percentage of trees reduced.	**Achieved:** Mature cypress trees reduced by > 50 %. **Partially Achieved:** Mature cypress trees reduced by 25–50 %. **Not Achieved:** Mature cypress trees reduced by < 25 %.
Reduce remaining heavy fuels (tree crowns, etc) post-harvest by > 50 %.	Choose one of these options: Visual estimation of percentage of heavy fuels burnt–from one or more vantage points, or from the air. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating the percentage of heavy fuels burnt.	**Achieved:** Heavy fuels reduced by > 50 %. **Partially Achieved:** Heavy fuels reduced by 25–50 %. **Not Achieved:** Heavy fuels reduced by < 25 %.

The recruitment of native grasses is promoted post fire.	Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity) and estimate recruitment of grasses. **Before and after the burn** (after suitable germination/ establishment conditions, and if using cover – a growing season): define the density of the recruitment using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]): • Light = Grasses have increased by 0–24 % cover. • Medium = Grasses have increased by 25–75 % cover. • Dense = Grasses have increased by > 75 %.	**Achieved:** Grass recruitment 'raises' two 'density categories' (e.g. from light before the fire to dense after the fire). **Partially Achieved:** Grass recruitment 'raises' one 'density category' (e.g. from light before the fire to medium after the fire). **Not Achieved:** No change in the density category of grasses.

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 **moderate**, but a number of **high** severity fires may be required initially.

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)
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.
High (H)	200–500	1.0–2.0	5.0–10	Ground and mid-stratum burnt. Some habitat trees and fallen trees affected. Severe scorch with 50–100 % of crown affected. Up to 50 % of stem circumference charred or weeping.

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

Post moderate-severity fire showing the removal of most surface fuels in the burnt area and some canopy scorching.
Stephen Berlin, DAFF.

To reduce the number of young trees multiple high-severity burns may be required initially (aim for a high percentage of scorching and stem charring).
Stephen Berlin, DAFF.

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

- Fire frequency will largely depend on when the fuel load has accumulated to a point in which a fire will carry. It is important to assess fuel loads in post-production sites and be operationally able to respond to opportunities to burn these sites as they arise.
- As a rehabilitation issue, it is likely that it will take a number of fires of varying severity to address this issue, after which aim to revert to the recommended frequency refer to Issue 2.

Mosaic (area burnt within an individual planned burn)

- Aim for a high percentage of burn area. The percentage of coverage may be altered to suit the objectives of the planned burn.

Other considerations

- Be aware that this is a new and developing issue and requires a commitment to monitoring the site (e.g. by using observation points) pre and post-burn. The recommended fire parameters will need to be adjusted and refined to suit the objectives and as land managers become more familiar with burning these sites.
- A high intensity burn after logging operations often will result in the heavy regrowth of wattle and associated species. Follow up fire should be programmed.

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.

Season: Throughout the year where there is good soil moisture. Avoid periods of increasing fire danger

Soil moisture: Good soil moisture is recommended to retain a high percentage of leaf litter and not to expose patches of mineral earth or sand.

FFDI: < 16

DI (KBDI): < 120

Wind speed: Beaufort scale 1–3, up to four (10–23 km/h) within the forest. If the objective is to reduce mature cypress trees than near calm conditions are preferable to ensure a good residence time at the base of trees.

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** is used to create variability in fire severity (promoting a rich landscape mosaic) and limit the scorch and severity of fire on upper slopes. Aerial ignition using incendiaries from a fixed-wing aircraft or helicopter is often used in the Brigalow bioregion due to the extensive areas requiring burns. This tactic maximises resources and allows for the ability to respond to burn opportunities as they arise. Gridding with a fixed-wing aircraft allows a greater coverage of large, flat areas while helicopters provide the opportunity to directly target topographical features such as peaks, ridges and spurs (creating a backing fire downhill). 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 as smoke from fires lit by ground crews may impair the vision of the pilot and hamper lighting efforts. 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.
- **Smoke issues.** Cypress pine litter retains a high level of moisture and often low-severity planned burns will only remove the top layer (approximately the first 10 millimetres). Fires in cypress pine litter can also smoulder for long periods (creating a lot of smoke)—be aware of these smoke impacts on urban settlements. Planned burns in adjoining areas should avoid periods when the atmosphere is stable as it is likely to create an inversion layer causing smoke to persist for long periods. To avoid this, undertake burns when the prevailing weather conditions (in particular wind direction) will direct the smoke away from settled areas. Standard neighbour notification protocols should be followed. Note that smoke may also impact on apiary sites—smoke and heat can impact on honey production.
- **Progressive burning** can be implemented in surrounding fire-adapted communities (e.g. eucalypt forests and woodlands). Under mild conditions the fire is unlikely to carry into the cypress pine forest. Planned burns can then be implemented into the cypress pine forest at a later date. Utilise conditions that will achieve the desired severity and objective of the planned burn.

- Be aware that **fuel loads** (in particular the presence of 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 sufficient fuel on casual aerial observation, it is common in cypress to have some areas where there is an accumulation of elevated fuels and lack of ground fuels. Attempting planned burns where there is a lack of ground fuel may exhaust fuels limiting later planned burn efforts. Using **grassy areas to push fire** into areas that have less available fuel may assist in carrying fire through a site that has been cleared and has a fragmented fuel structure and less likely to carry fire. Ensure there is good soil moisture at the time of burning to promote the regeneration of grasses.
- **Ground ignition**. The lighting patterns used will be dependant upon the objective of the burn and the issues to be addressed.
- **Spot lighting** can be used to effectively alter the desired intensity of a fire (particularly where there is an accumulation of elevated or volatile fuels). Spots close 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 slow moving, **low intensity backing fire** will generally result in a more complete coverage of an area and ensures the fire has a greater amount of residence time, while ensuring fire intensity and rate of spread are kept to a minimum. A greater residence time is also useful in reducing overabundant trees.
- A **running fire** (closely spaced spot ignition or strip/line ignition with the wind) is often favoured within cypress forests to ensure the fire carries across the available leaf litter (which is often heavily compacted in these areas) and limit flame residence time around the bases of cypress pines. 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 cypress pine.
- **Commence lighting on the leeward (smoky) edge** to 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.
- **Timing burns post harvesting.** Snigging tracks are usually left in good working order following harvesting operations. Timing planned burns at this time may provide better access to areas for ground ignition.

Issue 4: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses, as they can dramatically increase fire severity and are often promoted by disturbance such as fire. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat. This species alters fuel characteristics and promotes a cycle of damaging high severity fires which can result in the fragmentation and overall decline in the extent of cypress pine and casuarina open-forests and woodlands and the forming of dense 'locked' stands.

Chapter 7: Acacia dominated communities

Stretching from the New South Wales border to Townsville, acacia communities characterise the Brigalow Belt bioregion. This fire vegetation group occurs as open forests and woodlands on coastal hills, lowland flats, plains, ridgelines, escarpments and tablelands (Bailey 1984; Hodgkinson 2002). Typically they are dominated by a single acacia species as a pure stand or in association with eucalypts or casuarinas. The understorey varies and may include some softwood species, shrubs, grasses and forbs (Hodgkinson 2002). Brigalow dominated communities are covered separately in Chapter 8.

Fire management issues

In most instances fire is not applied directly to acacia dominated communities through planned burns. Instead, the 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 encroach upon the acacia 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 potential encroachment of fire into acacia communities).

Issues:

1. Burn adjacent fire-adapted communities to maintain health of acacia communities.
2. Manage invasive grasses.

Extent within bioregion: 1 647 279 ha, 5 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Carnarvon National Park, 62 580 ha; Blair Athol State Forest, 35 799 ha; Expedition (Limited Depth) National Park, 24 942 ha; Redcliffevale Station 17 095 ha; Bedourie Proposed addition to Expedition National Park, 16 746 ha; Chesterton Range National Park, 13 206 ha; Boondandilla State Forest, 11 652 ha; Mount Nicholson State Forest, 9 945 ha; Oakvale State Forest, 9 663 ha; Goodedulla National Park, 8 224 ha; Allies Creek State Forest, 7 573 ha; Amaroo State Forest, 7 011 ha; Dawson Range State Forest, 6 627 ha; Squire State Forest, 6 006 ha; Kettle State Forest, 5 955 ha; Duaringa State Forest, 5 732 ha; Fairbairn State Forest, 5 104 ha; Serocold State Forest, 4 914 ha; Junee State Forest, 4 634 ha; Belington Hut State Forest, 3 898 ha; Pluto Timber Reserve 3 547 ha; Apsley State Forest, 3 490 ha; Nandowrie State Forest, 3 400 ha.

Issue 1: Burn adjacent fire-adapted communities to maintain health of acacia communities

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.

Awareness of the environment

Key indicators of mature acacia dominated communities:

- The canopy can vary from open to closed and is dominated by a single acacia species. Eucalypts and emergent trees are occasionally present.
- The acacias are mature (i.e. are not regrowth) and on average have reached their maximum height.
- Depending upon soil type, topography, vegetation structure and season, the understorey can vary from sparse to moderately dense with grasses (e.g. *Calyptochloa gracillima and Sporobolus caroli*), herbs and forbs.
- There may be some evidence of regenerating acacias (e.g. seedlings) though these may be very sparse if present at all.
- Will usually be somewhat sheltered from fire by topographical features.
- Leaf litter and fine fuels are sparse.

Bendee and rosewood. Logs and fallen branches of various sizes are scattered on the ground in the majority of mature acacia dominated communities, providing refuge for a variety of fauna.

Rhonda Melzer, QPWS, Taunton National Park-Scientific (2005).

A Blackwood dominated community. Blackwood is easily killed by fire. It is reliant on high rainfall (rather than fire) for germination.

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

A gidgee dominated community. This species is extremely fire sensitive (killed by fire). It does not regenerate from seedlings or basal suckering post-fire.

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

A lancewood dominated community. While killed by fire, lancewood regenerates post fire via abundant seedlings which will often initially form dense clumps.

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

Rosewood is characterised by a buttressed trunk base. Good seasonal rainfall can promote a grassy understorey and a continuity of fuels. In later seasons the grasses cure and provide the opportunity for fire to carry into this community.

Rhonda Melzer, QPWS, Duaringa State Forest (2009).

Discussion

- Fire-killed acacias such as lancewood *Acacia* shirleyi, rosewood *Acacia rhodoxylon* 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 require a fire and good rain to promote germination. Although it is recommended to mitigate wildfire impacts by burning surrounding areas, the occasional (rare) wildfire may play a role in the persistence of this community in the landscape. It is then critical however, to exclude further fires until the acacias reach maturity and set several seed crops.
- Other acacias such as brigalow *Acacia harpophylla*, boree *Acacia tephrina*, gidgee *Acacia cambagei*, mulga *Acacia aneura*, and blackwood *Acacia argyrodendron* 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.
- Historically, fire within most acacia communities has been infrequent, estimated at between 10 to 50 years (though this differs where acacias are associated with grasslands). In general they have occurred following prolonged rainfall which has resulted in substantial grass growth creating sufficient fuel to carry fire (Hodgkinson 2002) or during extensive wildfires. Changes in land use (through clearing and use of pastoral fire) and spread of invasive grasses have resulted in fires of a greater frequency and severity causing undesirable impacts.
- Be aware that following a fire that has affected an acacia community, a more proactive fire management approach in the surrounding areas will often be required to allow the acacia regrowth sufficient time to recover and mature.
- 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). Refer to Chapter 12 (Issue 5), for information regarding the management of invasive grasses.
- Fire exclusion in acacia/eucalypt mixed open forest can result in an accumulation of fuels that promote extensive, high severity 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.

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.

Objective: Limit fire encroachment into acacia dominated communities.

Select the following for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Minimal scorching or penetration of mature acacia tree edge.	**After the burn** (immediately-very soon after): visual estimation of percentage of margins scorched – from one or more vantage points, or from the air. **OR** **After the burn** (immediately-very soon after): walk the margin of the FVG or representative sections (e.g. a 100m long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** Minimal scorching or penetration < 5 % of the margins scorched. **Partially Achieved:** Some scorching or penetration 5–15 % margins scorched. **Not Achieved:** >15 % of margins scorched.

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

- Implement fires in adjacent fire-adapted communities as recommended for that fire vegetation group. Use good soil moisture, **patchy** to **low** severity burns, appropriate weather conditions and tactics (e.g. using landscape features such as drainage lines and rocky outcrops) so that the resulting fire will self extinguish near non-target community boundary.

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

- Implement fires in adjacent fire-adapted communities as recommended for that fire vegetation group but in such a way as to limit fire encroachment into acacia communities.
- In acacia communities with fire promoted germination, long fire intervals (often greater than 20 years) are required to enable the new generation of plants sufficient time to mature and set seed, prior to being exposed to further fires.
- Repeated fires within the same decade can result in a decline in abundance and distribution of many species of acacia (Williams et al. 2008).

Mosaic (area burnt within an individual planned burn)

- Aim for an increased mosaic (e.g. 40 per cent to 60 per cent) of burnt patches within surrounding communities to limit the severity and extent of subsequent unplanned fires.

Landscape Mosaic

- Aim to ensure acacia dominated communities remain long unburnt (and in some cases unburnt). The highest proportion of burning in surrounding areas should be implemented in the grassy open forests and woodlands. This will reduce the threat of repeated fires burning extensively across the landscape into communities that require longer fire free intervals such as acacia (Williams and Tran 2009).

A patch of lancewood affected by a high-severity wildfire. Note that there has been 100 per cent canopy scorch in some areas. Planned burns in surrounding areas can assist in limiting the extent and impact of wildfires on these sensitive communities.

Chris Crafter, QPWS, Boodjamulla National Park (2006).

Lancewood woodland on a rocky outcrop. Often acacia communities will be sheltered from fires due to landscape features such as bare, rocky outcrops which assist in their protection.

Rhonda Melzer, QPWS, Marlborough (2007).

Timing burns when landscape features such as melon holes retain water can assist in achieving a mosaic and limit fire encroachment into non-target communities.

Rhonda Melzer, QPWS, Nairana 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.

- **Progressive burning.** Planned burns of varying size are strategically lit throughout the year in surrounding fire-adapted fire vegetation groups when conditions allow. This creates a rich mosaic of burnt and unburnt patches that can be used to establish a safe perimeter allowing further planned burns to take place. This tactic is also useful in creating a greater landscape mosaic and altering fuel loads which may assist in reducing the extent of unplanned fires. This has been used to good effect in areas such as Boodjamulla National Park where planned burns of varying size are strategically lit adjacent to lancewood patches throughout the year when conditions allow (Williams and Tran 2009).
- **Limit fire encroachment into non-target communities.** Undertaking burning in areas adjacent to acacia dominated communities under mild conditions or late afternoon will assist in creating a low severity fire that ideally will self extinguish overnight. 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 slope towards the non-target community. Use appropriate lighting patterns (e.g. spot lighting with matches) along the margin of the non-target community (refer to Figures 1 and 2, next page) to promote a low intensity backing fire that burns away from the non-target community creating a buffer zone preferably of (preferably of approximately 100 metres. In general spot lighting is the more rather than running a continuous drip torch line along the margin of the community is preferred to avoid the resulting fire being of a greater severity than desired. Once an adequate buffer has been established, additional lighting of the surrounding area can then commence if required. In both instances ensure good soil moisture is present within the non-target community.
- **Aerial ignition**. For broad-scale fixed-wing aerial ignition, use appropriate conditions so the fire can to self-extinguish near the edge of the acacia community. Aerial ignition by helicopter allows greater flexibility to directly target the edge of the acacia dominated communities. Used in areas that are particularly inaccessible, this tactic can create a backing fire that moves away from the community (especially when the community is located upslope from the fire-adapted vegetation). Be aware that burning during spring may impact upon the habits of critical pollinators.

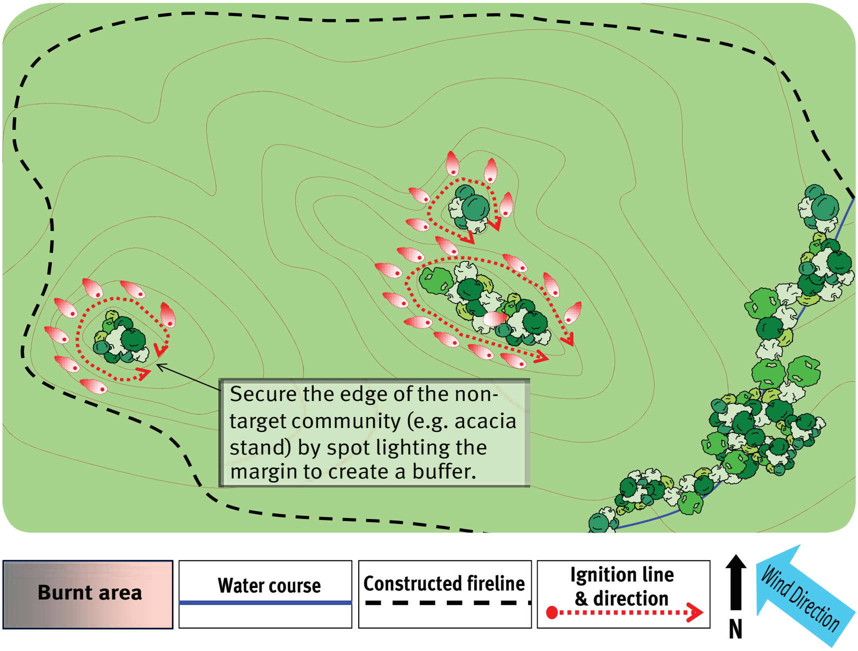


Figure 1: Creating a buffer zone surrounding a non-target community. In most instances a buffer of approximately 100 m is preferred prior to further lighting of surrounding areas.

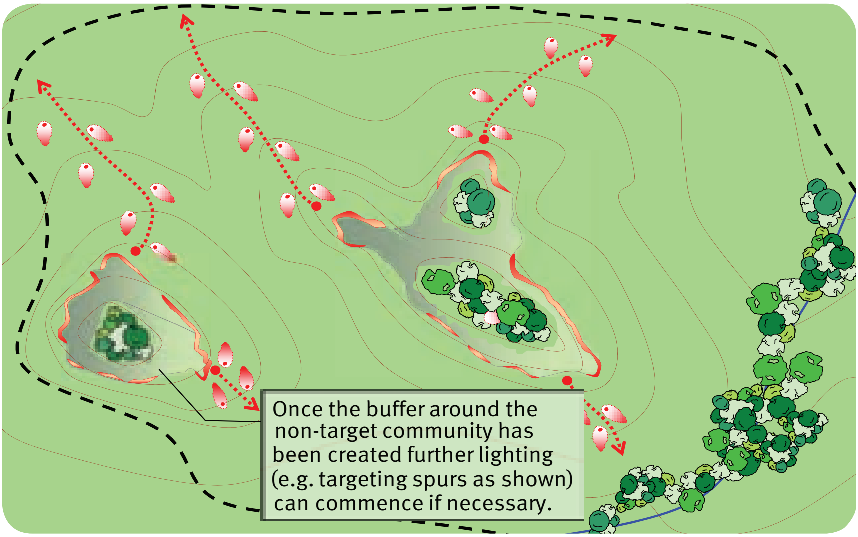


Figure 2: Once a buffer has been created further lighting in the surrounding area can commence if required. This will be determined by the objective of the burn and the desired mosaic and will not always be necessary.

Issue 2: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses, as they can dramatically increase fire severity and are often promoted by disturbance such as fire which results in significant damaging impacts upon the vegetation community in which it has invaded. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat to acacia dominated communities by altering fuel characteristics and promoting a cycle of damaging high severity fires which gradually results in the fragmentation and overall decline in the extent of acacia dominated communities.

Chapter 8: Brigalow communities

Brigalow communities are dominated by brigalow *Acacia harpophylla*. They can occur as dense stands or as open-forests with acacias, eucalypts, casuarinas and soft wood species. Brigalow has a sparse grassy, shrubby or mixed grassy/shrubby understorey and occasionally abuts softwood scrub communities. The community has a canopy of between nine and 20 metres (depending upon rainfall) and occurs on hill slopes, undulating plains and flat land; generally as tracts or patches within other fire vegetation groups. Brigalow communities were once widespread covering over seven million hectares of Queensland and making up approximately 40 per cent of the Brigalow Belt bioregion (EoE 2007). However, competition with agricultural and pastoral land uses has resulted in clearing of 90 per cent of the original brigalow communities (EoE 2007). In Queensland 16 brigalow dominated regional ecosystems are listed as **endangered** under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Fire management issues

Brigalow does not require fire for germination and it is a relatively poor reproducer (Butler 2007). If exposed to fire, brigalow regenerates by suckering from the roots and recovery post fire can be particularly slow depending upon fire intensity and seasonal conditions (Butler 2007). Brigalow communities are sensitive to fire therefore surrounding areas should be targeted to help mitigate the risk, frequency, intensity and extent of unplanned fires impacting on brigalow. Where brigalow occurs as an intact stand it is somewhat self-protecting; a fire that will penetrate into the brigalow community is generally rare due to the closed structure of the community and a lack of fuels. These become vulnerable to fire during severe fire weather where they adjoin fire-adapted communities and unseasonably high levels of rainfall have resulted in significant grass growth and a continuity of fuels, or where the edge of brigalow communities has been invaded by invasive grasses such as buffel grass *Cenchrus* ciliaris and green panic *Megathyrsus maximus* var. *pubiglumis* which can then draw fire into the brigalow.

Brigalow can also occur as an open tract of forest, often in association with fire-adapted species such as eucalypts or fire-sensitive species such as casuarinas. These open areas often have a more continuous ground layer of grasses and other species that carry fire. In these areas, fire management should aim for low-intensity mosaic burning to reduce the occurrence and extent of severe fires. In the absence of fire, brigalow has also been known to encroach into neighboring fire-adapted communities. Appropriate fire management in these communities will help managing this encroachment.

Introduced invasive grasses pose the greatest threat to brigalow communities by drawing fires into these areas and increasing fire severity. Particularly vulnerable are fragmented remnants (e.g. adjacent to roadsides), patchy regrowth or where brigalow occurs in low rainfall areas. Species such as buffel grass or green panic greatly alter fuel characteristics at the site (Butler 2007) and influence the potential for frequent and damaging fires.

Issues:

1. Burn adjacent fire-adapted communities to maintain health of brigalow communities.
2. Use fire to maintain open brigalow communities using low-severity mosaic burning.
3. Manage invasive grasses.

Extent within bioregion: 1 019 659 ha, 3 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Carnarvon National Park, 23 005 ha; Culgoa Floodplain National Park, 18 816 ha; Dipperu National Park (Scientific), 6 395 ha; Southwood National Park, 5 591 ha; Nairana National Park, 5 031 ha; Wilandspey Conservation Park, 4 805 ha; Tregole National Park, 4 738 ha; Nairana National Park (Recovery), 4 691 ha; Junee State Forest, 3 841 ha; Yuleba State Forest, 3 625 ha; Palmgrove National Park (Scientific), 3 409 ha; Mazeppa National Park, 2 972 ha; Blair Athol State Forest, 2 806 ha; Taunton National Park (Scientific), 2 758 ha; Lonesome proposed National Park, 2 510 ha; Orkadilla State Forest, 2 363 ha; Chesterton Range National Park, 2 255 ha; Kettle State Forest, 2 117 ha; Expedition (Limited Depth) National Park, 1 967 ha; Epping Forest National Park (Scientific), 1 816 ha; Junee National Park, 1 582 ha; Humboldt State Forest, 1 274 ha; Nogoa River Proposed National Park, 1 222 ha; Arthurs Bluff State Forest, 1 089 ha; Blackdown Tableland National Park, 1055 ha; Boondandilla State Forest, 994 ha; Barakula State Forest, 923 ha; Withersfield State Forest, 901 ha; Narrien Range National Park, 873 ha; Erringibba National Park, 844 ha; Goodedulla National Park, 690 ha; Bendidee National Park, 679 ha.

Issue 1: Burn adjacent fire-adapted communities to maintain health of brigalow communities

Burning of adjacent areas to create a buffer of low fuel.

Awareness of the environment

Key indicators

Indicators of brigalow communities around which fire management is required to limit fire encroachment:

- The presence of a brigalow stand. Within a brigalow community the canopy height is generally uniform. Brigalow height may vary in different areas depending on rainfall and whether it is a mature or regenerating stand.
- Brigalow stands are sometimes associated with belah *Casuarina cristata*, acacias, eucalypts (eucalypts may be emergent) and softwood scrub species.
- In adjacent areas where there is a continuous cover of fine fuels such as grasses, leaf litter, sedges and forbs, fire has a greater potential to penetrate into brigalow stands.

A brigalow-dominated community. Brigalow is 'top-killed' by fire and will slowly recover by suckering from the roots post fire.

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

Brigalow and box community. Scattered logs and debris in this community provides valuable refuge for a variety of fauna in particular invertebrates and reptiles.
V.J. Neldner, Queensland Herbarium.

Brigalow and Blackwood community on floodplains. There are some scattered shrubs and grasses are very sparse. Fire is unlikely to carry in this community.
V.J. Neldner, Queensland Herbarium.

A brigalow and belah community. Because of the continuous ground layer of grasses, fire is likely to carry into this brigalow community particularly after high rainfall has resulted in good grass growth.

Bill McDonald, Queensland Herbarium, Lake Nuga Nuga National Park (2004).

Brigalow often occurs along the margin of softwood scrub. Maintaining fire in the surrounding fire-adapted communities will help reduce fuel loads and mitigate wildfire risk.

Bernice Sigley, QPWS (2011).

Discussion

- Mature old-age stands of brigalow are particularly important to conserve and protect from inappropriate fire encroachment because they are very rare and conserve a number of regionally endemic and threatened fauna species. Mature stands are indicated by a uniform canopy height (can be up to 20 metres) with a wide variety of habitat features such as fissures or exfoliating (peeling) bark and refuge such as litter, logs and fallen branches.
- Fauna in these areas may include the yellow-tailed black cockatoo *Calyptorhynchus funereus*, little pied bat *Chalinolobus picatus*, south-eastern long-eared bat *Nyctophilus corbeni*, rough frog *Cyclorana verrucosa*, golden-tailed gecko *Strophurus taenicauda*, Dunmall's snake *Furina dunmalli* and the brigalow scaly-foot *Paradelma orientalis*.
- Brigalow and belah forests are listed as **endangered** under the *Environment Protection and Biodiversity Conservation Act 1999* and are important habitat for the **rare** painted honeyeater *Grantiella picta* and **vulnerable** northern imperial hairstreak butterfly *Jalmenus evagorus eubulus* (QPWS nd.).
- Invertebrates such as the military slater *Australodillo bifrons* and several species of native snails are often found in old stands of brigalow and are reliant upon the microhabitats in moist places such as flood debris on drainage lines, leaf litter build up in soil cracks and around logs and stumps. These are used as cover during times of migratory procession.
- The height of brigalow stands can vary depending upon soil type and rainfall. They range from nine metres in areas with an average of around 500 millimetres per annum to up to 20 metres in higher rainfall areas that average around 750 mm per annum (Butler 2007).
- Germination of brigalow is very rare. In general it requires winter rains to promote flowering, and follow up rain for germination. A lack of brigalow seedlings does not mean that the community is of poor health. Seedlings are only likely to be observed following unseasonably high rainfall events and these may occur only three or four times a century (Butler 2007).
- Brigalow regrowth is particularly susceptible to fire and it is important to maintain a buffer of low fuel around regenerating stands to limit further degradation of the community and encroachment by neighbouring communities (Myers et al. 2004). Grazing has been useful as a means to reduce fuels while in the absence of grazing, other methods such as mechanical or chemical control, and/or fire management to reduce fuel, may be required.

Mosaic burning around brigalow to reduce fuel loads and limit the threat posed by wildfires.

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

What is the priority for this issue?

Priority	Priority assessment
Very high	Planned burn required to maintain areas of **special conservation significance.**

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.

Objective: Limit fire encroachment into brigalow communities
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)
Limit the impact of fire on fire-sensitive species known to occur within an area.	**Before the burn:** Mark the start and finish of a transect line (e.g. 50 m or 100 m long) along the margin of an area that includes fire-sensitive species that may be impacted upon by the burn. **Or** **Before the burn:** Count the actual number of fire-sensitive species in a series of quadrates perhaps 10 x 10 m in size spaced evenly along the transect; calculate the frequency of occurrence (i.e. if you assess 50 quadrates and 10 of them contain fire-sensitive species, then the frequency is 10/50 x 100 = 20 %).	**Achieved:** < 5 % of fire-sensitive species affected by fire. **Partially Achieved:** 5–10 % of fire-sensitive species affected by fire. **Not Achieved:** > 10 % of fire-sensitive species affected by fire.
Minimal scorching or penetration of mature tree edge.	**After the burn** (immediately–very soon after): visual estimation of percentage of margins scorched – from one or more vantage points, or from the air. **Or** **After the burn** (immediately–very soon after): walk the margin of the fire vegetation group or representative sections (e.g. a 100 m long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** Minimal scorching or penetration < 5 % of the margins scorched. **Partially Achieved:** Some scorching or penetration 5–10 % margins scorched. **Not Achieved:** > 10 % of margins scorched.

Fire has not resulted in the encroachment of invasive grasses.	**After the burn** (after suitable germination/establishment conditions): Walk and where possible GPS the margin of the community and compare pre and post-burn distribution of invasive grasses.	**Achieved:** No encroachment of invasive grasses. **Partially Achieved:** Minor expansion of invasive grasses distribution into community; can be addressed with control measure such as herbicides. **Not Achieved:** Significant encroachment of invasive grasses; and will be difficult to be controlled.

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

- Establish a buffer of low fuel loads adjacent to brigalow using a **low**-severity fire.

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

- In adjacent areas, as often as sufficient fuel exists to carry a fire.

Mosaic (area burnt within an individual planned burn)

- Aim for a greater coverage of fire than usual in the areas directly surrounding brigalow to help mitigate encroachment of unplanned fire and create a buffer of low fuel loads.

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.

Season: As conditions allow however late wet or early dry season (March to April) is preferred to ensure good soil moisture. Avoid dry periods or burning when there is an increasing fire danger as this will often result in open patches of bare ground that will allow weed encroachment.

FFDI: < 11

DI (KBDI): < 120, ideally 80–100

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

Soil moisture: Following periods of good rainfall gilgai or 'melon holes' may have free standing water. Timing planned burns with these events may assist in limiting fire encroachment into brigalow communities

Brigalow with gilgai and free standing water.
Paul Lawless Pyne, QPWS, Humboldt National Park (2003).

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.

- **Fuel reduction** methods such as slashing, spraying and grazing to create a buffer around a brigalow community may also be useful to reduce the severity and extent of fire.
- **Limit fire encroachment into non-target communities.** Undertaking burning in areas adjacent to brigalow-dominated communities under mild conditions or late afternoon will help to create a low-severity fire that will (ideally) self-extinguish overnight. 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-slope towards the non-target community. Use appropriate lighting patterns (e.g. spot lighting with matches) along the margin of the non-target community to promote a low-intensity backing fire that burns away from the non-target community (create a buffer zone preferably of approximately 100 metres). Rather than running a continuous drip torch line along the margin of the community, spot lighting is preferred and will avoid the resulting fire being of a greater severity than desired. In both instances ensure good soil moisture is present within the non-target community.
- **Establishment of fire exclusion or wildfire mitigation zones.** Combined, these zones give the land manager clear guidelines to conduct planned burns in the surrounding fire-prone vegetation in a way that will create a buffer of low fuel loads and minimize the risk of a fire entering or impacting upon brigalow. Be aware that identifying an area as an exclusion zone assumes all reasonable measures to exclude fire from an area of brigalow (such as regular planned burns to create a buffer from the surrounding vegetation) will be undertaken in advance and is not necessarily limited to the ‘day’ of a wildfire (e.g. you may have patches of brigalow that may be inaccessible by vehicle or are unable to be reached safely and ‘defended on the day’ if threatened by wildfire).
- **Progressive burning** has been used to good effect in areas such as Boodjamulla National Park where planned burns of varying sizes are strategically lit adjacent to lancewood patches throughout the year, when conditions allow (Williams and Tran 2009).
- **Aerial ignition** using a helicopter with aerial incendiaries can be useful to directly target the edge of brigalow communities in inaccessible areas. This tactic creates a backing fire that burns away from the community, particularly when it is upslope from fire-adapted vegetation.

Reducing fuels by slashing, weed spraying and/or grazing along firelines adjacent to brigalow communities may limit the extent and impact of wildfires on these communities.

Bill McDonald, Queensland Herbarium (2004).

A brigalow and belah community. This is a good example of where edge-lighting tactics under mild conditions could help create a buffer zone to manage fuel loads.

V.J. Neldner, Queensland Herbarium, Arcadia Valley (1982).

Issue 2: Use fire to maintain open brigalow communities using low-severity mosaic burning

Use low-severity mosaic burning to maintain open brigalow communities and to mitigate the impacts of wildfire.

Awareness of the environment

Indicators of open brigalow communities where fire management is required:

- The presence of mature brigalow in an open community. Brigalow height may vary depending on rainfall, soil type and whether it's a mature or regenerating stand.
- The presence of brigalow open-forests sometimes with associated belah acacias, cypress and eucalypts.
- The understorey may consist of native grasses or invasive grasses. Young acacias, cypress, eucalypts and softwood scrub species such as false sandalwood may be present.
- The ground layer has a cover of fine fuels such as grasses, leaf litter, sedges and forbs that can carry a fire.

A low-intensity, mosaic fire in this brigalow and mountain yapunyah community with a grassy understorey will help managing fuel loads and maximise species diversity. Be aware of buffel grass in surrounding areas.
Bill McDonald, Queensland Herbarium, Roundstone Conservation Park (2002).

Discussion

- These communities contain a high diversity of endemic species as well as a high proportion of threatened species.
- This community is heavily influenced by fire intensity. High-intensity fires often reduce the numbers of brigalow while low-intensity mosaic burning will help minimise damage to brigalow and promote diversity within the community.
- Low-intensity fires are an important tool used to maintain brigalow communities. A build-up of fuels (which is highly likely in the absence of fire), can increase the risk of high-intensity fires and can top-kill the brigalow.
- Be aware that in the long absence of fire, the brigalow canopy may close and be somewhat self-protecting from fire. Prior to undertaking planned burns in open brigalow communities, the land manager needs to be clear about how fire will shape the community, and the objectives of fire management within it.
- Young brigalow remain highly susceptible to fire until they reach maturity (after which most will survive a low-intensity burn).
- Germination of brigalow is very rare. In general it requires winter rains to promote flowering and follow up rain for germination. A lack of brigalow seedlings does not mean that the community is of poor health. Seedlings are only likely to be observed following unseasonably high rainfalls which may occur three or four times a century (Butler 2007).
- After a disturbance (e.g. fire), brigalow will produce suckers from the roots. The amount of suckers produced is dependent upon the size of the brigalow, the type of disturbance and existing environmental conditions (e.g. soil moisture at the time of the disturbance).

Brigalow regrowth with a dense grassy understorey.
Bill McDonald, Queensland Herbarium, Castlevale (2009).

What is the priority for this issue?

Priority	Priority assessment
Very high	Planned burn required to maintain areas of **special conservation significance.**

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 25–60 % spatial mosaic of burnt patches.	Choose one of these options: • Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air. • Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. • In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating the percentage of ground burnt within visual field.	**Achieved:** 25–60 % burnt. **Partially Achieved:** between 10–25 % **Or** 60–75 % burnt. **Not Achieved:** < 10 % or > 75 % burnt.

Fire has not resulted in the encroachment of invasive grasses.	**After the burn** (after suitable germination/establishment conditions): Walk and where possible GPS the margin of the community and compare pre and post burn distribution of invasive grasses.	**Achieved:** No encroachment of invasive grasses. **Partially Achieved:** Minor expansion of invasive grasses distribution into community; can be addressed with control measure such as herbicides. **Not Achieved:** Significant encroachment of invasive grasses; and will be difficult to control.
No loss of mature brigalow trees.	Before and after fire, select three or more sites of a 50 m radius (taking into account the variability of landform and likely fire intensity) and estimate percentage of mature brigalow trees retained after fire.	**Achieved:** > 95 % key habitat features retained. **Partially Achieved:** 75–95 % retained. **Not Achieved:** < 75 % retained.
A patchy or low-severity fire with average flame height less than one metre.	During the burn a visual estimation of the average flame height. Post burn the average scorch height can also be a useful indicator of flame height.	**Achieved:** Average flame height is less than one metre. **Partially Achieved:** Average flame height is one to two metres. **Not Achieved:** Average flame height is greater than two metres.

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

- A **patchy** or **low**-severity fire.

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)	< 100	< 0.5	< 2	High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels, some scorching of elevated fuels (no higher than two metres). No canopy scorch.
Low (L)	< 100	< 0.5	< 2	Some patchiness, most of the surface and near-surface fuels have burnt. Some scorching 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 discussion)

- Ensure the fire is frequent enough to avoid fuel build-up. This will mitigate the impacts of wildfire.
- 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.

Mosaic (area burnt within an individual planned burn)

- 25–60 per cent.

Landscape Mosaic

- The highest proportion of burning in surrounding areas should be implemented in the grassy open-forests and woodlands that intermix with shrubby woodlands. This will reduce the threat of repeated fires burning extensively across the landscape into communities that require longer fire free intervals such as acacia (Williams and Tran 2009).
- Aim for a greater mosaic (e.g. 30 per cent to 60 per cent) of burnt and unburnt patches within surrounding communities to limit the severity and extent of unplanned fires.

Other considerations

- Fire frequency on existing grazing leases is influenced by the level of grazing. Overgrazing can result in the loss of ground layer vegetation, increase the thickening of the shrub layer and reduce the capacity for fire to carry.

What weather conditions should I consider?

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

Season: Late wet/early dry season (March to April) or as favourable weather conditions become available throughout the year.

FFDI: < 11

DI (KBDI): < 100

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

Soil moisture: Ensure good moisture conditions to protect the bases of grasses and promote regeneration.

Other considerations: Avoid burning when there are periods of increasing fire danger to avoid re-ignition.

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 applied to aerial and ground ignition and can be used to effectively alter the desired intensity of a fire, particularly where there is an accumulation of 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 low intensity backing fire.** A slow moving, low intensity backing fire will generally result in a more complete coverage of an area and ensures the fire has a greater amount of residence time, while ensuring fire intensity and rate of spread are kept to a minimum.

Issue 3: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses, as they can dramatically increase fire severity and are often promoted by disturbance such as fire. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat to brigalow stands by altering fuel characteristics and promoting a cycle of damaging high severity fires which gradually results in the fragmentation and overall decline in the extent of these communities.

Buffel grass encroachment into brigalow. Invasive grasses pose the greatest potential threat where they adjoin brigalow communities.

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

Chapter 9: Riparian, springs, fringing and foredune communities

This fire vegetation group includes spinifex grassland and herblands on foredunes, coastal she-oak communities, microphyll vine forest (beach scrub) on sandy beach ridges, river she-oak open forest, riverine wetlands, springs and eucalypt fringing forests.

Fire management issues

Most of the species in these communities are fire sensitive. Do not intentionally burn. When burning adjacent fire-adapted communities, limit fire encroachment by burning under suitable conditions and using tactics such as burning away from the community's edge. Many of these communities are subject to weed invasion, in particular lantana and invasive grasses such as green panic and guinea grass—both of which pose a significant threat by altering the fuel loads (in-turn increasing fire risk). In some cases it may be necessary to use fire to control lantana as it is an important component of control programs by improving access and efficiency of herbicide spraying.

Springs have a biodiversity status of **endangered** and contain a number of rare and threatened species such as the **vulnerable** hairy-joint grass *Arthraxon hispidus*. Sedges can be disadvantaged by repeated fires and care should be taken when burning in areas surrounding springs where a dry peat layer has developed (particularly in degraded situations). Proactive fire management in surrounding fire-adapted areas will mitigate the impacts of unplanned fire.

Issues:

1. Limit fire encroachment into riparian, springs, fringing and foredune communities.
2. Manage lantana.
3. Avoid peat fires.

Extent within bioregion: 473 840 ha; 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Boxvale State Forest, 2 147 ha; Carnarvon National Park, 1 375 ha; Palmgrove National Park (Scientific), 1 106 ha; Expedition (Limited Depth) National Park, 1 071 ha; Bowling Green Bay National Park, 818 ha; Kumbarilla State Forest, 806 ha.

Issue 1: Limit fire encroachment into riparian, springs, fringing and foredune communities

Refer to Chapter 12 (Issue 1), regarding fire management guidelines.

Many riparian and fringing communities contain a high proportion of fire-sensitive species such as river she-oak *Casuarina cunninghamiana* and/or habitat trees. Too frequent and/or severe fire removes, or inhibits the development of structurally complex ground and mid-strata vegetation and may open up the canopy. This in turn may increase the risk of weed invasion and soil erosion, leading to a greater production of fine fuel (mainly grass) and hence an increase in the fire hazard. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in many riparian communities to promote structurally complex ground and mid-strata vegetation and retain mature habitat trees.

Patchy to low severity burns in surrounding areas, late wet season to early dry season (e.g. March to April), that on some occasions trickle into eucalypt fringing Queensland blue gum *Eucalyptus tereticornis* will be useful to reduce fuel loads and mitigate impacts of wildfire and in particularly the loss of habitat trees.

Coastal she-oak *Casuarina equisetifolia* is extremely fire-sensitive. When burning adjacent fire-adapted communities, care should be taken to avoid any fire penetration. A bare earth buffer can easily be scratched with a rake-hoe through casuarina needles on sand to prevent fire trickling into these communities. Storm burning (in adjacent communities) may be useful to minimise impacts on mature she-oak. Be aware that dense Singapore daisy *Sphagneticola trilobata* and infestations of high-biomass grasses can draw fire into these communities.

Coastal she-oak are easily killed by fire and are an important food tree for the red-tailed black cockatoo. When burning adjacent fire-adapted communities, care should be taken to avoid any fire penetration.

Bill McDonald, Queensland Herbarium (2008).

Microphyll vine forest on sandy beach ridges. This community is fire-sensitive and does not require fire.

Bill McDonald, Queensland Herbarium (2010).

Avoid fire into most riparian communities. Implementing planned burns in surrounding fire-adapted communities (in the recommended season using appropriate tactics) will limit the potential impacts on this community.

Paul Lawless-Pyne, QPWS, Kroombit (2011).

Grasses such as green panic have established along the margin of this dune community. This has greatly increased the fuel load and potential for fire to carry into this community.
Bill McDonald, Queensland Herbarium (2010).

Perched springs are fairly self-protecting from fire. However, ensure free-standing water is present when implementing burns in the surrounding area.
Paul Lawless-Pyne, QPWS, Homevale Dams (2010).

Issue 2: Manage lantana

Refer to Chapter 12 (Issue 6), regarding fire management guidelines.

Lantana can often invade the edge of riparian, fringing and foredune communities, increasing fuel and drawing fire into these communities. Fire in riparian areas can be a useful strategy to control lantana to aid the recovery of native vegetation.

Issue 3: Avoid peat fires

Refer to Chapter 12 (Issue 4), regarding fire management guidelines.

Springs accumulate decayed, densely-packed vegetation known as peat which can be exposed during times of drought or below-average rainfall. In the absence of good soil moisture, peat can be ignited easily and result in a peat fire. Peat fires can burn for months at a time and can have very negative impacts on the vegetation community. Peat takes many years to re-form.

Chapter 10: Rainforest and vine thicket

Rainforests including semi-evergreen vine thickets (SEVT) and microphyll vine forests are found from lowlands and plains to the uplands and tablelands of the Great Dividing Range. In the Brigalow Belt bioregion, rainforest is found within elevated refuges such as Carnarvon Gorge and Blackdown Tableland, while SEVT ecosystems usually occur as discrete or fragmented patches scattered throughout the bioregion situated within a range of other vegetation types particularly brigalow *Acacia harpophylla* forest (QPWS 2007).

Fire management issues

Typically, rainforests in the Brigalow Belt bioregion are located within areas that will not burn due to topography, an internally-moist microclimate and a lack of available fuels (Williams et al. 2006; QPWS 2007). Scorching of rainforest margins may occur during periods of drought, where they have been subjected to disturbance and/or where fire-promoted invasive species (such as high-biomass grasses and lantana) have established. SEVT share a number of factors in common with other rainforests which generally reduce the likelihood of fire impacting upon the community. Smaller isolated patches of SEVT are more susceptible to the impacts of fire than larger undisturbed stands as they have a greater exposure to edge effects including increased fuel loads and fires of greater intensity and frequency. These edge effects are generally associated with introduced grass pasture species (e.g. buffel grass or green panic) that exist in areas adjacent to the thickets, or in areas invaded by lantana (QPWS 2007). Repeated fires combined with the slow rate of regeneration characterised by vine thicket vegetation have been attributed to the rapid decline of SEVT remnants, particularly those adjacent to roadsides and the hill slope fragments in Queensland (McDonald 1996).

The main strategy is to maintain surrounding fire-adapted communities with mosaic burning to minimise the spread and severity of wildfire during very severe weather events. In certain situations, rainforests and SEVT are more vulnerable to fire (e.g. coastal littoral rainforest, dry scrubs or where damaged rainforest is upslope from a planned burn area). In these instances, it may be necessary to employ specific tactics such as burning away from rainforest edges. Occasionally, fire is used within rainforest areas for specific weed control and rehabilitation purposes.

Issues:

1. Limit fire encroachment into rainforest and semi-evergreen vine thickets.
2. Manage invasive grasses.

Extent within bioregion: 313 984 ha; 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Carnarvon National Park, 13 487 ha; Palmgrove National Park (Scientific), 3 664 ha; Goodedulla National Park, 3 371 ha; Expedition (Limited Depth) National Park, 3 194 ha; Sonoma State Forest, 2 881 ha; Bowling Green Bay National Park, 2 652 ha; Coominglah State Forest, 1 799 ha; Bunya Mountains National Park, 1 765 ha; Dipperu National Park (Scientific), 1 515 ha; Carminya Forest Reserve, 1 196 ha; Belington Hut State Forest, 1 084 ha; Redcliffevale Station 933 ha; Homevale Resources Reserve, 932 ha; Zamia State Forest, 856 ha; Lonesome proposed NP 720 ha; Rundle Range National Park, 719 ha; Bukkulla Conservation Park, 674 ha; Magnetic Island National Park, 669 ha; Mount O'Connell National Park, 565 ha; Allies Creek State Forest, 530 ha; Peak Range National Park, 523 ha; Homevale National Park, 517 ha; Bouldercombe Gorge Resources Reserve, 513 ha; Don River State Forest, 498 ha; Mount Hopeful Conservation Park, 497 ha; Mount Etna Caves National Park, 496 ha; Marlborough State Forest, 462 ha; Callide Timber Reserve, 452 ha; Mount Archer National Park, 431 ha; Tierawoomba State Forest, 431 ha.

Issue 1: Limit fire encroachment into rainforest and semi-evergreen vine thickets

Refer to Chapter 12 (Issue 1), regarding fire management guidelines.

Mosaic burning in surrounding fire-adapted vegetation communities will limit the potential impacts of unplanned fires on non-target communities such as rainforests and SEVT. The edges of these communities are generally self-protecting during planned burning under appropriate conditions. Sometimes however, it may be necessary to burn back from the rainforest edges.

The understorey of a typical semi-evergreen vine forest. Though there are some surface fuels, these communities are generally self-protecting and unlikely to burn if undisturbed.
Bill McDonald, Queensland Herbarium, Expedition Range (2004).

Edge-lighting tactics under mild conditions to create a low-severity fire may be useful in managing the high fuel loads adjacent to this softwood scrub community.

Bernice Sigley, QPWS (2011).

Araucarian microphyll vine forest bordered by open eucalypt forest. Manage fire in the surrounding landscape carefully to limit encroachment into fire-sensitive communities.

Rhonda Melzer, QPWS, Kroombit tops (1992).

Isolated patches of softwood scrub are vulnerable to wildfire particularly when they are upslope of fire-adapted communities.

Bernice Sigley, QPWS, Moolayember National Park (2010).

Post wildfire in a SEVT. The fire has killed most trees and shrubs and removed logs and vegetative debris. The community is now susceptible to encroachment by invasive grasses.
Mark Cant, QPWS, Bunya Mountains National Park (2009).

Where possible, hazard reduction burns in the area adjacent to softwood scrub will further protect these communities.
Bernice Sigley, QPWS, Moolayember National Park (2010).

Issue 2: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive pasture grasses as they can dramatically increase fire severity, are often promoted by fire and may result in significant damaging impacts upon the vegetation community in which they have invaded.

The damaging impacts of the gradual encroachment of invasive grasses and increased severity and frequency of fire are shown in these two photos. The dry rainforest that would normally be sheltered on this hillside has been degraded, fragmented and almost lost due to a cycle of invasive grass encroachment and wildfires over 17 years.

Paul Williams, Vegetation Management Science Pty Ltd, Toogoora Rock (1990 and 2007).

Chapter 11: Mangroves and saltflats

This fire vegetation group occurs along intertidal flats and is subject to inundation.

Mangroves

Mangroves are most common near or within estuarine or brackish water on intertidal flats which are often dissected by tidal streams. They can extend into the upper tidal reaches of creeks and rivers where there is a high freshwater influence. They are periodically inundated through seasonal tidal action and storms. The structure of mangroves varies (according to their position in regards to inundation) however, in most instances they occur in stands as low trees or shrubs with very little other vegetation present. The presence of a low shrub layer can vary and is often made up of a mix of mangrove species including juvenile canopy species and samphires (a group of succulent sub-shrubs, shrubs and annuals, such as *Halosarcia* spp).

Salt flats

Grasslands, forblands, and sedgelands occur on saltflats and mudflats, generally on the landward side of intertidal flats—which are often only inundated by the highest of spring tides. Grasses such as saltwater couch *Sporobolus virginicus* are common within this fire vegetation group. Plants within the shrub layer can include *Suaeda australis* and *Halosarcia indica*, forbs, sedges and occasionally stunted mangroves around the edges.

Fire management issues

Mangroves

Mangroves are not fire dependent and generally do not burn. Mangroves can be scorched in nearby planned burning operations particularly along the margin of flammable vegetation, but it is rare that any lasting damage is done. Rubber vine *Cryptostegia grandiflora* has been recorded in this fire vegetation group.

Saltflats

While some species in this community are tolerant of occasional fire (e.g. saltwater couch *Suaeda australis* and *Halosarcia indica*) (Williams 2009), they do not require fire, and in general should not be deliberately targeted for burning. Fires have been known to occasionally carry into this community from conservation burns in surrounding fire-adapted communities and when targeting weeds such as rubber vine *Cryptostegia grandiflora* and para grass *Urochloa mutica* with fire. Such fires are not known to cause lasting impacts.

In most instances fire management will aim to limit fire encroachment into mangroves and saltpan areas by burning surrounding fire-adapted vegetation communities. Occasionally, burns may be planned within these communities as part of a control program targeting invasive species such as rubber vine and para grass.

Issues:

1. Limit fire encroachment into mangroves and saltpans.
2. Manage invasive grasses.
3. Manage rubber vine.

Extent within bioregion: 206 136 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Bowling Green Bay National Park, 22 937 ha; Bowling Green Bay Conservation Park, 2 460 ha; Townsville Town Common Conservation Park, 1 712 ha; Proposed Cromarty Wetlands Conservation Park, 595 ha; Cape Upstart National Park, 337 ha; MacKenzie Island Conservation Park, 245 ha; Broad Sound Islands National Park, 200 ha; Sandfly Creek (South Bank of Ross River), 194 ha; Shoalwater Bay Conservation Park, 172 ha; Charon Point Conservation Park, 161 ha; Newport Conservation Park, 113 ha; Cape Upstart Reserve for Env Purp (Adj to Cape Upstart NP), 64 ha; Causeway Lake Conservation Park, 53 ha; Keppel Sands Conservation Park, 39 ha; Rundle Range National Park, 25 ha; Abbott Bay Resources Reserve, 19 ha; Rundle State Forest, 16 ha; Magnetic Island National Park, 7 ha; Bolger Bay Conservation Park, 2 ha; Capricorn Coast National Park, 1 ha.

Issue 1: Limit fire encroachment into mangroves and saltpans

Refer to Chapter 12 (Issue 1), regarding fire management guidelines.

Mosaic burning of surrounding fire-adapted vegetation communities will assist in limiting potential impacts of unplanned fires on non-target communities such as mangroves and saltpans. Due to their location, these communities are generally self-protecting during planned burning in appropriate conditions. Coinciding planned burns with high tides and inundation will further limit the chance of fire encroaching into this community.

Depending upon conditions at the time of burning, if a planned burn does carry into a saltpan area it is unlikely to cause any lasting impacts and this community has in the past, demonstrated good post-fire recovery (Williams 2009).

Saltwater couch on salt flats. Although this species can tolerate occasional fires (such as a fire used to target rubber vine) it is generally not deliberately burnt.
Bill McDonald, Queensland Herbarium.

Marine couch grassland and samphire herbland.
Rhonda Melzer, QPWS, Coorooman Creek (2007).

Low mangrove forest.
Rhonda Melzer, QPWS, Coorooman Creek (2007).

Issue 2: Manage invasive grasses

Refer to Chapter 12 (Issue 5), regarding fire management guidelines.

It is important to be aware of the presence of invasive grasses as they can dramatically increase fire severity, are often promoted by fire and may result in significant damaging impacts upon the vegetation community in which they have invaded.

Issue 3: Manage rubber vine

Refer to Chapter 12 (Issue 7), regarding fire management guidelines.

Rubber vine *Cryptostegia grandiflora* is an aggressive, vigorous climber that can rapidly spread and smother a range of vegetation communities—most notably riparian zones and waterways. Fire has been proven to be an effective control measure for rubber vine as well as being an effective follow-up to other control methods such as mechanical and herbicide control.

Rubber vine occurring in A marine samphire forbland. Forblands such as this can tolerate some fire. A series of fires may help reduce rubber vine.

Barry Nolan, QPWS, Cape Upstart (2007).

Chapter 12: Common issues

In the Brigalow Belt bioregion there are some issues where the fire management approach is similar irrespective of 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

1. Limit fire encroachment into non-target fire vegetation group.
2. Hazard reduction (fuel management) burns.
3. Planned burning near sensitive cultural heritage sites.
4. Avoid peat fires.
5. Manage invasive grasses.
6. Manage lantana and other weeds.
7. Manage rubber vine.
8. Post cyclone planned burning.
9. Manage severe storm or flood disturbance.

Issue 1: Limit fire encroachment into non-target fire vegetation groups

Non-target fire vegetation groups include rainforests, riparian, casuarina and foredune communities, as well as melaleuca communities, wetlands, saltmarsh, shrublands and tall open forests that are not-yet ready to burn. These communities are often 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:

- Cyclone or logging damage with dry fuel lying upon the ground inside of rainforest areas.
- Melaleuca, saltmarsh or wetland area without standing water or water logged conditions.
- Invasive grasses, rubber vine or lantana invading rainforest or riparian edges.
- The non-target community is upslope of a potentially running fire.

Avoid fire penetrating into most riparian communities. This callistemon vegetation is fire sensitive.

Mark Parsons, QPWS, Stoney Creek (2008).

Foredune she-oaks are killed by fire. Wildfire fuelled by tinder-dry Singapore daisy carried flames against the wind back onto the base of these horse-tailed she-oak trees. The Singapore daisy re-sprouted soon after the fire.

Mark Parsons, QPWS, Yingalinda (2009).

Littoral Rainforest is vulnerable to scorching by fire.

Mark Parsons, QPWS, Orpheus Island (2001).

A low-severity fire in a Melaleuca viridiflora community where ground saturation has been used to control fire entering the community.

Mark Parsons, QPWS, Sunday Creek (2010).

A low-severity backing fire used under appropriate conditions will not scorch the riparian community. Fire will trickle downhill and self-extinguish before reaching the riparian zone.

Kerensa McCallie, QPWS, Dinden National Park (2010).

The presence of weeds and a build-up of dead material can draw fire into rainforests.

Justine Douglas, QPWS, Curtain Fig National Park (2009).

Surface water is used to control fire encroaching into saltmarsh.

Mark Parsons, QPWS, Waterfall Creek (2010).

Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (e.g. there is no guarantee that peat swamps or rainforest litter will 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 the impacts of unplanned fire on non-target and fire-sensitive communities.
- Under appropriate 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. See the tactics at the end of this chapter.
- Ensure suitable conditions exist prior to burning melaleuca and wetland communities to avoid peat fires (refer to Issue 4 for fire management guidelines).
- Sometimes lantana forms a thicket that can draw fire into rainforest or riparian areas. Reduction of lantana may be advisable prior to burning to reduce biomass and avoid scorching rainforest or riparian edges (refer to Issue 6 for fire management guidelines on managing lantana and other weeds).
- The presence of high-biomass grasses can increase the severity of fire and may contribute to rainforest contraction (Bowman 2000). If high-biomass grasses are present use fire with caution (refer to Issue 5 for fire management guidelines on managing invasive grasses).
- 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 and may open up the canopy. This in turn may increase the risk of weed invasion and soil erosion and lead to a greater production of fine fuels and an increase in fire hazard. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in many riparian communities to promote structurally complex ground and mid-strata vegetation and retain mature habitat trees (all of which are important fauna habitat).
- Coastal she-oaks are an important food tree for the red-tailed black cockatoo. When burning adjacent fire-adapted communities, care should be taken to avoid any fire penetration. A bare earth buffer can easily be scratched with a rake-hoe through casuarina needles on sand to prevent fire trickling into these communities.
- The main strategy for saltmarsh is to burn with recent rain, the king tide or groundwater seepage—this will protect the saltmarsh vegetation. Saltmarsh is most vulnerable to scorching if fire-promoting plants (particularly flammable grasses) occur within or adjacent to them.

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.

Select the following as appropriate for the site:

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. **Or** **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. **Partially Achieved:** < 5 % scorched. **Not Achieved:** > 5 % scorched.

Fire penetrates no further than one metre 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. **Or** **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 one metre into the edge.	**Achieved:** Fire penetrates no further than one metre into the edge. **Not Achieved:** Fire penetrates further than one metre 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 to 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 within a fire-sensitive community is insufficient or the fire-sensitive community is upslope from the planned burn, consider using the 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 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.

- **Test burn** the site to ensure non-target communities will not be affected.
- **Do not create a running-fire.** When burning in adjacent sclerophyll forest during dry conditions use a low-intensity perimeter burn from the edge of non-target community 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 help promote a low-severity fire that trickles along the edge and usually self-extinguishes, especially 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 the 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.

Issue 2: 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.**

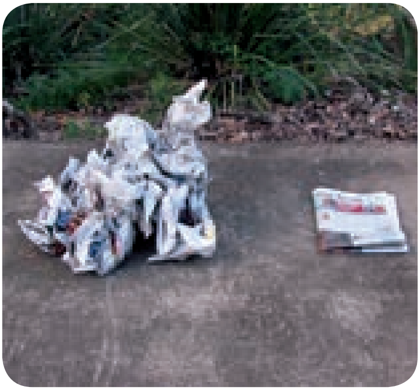


Photo 1a: The two samples above have the same **fuel load** (eighteen pages of newspaper) but a different fuel arrangement.

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. **Or** Reduce fuel load to < 5 tonnes/ha.	**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 or moderate. **Or** Fuel load has been reduced to < 5 tonnes/ha. **Not Achieved:** Fuel hazard has not been reduced to low or moderate **Or** fuel load is > 5 tonnes/ha.

Burn 90–100 % (for protection zone). 60–80 % (for wildfire mitigation zone).	Choose one of these options: a. Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air. b. Map the boundaries of burnt areas with GPS, plot on ParkInfo and thereby determine the percentage of area burnt. c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating the percentage of ground burnt within visual field.	**Protection zone Achieved:** > 90 % burnt. **Partially Achieved:** 80–90 % burnt, the extent and rate of spread of any subsequent wildfire would still be limited. **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). **Wildfire mitigation zone Achieved:** 60–80 % burnt. **Partially Achieved:** 50–60 % burnt. **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

- **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?

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.

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 r**unning 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**. Caution is required if the area is small in size or a narrow strip and the two lit lines will converge, creating a hot junction zone and greater than desired severity with the chance of fire escaping through a spot-over.

Issue 3: 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 scattered shell debris can indicate the presence of shell middens.
- The presence of 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:

- Ruined buildings, corrugated iron shacks, wooden house stumps, old fence posts, old stockyards, tombstones, wells, graves, bottle dumps, old machinery and iron debris may all indicate the presence of a significant site.
- The presence of quarries and old mines sites (often seen as deep holes covered with corrugated iron or wood).
- Plane wreckages.
- The presence of forestry artefacts including marked trees (shield trees), springboard trees (stumps or trees with axe notches cut into it to support boards) and old machinery such as winders (timber tramways) and timber jinkers (timber lifting wagon).

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

As required, choose three or more locations that will be good indicators for the whole burn area. Return to the same locations before and after the fire.

Select the following for the site:

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. **Partially Achieved:** minimal impact. **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 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 and thereby limit the spread and severity of wildfires, giving overall better protection to 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.

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.

- **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. rake-hoe line), trimming or leaf blowing the surface fuels away from the site to limit 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 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 will self-extinguish at the chipped or wet line.

Smoke directed away from rock art site during a planned burn.

Mark Parsons, QPWS, Fishers Creek (2010).

Issue 4: Avoid peat fires

Low-lying communities (including wetlands and melaleuca communities) can gradually accumulate partially decayed, densely-packed vegetation known as peat. In the absence of good soil moisture the peat can be easily ignited and result in a peat fire. Peat fires can burn for months, and can have very negative impacts on the whole ecosystem. Peat takes hundreds of years to re-form.

Awareness of the environment

Key indicators of suitable conditions that will avoid peat fires:

- Presence of visible standing water on the surface or surface water that covers the bases of sedges and grasses.
- In the absence of standing water, the peat should be water logged (it is possible to squeeze water out of it).

A melaleuca community with an understorey of ferns and sedges with standing water present.

Sylvia Millington, QPWS, Mount Coom (2010).

Post-fire in a melaleuca community with standing water.
Mark Parsons, QPWS, Sunday Creek (2010).

An ephemeral sedgeland with partially burnt fuels. Without standing water or moist soil, fire can burn underground for weeks or months.
Mark Parsons, QPWS, Sunday Creek (2010).

Discussion

- Due to its porous nature and high carbon content peat is easily ignited when dry and can burn / smoulder for an extended period of time, causing re-ignitions and long-term damage to ecosystems.
- Be aware of peat issues when burning in areas adjacent to melaleuca communities or wetlands. The condition of the peat should be checked to ensure that if fire encroaches, the peat will not ignite. If it is necessary to burn adjacent areas in less than ideal conditions, manage the fire carefully to minimise the risk of it entering peat areas (use suitable tactics such as burning away from wetland edges).
- However peat fires that are not extensive, down to about a metre in depth, might form a desirable aspect of wetland systems and restore channels of water movement within the landscape. It is not necessary to plan to burn peat; it will burn occasionally due to minor fluctuations in topography and moisture.

What is the priority for this issue?

Priority	Priority assessment
Very high	Where peat is present, it is important to consider the most appropriate management during burn planning and implementation.

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 the following for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
The planned burn does not result in a peat fire.	Ongoing visual assessment during and post burn to determine if the fire has carried into peat layer and developed into a peat fire.	**Achieved:** Fire did not carry into peat layer and develop into a peat fire. **Not Achieved:** Fire carried into peat layer and developed into a peat fire.

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** to **Moderate**.

A low-severity fire adjacent to a *Melaleuca viridiflora* community where ground saturation has been used to control fire encroachment.

Mark Parsons, QPWS, Sunday Creek (2010).

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.

Season: Avoid late dry season (August to September) fires in the vicinity of peat.

FDI: < 7

DI (DI (KBDI)): < 80

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

Soil moisture: Ensure standing water or water logged peat is present as it will avoid peat fires.

What burn tactics should I consider?

When burning adjacent fire-adapted areas, where the conditions of standing water or water logged peat can not be achieved, use tactics that will limit encroachment of fire into the community with peat. See below.

- **Spot ignition** can be used to effectively alter the desired severity of a fire. 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-severity fire.
- **A low-intensity backing fire** ensures the fire intensity and rate of spread are kept to a minimum. **Do not create a running fire.**
- **Limit fire encroachment into non-target communities.** Where the non-target community is present in low-lying areas (e.g. riparian systems, utilise the surrounding topography to create a low-intensity backing fire that travels down slope towards the non-target community). If conditions are unsuitable (e.g. the non-target community is too dry to ensure the 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 to promote a low-intensity backing fire that burns away from the non-target community.

Issue 5: Manage invasive grasses

It is important to be aware of the presence of invasive grasses as they can dramatically increase fire severity, are often promoted by fire and may result in significant damaging impacts upon the vegetation community that it has invaded. Many invasive grasses are capable of out-competing native species to form dominant stands. Buffel grass, guinea grass, thatch grass and green panic are of particular concern in the Brigalow Belt bioregion.

The spread of invasive grasses has resulted in significant changes to traditional fire regimes within the Brigalow Belt bioregion due largely to a significant increase in fuel load; in turn increasing flame height and fire intensity and providing fuel connectivity across the landscape, allowing fires to spread across a much greater area than previously possible (Eyre et al. 2009). This results in greater tree death particularly of acacias and loss of habitat features with flow on effects to native fauna and a cycle of damaging high-severity fires which gradually results in the fragmentation and overall decline in the extent of most vegetation communities in particular brigalow and dry scrub communities. While fire can be used as part of control for some species, 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 mono-specific stands.
- Invasive grasses are starting to penetrate the edge of brigalow and SEVT or other fire-sensitive communities or have become established throughout the community.
- The grasses have a large amount of biomass and/or dead material.
- Typically first appear along fire-lines and roads and similarly highly disturbed areas.
- Species such as green panic will generally grow taller than most native species and is also able to out-compete these species for space and resources (Butler and Fairfax 2003).
- Dead trees with charring high up the trunk may be present.

Discussion

- Be on the look out for newly forming stands and be especially vigilant in disturbed areas, particularly those where disturbance is ongoing (e.g. roadsides) and areas adjacent to or down stream from existing high biomass grass infestations (Melzer and Porter 2002). Control is often easier if their presence is detected and addressed early before it has become established.
- Prior to undertaking planned burns in areas where high biomass grasses occur, become familiar with the response of this grass to fire (e.g. if it is promoted or killed) and other factors such as fire severity type and weather conditions which may favour and further its 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 and softwood scrub communities that are maintained in a healthy condition will often also act as a preventive buffer that limits the spread of invasive grasses into acacia communities.
- Invasive grasses can cause the progressive loss of fire-sensitive communities and increase the risk of wildfires carrying into the canopy of the community (particularly during dry conditions). This can cause the loss of mature trees, and contribute to the gradual decline, fragmentation, and/or loss of fire-sensitive communities.
- Be aware of weed hygiene issues when managing high-biomass grasses. Vehicles, machinery and quad bikes aid their spread and should be washed down after exposure. Invasive grasses easily spread along fire control lines (usually due to machinery spreading seeds). Caution and awareness of weed hygiene issues are paramount when constructing and maintaining firelines and roads.
- In many cases it is important to avoid burning invasive grasses due to the likely increase in fire severity and risk of further promotion. 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 stimulate available seed bank stores that can be targeted with herbicide 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 manager often becomes one of fuel management. This may involve implementing mild or 'cool' fires (both within the site and in surrounding areas) by implementing tactics that burn away from the non-target community and limit the 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 must be determined on a case-by-case basis 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 can be an aspect of control often in combination with spraying and/or grazing.

Information for the control of specific species 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 penetrating several hundred metres into gidgee/brigalow woodland across a front several kilometres long, greatly increasing fuel loads and future impacts upon gidgee/brigalow (Butler and Fairfax 2003).
- The use of fire to control buffel grass is debated. Fire is known to promote the spread of buffel grass through disturbance. However, it may be used in tandem with other control methods such as spraying or grazing. In this case, fire is used to reduce the biomass of buffel grass providing access for herbicide treatment of the remaining clumps and seedlings. Be aware of the need to commit to follow-up spraying of the affected site for some time, as buffel grass will usually germinate en masse after fire and rain.
- Buffel grass is most vulnerable when at the end of its growing season when it is storing reserves. Consistent grazing at this time has helped in its control. Targeting burning at this time of the year may weaken buffel grass (Chamberlain 2003).
- The curing rate for buffel grass differs from native grasses—buffel grass tends to remain greener for longer periods of time. 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.
- In some instances creating a buffer through mechanical or chemical means (of about 50–100 metres) adjacent to an area of buffel grass may be useful in limiting its further spread.

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. Following a disturbance (such as fire) it is able to rapidly invade and form dense swards within a vegetation community.
Rhonda Melzer, QPWS, Nairana National Park (2005).

Excluding fire from areas affected by buffel grass may allow the canopy to recover and shade-out the buffel grass. Note the halo effect and shading-out of buffel grass as the canopy begins to close.

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

Guinea grass and green panic

- Herbicide is the most effective broad-scale control measure of green panic and guinea grass (alternatively use hand removal for small areas).
- Fire is not known to be an effective tool to manage guinea grass but can be useful in facilitating other control methods such as spraying. Be aware that too-frequent fire (every one to two years) promotes the spread of these species through disturbance and possibly through reducing canopy cover. Maintaining canopy cover (and therefore shade) will assist in guinea grass management.
- Green panic is shade-tolerant unlike many other grasses.
- Both species remain greener for longer periods than native grasses and will burn with a high-intensity due to the high amount of accumulated biomass when sufficiently cured.
- If either of these grasses must be burnt for any reason timing is a critical factor together with follow-up herbicide treatment. Avoid burning late in the season for a variety of reasons such as risk of creating high severity fire and protection of riparian zones.

Close up of guinea grass.

Paul Williams, Vegetation Management Science Pty Ltd, near Pattersons Gorge (2005).

The height, mass and structure of guinea grass infestations increases flame height and severity, contributing to tree death.

Mark Parsons, QPWS, Mullers Creek (2010).

Para grass

- Fire can be used with partial success for the management of para grass where it occurs in swamps and drainage lines. Fire is more effective where the para grass occurs within ephemeral swales that have dried out (limited windows of opportunity occur late season). Burning has been found to be more effective if used later in the year or in combination with chemical control.

Olive hymenachne

- Fire has been shown to be an effective tool to control this grass when used in combination with other methods such as grazing or herbicide control.
- Fire should be applied just prior to the wet season when plants have dried out sufficiently to provide suitable fuel. Fire should be followed by grazing or herbicide control.
- Fire will destroy seeds on the surface of the soil, but not buried seed, so follow up will be required.

Para grass is a significant threat to wetlands as it will out-compete and smother native grasses and choke up waterways. Fire followed by the application of herbicide has successfully been used to assist with the control of para grass infestations and promote the recovery of native grasses such as *Paspalidium udum* (Williams and Collet 2010).
Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common Conservation Park (2007).

Other invasive grasses

- Thatch, grader and coolatai are becoming more widespread (particularly along roadsides) and are likely to influence fire management in the future.
- Coolatai can produce seed in the first growth season and is self-fertile, enabling new populations to arise from a single plant (CRC Weeds 2007). It needs to be actively growing (during 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 flowering.
- Rhodes and red natal grass are common along roadsides and due to their differing curing rates to native grasses, burning surrounding areas can be difficult. Too-frequent fire or fires under dry conditions will promote red natal grass particularly where there are bare patches of earth. Due to its location (predominately road edges) there is often good access to these species for herbicide treatment. Be sure to treat infestations early before they can become established.
- Successful fire management techniques for other species of high-biomass grasses in the Brigalow Belt bioregion are not yet established and will need to be subject to experimentation. The examples above might be useful as a starting point.

This thatch infestation is adjacent to Ooline scrub. Black speargrass in the foreground gives an indication of the height of the thatch.

Dan Beard, QPWS, Carnarvon National Park (2009). **Insert:** Thatch grass seed head.

A mono-culture of thatch has replaced native pasture and begun to encroach into adjoining communities. Note the remnant scrub within the 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 of 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 or 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. **Partially Achieved:** Minor expansion of weed species distribution; will not increase fuel loads (e.g. scattered individuals spread into burn area; easily controlled). **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.	**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]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–75 % cover) = roughly equal proportions of target weed and native species. • Dense (> 75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation 'drops' two 'density categories' (e.g. from dense before the fire to light after the fire). **Partially Achieved:** Weed infestation 'drops' one 'density category' (e.g. from dense before the fire to light after the fire). **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. **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 continue 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.

As highly invasive weeds, exotic grasses such as this single guinea grass plant can quickly establish and spread. The maintenance of a healthy native grass cover is vital to exclude high-biomass exotic grasses. Fire has an important role in maintaining healthy continuous grass cover.
Mark Parsons, QPWS, Princess Hill (2007).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- This will depend on the species of invasive grass being targeted and often it is best to avoid fire all together. If burnt, in general invasive grasses should be burnt in ways that minimise fire severity. A **high**-severity fire may be required however, for 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 discussion)

- Fire frequency is dependent upon the grass species and objectives of the burn (see discussion above).

Mosaic (area burnt within an individual planned burn)

- Mosaic is dependent upon the species and objectives of the burn (see discussion above).

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.

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

GFDI: < 7, Low to moderate

DI (KBDI): < 100

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

Soil moisture: Ensure good soil moisture to retain a duff layer and limit the opening of bare ground and further encroachment of weeds.

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.

- **As part of a control program.** The initial spraying of high biomass grasses (e.g. guinea grass) with herbicide, followed a month later by a low to moderate intensity planned burn has been shown to be very effective as a control method. The successful treatment of these grasses will require continued monitoring and follow up, either by fire or herbicide, of any remaining plants and new seedlings.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire, particularly where there is an invasive grass infestation. Increased spacing between spots will result in a fire of lower-intensity. 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.** A slow-moving, low-intensity backing fire (lit against the wind or slope) will generally result in a more complete coverage of an area and reduction of fuels. This tactic ensures the fire has a greater amount of residence time, while ensuring fire intensity and rate of spread is kept to a minimum.
- **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 through the infestation (particularly if weather conditions are too mild or the grasses are not sufficiently cured). This can be achieved by shortening the spacing of lit spots or alternatively using line or strip ignition.

- **Limit fire encroachment into non-target communities.** Use appropriate lighting patterns (e.g. spot lighting with matches) in combination with 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 and not cured, under mild conditions, early morning on the dew or late afternoon or at night will assist in creating 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-slope towards the non-target community. In both instances ensure good soil moisture is present within the non-target community.
- **Fire exclusion.** Fire exclusion from an infested area of buffel grass may provide the opportunity for species such as brigalow or other acacias to out-compete the invasive grass. Ideally the acacia community would remain unburnt long enough to form a closed canopy that disadvantages and shades-out the buffel grass. This however requires active fire management in surrounding fire-adapted communities to prevent unplanned fire.

Issue 6: Manage lantana and other weeds

Lantana is found predominately in the northern extent of the Brigalow Belt bioregion in a range of vegetation groups favouring disturbed areas, rich soils, clearings, drainage lines, gullies, road verges and wet riparian pockets. The growing habit of lantana shades-out regeneration of native species and in particular grass, which in turn inhibits low-severity planned burns, but at the same time carries wildfire (Williams 2008). Where it occurs along rainforest edges, it increases the severity of fire against this edge, impacting on fire-sensitive ecosystems.

Awareness of the environment

Key indicators of *Lantana camara* where it has a scattered distribution:

- *Lantana camara* occurs as a scattered understorey plant.
- Grass fuels are still continuous despite the occurrence of lantana.

Key indicators of *Lantana camara* where it is a dense infestation:

- *Lantana camara* occurs as a dense infestation.
- There is an absence of grass or fine fuels.

Lantana occurring as a scattered understorey plant. Notice that grass fuels are still continuous and therefore the standard fire regime for the fire vegetation group could be applied to control lantana.

Mark Parsons, QPWS (2010).

Lantana/ guinea grass infestation.

Jenise Blaik, QPWS, Smithfield Conservation Park (2010).

Discussion

- A series of fires (with increased fire frequency) can be used to control lantana as the sole management method. This can be effective to reduce the abundance and density of lantana, or can reduce the size of individual plants so that native ground covers can compete. Where lantana is widespread this may be the only practical method of control. Implementing the recommended regime for the fire vegetation group is effective in the management of the density and occurrence of lantana where it is scattered as an understorey plant.
- In areas where lantana density is high but where some native grasses remain beneath it, the introduction of a low to moderate-severity fire on its own may be sufficient to control lantana and favour the native grasses.
- In areas where lantana has become a dense infestation of a limited size, an approach combining fire and herbicide becomes more practical (though fire on its own may prove sufficient).
- The use of fire in inappropriate conditions may promote lantana or scorch fire-sensitive communities, particularly where lantana occurs along rainforest margins. If lantana has been promoted, a follow-up low to moderate-severity backing fire in moist conditions may be required to favour the recruitment of native grasses (or at least reduce lantana back to root stock).

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.**

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)
Significant reduction in abundance of lantana.	**Before and after the burn** (after suitable germination/ establishment conditions, and if using cover – a growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–75 % cover) = roughly equal proportions of target weed and native species. • 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). **Partially Achieved:** Weed infestation 'drops' one 'density category' (e.g. goes from dense before the fire to medium after the fire). **Not Achieved:** No change in density category or weed density gets worse.
Majority of lantana clumps burnt back to the extent that regrowth is by basal resprouting (and hence follow-up spraying more efficient and effective).	**After the burn** (preferably after rain): visual estimation (by traversing the burn area on foot) of the percentage of clumps that are reduced to basal re-sprouting.	**Achieved:** ≥ 60 % of clumps reduced to basal resprouting. **Partially Achieved:** 25–59 % of clumps reduced to basal resprouting. **Not Achieved:** < 25 % of clumps reduced to basal resprouting.

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?

Key factors

- The principal factor for successful control is repetitive fire.

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

- Apply successive fires frequently (within three years of each other) until the observations indicate that the issue is under control. Then, re-instate the recommended fire regime for the fire vegetation group and continue to monitor the issue over time.
- Where lantana exists as a scattered understorey plant, it may be sufficient to apply the standard recommended fire frequency for the fire vegetation group in which it occurs. In any case, increasing the fire frequency for a while will assist control. Monitor the situation.

Mosaic (area burnt within an individual planned burn)

- Burn 90 per cent of the area where lantana has become a dense infestation.
- Within the fire vegetation group, increase the coverage of fire to 50–70 per cent where lantana is a scattered understorey plant.

Fire severity

- **Low** to **moderate**. Best results have been achieved using a slow moving backing fire with good residence time at the base of the plant in combination with high soil moisture. Fire severity should generally remain within the recommendations for the fire vegetation group in which the lantana occurs.
- For a dense infestation, **moderate** to **high**-severity fire may initially be required. A sequence of fires in dry conditions has been used to reduce the biomass of high density infestations. Be aware of potential damage to ecosystems and be cautious using this method adjacent to fire-sensitive vegetation and along creek lines.

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.

Season: Different approaches are possible including burning early in the year with good moisture, or alternatively, progressive burning to secure a late season burn under dry conditions. The treatment of lantana by fire has been very successful when implemented in the wet season with high relative humidity and temperatures, impending rain and good soil moisture.

FFDI: < 12 and occasionally up to 18 for higher severity fires

DI (KBDI): 80–120

Wind speed: Variable depending on objective and density of lantana infestation (denser infestation may require some fanning by wind so that the fire will carry).

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.

- **Line or strip ignition** can be used when the objective is to implement a fire of higher-severity (generally due to factors such as moist fuels, mild weather conditions and inconsistent fuels). This tactic may be required where the lantana infestation is of such a density that spot ignition will not be sufficient or there are minimal surface fuels available (e.g. grasses).
- **A low to moderate severity backing fire.** Where lantana is scattered in the understorey, a slow-moving, low to moderate-severity backing fire with good soil moisture (and the presence of sufficient surface fuels) will ensure a greater residence time at ground level and has proven to be successful in killing both seedlings and mature lantana plants.
- **Subdividing lantana infestations.** Dividing an infestation into sections by hand or with heavy equipment can improve access, aeration and allow the infestation to be burnt in sections in order to manage fire severity and behaviour.
- **As part of a control program.** The initial over-spraying of lantana with herbicide (e.g. splatter gun), knocking down the lantana frames a month or so post herbicide treatment and then implementing a low to moderate-severity burn into the remaining material has been shown to be an effective control method (particularly useful along rainforest margins). Alternatively, it is possible to knock down the lantana prior to herbicide control. The successful treatment of lantana will require monitoring the site and follow-up treatments either by fire or herbicide treatment of any remaining plants and new seedlings.
- **Aerial incendiary using a 'heli-torch.** In moist shaded areas such as creek lines applying fire using a heli-torch may help control lantana. This involves aerial incendiary using gelled gasoline to ignite the lantana directly or to strip light where a higher intensity fire is required. The surrounding vegetation needs to be moist to wet, in order to ensure the fire doesn't spread and to provide optimum conditions to promote native grass recruitment.
- **Progressive burning** has been used to good effect in the wet tropics where lantana is present as a dense infestation. Implementing low-severity, early season burns (April onwards) to create a safe perimeter around the lantana infestation, followed by a burn in November–December of a **moderate** to **high** intensity can effectively target the lantana infestation.

Issue 7: Manage rubber vine

Rubber vine *Cryptostegia grandiflora* is most common in the northern extent of the Brigalow Belt. Rubber vine has the ability to smother trees and shrubs and shade-out grasses and marine forbs, often forming impenetrable thickets. It is found initially in riparian areas and once established in these areas it can aggressively spread into surrounding communities. It has also been found in higher areas and in isolated pockets where seeds have been dispersed by wind, water and birds.

Fire is known to be an effective control method to treat rubber vine both alone and in combination with other treatments such as herbicide application.

Awareness of the environment

Key indicators of where rubber vine can be managed with fire:

- Rubber vine can be managed with fire where it occurs in non fire-sensitive vegetation or where the fire extent can be limited.
- Where grass or forbland fuels are still continuous despite the occurrence of rubber vine.
- When grass fuel crumbles in the hand (an indicator that the grass is sufficiently cured), fire will be able to carry.
- Controlling rubber vine with fire when it is affected by rust or when the latex appears grey will often result in a better kill.

Fire killed rubber vine. Fire can be a useful technique to kill rubber vine in inaccessible or remote locations.

Barry Nolan, QPWS, Cape Upstart (2009).

Key indicators of rubber vine in situations where care should be taken in using fire or fire alone would be insufficient:

- Where rubber vine occurs in areas of insufficient fuel to sustain fire.
- Where rubber vine occurs in fire-sensitive vegetation or where fire is not desired.

Rubber vine smothering native trees. Fire has been applied to kill rubber vine in the foreground but due to low fuel, has not reached some plants.

Above: Rubber vine flower, Col Dollery.

Barry Nolan, QPWS, Cape Upstart National Park (2008).

Rubber vine beside a spring. Fire might be a useful tool near watercourses in which herbicide use poses an environmental risk.
John Clarkson, QPWS, Undara (2009).

Emergent seedlings. If fire were to trickle between the boulders the low fuel load may provide insufficient residence time to cause the sap to boil and kill the plants.
Kerensa McCallie, QPWS, Gloucester Island (2005).

Rubber vine on beach dunes. Fire should not be applied where rubber vine occurs in fire-sensitive vegetation such as beach scrubs unless the impact of fire is limited or other control options are not available.
Kerensa McCallie, QPWS, Gloucester Island (2005).

Discussion

- A single fire can often be useful to reduce or eliminate rubber vine seeds, seedlings and plants where sufficient fuel is available and also to promote native grass recruitment. A follow-up fire may then be required to treat any remaining seedlings or plants. Plants should be scorched to the tip or all leaves completely browned.
- More mature plants require increased residence time to allow the sap to boil, which will kill the plant. Simply scorching mature rubber vine is not sufficient to kill them.
- Insufficient residence time or fire severity will not kill mature rubber vine plants. They are able to re-grow from undamaged material at the base of the plant. In some circumstances, such as rubber vine growing in harsh conditions such as sand, an enlarged root system may develop allowing greater capacity to recover after fire.
- In areas where rubber vine has shaded-out native grasses, mechanical or chemical control may be necessary. A combination of fire and chemical control could also be useful where grasses abut an infestation. A running fire into the rubber vine may reduce the area requiring chemical treatment or increase accessibility.
- Care should be taken using fire where fire-adapted communities adjoin fire-sensitive communities such as rainforest. Accumulated dead plant material or high-severity fire could draw fire in to these communities.
- Be aware of weed hygiene issues when planning burns in areas with rubber vine. Fire vehicles and machinery can aid seed spread along firelines and should be washed down after exposure.
- A heli-torch can be used to control rubber vine in fire-sensitive communities, inaccessible areas or where chemical use is not viable. The flammable petroleum-based gel is applied directly to the plant then ignited. The success of this method is generally reliant upon the moisture content of the rubber vine (which needs to be high to effectively cause the sap to boil and kill the plant). In some areas this method has been very successful; however mixed results have been reported in other areas. See tactics below.

A sequence of images showing the successful control of rubber vine with fire. The above image was taken in December 2004. A moderate-severity fire was used to scorch smaller plants to their tips and brown the leaves of the taller plants. Taken in October 2005, the image below shows the high mortality of young rubber vine plants and the significant reduction of climbing adult plants. The fire has also promoted a good cover of native grasses.

Paul Williams, Vegetation Management Science Pty Ltd, St Helliers (2004 and 2005).

Paul Williams, Vegetation Management Science Pty Ltd, St Helliers (2004 and 2005).

Rubber vine control by 'heli-torch'. One technique used with success in areas where fire is not desired is aerial ignition using flammable gel. The gel produces fires of limited extent in the right conditions.

Barry Nolan, QPWS, Cape Upstart (2008).

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**.

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 the following for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 90 % reduction in number of rubber vine seedlings, saplings and young plants or mature plants.	**Before and after the burn** (after suitable germination/ establishment conditions, or a growing season): In three locations (that take account of the variability of landform and weed density within burn area), one year after fire estimate what percentage of saplings have been killed. **Or** If using the 'heli-torch' method, retrace the flight path in three locations and estimate the percentage of mature rubber vine plants killed.	**Achieved:** > 90 % understorey saplings killed*. **Partially Achieved:** 75–90 % understorey saplings killed*. **Not Achieved:** < 75 % understorey saplings killed*. *Killed for the purposes of this guide relates to the death of the above ground component of the sapling (rather than the lignotuber). *If there are a high percentage of saplings re-sprouting, follow up planned burns may be required. *It is not necessarily a good outcome if you have killed most of the overabundant saplings, and yet the fire was too severe.

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?

Key factors

- The principal factor in successful control is residence time. Slow-moving fire or fire applied at a high-intensity (sufficiently enough to boil the sap of the plants) is required to kill mature rubber vine.
- A second fire may be required where mature plants have re-sprouted or seedlings emerged from the seed bank.

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

- Apply a follow-up burn in the following year if the observations indicate that the issue is not under control. In some cases a third fire may be required to completely remove the infestation. Once resolved, re-instate the recommended fire regime for the fire vegetation group. Continue Monitoring the issue over time.
- Where rubber vine occurs in fuel loads sufficient to ignite the area surrounding, applying the standard recommended fire frequency for the fire vegetation group in which it occurs may be sufficient. In any case, increasing fire frequency for a while will assist control. Monitor the situation.

Mosaic (area burnt within an individual planned burn)

- Burn 90 per cent of the area where rubber vine has become a dense infestation; or
- Within the fire vegetation group, increase the coverage of fire to 50–70 per cent where rubber vine is a scattered understorey plant.

Fire severity

- **Low** to **moderate**. Best results have been achieved using a slow-moving backing fire with good residence time at the base of the plant in combination with high soil moisture. Fire severity should generally remain within the recommendations for the fire vegetation group in which the rubber vine occurs.
- For a dense infestation, a **moderate** to **high**-severity fire may initially be required. A sequence of fires in dry conditions has been used to reduce the biomass of high-density infestations. Be aware of potential damage to ecosystems and be cautious when using this method adjacent to fire-sensitive vegetation and along creek lines.
- Use a **high**-severity fire applied using a ‘heli-torch’ to scorch the plant top visible from the air for a sufficient length of time so that the sap is boiled.

Post a moderate-severity fire to control rubber vine. The fire has scorched most of the young plants and adult trees that had begun to smother trees.
Paul Williams, Vegetation Management Science Pty Ltd, St Helliers (2004).

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.

FFDI: < 12 and sometimes 18 for higher severity fires.
DI (KBDI): 80–120.

Season: Different approaches are possible and include burning early in the year with good moisture or progressive burning to secure a late season burn under dry conditions. In some areas the treatment of rubber vine by fire has been very successful when implemented with storm burning under conditions of high relative humidity and temperatures, impending rain and good soil moisture.

Wind speed: Beaufort scale 1–4, < 23 km/hr. Wind speed is variable and depends on the objectives and density of rubber vine infestation (denser infestation may require some wind so that the fire will carry).

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.

- **Line or strip ignition** is used when the objective is to implement a fire of higher severity, generally due to factors such as moist fuels, mild weather conditions and inconsistent fuels. This tactic may be required where the rubber vine infestation is of such a density that spot ignition will not be sufficient or only minimal surface fuels are available (e.g. grasses).
- **A low to moderate-severity backing fire.** Where rubber vine is scattered in the understorey, a slow-moving, low to moderate-severity backing fire with good soil moisture (and presence of sufficient surface fuels) ensures a greater residence time at ground level. This has proven to be successful in killing seeds, seedlings, young and some mature rubber vine plants.
- **Subdividing rubber vine infestations.** Dividing an infestation into sections by hand or with heavy equipment can improve access, aeration and allow the infestation to be burnt in sections in order to manage fire severity and behaviour.
- **As part of a control program.** In areas where dense rubber vine shades out grasses limiting fuel available for fire, initial herbicide treatment could be used. Care should be taken when applying fire to dead rubber vine plants which remain hanging in the canopy as they may act as elevated fuels. The biological control agent rubber vine rust, rarely kills mature plants on its own. However it may defoliate the rubber vine allowing fuel loads to increase such that fire can be applied.
- **Aerial incendiary using a 'heli-torch'.** In areas where rubber vine has invaded communities where fire is either not required or desired such as those which are fire sensitive, applying fire using a heli-torch may help control the issue. This involves aerial incendiary using gelled gasoline to ignite the rubber vine directly. The surrounding vegetation needs to be moist to wet to ensure the fire doesn't spread.

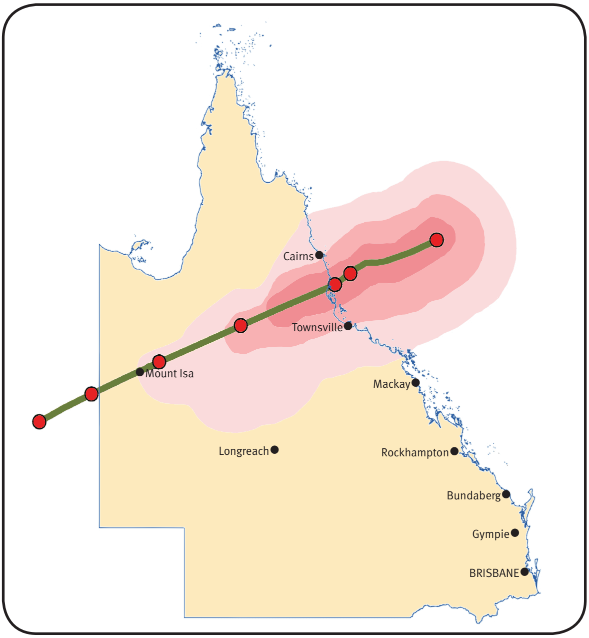
Issue 8: Post cyclone planned burning

In the event of a severe tropical cyclone (category three or higher) the canopy of trees and shrubs may be stripped, accumulating upon or suspended above the ground as leaves, fine leaf shred and branches. Snapped limbs can be left hanging in the canopy creating ladder fuel. In the event of a category four or higher cyclone, understorey vegetation is also damaged further increasing elevated fuels. A high level of fallen tree damage can also be expected, increasing heavy-fuel loads and impeding fireline access.

Once dry, the changed fuel conditions may lead to:

- the potential for extensive or high severity wildfires
- an increased fuel hazard near to assets and infrastructure
- altered fire behaviour during planned burning operations in the two years following a cyclone
- fire-sensitive communities becoming vulnerable to fire encroachment during certain dry periods
- an opportunity to re-introduce fire into areas that have been transitioning to closed forest.

Strategic planned burning with high soil moisture and avoiding dry conditions; encouraging landholders to mechanically reduce fuel; avoiding ignition sources during risk periods; and reviewing scheduled planned burns to make use of moister seasonal conditions are strategies to compensate for changed fuel conditions.



Illustrating the extensive region of wind damage caused by Cyclone Yasi which devastated the Cassowary Coast in February 2011.

David Clark, QPWS (2011).

Awareness of the environment

Indicators of increased fuel hazard due to a severe tropical cyclone:

- there has been at least a **category three severe tropical cyclone** (165–224 km/hr, very destructive winds)
- vegetation and branches stripped from open forest trees
- leaf, leaf shred, branches and limbs accumulate on the ground as significant fuel loads
- branches and fine fuel elevated above ground where they can easily aerate and become an elevated fuel hazard
- the reduction in native vegetation cover has allowed the establishment of high biomass invasive grasses (refer to Issue 3)
- rainforest or other fire-sensitive community extensively stripped of canopy foliage creating an open structure, with fuel accumulation on the ground or suspended; the open structure creating conditions where forest floor fuels become flammable under dry conditions.
- there has been at least a **category four severe tropical cyclone** (225–279 km/hr, very destructive winds)
- in this case, understorey vegetation may also be severely damaged creating excessive vertical and ladder fuels leading to an increased fuel hazard.

Although cyclone categories have been used to indicate wind damage, be aware that the pattern of damage can be quite variable. For example, a forest might be stripped of canopy vegetation, however have no accumulated fuel, as the fuel was blown elsewhere. Similarly a forest that did not sustain wind damage (e.g. the protected side of a ridge) may have received the blown fuel.

Therefore post cyclone assessments on the ground and/or by air are essential. Monitoring fuel conditions in the years following a cyclone is important as fuel matures and breaks down at different rates in different locations.

Strewn fuel and fallen branches will create a high fuel hazard when dry. Dead or fallen trees will allow fires to smoulder for some time, creating re-ignition risk.
Audrey Reilly, QPWS, Cyclone Yasi, Murray Falls (2011).

Category 5 cyclonic winds can cause build-up of fine and elevated fuels over substantial areas. Suspended fuel is aerated which decreases drying time and increases combustibility.
Richard Lindeman, QPWS, Cyclone Yasi, Stephens Island, Barnard Island Group National Park (2011).

These fallen fuels have dried to a point of ignition within 2 weeks of a cyclone.

Mark Parsons, QPWS, Cyclone Yasi, Lily Creek (2011).

Be aware of changed fuel conditions next to assets and infrastructure after cyclonic wind impact.

Audrey Reilly, QPWS, Cyclone Yasi, Bingal Bay (2011).

Strewn fuel and trees fallen across fire lines is one of the many issues to consider when planning fires after cyclones.

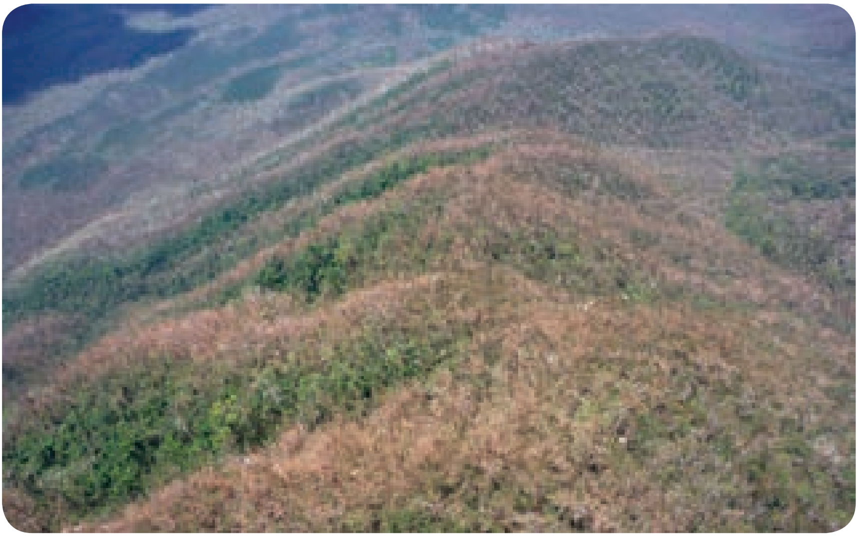
Audrey Reilly, QPWS, Cyclone Yasi, Murray Falls (2011).

A melaleuca wetland severely impacted by cyclonic winds. Be aware that fuel lying upon wetlands may carry fire where it would not usually travel. Also, this wetland now has an enormous amount of ladder fuel which will increase fire severity leading to tree death if burnt inappropriately.

Audrey Reilly, QPWS, Cyclone Yasi, Hull River (2011).

Melaleuca wetland damage by Category 5 cyclonic winds. Notice that most trees have been stripped and many lie on the ground.

Audrey Reilly, QPWS, Cyclone Yasi, Hull River (2011).



Category five cyclonic winds impacted these ridges and peaks, causing a build up of dead and flammable material next to vine forest. Avoid fires in the late dry season as vine forest/ rainforest edges are potentially vulnerable to fire in the two years after a cyclone, if they are upslope of a run of fire.

Audrey Reilly, QPWS, Cyclone Yasi, Cardwell Range (2011).

Discussion

- After a severe tropical cyclone, people will not naturally think about planned burning. However, without a fuel reduction strategy, there is a risk of extensive wildfires in the following dry season and a risk of fires that will impact on an already stressed canopy.
- The canopy of trees damaged by severe cyclones is particularly susceptible to further impacts (such as canopy scorch) and may lead to tree death. Until the health of the canopy is completely restored, fires which may impact them should be avoided.
- The best time to act on post-cyclone fuel reduction is soon after rain. Moist and humid conditions create slow-moving, trickling fires with good residence time. Such fires have good fuel consumption, are of low-severity, are easy to control and allow disorientated and distressed fauna to find refuge areas. These fires are also less likely to stress the canopy. Another effective time to utilise moist conditions is the following storm season.
- On islands where ignition sources can be reliably controlled, consider avoiding fires altogether, particularly where fires are likely to lead to canopy scorch.
- Despite best efforts, after a cyclone that causes extensive damage, it will not be possible to reduce fuel hazard in all the areas where it would be desirable to do so. A prioritised approach is required.
- The best way to protect property and infrastructure is emphasising the landholder's responsibility to mechanically clean up fuel. However, planned burning in moist conditions may form part fuel reduction strategies.
- Expectations of how fire behaves in a normal year must be reconsidered post cyclone (or even after a severe storm). It is likely programmed fire management can continue, but only after re-assessment of planned burn areas. Be aware that increased finer fuels and increased native or high biomass invasive grass cover, suspended and aerated fuel, open canopies and continuous fuel will change the way fire behaves. Fire will be more severe and may carry where it would not normally (e.g. over gullies, over streams, over firelines, and over wetlands). Site preparation, careful consideration of tactics and a different burning window may be required, using more moist and humid seasonal conditions than normal years in order to compensate for increased fuel.
- If it is not possible to use moister seasonal conditions and yet it is still important to reduce fuel, careful consideration of ignition tactics will be required. Backing fires away from risk areas, down slope and/or against the wind can be considered. Afternoon and evening conditions can also be considered.

- After a category four cyclone in fire-adapted communities that have been transitioning to closed forest, it becomes easier to re-introduce fire because the community has been opened due to wind damage. Be aware of the opportunity to re-introduce fire especially for ecosystems where few examples remain in an open state. This might be one of the few opportunities to recover transitioning ecosystems.
- After at least a category four cyclone, there will be a substantial number of fallen trees that may smoulder long after fire (especially after the second year), creating a re-ignition risk if burning in increasing fire hazard periods. Planned burning will not normally consume fallen trees, and the problem is likely to persist for years after a cyclone. Burning with moisture and in periods of stable moist conditions, or in declining fire hazard, will minimise the risk.
- If there is a dry period immediately after a cyclone (within a few weeks), prior to canopy and vines closing over, rainforests may become vulnerable to fire. If this occurs, consider actions (e.g. fire bans and park closures) that would limit ignition sources until the risk passes.
- During the October–November period in the two years after a cyclone, rainforest edges are vulnerable to upslope runs of fire. Lantana, high biomass grass invasion and multiple severe cyclone events (causing an increasingly open canopy) increases risk of encroachment.
- Be aware of how the three dimensional structure of fuel influences fire behaviour. To estimate fuel hazard (recommended for use in open forests and woodlands) use the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b). The digital version can be sourced online from the Victorian Department of Sustainability and Environment <www.dse.vic.gov.au>. Fuel hazard is 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).
- In some locations cyclones may provide a rare opportunity to reintroduce fire into open forests and woodlands which are in the late stages of transition to closed forest communities through shrub and vine forest invasion. Species found in eucalypt forest and woodland in particular need abundant light and bare soil to establish. Temporarily reducing the understory through planned burning may allow seedlings of canopy trees such as eucalypts to establish and thus halt or slow the transitioning process.

What is the priority for this issue?

Priority	Priority assessment
Highest	Fuel management through the implementation of planned burns to protect life, property, and conservation values.
Very high	Simplifying the vegetation structure and maintaining relatively low fuels is an important issue for proactive wildfire management and limiting the potential impact and spread of wildfires. Conservation burn in areas where applying fire or limiting encroachment of fire is critical to conserve remaining examples of an ecosystem.

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 objectives as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
No canopy scorch.	There are two options: 1. From one or more vantage points, estimate extent of canopy scorched. 2. In three locations (that take account of the variability of landform within burn area), walk 300 m or more through planned burn area estimating the percentage of canopy scorched within visual field.	**Achieved:** No canopy scorch. **Partially Achieved:** One to 20 % of canopy scorched. **Not Achieved:** Greater > 20 % of canopy scorched.
Reduce overall fuel hazard to low. **Or** Reduce fuel load to less than five tonnes/ha.	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. **Or** Fuel load has been reduced to less than five tonnes/ha. **Not Achieved:** Fuel hazard has not been reduced to low. **Or** Fuel load is greater than five tonnes/ha.

Fire mosaic 70–100 % burnt.	There are three options: 1. From one or more vantage points, estimate aerial extent of ground burnt. 2. In three locations (that take account of the variability of landform within burn area), walk 300 m or more through planned burn area estimating the percentage of ground burnt within visual field. 3. Walk into one or more gully heads, and down one or more ridges and estimate the percentage of ground burnt within visual field.	**Achieved:** Mosaic > 70 %. **Partially Achieved:** Mosaic 50–70 %, the extent and rate of spread of any subsequent wildfire would still be limited. **Not Achieved:** Mosaic < 50 %. High proportion of unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be 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.

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** and occasionally **moderate**. Slow-moving trickling fires are preferred. Be aware that in the two years after a cyclone, burning during dryer months may create a higher than anticipated fire severity.

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

- After a cyclone, it may be imperative to reduce fine fuels to reduce risk.

Mosaic (area burnt within an individual planned burn)

- Burn 70 per cent of the area to reduce litter fuels.

Other consideration

- Planned burning in moist conditions is only one of the ways to reduce risk after a cyclone. Mechanical fuel reduction and avoiding ignition sources during risk periods are also important strategies.
- Fires should not scorch the canopy of trees which have been cyclone damaged. Be aware that this may be more difficult following cyclones due to the higher fuel loads—considerable care should be taken.

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.

Recent rain: Burn soon after rain events as this increases the controllability of fire where excessive fuels have accumulated. Use the drying tables available in the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to estimate how soon the site will be ready to carry fire after rain (but take account of the fact there are suspended aerated fuels that might dry sooner). Moist conditions will recur in the following storm burning season (November to January).

Season: Aim for **summer** until **autumn**. Also, storm burns during **December** until **January**

FFDI: < 11

Relative humidity: > 60 per cent humidity will create conditions where fire will trickle. This helps create a low-severity fire with sufficient residence time to consume fuel.

Wind speed: < 15 km/hr (higher for storm 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.

- **Progressive burning** is very useful after a cyclone when combined with careful observations of fire behaviour, as this will indicate when conditions are becoming too dry for easy control of fires.
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low-intensity backing fire.
- **A low-intensity backing fire.** A slow moving, low-intensity backing fire will generally result in a better consumption of surface 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. Fauna that has been disorientated or distressed post cyclone will find this sort of fire easier to take refuge from.
- **Spot ignition** can be used to alter the desired intensity of a fire, particularly where there is a high accumulation of available and volatile fuels. 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 and fuel loads, etc.
- **Afternoon ignition.** This is particularly useful where suitable conditions are not available during the day. This will assist in promoting a low-severity fire that may trickle along the edge of non-target communities and generally self extinguish due to milder conditions overnight.

- **Limit fire encroachment into non-target communities.** Where the non-target community is present in low lying areas (e.g. riparian systems) utilise the surrounding topography to create a low-intensity backing fire that travels down slope towards the non-target community. If conditions are unsuitable (e.g. the non-target community has been damaged by a cyclone and is upslope) use appropriate lighting patterns combined with active suppression along the margin of the non-target community to promote a low-intensity backing fire that burns away from the non-target community (refer to Issue 1, for fire management guidelines).
- **Use strip ignition to draw** fire away from the non-target community's edge. Using more than one line of ignition can create convective updrafts which draws fires together and away from non-target areas. It is important to have safe refuges when undertaking this type of burning (e.g. for lighting along a track the person furthest from the track should walk parallel to the track and at least 20 metres ahead of the person lighting nearer the track). This reduces the chance of the 'outer' person becoming cut off from the refuge area.
- **Wet lines, blower lines (to clear strewn material) and/or rake-hoe lines** may have to be established along the edge of non-target communities. It is time consuming to establish wet lines, blower lines or rake-hoe lines especially where the boundary between ecosystems is extensive and where there has been considerable fallen timber, so use this tactic only where the prevailing weather conditions or the above tactics are not suitable to limit fire encroachment into non-target areas.

Issue 9: Manage severe storm or flood disturbance

In the event of a severe storm, the canopy of trees and shrubs may be stripped, with the debris accumulating on the ground or left suspended. Snapped limbs can be left hanging in the canopy increasing elevated fuels, and high numbers of fallen trees can greatly increase fuel loads and impede fireline access.

Major flood events can have a significant impact on riparian communities, by removing ground and mid-stratum vegetation and in some cases canopy trees. Invasion of exotic grasses and other weeds may often follow, increasing fuel loads and creating a fire-prone community which can inhibit the recovery of riparian vegetation.

Changed fuel conditions from severe storm or flood disturbance may lead to:

- the potential for high-severity wildfires
- an increased fuel hazard close to assets and infrastructure
- altered fire behaviour during planned burning operations in the months and years following a severe storm or flood event
- fire-sensitive communities (e.g. riparian) becoming vulnerable to fire encroachment during drought periods
- an opportunity to re-introduce fire into areas with overabundant saplings at an advanced stage.

An initial assessment and review of strategic fire control lines and the fire management zoning plan will usually be required. Possible strategies to manage changed fuel conditions include strategic planned burning with high soil moisture (and avoiding dry conditions), encouraging neighbouring landholders to mechanically reduce fuel, avoiding ignition sources during risk periods and reviewing scheduled planned burns to make use of moister seasonal conditions.

Severe storm events can dramatically alter forest structure. Reassessment of zoning plans may be required in response to greatly increased fuel loads.

Peter Cavendish, QPWS, D'Aguilar National Park (2008).

Riparian vegetation has been completely removed during a severe flood event and replaced by flammable exotic grasses. Although previously used as a strategic fireline, flood impacts have instead created a potential fire corridor.

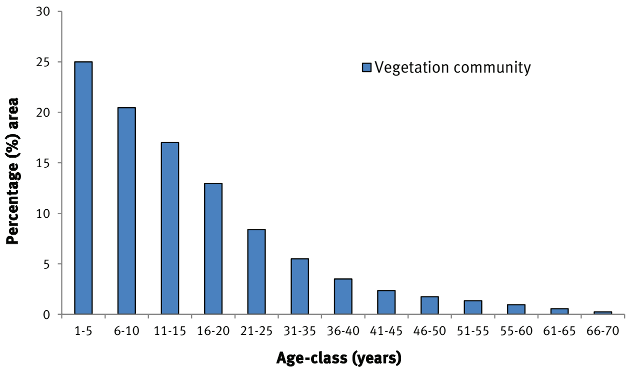
Dave Kington, QPWS, Lockyer National Park (2011).

Flood events can create concentrated areas of high fuel hazard. Large deposits of debris adjacent to or within fire-sensitive communities can increase the risk of fire encroachment.

Dave Kington, QPWS, Lockyer National Park (2011).

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). **Figure 1: Idealised age-class distribution (concept only)** 
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: • Beaufort force (or Beaufort number) • wind speed • 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.

Terminology	Definition
Clarification over the terms **'fire vegetation group'** and **'fire management zone'.**	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.
Fire perimeter	The outer containment boundary in which fire is being applied.
Fire regime	The recommended use of fire for a particular vegetation type or area including the frequency, intensity, extent, severity, type and season of burning.
Fire regime group (FRG)	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.

Fire management zone	Fire management sub-zone or Fire vegetation group
Conservation	FVG1
	FVG2
Protection	P1
	P2
Wildfire mitigation, etc	W1
	W2

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: • are generally taller than native species • can lead to decreased biodiversity • increase biomass • increase fire severity • 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.

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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 Brigalow Belt bioregion	Percentage
Eucalypt forest and woodland	9 394 566	26
Grasslands	516 922	1
Heath and shrublands	43 999	0
Melaleuca communities	80 936	0
Wetlands and swamps	44 917	0
Cypress pine and bull oak communities	1 435 480	4
Acacia dominated communities	1 647 279	5
Brigalow communities	1 019 659	3
Riparian, springs, fringing and dune communities	473 840	1
Rainforest and vine thicket	313 984	1
Mangroves and saltpans	206 136	1
Non-remnant and other land	21 166 016	58
Other bioregions	161 659	0
Plantations	596	0
Sand, water and other	88 871	0
TOTAL	**36 594 860**	**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		11.10.1, 11.10.1a, 11.10.1d, 11.11.10, 11.11.10a, 11.11.11, 11.11.20, 11.11.9, 11.12.1b, 11.12.2, 11.12.2a, 11.12.2b, 11.12.2c, 11.2.1, 11.3.10, 11.3.13, 11.3.2, 11.3.29, 11.3.2a, 11.3.30, 11.3.30a, 11.3.30d, 11.3.35, 11.3.35a, 11.3.7, 11.3.9, 11.3.9a, 11.4.13, 11.4.2, 11.5.5, 11.5.5a, 11.5.5c, 11.5.8c, 11.7.3, 11.8.14, 11.8.15, 11.8.4, 11.8.4a, 11.9.2, 11.9.9, 11.9.9a.
	2		Eucalypt forest and woodland-shrubby		11.10.11, 11.10.11a, 11.10.12, 11.10.13, 11.10.13a, 11.10.13b, 11.10.7, 11.10.7a, 11.11.12, 11.11.15, 11.11.15a, 11.11.15b, 11.11.15c, 11.11.15d, 11.11.3, 11.11.3c, 11.11.4, 11.11.4a, 11.11.4b, 11.11.4c, 11.11.4d, 11.11.6, 11.11.7, 11.11.7a, 11.11.7x1, 11.11.8, 11.12.1, 11.12.10, 11.12.13, 11.12.13a, 11.12.13b, 11.12.17, 11.12.19, 11.12.1a, 11.12.20, 11.12.3, 11.12.5, 11.12.5a, 11.12.6, 11.12.6a, 11.12.6b, 11.12.8, 11.12.8a, 11.12.8b, 11.12.9, 11.12.9a, 11.3.29a, 11.4.12, 11.5.12, 11.5.12a, 11.5.2, 11.5.20, 11.5.21, 11.5.3, 11.5.8a, 11.5.8b, 11.5.9, 11.5.9a, 11.5.9b, 11.5.9c, 11.5.9d, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.8.2, 11.8.2a, 11.8.5, 11.8.8, 11.9.7, 11.9.7a.
	3		Eucalypt forest and woodland-tall		11.10.2, 11.10.2a, 11.10.5, 11.5.7, 11.8.1.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
	1		Eucalypt forest and woodland-alluvial plains		11.3.23, 11.3.26, 11.3.28, 11.3.3, 11.3.36, 11.3.37, 11.3.38, 11.3.39, 11.3.3b, 11.3.3c, 11.3.4, 11.3.6, 11.3.3x1.
2	1	**Grasslands**	Tussock grasslands		11.11.17, 11.12.16d, 11.12.16x1, 11.12.1c, 11.3.20, 11.3.21, 11.3.24, 11.3.31, 11.4.11, 11.4.4, 11.8.11, 11.8.10, 11.9.12, 11.9.3, 11.9.3a.
	2		Spinifex grasslands		11.5.6, 11.5.14.
3	1	**Heath and shrublands**	Heath and shrublands		11.12.14, 11.12.18, 11.12.18a, 11.3.33, 11.5.10, 11.5.18, 11.7.5, 11.7.5a, 11.8.12, 11.8.7.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
4	1	**Melaleuca communities**	Melaleuca communities		11.12.11, 11.2.5, 11.2.5a, 11.2.5b, 11.3.12, 11.3.12a, 11.3.38a, 11.5.8, 11.8.11a.
5	1	**Wetlands and swamps**	Wetlands and swamps		11.2.4, 11.3.24a, 11.3.27, 11.3.27a, 11.3.27b, 11.3.27c, 11.3.27d, 11.3.27e, 11.3.27f, 11.3.27g, 11.3.27h, 11.3.27i, 11.3.27x1a, 11.3.27x1b, 11.3.27x1c, 11.3.2b, 11.5.17, 11.5.3b.
6	1	**Cypress pine and bull oak communities**	Cypress pine and bull oak communities		11.10.6, 11.10.9, 11.12.15, 11.3.14, 11.3.18, 11.3.19, 11.3.32, 11.5.1, 11.5.14a, 11.5.2a, 11.5.4, 11.5.4a, 11.5.5b, 11.8.9, 11.9.13.
7	1	**Acacia dominated communities**	Acacia dominated communities		11.10.3, 11.10.4, 11.10.4a, 11.10.4b, 11.10.4c, 11.10.4d, 11.11.1, 11.11.2, 11.12.16, 11.12.16a, 11.3.34, 11.4.12a, 11.5.11, 11.5.13, 11.5.1a, 11.7.2, 11.8.5a.
8	1	**Brigalow communities**	Brigalow communities		11.11.13, 11.11.14, 11.11.16, 11.11.19, 11.12.21, 11.3.1, 11.3.1a, 11.3.16, 11.3.17, 11.3.1b, 11.3.1d, 11.3.5, 11.3.8, 11.4.10, 11.4.3, 11.4.3a, 11.4.3b, 11.4.5, 11.4.6, 11.4.7, 11.4.8, 11.4.9, 11.4.9a, 11.4.9b, 11.5.16, 11.7.1, 11.9.1, 11.9.10, 11.9.11, 11.9.5, 11.9.5a, 11.9.6.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
9	1	**Riparian, springs, fringing and dune communities**	Riparian, springs, fringing and dune communities		11.10.14, 11.2.2, 11.2.2a, 11.2.2b, 11.2.3, 11.3.15, 11.3.15a, 11.3.22, 11.3.25, 11.3.25a, 11.3.25b, 11.3.25c, 11.3.25d, 11.3.25e, 11.3.25f, 11.3.25g, 11.3.3a, 11.3.4a.
10	1	**Rainforest and vine thicket**	Rainforest and vine thicket		11.10.8, 11.11.18, 11.11.21, 11.11.5, 11.12.12, 11.12.4, 11.12.4a, 11.12.7, 11.3.11, 11.3.11x1, 11.4.1, 11.5.15, 11.7.1x1, 11.8.13, 11.8.6, 11.9.14, 11.9.4, 11.9.4a, 11.9.4c, 11.9.8, 11.11.5a, 11.8.3.
11	1	**Mangroves and saltpans**	Saltpans		11.1.1, 11.1.2, 11.1.2a, 11.1.2b, 11.1.3, 11.1.3a.
	1		Mangroves		11.1.4, 11.1.4a, 11.1.4b, 11.1.4c, 11.1.4d.

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. 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 regional ecosystem 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	11.10.14, 11.10.2a, 11.12.11, 11.12.5a, 11.3.1a, 11.3.22, 11.3.24a, 11.3.3b, 11.5.11, 11.5.5b, 11.7.1x1, 11.8.10, 11.8.4a.

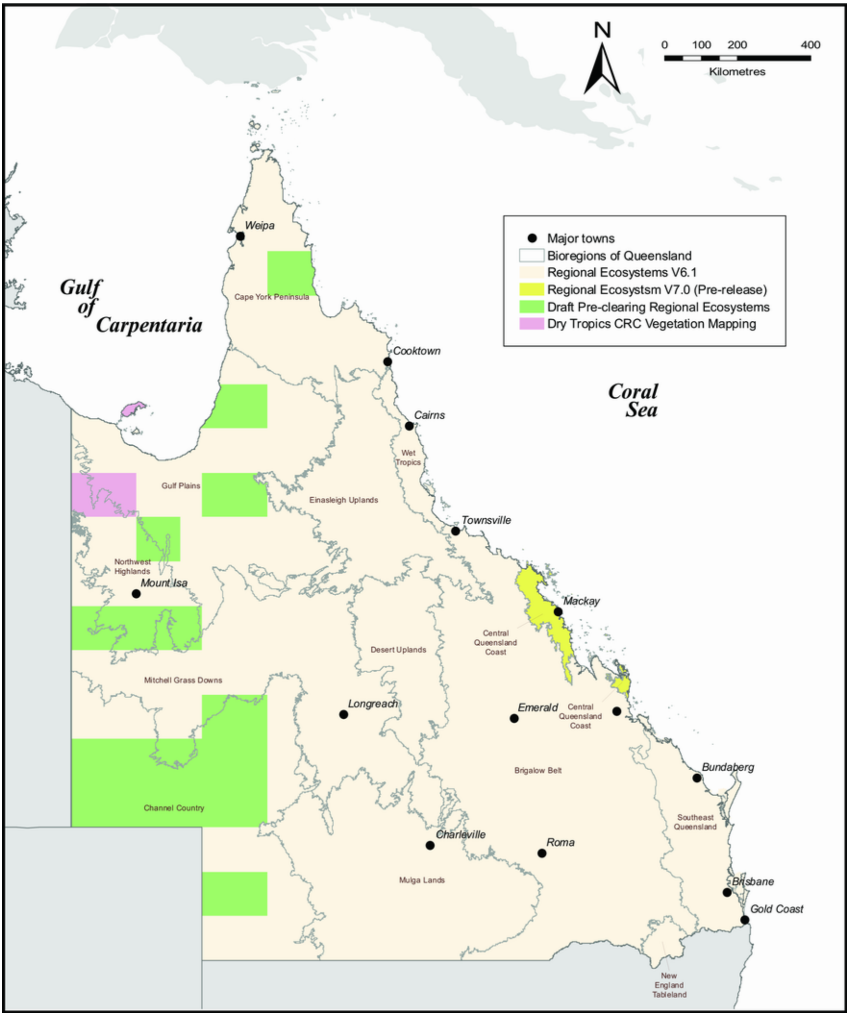

Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

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.

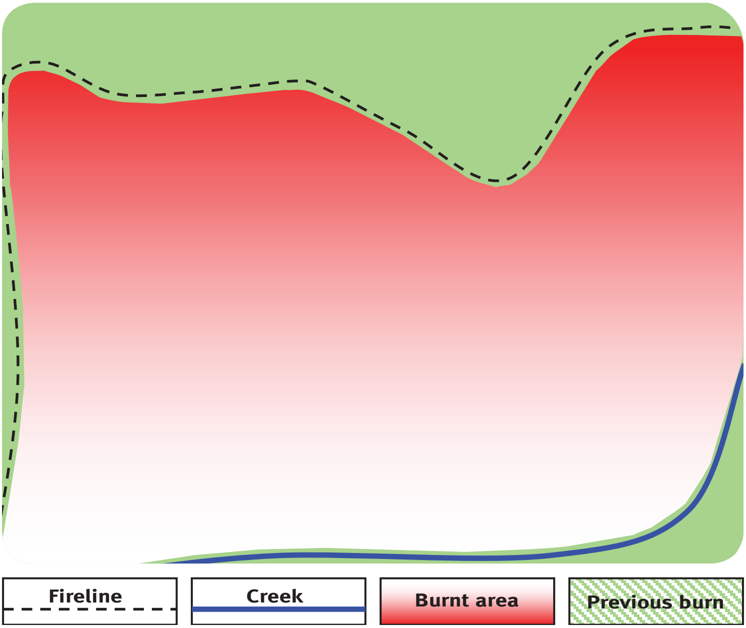

Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

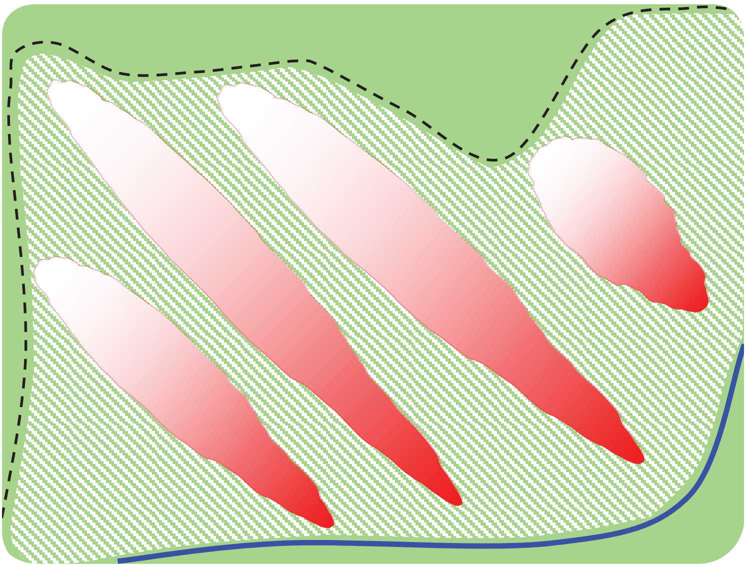

Figure 2: Planned mosaic burn—year 8.

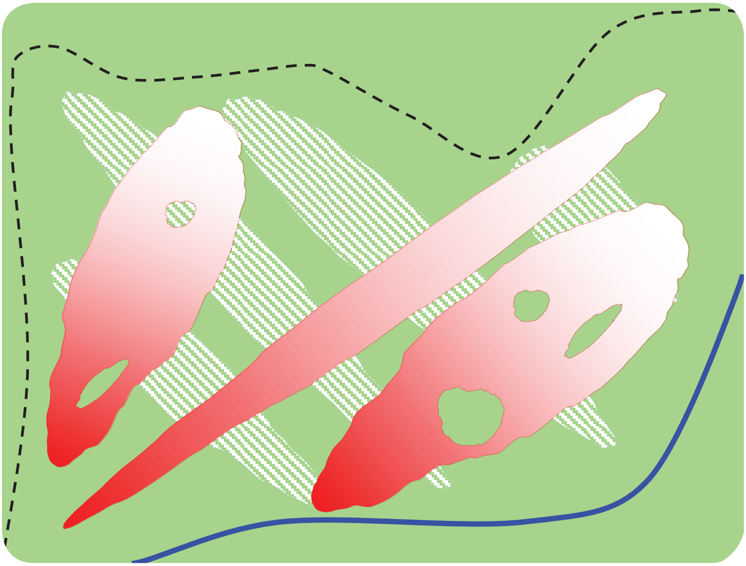

Figure 3: Planned mosaic burn—year 20.

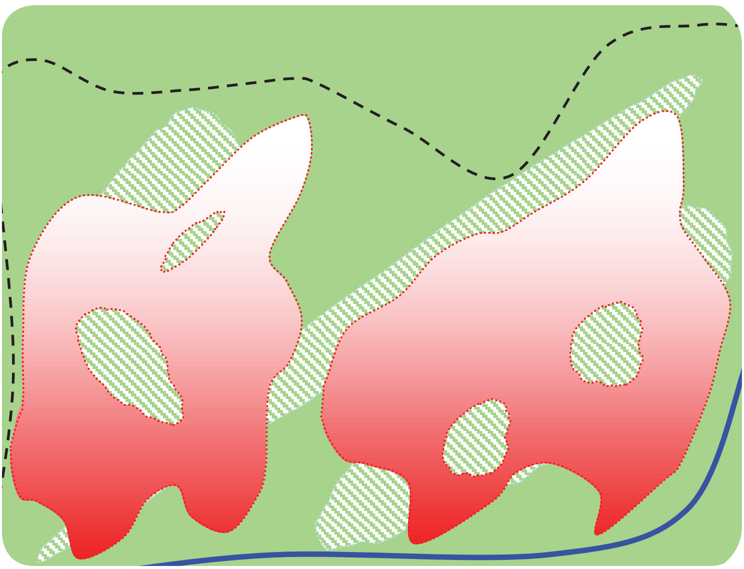

Figure 4: Planned mosaic burn—year 28.

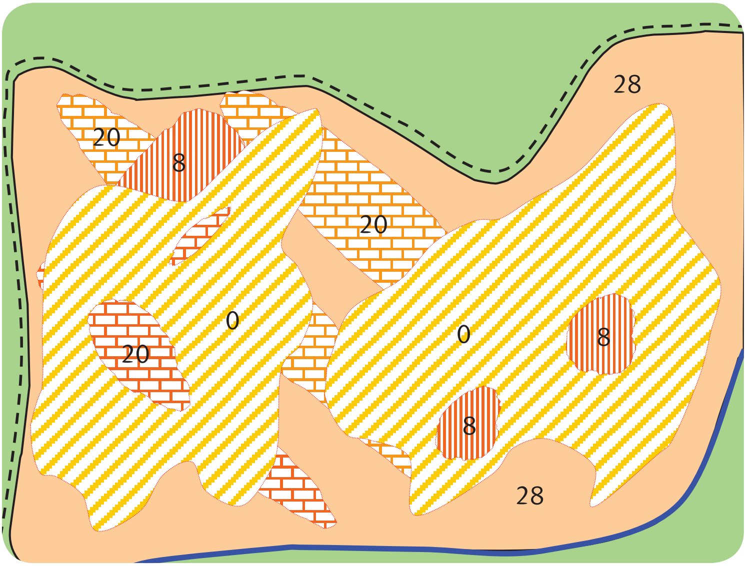

Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

Mosaic burn on Expedition National Park showing ~60 per cent coverage across the landscape.
Jono Handreck, QPWS, Expedition National Park (2011).

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