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.

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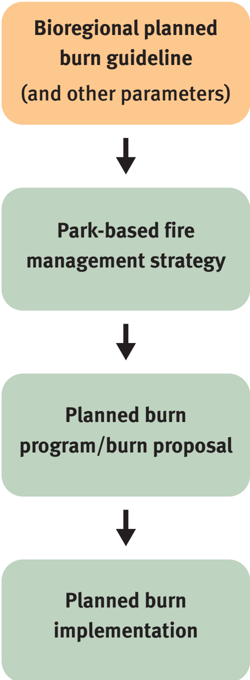
A low-intensity, mosaic fire in this brigalow and mountain yapunyah community with a grassy understorey will help managing fuel loads and maximise species diversity. Be aware of buffel grass in surrounding areas.

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).

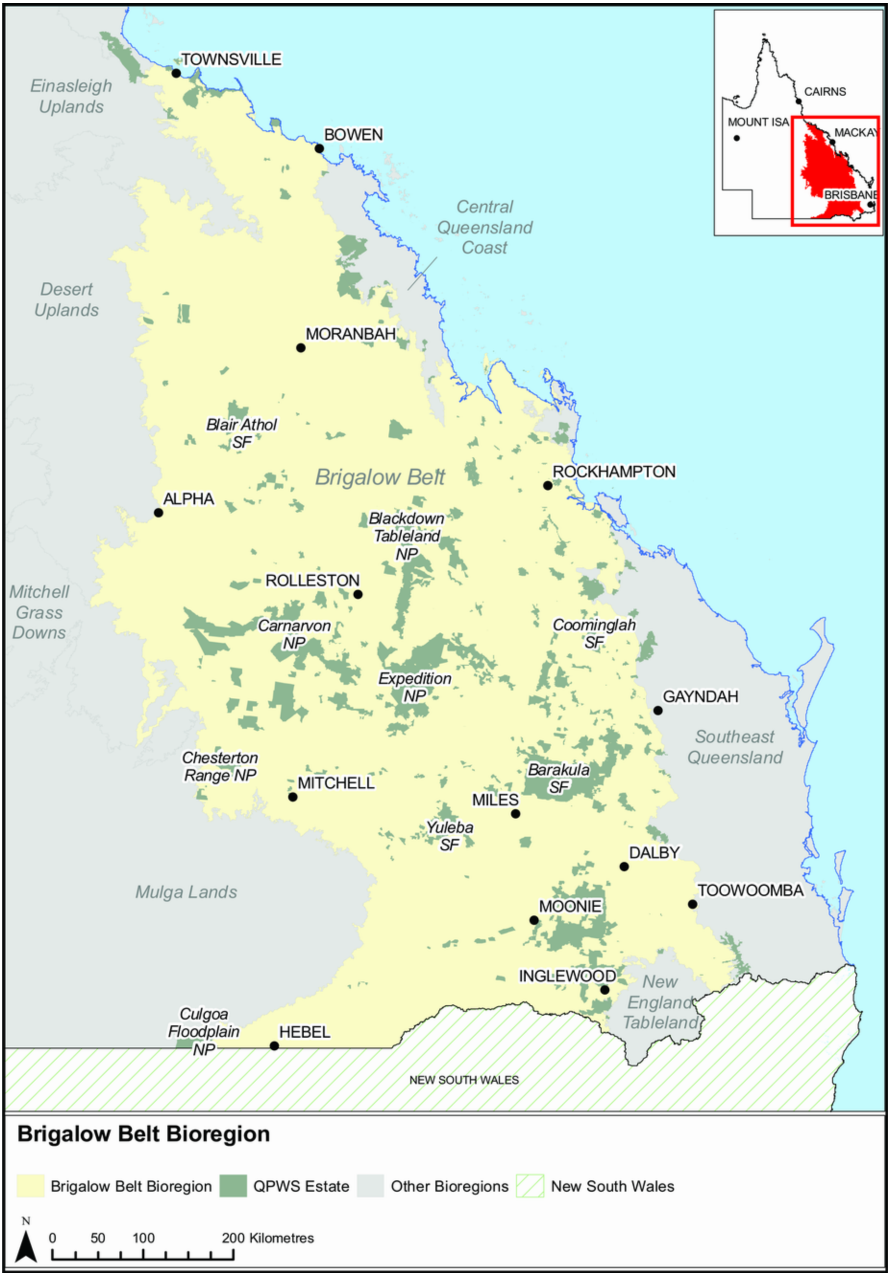


Figure 1: Map of Brigalow Belt bioregion of Queensland.

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).

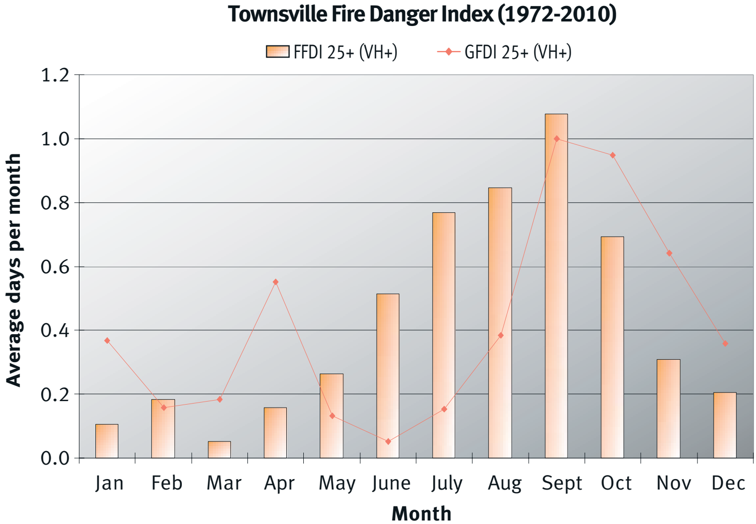


Figure 2a: Fire weather risk in the northern Brigalow Belt bioregion.

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).

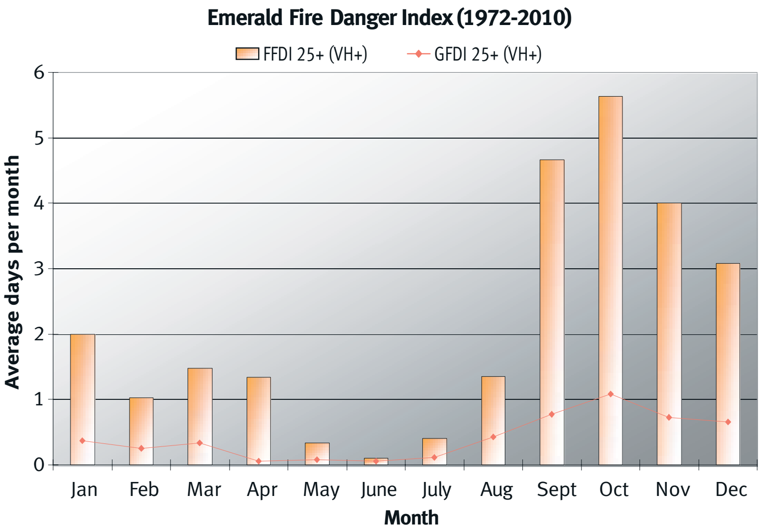
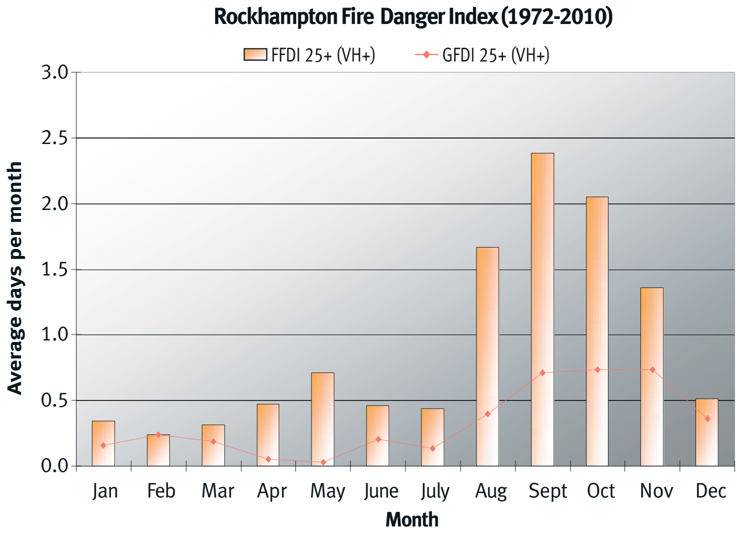
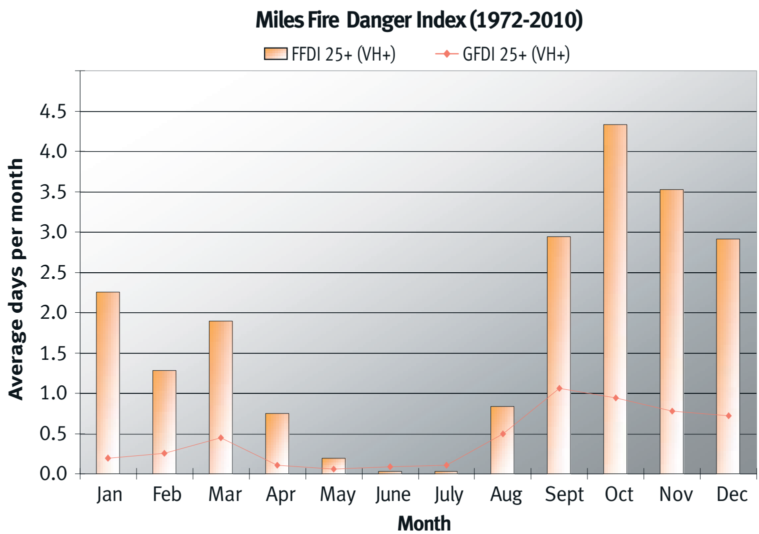


Figure 2b: Fire weather risk in the southern Brigalow Belt bioregion.





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).

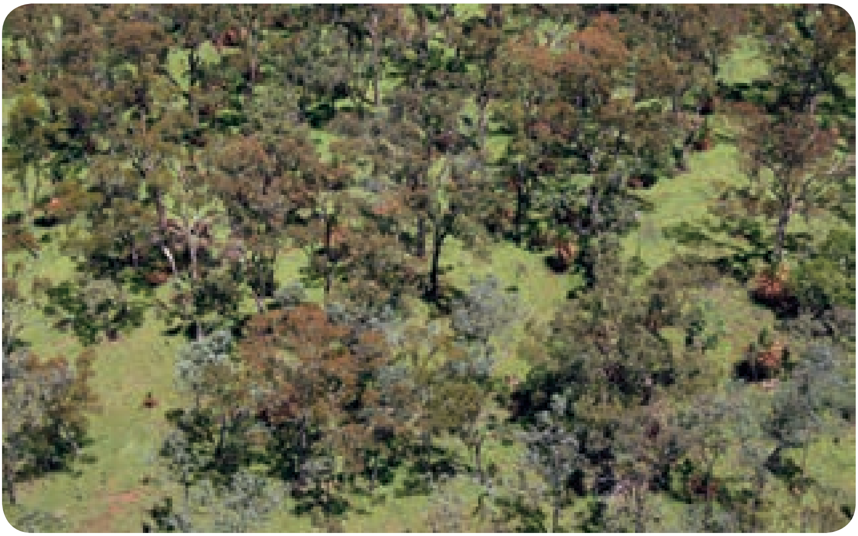
Poplar box woodland with a healthy grass-layer on flood plains. There is a good mix of trees of different ages, from saplings to habitat trees.

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

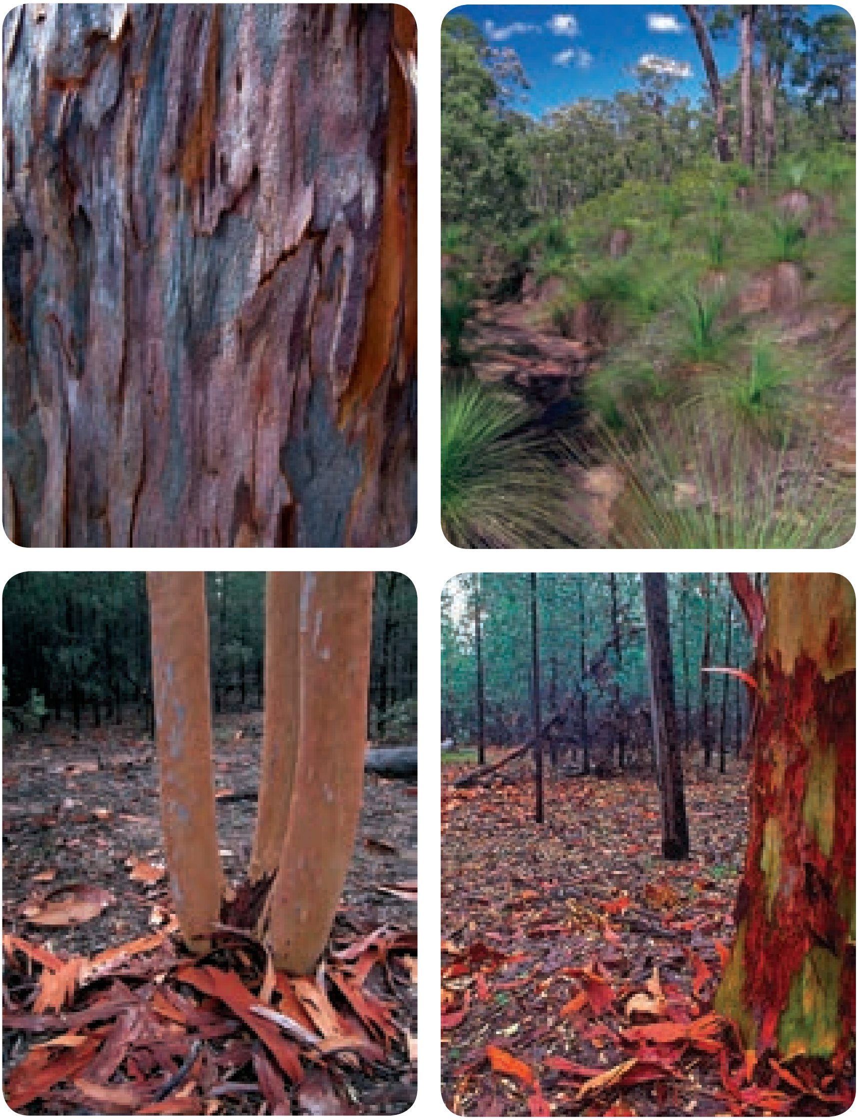
- Some protected areas contain disturbed systems that may be recovering from previous land management (e.g. clearing, logging and grazing). In these systems, the canopy may be understocked and have fewer larger trees (including habitat trees), overstocked or not contain sufficient recruiting canopy species 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.