Department of National Parks,
Recreation, Sport and Racing

Planned Burn Guidelines

Channel Country 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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Disclaimer

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

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Front cover photograph: Near Morney Station homestead, near Diamantina Development road. Dissected tableland scarp dominated by *Acacia siberica* with *Acacia cambagei* (gidgee) open woodland, Dale Richter, Queensland Herbarium (2010).

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Foreword

The Channel County bioregion contains a diversity of landscapes including vast braided channels and associated floodplains, gibber plains and extensive dune fields. Areas of Mitchell grass, gidgee woodlands and low rocky ranges are also common. Whilst it is predominantly sparsely vegetated, significant wet seasons occasionally occur which can significantly increases vegetation cover and dramatically alters the fire landscape.

The 'boom and bust' nature of the Channel Country often results in long periods of reduced vegetation cover, limiting the potential for implementing planned burns. The dune fields of Munga-Thirri and Welford National Parks are typical examples of this cyclic nature.

Despite this, fire still plays a vital role in ecosystems. The main challenge in the Channel Country is to determine the most suitable fire regimes to ensure diverse and healthy ecosystems across the bioregion are maintained. Planned burns need to balance ecological burning with hazard reduction burning in times of high fuel loads. This planned burn guideline will be an important tool to provide guidance and understanding of fire in the Channel Country bioregion.

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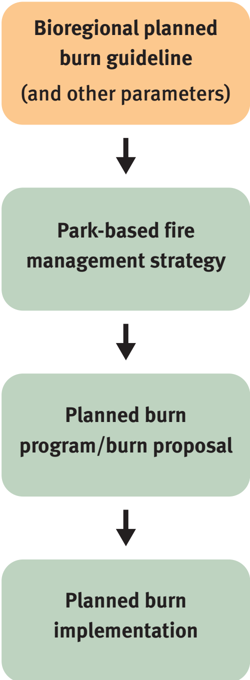


How the planned burn guideline fits into the QPWS Fire Management System.

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 Channel Country bioregion (refer to Figure 1) and covers the following fire vegetation groups: eucalypt woodlands, grasslands, forblands and shrublands, acacia dominated communities and springs (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Channel Country. 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.

Bruce Wilson, Queensland Herbarium (2009).

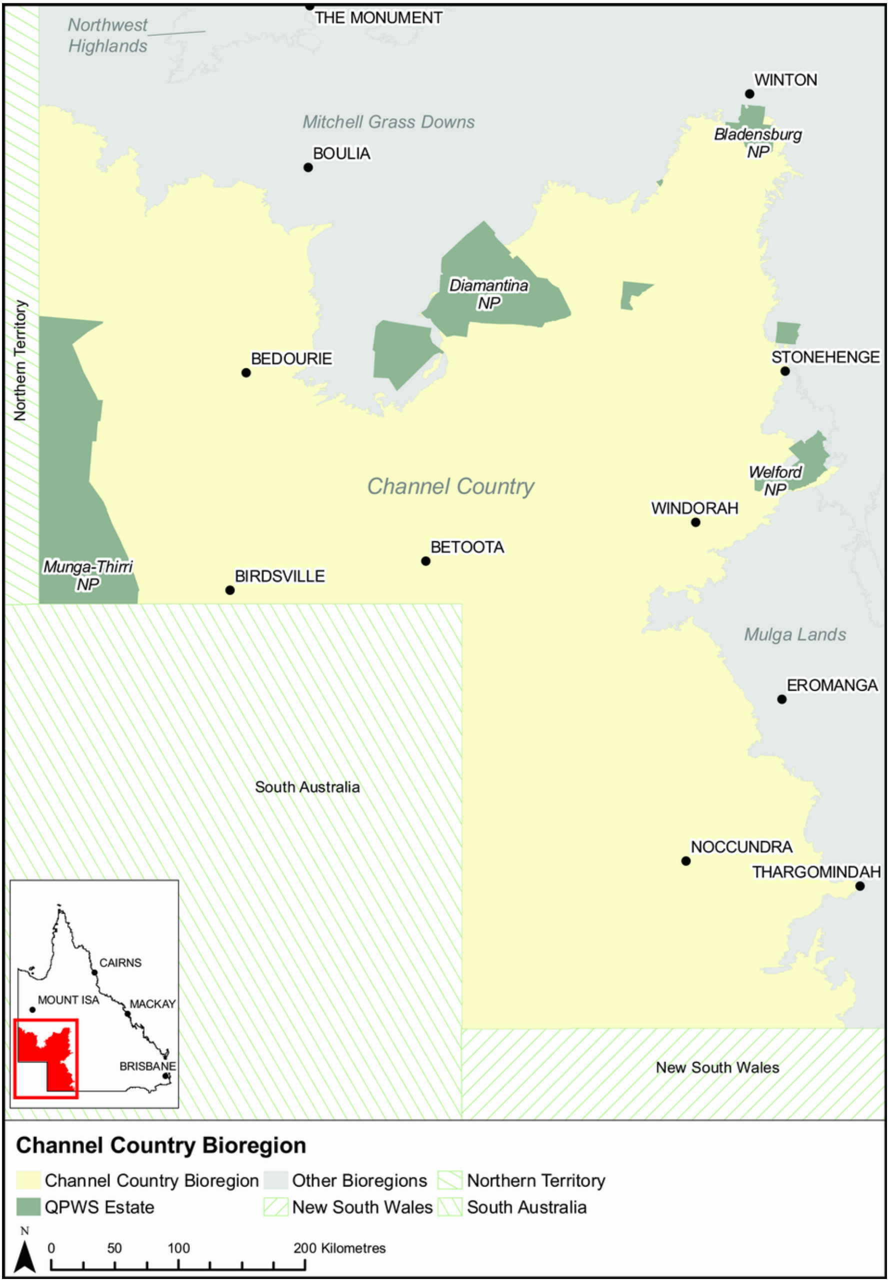


Figure 1: Map of Channel Country bioregion of Queensland.

Fire and Climate in the Channel Country bioregion of Queensland

In the Channel Country is characterised by prolonged dry periods with infrequent wet seasons. The extensive dry phases result in very little fuel available to carry a fire across the landscape. What little vegetation does exist is critical fauna habitat and it is vital that ecosystems are maintained as dry-time refuge areas. So although planned burning occurs most years to create habitat diversity, it is important to retain good vegetation cover.

The infrequent wet seasons are 'boom' events changing the normally sparsely vegetated countryside into a network of braided channels with abundant ephemeral vegetation. Often channels and swales fill due to distant rain events. Water, often from hundreds of miles away, floods down the channels causing defined areas of flourishing vegetation adjacent to sparse open country. At other times widespread rainfall events soak the landscape, causing even the sand dunes to be vegetated with ephemeral grasses and forbs. Once the water starts to dissipate, the ephemeral grasses and other ground cover quickly dries to become highly flammable for a short period until they start to desiccate and disintegrate.

During these high fuel periods, wildfires can sweep across vast areas removing all vegetation, potentially devastating flora and fauna communities. Planned mosaic burning efforts are concentrated after good rain so that continuous fuel can be broken-up to impede wildfire runs and to ensure the rapid recovery of native species. Rapid recovery has the added benefit of reducing the risk of soil erosion and minimising the risk of weed invasion and establishment.

Planned burning within the Channel Country must remain flexible to allow for variation in the timing and length of climatic events which dictate fuel loads. Limited windows of opportunity to burn occur due to the rapid drying out of areas, lack of control lines and distances involved to conduct test burns. Vigilance is required in recognising prospects to burn and capitalising on these opportunities. It is also important to be aware of conditions prior to and following burns.

Fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). The average temperature on these days is often above 36°C with low humidity (below 15 per cent) and sustained winds of more than 17 km/hr (refer to Figure 2). 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>.

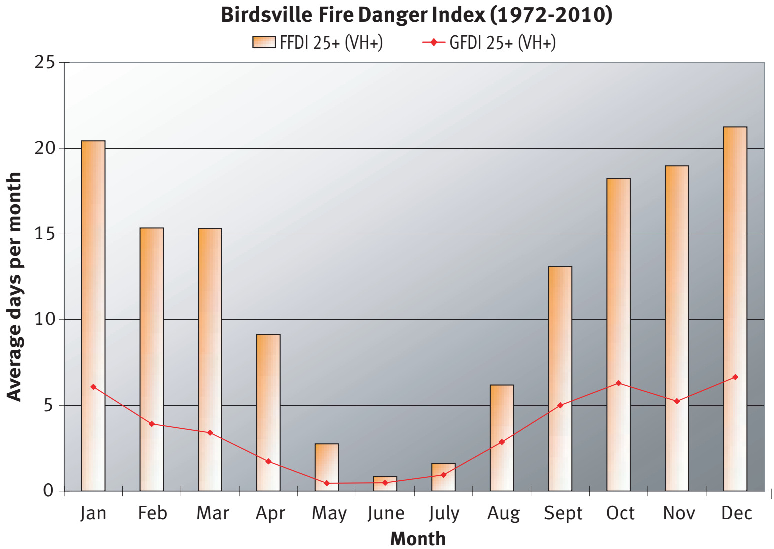


Figure 2: Fire weather risk in the Channel Country bioregion.

The likelihood of a fire weather day or sequence of days (FDI 25+) increases significantly after September and reduced during the winter season.

Swales provide a fire corridor when conditions are optimum. This wildfire often crossed over the dunes.

Steven Heggie, Bush Heritage Australia, Ethabuka Reserve (2011).

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 woodlands

This fire vegetation group includes open woodland communities with river red gum *Eucalyptus camaldulensis*, and coolabah *Eucalyptus coolabah*, sometimes associated with paperbarks (*Melaleuca* spp.) and acacias. In the Channel Country, eucalypt woodlands are mostly confined to watercourses, floodplains and drainage lines. The ground layer is dominated by tussock grasses with rushes and sedges present in wetter sites. In some areas a shrub layer may be present. These communities generally have very sparse understoreys.

Eucalypt communities with Normanton box *Eucalyptus normantonensis*, napunyah *Eucalyptus thozetiana* and desert bloodwood *Corymbia terminalis* are generally associated with a ground layer of spinifex. Refer to Chapter 2 (Issue 1), regarding information on fire management guidelines for spinifex eucalypt communities.

Fire management issues

A key fire management issue for all Channel Country fire vegetation groups is limited information or data on appropriate fire regimes. Therefore these guidelines must be considered provisional as practitioners continue to refine their understanding.

Fuel-loads are generally low in this fire vegetation group and fires do not often occur. They may occasionally burn with surrounding fire-adapted vegetation, but they are not usually burnt intentionally. Years of increased rainfall can result in increased fuel-loads in some areas which may result in the woodland being at risk of wildfire impacts.

Maintaining appropriate mosaic burning in surrounding fire-adapted areas is the best strategy to mitigate the spread of wildfire into these communities. In certain situations it may be necessary to deliberately target areas with low-severity fire to mitigate wildfire risk. Be aware that invasive grass species such as buffel grass *Cenchrus ciliaris*, can alter fuel characteristics (increasing fire severity) and influence the potential for frequent and damaging fires in this fire vegetation group.

Issues:

1. Maintain healthy eucalypt woodlands
2. Limit fire encroachment into eucalypt communities
3. Manage invasive grasses
4. Reduce woody weeds.

Extent within bioregion: 556 530 hectares (ha), 2 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Location of this FVG: Diamantina National Park, 39 517 ha; Munga-Thirri National Park, 12 225 ha; Welford National Park, 3 936 ha; Bladensburg National Park, 1 203 ha; Goneaway National Park, 209 ha; Astrebla Downs National Park, 14 ha.

Issue 1: Maintain healthy eucalypt woodlands

Maintaining mosaic burning in surrounding fire-adapted areas is the best strategy to mitigate the spread of wildfire into these communities. In certain situations it may be necessary to deliberately target areas of this fire vegetation group with low-severity fire to mitigate wildfire risk, especially after a wet season or flooding event.

Awareness of the environment

The following indicators may alert you that fire is required in eucalypt woodlands:

- A very wet year or succession of wet years, or a flooding event, has provided a boost to the growth of grasses and therefore an increase in fuel-loads and fuel connectivity.
- Grass tussocks are more or less continuous across the ground layer, in such a way that will carry fire.
- An abundance of native shrubs or trees such as gidgee and mulga have begun to appear above the grass layer and are more than scattered.
- Seedlings of woody weeds such as prickly acacia *Vachellia nilotica*, parkinsonia *Parkinsonia aculeata* are abundant and emerging above grasses, especially after high rainfall events.

Healthy coolibah low open woodland with grassy understorey. Occasional low-severity fire following good seasons should be considered to mitigate the potential for wildfires.
Bruce Wilson, Queensland Herbarium, Diamantina River floodplain (2007).

Following an exceptional wet season, grassy fuel loads increase across the landscape. Planned burning can assist in breaking-up fuel and mitigating wildfire impacting on riparian areas.

Bruce Wilson, Queensland Herbarium (2009).

Coolabah *Eucalyptus coolabah* on a seasonal waterhole. Manage fire carefully to minimise impacts to fire- sensitive coolabah.

Dale Richter, Queensland Herbarium, Carryana Station (2009).

River red gums *Eucalyptus camaldulensis* on a seasonal watercourse provide habitat/ hollows for arboreal fauna species and birds.

Rob Murphy, QPWS, Goneaway National Park (2009).

Eucalypt spp., dominate this riparian community and are also scattered on floodplains. Whilst fuel loads are generally low, grass growth on floodplains will increase following flood events.

Bruce Wilson, Queensland Herbarium, East of Mt Howitt Station (2009).

In some eucalypt communities ground layer fuels are very sparse and will rarely carry a fire.

John Neldner, Queensland Herbarium, north-east of Munga-Thirri National Park (2007).

Discussion

- Rainfall and associated flooding events are the main factor influencing grass growth in eucalypt communities. A very wet year or succession of wet years can provide a boost to the growth of grasses (and a consequent increase in fuel-loads).
- River red gums *Eucalyptus camaldulensis* and coolabah *Eucalyptus coolabah* are sensitive to too frequent and/or high severity fire which can inhibit the recruitment of seedlings, kill young pants and also some mature trees.
- Coolibah swamp associated with a dense layer of lignum *Muehlenbeckia florulenta* should not be burnt. Limit fire encroachment into these areas (refer to Chapter 6, Issue 3).
- A flush of coolabah, *Eucalyptus coolabah* saplings may occur following major rainfall events and will naturally thin out during dry periods.
- Eucalypt dominated riparian communities have a very high number of flora and fauna species as compared to all other fire vegetation groups in the Channel Country bioregion.

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)
40–60 % spatial mosaic of burnt patches.	Choose one of these options: 1. Visual estimation of percentage of vegetation burnt – from one or more vantage points, or from the air. 2. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. 3. Quantitative estimation of percentage of vegetation burnt from satellite imagery.	**Achieved:** 40–60 % burnt. **Partially Achieved:** between 30–40 % or 60–75 % burnt. **Not Achieved:** < 30 % or > 75 % burnt.
Minimal canopy scorch.	In the days post fire, walk through/ drive past 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.

> 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.

Monitoring the issue over time

Monitoring fuel loads following wet years is important to determining planned burn requirements in eucalypt communities.

Alicia Whittington, QPWS, Eyre Creek Adria Downs.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low**, with the occasional **moderate**-severity fire. An occasional moderate severity fire helps to ensure emerging overabundant trees are managed (in situations where this is becoming a problem).

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 will depend on seasonal conditions (rainfall or flooding events), fuel accumulation and the need for burning to mitigate wildfire. 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).

Mosaic (area burnt within an individual planned burn)

- A mosaic of 40–60 per cent burnt to limit the severity and extent of potential future wildfires.

Landscape mosaic

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

Other considerations

- Once an area has recovered from wildfire, plan patchy burns to break up areas of continuous fuel and re-establish a mosaic of vegetation age-classes. This will assist in preventing a cycle of repeated wildfire promoted by single-aged fuel and help to reduce overabundant seedlings/saplings stimulated by wildfire.

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. Drought conditions may also lead to poor results and/or wildfires.

Season: Autumn to early spring. To maximise species diversity, aim to implement burns at varying times of the year.

Soil Moisture: Good soil moisture at the time of burning is the critical factor.

FDI: < 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).

What burn tactics should I consider?

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

- **Aerial ignition** from a fixed wing aircraft or helicopter is often used in the Channel Country bioregion due to the scale and inaccessibility of areas being managed.
- **Spot ignition** can be used to alter the desired intensity of a fire particularly where there is an accumulation of volatile fuels. Spots placed closer together will result in a line of fire that is of greater intensity (i.e. as spots merge they create high-intensity junction zones). Spots placed further apart will result in a lower-intensity fire. Note that the spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Commence lighting on the leeward (smoky) edge**. This can create a low-intensity backing fire into the burn area or create a containment edge for a higher-severity fire ignited inside the burn area.
- **A low-intensity backing fire with good residence time.** A slow moving fire will generally result in the more complete coverage of an area and a better reduction of available fuels. As the intensity and rate of spread are kept to a minimum, the fire has a greater amount of time to burn fuels in that area. This tactic is also useful to reduce fine fuels such as grasses, leaf litter, twigs and overabundant seedlings and saplings.
- **Afternoon or evening ignition.** If conditions are not ideal but fire management is required, implementing afternoon or night ignition can reduce environmental impacts. This is also a useful technique to create patchy fires in continuous fuel, as fire fronts created through spot ignition self-extinguish in overnight conditions prior to joining.

Issue 2: Limit fire encroachment into eucalypt communities

Refer to Chapter 6 (Issue 3), regarding fire management guidelines.

To assist in the protection of eucalypt communities, maintain a varied landscape mosaic of burnt and unburnt patches in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging unplanned fires encroaching.

Issue 3: Manage invasive grasses

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

Refer to Chapter 6 (Issue 4), for fire management guidelines.

Issue 4: Reduce woody weeds

Woody weeds, in particular prickly acacia *Vachellia nilotica*, but also parkinsonia *Parkinsonia aculeata* and mesquite *Prosopis* spp. are known to be an issue in eucalypt communities. While fire is known to be an effective tool to manage the seedlings and saplings of some woody weeds, mature plants are often highly fire-resistant and top kill mainly results in resprouting.

Refer to Chapter 6 (Issue 5), regarding fire management guidelines.

Chapter 2: Grasslands

Grasslands are open and treeless or contain scattered trees or shrubs. The grasslands of the Channel Country bioregion occur on floodplains, channels, plains and undulating dune fields throughout the bioregion.

There are two main types of grassland communities:

Spinifex grasslands

Sand dunes and sand plains tend to support spinifex *Triodia* spp. with some scattered isolated trees (e.g. Normanton box *Eucalyptus normantonensis* , napunyah *Eucalyptus thozetiana* and desert bloodwood *Corymbia terminalis*) and shrubs (e.g. *Acacia* spp.). Forbs, legumes, tussock grasses and sand patches may also be found within the spaces between spinifex clumps. The ground layer is not usually continuous and may remain discontinuous for many years, but after a good season of rain, spinifex connectivity may develop.

Tussock dominated grasslands

On floodplains and clay plains common species include Mitchell grasses *Astrebla* spp., and wire grass *Aristida* spp. Low trees (e.g. *Acacia cambagei*) and scattered emergent shrubs. The ground layer is not usually continuous and may remain discontinuous for many years, but after a season of high growth grass connectivity may develop.

Fire management issues

A key fire management issue for all Channel Country fire vegetation groups is limited information or data on appropriate fire regimes. Therefore these guidelines must be considered provisional as practitioners continue to refine their understanding.

A very wet year or succession of wet years, or as a result of floods, grass growth can be boosted leading to an increase in fuel load and sufficient fuel connectivity to support wildfire. Wildfires impact on ecological values, nearby fire-sensitive communities and property. This is exacerbated by large tracts of inaccessible land, long dry-seasons and extended periods of very high fire danger. The main fire management strategy is to use mosaic burning to break up the continuity of fuel and provide a rich age-class structure to support diverse habitats. Despite the need to break up fuel continuity to mitigate wildfire, it is still important to ensure significant grass cover where possible to provide habitat or protect habitat features. A mosaic approach to planned burning is therefore required. Planned burning can occur in most years and this will help create habitat diversity, but significant areas may be left long unburnt until a good season of rain, after which burning efforts increase.

Overabundant acacia saplings in tussock grassland communities can lead to woody thickening. Often this is associated with a long absence of fire or germination events associated with successive good growing seasons.

Weed species such as buffel grass pose a significant threat to grassland community health and may increase fire severity.

Issues:

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

Extent within bioregion: 9 551 637 ha, 41 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Location of this FVG: Munga-Thirri National Park, 982 837 ha; Diamantina National Park, 155 628 ha; Welford National Park, 24 023 ha; Bladensburg National Park, 13 538 ha; Goneaway National Park, 4 662 ha; Lark Quarry Conservation Park, 24 ha.

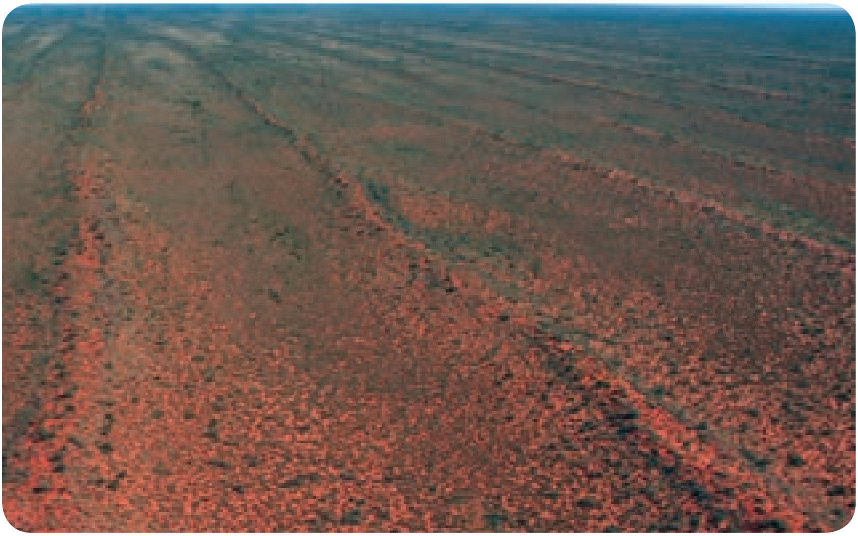
Issue 1: Maintain spinifex grasslands

Use low-severity mosaic fires to maintain spinifex grasslands and reduce impacts of wildfire.

Awareness of the environment

Key indicators of healthy Spinifex grasslands:

1. Ground layer is characterised by the presence of spinifex *Triodia* spp., which grow as hummocks that can vary greatly in diameter.
2. Spinifex shows a variation in time-since-fire across the landscape with ranging from young hummocks to old hummocks.
3. Other grasses including wiregrasses *Astrida* spp., Mitchell grasses *Astrebla* spp. and forbs are also present, particularly after good seasonal rains.
4. Scattered eucalypts, acacia or a mix of shrubs including *Eremophila* spp. may be common.



Aerial view of spinifex dominated communities on sand dunes and swales.
Alicia Whittington QPWS, Munga Thirri National Park (2010).

Sparse dune vegetation rarely carries fire until successive wet seasons boosts growth.

Rob Murphy, QPWS, Welford National Park (2010).

Spinifex of varying age classes and shrubs dominate this sand dune crest. Long unburnt spinifex (areas of dark grey spinifex) are healthy habitat features; however, a build-up of long unburnt spinifex over large areas can indicate that planned fire should be considered.

Dan Kelman, Queensland Herbarium, Simpson Desert (2010).

Healthy spinifex grassland on sand plains with scattered trees. While spinifex increases in size and fuel load with time, rainfall is the main factor influencing spinifex growth.

Dale Richter, Queensland Herbarium, Carryana Station (2010).

The following indicators may alert you that fire is required to maintain spinifex grasslands:

- Over large areas, spinifex hummocks have expanded in diameter and are starting to collapse in the centre. Long unburnt spinifex is moribund (i.e. has no fresh growth, looks grey and old).
- Spinifex hummocks are contiguous and able to carry even low-severity fire across a broad area.
- Where they occur, obligate seeders (e.g. *Acacia* spp., *Grevillea* spp.) are in the shrub layer, but are not healthy (e.g. are old or dying or of a single age-class).
- Gidgee, cassias *Senna* spp., or *Eremophila* spp. are starting to become common or seedlings are starting to become visible amongst the spinifex, particularly after a good wet season.

A small thicket of casuarina saplings has germinated after a planned burn. This is not considered an issue as it resulted from a localised hotspot and is not widespread.
Jenise Blaik, QPWS, D'Aguilar National Park (2012).

Discussion

- Fire intensity, frequency and timing, particularly extensive and widespread fires, can threaten species such as the crest-tailed mulgara *Dasycercus cristicauda*, brush-tailed mulgara *Dasycercus blythi* and striated grasswren *Amytornis striatus*. These species rely on mature spinifex communities for food, breeding habitat and cover from predators including foxes and cats (DERM 2010c). Maintaining a mosaic of ages of spinifex communities across the landscape will assist in maintaining sufficient areas of mature spinifex. Good spinifex cover is desirable but not so much as to cause risk of extensive wildfires.
- It is important to note that while spinifex tends to continue to increase in size and fuel-load with time, rainfall is the main factor influencing spinifex growth. A very wet year or succession of wet years can provide a boost to the growth of spinifex (and a consequent increase in fuel-load). This can result in extensive wildfires the following dry season.
- Recently burnt spinifex communities tend to have a greater diversity of resprouting perennials, annuals and ephemeral forbs scattered amongst the spinifex clumps.
- Shrub species diversity in spinifex dominated woodlands declines over time-since-fire. Conversely, the number of adult and dead shrubs increases in very long unburnt woodlands.
- There is a distinct type of sand dune vegetation in the northern Simpson Desert region that tend to have good spinifex cover right to the dune crest and have a higher fuel load than most. Be aware that in these areas, fire is much more likely to carry between swales.
- It was noted during the 2011 wildfire season that even ten-year-old fire-scars in spinifex country (that mostly burnt during drought periods) were able to be used to control early season wildfires. Later in the season however, the wildfire crossed fire-scars of a similar age.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Within individual burn areas, a mosaic of burnt and unburnt areas is achieved.	Choose one of these options: • Visual assessments from one or more vantage points, or from the air. • In three locations (taking into account the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating percentage of ground burnt; and range of fire-age-classes within visual field. • Using fire scar remote sensing data (e.g. NAFI), estimate the area burnt.	**Achieved:** 20–60 % burnt ground. **Partially Achieved:** 15–30 % or 60–75 % burnt ground. **Not Achieved:** < 15 % and > 75 % of burnt ground.
Proactive planned burning has prevented impacts of wildfire on natural/ cultural resources and infrastructure.	Using fire scar remote sensing data (e.g. NAFI), estimate the area of planned burns against wildfire on an annual basis.	**Achieved:** Annual area of planned burn prevents impacts of wildfire. **Not Achieved:** Wildfire has a significant impact.

Spinifex at different stages of time-since-fire recovery across the landscape.	• Visual assessments from one or more vantage points, or from the air. • In three locations (taking into account the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating percentage of ground burnt; and range of fire-age-classes within visual field.	**Achieved:** Spinifex has considerable diversity in time-since-fire from young hummocks to old hummocks. **Not Achieved:** There is little diversity with most areas of a similar age-class.

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 a small amount of recorded data. Instructions for establishing observation points can be obtained from the monitoring section of the QPWS Fire Management System.

- Monitoring spinifex cover (i.e. continuity of cover, ground layer diversity, fuel loads) across the landscape is the best indicator of when a fire is required.
- Monitoring of shrubs and obligate seed regenerating species can assist in ensuring fires are sufficiently patchy and that some areas remain long unburnt. Obligate seeders are killed by fire, these species need to mature and set seed (ideally a few times) prior to being exposed to fire again.

Firescars from a wildfire are still evident eight years on. Landscape mosaic burning is a high priority to reduce fuel loads and minimise the risk of repeat extensive wildfire.
Alicia Whittington, QPWS, Munga Thirri National Park (2010).

Dune vegetation removed during a wildfire event. It may be desirable to use ignition patterns that limit vegetation removal on dune slopes, as these areas are prone to erosion.
Steven Heggie, Bush Heritage Australia, Ethabuka Reserve (2011).

Spinifex and shrub layers can be used to help determine suitable fire frequency. Note that the ground layer is more or less continuous and some short lived shrubs have matured and died. These are indicators of the need for mosaic burning.

Alicia Whittington, QPWS, Munga Thirri National Park (2010).

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)	100–500	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)

- 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 ten years for spinifex dominated communities.
- It is important to maintain an active fire program to achieve a landscape mosaic. Because of the issue of scale, and time before an area will re-burn, a landscape mosaic can be achieved by applying small burns every year.
- Seasonal rainfall and the fuel it generates are the key drivers of fire extent and frequency in spinifex dominated woodlands. Use the strength of the wet season and the time since previous fire to help guide suitable fire frequencies.
- Ensure areas are left long unburnt (> 25 years) provided that they do not create a risk of extensive wildfire.

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

- It is important to maintain an active fire program to achieve a landscape mosaic. Because of the issue of scale, and time before an area will re-burn, a landscape mosaic can be achieved by applying small burns every year.
- In general, within the management area, do not burn more than ten to fifteen per cent of spinifex communities within the same year. In years with exceptional rainfall or widespread flooding, fuel loads across the landscape may be very high, and it may be beneficial to burn more than twenty per cent. During drier periods it may be necessary to minimise the amount of planned burning.

Other considerations

- Due to high soil moisture with summer rainfall, wet season fires may be useful to promote spinifex. Decreased spinifex growth after dry season fires results in loss of fauna habitat and can lead to erosion in some areas.
- Wildfires resulting from lightning strikes are common during the storm season.

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. Drought conditions may also lead to poor results and/or wildfires.

Season:

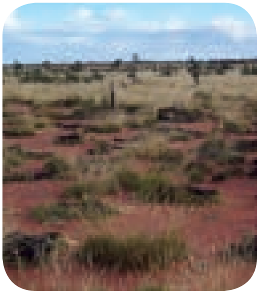
- Wet season to early dry season and storm burns. Concentrate efforts after good rainfall. Storm season fires will limit the chance of extensive wildfires later in the dry season (Crowley 2003).
- Be aware that grass growth and recovery post fire is slower in winter which may result in patches of bare ground for longer periods and provide the opportunity for encroachment of weeds and wind erosion of dunes.

GFDI: < 7

DI (KBDI): < 100

Wind speed: Beaufort 1–2, < 23 km/hr. Sometimes wind will be required to help the fire carry in spinifex communities.

A 2011 wildfire burnt in a continuous line over swales and dunefields. This followed two consecutive wet seasons which resulted in a good cover of ground fuels.
Steven Heggie, Bush Heritage Australia, Ethabuka Reserve (2011).



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

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.

- **Strategic annual burn planning**, to manage fire size and intensity, to plan an annual patchwork of burns across the landscape. Ideally burning should be undertaken in these communities every year, varying ignition points across the landscape. Natural boundaries and previously burnt areas can be used to manage the scale of burns.

Aerial ignition

- Aerial ignition is useful in the Channel Country bioregion due to the remote inaccessible terrain.
- Aerial incendiary operations allows for variations in ignition points (as opposed to repetitive lighting of main burn operations from firebreaks), and creates a landscape mosaic and patchiness within individual burns.
- It is recommended that an aerial incendiary plan is developed to ensure drop patterns achieve the desired burn objectives. Use of aerial photographs is recommended (stereoscopic images are particularly useful to gain an understanding of terrain) and it is good practice to plot the incendiary drop path onto a map or aerial photograph.
- **Spot ignition** is often used to alter the intensity of a fire and create a mosaic of burnt and unburnt areas. This can be achieved using a range of methods including drip torches, matches and incendiaries. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Limit fire encroachment into non-target communities.** In some cases, riparian communities can occur adjacent to grasslands. Use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community.
- Creating a **running** fire (through closely spaced spot ignition or line ignition with the wind), may help in addressing the issue of encroachment of woody species.
- **Commence lighting on the leeward (smoky) edge** to contain the fire 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.

Proactive planned burning has reduced spinifex fuels in this grassland community.
QPWS, Welford National Park (1993).

Aerial incendiaries targeting dune swales. Be aware of different methods for drop patterns, including random placement and grid patterns.
Alicia Whittington, QPWS, Munga Thirri National Park (2010).

Issue 2: Maintain tussock grass communities

Use low-severity mosaic burning to maintain tussock grass communities.

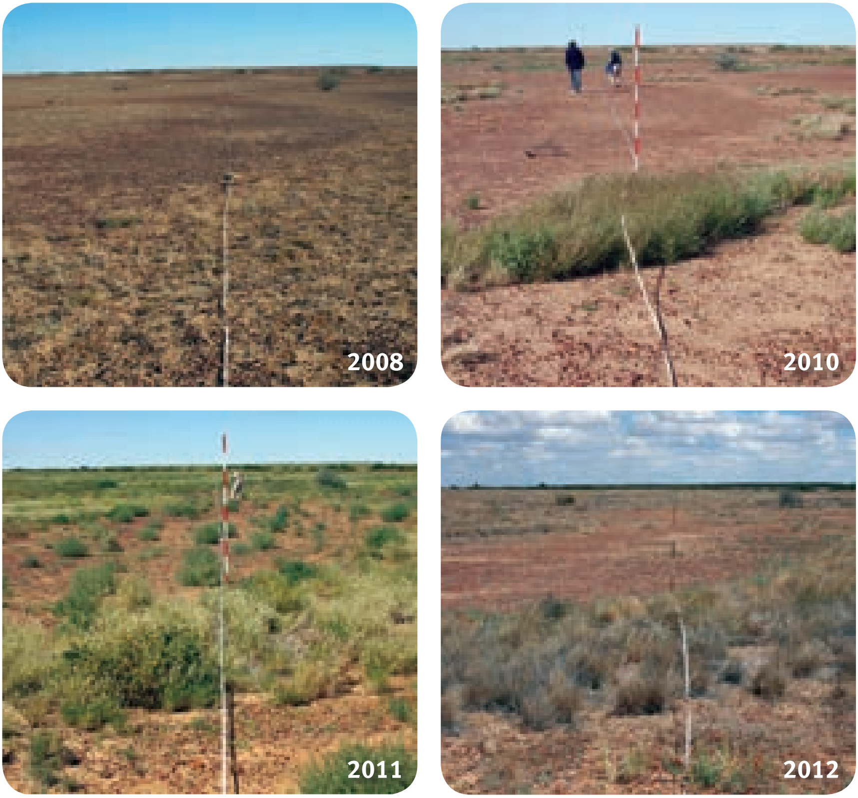
Awareness of the environment

Key indicators of healthy tussock grass communities:

- Ground layer is dominated by Mitchell grass *Astrebla* spp. or wiregrass *Aristida* spp.
- Often there is a very diverse mix of other species of grasses, forbs and legumes present (particularly after good seasonal rains).
- Scattered low trees and shrubs may occur including *Eucalypts* spp., *Acacia* spp., whitewood *Atalaya hemiglauca* and vine tree *ventilago viminalis*, particularly on drainage lines.
- In some areas tussock grasses are so sparse there is rarely enough fuel to carry a fire.

Although from a neighbouring bioregion, these images from Astrebla Downs National Park illustrate the effects of a wet season on grass fuel loads and connectivity. From top left: taken in 2009 after a long dry period, followed by a wet season in 2010 and then again in 2011 illustrating rapid grass growth. Grass cover begins to decline again in 2012.

Astrebla Downs National Park: Chris Crafter, QPWS (2009), Peter McRae, QPWS (2010 and 2011), Alicia Whittingham, QPWS (2012).



This area in Diamantina National Park is an example of the boom and bust cycle typical of the Channel Country bioregion. In this area, grasses are still fairly sparse even after good rain. The 2008 photo was taken after a long dry period, 2010 and 2011 were wet years and in 2012, the site was beginning to return to mostly bare ground.

Maree Rich, QPWS, Diamantina National Park, Bilby North monitoring site (2008, 2010, 2011, 2012).

Wiregrass *Aristida* spp. often replaces Mitchell grasses on stoney pavements. There is rarely enough fuel to carry a fire into these communities and they are generally not targeted for burning.

Bruce Wilson, Queensland Herbarium, Diamantina National Park (2008).

The following indicators may alert you that fire is required to maintain tussock grass communities:

- Grass tussocks have become more continuous across the ground layer allowing the passage of fire.
- An accumulation of dead material in tussocks, collapsing grass and poorly formed grass clumps are present.
- The diversity and abundance of herbs and forbs between tussocks have declined (but not due to seasonal variation —they are more diverse and abundant after wet periods).
- Saplings of native shrubs or trees such as gidgee and mulga have begun to appear above the grass layer and are more than scattered.
- Seedlings of woody weeds such as prickly acacia *Vachellia nilotica*, parkinsonia *Parkinsonia aculeata* and mesquite *Prosopis* spp. are abundant and emerging above grasses, especially after high rainfall events.

Discussion

- Fauna such as the fat-tailed dunnart *Sminthopsis crassicaudata* and Giles' planigale *Planigale gilesi* inhabit Mitchell grasslands, sheltering in crevices within the cracking clay soils or in grasses. Designing burn programs to retain areas of grass cover where possible is important to shelter such fauna against predation. Be aware that fires can attract a flush of predators such as feral cats. Mosaic planned burning with a relatively small patch size is useful to retain areas of good grass cover and mitigate predation effects. Enhanced pest control programs may need to be considered in years of extremely high predator numbers.
- The proportion of perennial and annual grasses varies across the landscape and reflects soil type, soil moisture and disturbance history.
- Fire is required to maintain the dominance of Mitchell grass in these communities. Fire also promotes new tillers (fresh growth) in Mitchell grass tussocks and stimulates seed production (Wilson 1992b, Scanlan 1980, 1983). An abundance of other grass species such as feathertop, may indicate the need for fire management to restore balance.
- Fires that are too severe and occur without sufficient soil moisture result in the death of sub-soil grass bases/roots and slow post-fire recovery time. Burning without soil moisture will often kill the grasses, slow the seedling establishment and give a competitive advantage to weeds and woody species.
- Fire can be used to push back encroachment of woody stemmed plants (e.g. gidgee and mulga).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 95% of grass bases remain after fire.	Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity) and estimate cover of grasses that recover one to three months after fire.	**Achieved:** > 95% recover. **Partially Achieved:** 90–95% recover. **Not Achieved:** < 90% recover.
> 75% of woody saplings/ seedlings < 1 m in height are scorched to the tip.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity), and estimate the percentage of saplings/ seedlings scorched.	**Achieved:** > 75%. **Partially Achieved:** 25–75%. **Not Achieved:** < 25%.
Proactive planned burning has prevented impacts of wildfire on natural/ cultural resources and infrastructure.	Proactive planned burning has prevented impacts of wildfire on natural/cultural resources and infrastructure.	**Achieved:** Annual area of planned burns prevents impacts of wildfire. **Not Achieved:** Wildfire has a significant impact.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

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

- 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). Fire frequency will depend on the need for burning based on fuel accumulation, maintaining a diversity of age-classes and seasonal conditions.
- For Mitchell grass communities consider a broad fire interval range of between ten to fifteen years.

Mosaic (area burnt within an individual planned burn)

- Where fuels are continuous, use of appropriate tactics and conditions are essential to avoid large tracts burning in one event (see conditions and tactics below). Mosaics are best achieved by applying appropriate tactics (like widely spaced spot ignition) and burning with good soil moisture. With this in mind, where possible, attempt to create a small patch size (e.g. less than five hectares) of burnt and unburnt areas.

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 twenty 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. Ensure good soil moisture at the time of burning to avoid favouring woody species.

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 and early dry season when there is good soil moisture or early storm season or after good spring rains
- Winter fires may reduce burn severity and extent due to mild conditions

GFDI: < 9

DI (KBDI): < 100

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

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

What burn tactics should I consider?

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

Aerial ignition

- Aerial ignition is useful in the Channel Country bioregion due to remote inaccessible terrain.
- Aerial incendiary operations allows for variations in ignition points (as opposed to repetitive lighting of main burn operations from firebreaks), and creates a landscape mosaic and patchiness within individual burns.
- It is recommended that an aerial incendiary plan is developed to ensure drop patterns achieve the desired burn objectives. Use of aerial photographs is recommended (stereoscopic images are particularly useful to gain an understanding of terrain) and it is good practice to plot the incendiary drop path onto a map or aerial photograph.
- **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.
- **Commence lighting on the leeward (smoky) edge** to contain the fire 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.
- **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**. It is beneficial to conduct planned burns following rain to ensure good soil moisture throughout the site (including drainage lines). Aim for times when there is visible surface water and when there is a high likelihood of rain in the days post burn.

Strip lighting every 50 to 100 meters can be useful to create a patchy mosaic in Mitchell grass grasslands. Some wind may be required to ensure the fire will carry.
Paul Williams, Vegetation Management Science Pty Ltd (2004).

Issue 3: Manage invasive grasses

It is important to be aware of the presence of invasive grasses, as they can dramatically increase fire severity which results in significant damaging impacts upon the vegetation community in which it has invaded. Invasive grasses are also promoted by fire.

Refer to Chapter 6 (Issue 4), for fire management guidelines.

Chapter 3: Forbland and shrubland communities

This fire vegetation group includes forblands, shrublands, vegetated swamps, herbfields, claypans and saltpan scald areas.

Fire management issues

A key fire management issue for all Channel Country fire vegetation groups is limited information or data on appropriate fire regimes. Therefore these guidelines must be considered provisional as practitioners continue to refine their understanding.

Most of the species in these communities are fire sensitive—do not intentionally burn. Most areas will not carry fire due to sparse fuels. However, after a good season or seasons of rainfall, they may develop a cover of fuel and become more vulnerable to fire.

Proactive fire management in surrounding fire-adapted areas will mitigate impacts of unplanned fire. When burning adjacent fire-adapted communities, limit fire encroachment by burning under suitable conditions and/or using suitable tactics. Occasionally, burning within these communities may be required to break-up continuous fuel.

Issue:

1. Limit fire encroachment into forbland and shrubland communities.

Extent within bioregion: 6 842 484 ha, 29 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

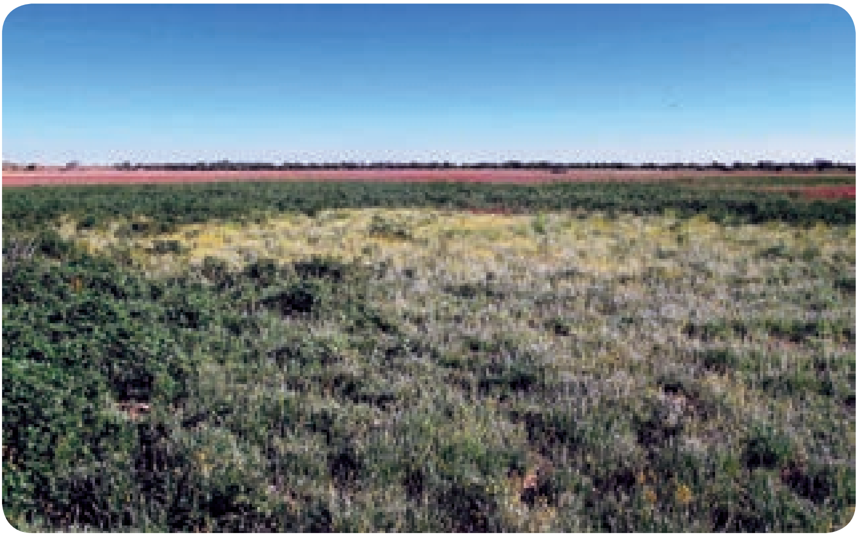
Location of this FVG: Diamantina National Park, 129 876 ha; Welford National Park, 11 479 ha, Munga-Thirri National Park, 8 069 ha; Bladensburg National Park, 4 738 ha; Astrebla Downs National Park, 672 ha; Goneaway National Park, 266 ha.

Issue 1: Limit fire encroachment into forbland and shrubland communities

Maintaining appropriate landscape mosaic burning in adjacent fire-adapted communities is the best strategy to limit the frequency and potential impacts of severe, unplanned fires in forbland and shrubland communities.

Refer to Chapter 6 (Issue 3), regarding fire management guidelines

Patchy to low-severity burns in the forblands, shrublands and vegetated swamps may occasionally be necessary to reduce fuel loads and mitigate impacts of wildfire. These fires should be implemented after storms, in wet seasons (when there is good soil moisture) or in winter (when fire is easily controlled).



A cover of forbs develops rapidly after rainfall.

Dale Richter, Queensland Herbarium,140 km south-west of Windorah (2010).

Samphire and other wetland plants dry out once water recedes.
Robert Ashdown, QPWS, Currawinya National Park (2006).

Salt-pan with sparse vegetation that will not carry a fire.
Dale Richter, Queensland Herbarium, 140 km south-west off Windorah (2010).

QPWS, Diamantina National Park (2005).

Queensland bluebush, river cooba and creek wilga shrubland.
Maree Rich QPWS, Diamantina National Park (2012).

Chapter 4: Acacia dominated communities

This fire vegetation group consists of acacia woodlands and shrublands. The main canopy trees are gidgee *Acacia cambagei*, Georgina gidgee *Acacia georginae*, and mulga *Acacia aneura*. However scattered areas of lancewood *Acacia shirleyi* and waddy wood *Acacia peuce* also occur. Acacia communities may occur as pure stands or in association with eucalypts or grasslands. The ground layer is generally sparse (but not always) and may include tussock grasses, spinifex and shrubs.

Fire-sensitive species such as western dead finish *Acacia tetragonophylla* and false sandalwood *Eremophila mitchellii* are often associated with acacia communities. Acacia dominated communities are the third largest fire vegetation group within the Channel Country bioregion.

Fire management issues

A key fire management issue for all Channel Country fire vegetation groups is limited information or data on appropriate fire regimes. Therefore these guidelines must be considered provisional as practitioners continue to refine their understanding.

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

Open grassy acacia communities may require infrequent patchy burns to protect them from late-season wildfire or to promote ground layer diversity.

Issues:

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

Extent within bioregion: 6 095 786 ha, 26 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Location of this FVG: Diamantina National Park, 70 867 ha; Bladensburg National Park, 43 355 ha; Goneaway National Park, 20 572 ha; Welford National Park, 19 219 ha; Munga-Thirri National Park, 10 836 ha; Lark Quarry Conservation Park, 1 223 ha; Lochern National Park, 902 ha.

Issue 1: Limit fire encroachment into acacia communities

Refer to Chapter 6 (Issue 3), regarding fire management guidelines.

Most acacia communities are fire sensitive. To assist in their protection maintain a varied landscape mosaic of burnt and unburnt patches in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging unplanned fires encroaching into acacia dominated communities.

Mulga, horse mulga, mineritchie and ghost gum. Even after a good season, fire is unlikely ever to carry.

Maree Rich, QPWS, Diamantina National Park (2011).

Mulga and *Eremophila dalyana*. This community is also unlikely to ever burn due to sparse fuels.

Maree Rich, QPWS, Diamantina National Park (2011).

These *Acacia shirleyi* are very fire sensitive. These trees were killed by a small spinifex fire at their base.

Maree Rich, QPWS, Diamantina National Park (2011).

Bastard mulga, *Acacia stowardii* and mulga *Acacia aneura* with a ground layer of grasses, herbs and mixed shrubs. While fire plays no role in the recruitment of these species a low- severity fire may occasionally be required to protect it from high-severity wildfire.
Dale Richter, Queensland Herbarium, Flodden Hills Station (2011).

Gundabluie and whitewood woodland is just visible in the background of this photo. It is recovering from grazing. Fire is undesirable and unlikely to carry in most years.
Maree Rich, QPWS, Diamantina National Park (2012).

Discussion

- Prior to undertaking planned burns in open acacia communities, the land manager needs to be clear about how fire will shape the community and the objectives of fire management within that community. Introducing occasional fire will retain open acacia communities and control woody thickening. Alternatively, a long-absence of fire may cause the canopy of acacia communities to close and become a more self-protecting community.
- Where woody thickening is an issue (e.g. *Acacia cambagei*, *Eremophila mitchellii*.), implement burns soon after high rainfall events, before woody seedlings become established.
- After good seasons, some acacia communities can develop a dense and diverse grass layer that requires fire to maintain ground layer diversity and reduce fuel loads. However, fire severity needs to be low to ensure acacia trees are not damaged by canopy scorch.
- When conducting planned burns in areas adjacent to acacia communities it is important to be aware of the dominant acacia species, their response to fire and the presence of invasive grasses.
- Acacias such as gidgee, mulga and waddy wood *Acacia peuce* are long-lived and susceptible to frequent and/or intense fire. Fire plays no role in their germination which is very occasional and generally follows high rainfall years. As recruitment only occurs following occasional high rainfall events, it may be important to ensure fire does not impact these areas while young trees are becoming established.
- Be aware that following a fire that has affected an acacia community, a more proactive fire management approach in the surrounding areas will often be required to allow the acacia regrowth sufficient time to recover, mature and for a seed bank to be replenished in the soil (DERM 2002).

Issue 2: Manage invasive grasses

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

Refer to Chapter 6 (Issue 4), for fire management guidelines.

Chapter 5: Spring communities

This fire vegetation group includes mound springs associated with the Great Artesian Basin discharge areas and associated vegetated swamps.

Fire management issues

Most of the species in these communities are fire sensitive. Do not intentionally burn. In the Channel Country bioregion, springs have a biodiversity status of **endangered** and a number of rare and threatened flora/fauna species are associated with these communities.

In many areas of the Channel Country Bioregion these spring communities are a refuge for small mammal populations such as long-haired rats, leggadina, plains rats and dunnarts that expand out from these areas in good years. Fire impacts on the ecological functioning of the springs and refuge populations.

Spring communities of the Channel Country bioregion are often self-protecting when surrounded by scalded ground. However, where fuel connectivity has increased, appropriate mosaic burning in surrounding fire-adapted areas is important to mitigate potential wildfire impacts.

Issue:

1. Limit fire encroachment into spring communities.

Issue 1: Limit fire encroachment into spring communities

In situations where planned burning nearby may potentially encroach into spring areas, see Chapter 6 (Issue 3), regarding fire management guidelines.

Springs should not be intentionally burnt. Burn adjacent fire- adapted ecosystems under conditions that limit fire encroachment.

Bruce Wilson, Queensland Herbarium (2008).

Chapter 6: Common issues

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

Fire management issues:

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

Issue 1: Hazard reduction (fuel management) burns

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

Awareness of the environment

Main indicators of where fire management is required

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

or

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

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

- Containment hazards (e.g. stumps, logs and stags) are present along firelines within protection zones.
- Dead material has accumulated around the base of grasses, sedges and ferns.
- There is an accumulation of continuous surface fuels that will carry a fire.
- Ground layer plants or shrubs are smothered by leaf litter in some areas.
- Shrub branches have dead material.

Discussion

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

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

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

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

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

Troy Spinks, QPWS (2010).

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

Troy Spinks, QPWS (2010).

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Return to the same location and record counts before and after the burn to support the estimations.

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

Burn 90–100 % (for protection zone) 60–80 % (for wildfire mitigation zone).	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 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.	**Protection Zone** **Achieved:** Mosaic > 90 %. **Partially Achieved:** Mosaic 80–90 %, the extent and rate of spread of any subsequent wildfire would still be limited. **Not Achieved:** Mosaic < 80 %. High proportion of unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be sufficiently limited). **Wildfire Mitigation Zone** **Achieved:** Mosaic 60–80 %. **Partially Achieved:** Mosaic 50–60 %. **Not Achieved:** Mosaic < 50 %. High proportion of unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be sufficiently limited).

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

Fire frequency / interval

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

Mosaic (area burnt within an individual planned burn)

- Fire coverage of > 90 per cent for **Protection Zones** or between 60–80 per cent for **Wildfire Mitigation Zones**.

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.

FDI: < 12

DI (KBDI): < 120

Season: Where possible Autumn-Winter. Avoid periods of increasing fire danger where relights are likely

Wind speed: Beaufort 1–4, < 23 km/hr

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

- reduce scorch height and limit leaf drop post fire
- minimise impact upon habitat trees, soils and other environmental values
- reduce the likelihood of a thicket of woody species developing post fire
- favour grasses over woody species as woody species will create undesirable fuel conditions.

What burn tactics should I consider?

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

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

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

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

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

David Cameron, DNRM (2004).

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

QPWS, Carnarvon Gorge.

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

David Cameron, DNRM, Unspecified location.

Aboriginal wells could be vulnerable to site disturbance during fire control operations.

Dale Richter, Queensland Herbarium, Channel country (2010).

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

David Cameron, DNRM, Bribie Island (2005).

Key indicators of European cultural heritage sites:

- Ruined buildings, corrugated iron shacks, wooden house stumps, old fence posts, old stock yards, tomb stones, wells, graves, bottle dumps, old machinery and iron debris, may all indicate the presence of a significant site.
- Quarries and old mines sites, deep holes sometimes covered with corrugated iron or wood.
- Plane wreckage.
- Forestry artefacts including marked trees (shield trees), springboard trees (stumps or trees with axe notches cut into it to support boards), and old machinery such as winders (timber tramways), and timber jinkers (timber lifting wagon).

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

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

Early explorer scar trees or memorial trees are vulnerable to fire especially if fuel has built up around the base of the tree.

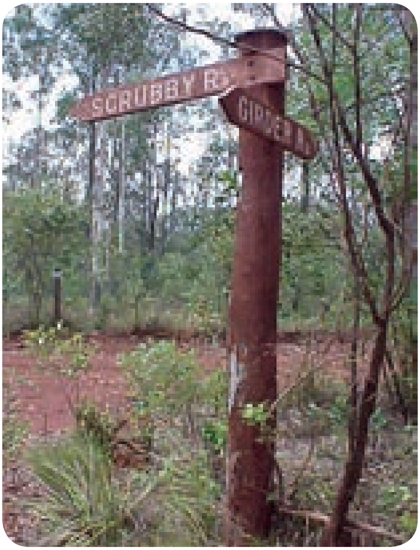
Bruce Wilson, Queensland Herbarium, adjacent to dig tree, Coopers Creek (2009).

Iconic structures sometimes need protection if vegetation growth increases the fire hazard.

Rob Murphy, QPWS, Poeppels Corner (2009).

Old abandoned European artefacts can become overgrown and vulnerable to fire damage.

Dale Richter, Queensland Herbarium, Channel country (2010).



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

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

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

David Cameron, DNRM, various locations.

Discussion

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

What is the priority for this issue?

Priority	Priority assessment
Highest	Fuel management through the implementation of planned burns within **Protection Zones** to protect life, property, and conservation values.
Very high	Planned burn required to maintain areas of **special conservation significance.**

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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 a small amount of recorded data. 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

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

Fire frequency / interval

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

Season: Favour early season burning and moist conditions

FDI: < 11

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

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

Wind speed: < 15 km/hr

Soil Moisture: Ensure good soil moisture

What burn tactics should I consider?

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

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

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

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

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

Non-target fire vegetation groups include forblands and shrublands, springs and fire-sensitive acacia communities. When healthy these communities may be self-protecting if fire is used under appropriately mild conditions or due to low fuel loads. A succession of high rainfall years or invasive grasses can promote fuels in otherwise self-protecting communities. Care should be taken to manage fuel around fire-sensitive communities under these conditions. Tactics such as burning away from these communities can be used in situations where they require additional protection.

Awareness of the environment

Indicators of fire encroachment risk:

- Conditions are not mild enough and/or fuels are not sufficiently sparse to ensure fire extinguishes on the edge of fire vegetation group.
- There is an accumulation of continuous surface fuels that will carry a fire within the non-target fire vegetation group.
- Invasive grasses are invading fire-sensitive communities.
- The non-target community is upslope of a planned burn area.

Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (high fuel loads due to a successive high rainfall years), it has the potential to damage non-target and fire-sensitive fire vegetation groups. Proactive broad scale management of surrounding fire-adapted areas with mosaic burning is one of the best ways to reduce impacts of unplanned fire on non-target and fire-sensitive communities.
- The presence of invasive grasses increases the severity of a fire and may contribute to the contraction of acacia communities. If invasive grasses are present, use fire with caution.

What is the priority for this issue?

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

Adult acacia killed by wildfire.

David Akers, EHP, Simpson Desert.

Eucalypt woodland along watercourses are vulnerable to intense fires. Note the pictured burnt and unburnt riparian woodlands.

Alicia Whittington, QPWS, Bladensburg National Park (2010).

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. Return to the same location and record counts before and after the burn to support the estimations.

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

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

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 a small amount of recorded data. 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?

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

Fire severity

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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.

FDI: Refer to relevant fire vegetation group

DI (KBDI): Refer to relevant fire vegetation group

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

Soil Moisture: If fuel moisture within a fire-sensitive community is insufficient, consider using tactics outlined below.

Riparian habitats are vulnerable to intense fires. Keeping fuel loads low in adjacent fire-adapted communities will limit potential impacts to riparian communities.
QPWS, Mariala National Park (1995).

What burn tactics should I consider?

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

- **Test burn** the site to ensure non-target communities will not be affected.
- **Do not create a running-fire.** When burning in adjacent fire-adapted areas during dry conditions or where there is continuous fuel, use a **low-intensity perimeter burn** from the edge of non-target community to protect its margins.
- **Commence lighting on the leeward (smoky) edge** to establish the fire and promote a low-intensity backing fire. Depending on available fuels and the prevailing wind on the day, this may require either spot or strip lighting or a combination of both.
- **Afternoon ignition.** Planned burning in areas adjacent to non-target communities can be undertaken late in the afternoon. The milder conditions during this period will assist in promoting low-severity fires that trickle along the edge and generally self-extinguish, particularly during winter.
- **Use Strip ignition to draw** fire away from the non-target community's edge. When more than one line of ignition is used it can create micro wind conditions that can draw fire away from non-target areas. It is important to have safe refuges when undertaking this type of burning.

Issue 4: Manage invasive grasses

Exotic grasses are capable of out-competing native species to form dominant stands. The main invasive grass of concern in the Channel Country bioregion is buffel grass *Cenchrus ciliaris*. Invasive grasses generally produce more dry matter than native grasses, increasing fuel-loads, spotting and flame height—leading to increased fire severity and rate of spread. They tend to occur as a result of disturbance and spread along firelines, roads and utility easements or where cattle or kangaroos camp under trees. It is important to be aware of the presence of high biomass grasses during planned burn operations.

Awareness of the environment

Key indicators: Note: be on the lookout for newly forming stands; control is much easier if their presence is detected early.

- The presence of high biomass grasses, usually occurring in a dense infestation.
- High biomass grasses generally form a monoculture (single species dominated stands).
- Generally taller than native species.
- Have a lot of mass and/or dead material.
- Be on the look out for newly forming stands and be especially vigilant in disturbed areas, particularly those where disturbance is ongoing (e.g. roadsides) and areas adjacent to or downstream from existing high biomass grass infestations (Melzer and Porter 2002). Control is often easier if their presence is detected and addressed early before it has become established.
- Prior to undertaking planned burns in areas where invasive grasses occur, become familiar with the response of this grass to fire (e.g. if it is promoted or killed) and other factors such as fire severity and weather conditions which may favour and further its spread.
- Invasive grasses cause the progressive loss of fire-sensitive communities and also increase the risk of wildfires carrying into the canopy of the community and causing the loss of mature trees. This contributes to the gradual decline and fragmentation of the extent, and/or loss of a population of fire-sensitive communities.
- The closed canopy of healthy, mature acacia stands will often suppress and prevent the encroachment and establishment of invasive grasses.
- There is a relationship between fire timing, frequency and severity and the ability of these grasses to invade which is still poorly understood. You are encouraged to record observations regarding these species' response to fire.

- Be aware of weed hygiene issues when planned burning in areas with high biomass grasses. Fire vehicles and machinery can aid seed spread along firelines and roads and should be washed down after exposure.
- In many cases, it is desirable to avoid burning high-biomass invasive grasses due to the likely increase in fire severity and the potential to promote them; however the risk of wildfire later producing an even higher severity fire must be considered. In some situations, burning high biomass grasses under mild conditions with planned fire is more desirable than allowing them to burn with wildfire.
- Once an area has been impacted by invasive grasses (in particular within fire-sensitive communities) the aim of the land manager often becomes one of fuel management. This may involve implementing mild or 'cool' fires both within the site and in surrounding areas by implementing appropriate tactics to burn away from the non-target community and limit edge effects on the margin. Other techniques which may be effective include slashing, spraying with herbicide and in some instances grazing (Melzer and Porter 2002; Butler and Fairfax 2003).

Buffel grass *Cenchrus ciliaris*

- Buffel grass is a long-lived perennial invasive grass (individual tussocks may live up to 15–20 years), that has become widespread in the Channel Country. It may be slow to establish but will spread quickly after favourable seasonal conditions (e.g. consecutive years of above average summer rainfall) (Miller et al. 2010).
- Buffel grass has a deep root system and can expand into bare areas adding to the continuous flammable cover in spinifex communities.
- The regenerative traits of buffel grass means that it has a competitive advantage over native grasses which are shorter lived and rely on conditions suitable for germination (e.g. good soil moisture). Buffel grass has the ability to carry a fire at much shorter intervals than native grasses (Miller et al. 2010).
- Where buffel grass occurs within or adjacent to fire-sensitive communities, it poses a threat by altering fuel dynamics (connectivity, biomass and height).
- The use of fire to control buffel grass is often debated. Fire is not recommended as a tool on its own for reducing buffel grass, but fire may assist in facilitating other control methods such as spraying or grazing. Be aware that follow-up spraying of the affected site will need to be continued for some time as buffel grass will usually germinate en masse after fire and rain. Any fire applied to buffel should be of a low severity. Using night time burns when conditions are mild, may assist in achieving a **low**-severity burn.

Buffel grass, a high-biomass invasive grass is outcompeting native grasses in the grassland community.
Leasie Felderhof, Firescape Pty Ltd (2010).

Buffel grass can recover quickly after fire. Note old clumps and regrowth post fire.
Justine Douglas, QPWS (2011).

The flowers and clumping form of the buffel grass tussock.
Jenny Milson, DAFF (2010).

What is the priority for this issue?

Priority	Priority assessment
High	It is important to be aware of the presence of high-biomass grasses so that their negative effects can be managed and the potential of control can be considered.

Assessing outcomes

Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around and if visibility is good look about and average the results. Return to the same location and record counts before and after the burn to support the estimations.

Choose from below as appropriate:

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

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

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

Monitoring the issue over time

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

This will depend on the species of invasive grass being targeted. In general invasive grasses should be burnt in ways that minimise fire severity.

Fire frequency / interval

Dependant upon objectives of burn, see discussion above.

Mosaic (area burnt within an individual planned burn)

Dependant upon objective of burn, see discussion above.

What weather conditions should I consider?

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

Season: Winter burning may provide conditions that limit fire severity.

FDI: < 7, low to moderate

DI (KBDI): < 100

Wind speed: Beaufort 1–2, or < 10 km/hr (unless a running fire is desirable, see tactics below).

What burn tactics should I consider?

Tactics will be site specific and often different tactics will need to be implemented at the same site due to changes in the topography, the weather and variations in the vegetation. During the planned burn, the review of the tactics being used will be ongoing and will need to be adjusted as required to achieve burn objectives. What is offered below is not prescriptive; rather it is a toolkit of suggested tactics that may assist with this issue.

- **Fire exclusion.** With regards to buffel grass, fire exclusion from an infested area may provide the opportunity for species such as mulga, brigalow or other acacias to out-compete buffel grass. Ideally the acacia community would remain unburnt long enough to form a closed canopy that may shade out and disadvantage buffel grass. Be aware that this tactic will still require fire management in surrounding areas to limit the chance of fire carrying into the area affected by buffel resulting in a high-severity fire that potentially may have devastating impacts upon the non-target community.
- **As part of a control program.** Apply a low severity burn in buffel grass and apply herbicide to the seedlings or recovering grass clumps (this may need to be done a number of times). The successful treatment of these grasses will require monitoring to ensure control activities have been completely successful and the buffel does not re-establish.
- **Spot ignition.** Can be used effectively to alter the desired intensity of a fire particularly where there is an invasive grass infestation. Increased spacing between spots will result in a lower intensity. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography, fuel loads etc.
- **A low-severity backing fire.** A slow moving, low-severity backing fire (e.g. against the wind or slope) will generally result in a more complete coverage of an area and a better consumption of available fuels. This tactic ensures the fire has a greater amount of residence time and reduction of available fuels, particularly fine fuels, while ensuring fire intensity and rate of spread is kept to a minimum.
- **Running fire.** For many invasive grasses it is recommended to burn early in the season. Conditions which favour a running fire will help carry the fire though the infestation if weather conditions are too mild or grasses are not sufficiently cured. This can be achieved by shortening the spacing of lit spots or alternatively using line or strip ignition.

Issue 5: Reduce woody weeds

Vachellia farnesiana (sometimes known as prickly mimosa, mimosa bush), parkinsonia *Parkinsonia aculeata* and prickly acacia *Vachellia nilotica* have a scattered distribution within the Channel Country bioregion; however, most of these have the potential to spread. Other woody weeds such as mesquite Prosopis spp. are also found but are less common. Fire may assist in the control of some species.

Parkinsonia forms dense thickets particularly along water courses, floodplains and in wetlands, endangering many threatened species and communities through displacement of native species, erosion and clogging of watercourses. Isolated but dense infestations occur below Windorah on the Cooper creek. It has potential for further spread.

Prickly mimosa *Vachellia farnesiana* grows in similar circumstances to parkinsonia but can also invade dry open grasslands and is able to form dense stands. Trees are scattered, but occur in large infestations where found. It occurs west of Winton on the open flood plains of the Diamantina River.

Prickly acacia is particularly damaging to grasslands where it can shade out native species, form dense thickets and eventually replace grasslands with shrubland/woodlands in which fires become difficult to reintroduce. It occurs in the Thompson River as far as Jundah. And has the potential to continue spreading south and further in to the Channel Country bioregion.

Awareness of the environment

Key indicators of where woody weeds can be managed with fire:

- woody weeds occur in fire-adapted vegetation or fire extent can be limited in fire-sensitive vegetation
- grass or forbland fuels are sufficiently continuous to carry fire despite the occurrence of woody weeds
- grass fuel crumbles in the hand meaning it is sufficiently cured to carry fire
- biocontrol agents are present which increase the effectiveness of fire as a control method (e.g. parkinsonia is affected with parkinsonia dieback).

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

- Woody weeds occur in areas of insufficient fuel to sustain fire.
- Soil moisture is low.
- Woody weeds occur in fire-sensitive vegetation and/or fire spread cannot be limited.
- Control of woody weeds cannot be achieved using fire alone. A combination of control methods is required.

Prickly acacia is of particular concern to native grasslands. If detected early, fire can be a useful tool to control saplings and seedlings; however it is much less effective on mature plants.

Kerensa McCallie, QPWS, 30 km east of Hughenden (2011).

Mature parkinsonia.
Eleanor Collins, QPWS, Moorinya National Park.

Parkinsonia flowers
Eleanor Collins, QPWS, Moorinya National Park.

Prickly acacia is of particular concern to native grasslands. If detected early, fire can be used to control the saplings and seedlings.
Jenny Milson, DAFF (2012).

Areas of the Channel Country have been invaded by mesquite
Jenny Milson, DAFF (2009).

Discussion

- Many species of woody weeds appear similar and care should be taken to ensure accurate identification before trialing any control method. Failure to do so could result in worsening the existing infestation.
- A single fire can be used to reduce or eliminate seeds, seedlings and young plants of some woody weeds where sufficient fuel is available (success rate is dependant on species). Follow up fires may be required should seedlings emerge or plants resprout.
- Care needs to be taken to identify new infestations of weeds as they emerge.
- Young plants/seedlings of woody weeds are more easily controlled with fire.
- Planned burning in areas with woody weeds is best conducted when the soil is moist to allow native species, especially grasses and forbs, the best chance of re-establishing.
- In areas where woody weeds have shaded out native grasses, mechanical or chemical control may be necessary. A combination of fire and chemical control could also be useful where grasses abut an infestation. A backing fire into the woody weeds may reduce the area requiring chemical treatment or increase accessibility.
- Care should be taken using fire where fire-adapted communities abut fire-sensitive communities. Dead plant material or high-severity fire could draw fire in to these communities.
- Be aware of weed hygiene issues when burning in areas with woody weeds. Fire vehicles and machinery can aid seed spread along firelines roads and tracks, and should be washed down after exposure.

Parkinsonia

- Fire will kill seeds on or close to the ground and has been shown to reduce the viability of seeds remaining suspended on the plant.
- Where 'parkinsonia dieback' (a soil-borne fungus) is present, fire seems to promote the rapid spread of this pathogen amongst the surviving plants. Parkinsonia affected with the dieback will appear to be dying back from the tips of the branches, with dead leaves remaining attached to the plant. Brown staining within the stems and branches may also be a good indicator of dieback. In well established areas of dieback, the fungus will spread through the soil infecting nearby trees.
- Any results of fire use on parkinsonia should be recorded and this information used to guide future fire management.

Prickly acacia

- Prickly acacia seedlings are known to be fire killed however mature plants are particularly fire resistant. Where top kill has occurred they tend to resprout from the base. Early detection of an infestation is the key to successful management as seedlings and saplings are much more susceptible to fire.

Mimosa bush or prickly mimosa

- Fire may not be a useful control method for this species as it resprout's from the base, however few published studies are available. Anecdotal observations suggest repeated fire may keep this species low in the ground layer and prevent dense infestations. Record observations of this species response to fire. *Vachellia farnesiana* is found within the bioregion but little information is available on its distribution.

Mesquite

- Fire is most effective on the tree-form of mesquite *Prosopis pallida*, but can also be used to control some shrub-form species. It is more effective when mesquite is at low and medium densities where sufficient fuel remains for fire to carry, or in areas that have first been chain pulled and allowed time to dry out.
- Fire can also assist in depleting the soil seed bank by killing seeds to a depth of 2 cm; however seedlings from undamaged seeds may appear after the fire and follow-up control may be required.
- Fires need to be of a high severity. DNRM (2003) found that late dry season fires in mesquite with a high fuel load remaining have been effective.

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.

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 60 % reduction in number of seedlings, saplings and young or mature plants.	**Before and after the burn** (after suitable germination/ establishment conditions, or a growing season): In three locations (that take account of the variability of landform and weed density within burn area), 1 year after fire estimate what percentage of saplings/seedlings/mature tree have been killed.	**Achieved:** > 60 % plants killed*. **Partially Achieved:** 40–60 % plants killed*. **Not Achieved:** < 40 % plants killed*. *It is not necessarily a good outcome if you have killed most of the plants and yet the fire was too severe.

Significant reduction in abundance of woody weeds.	**Before and after the burn** (after suitable germination/ establishment conditions, and if using cover – a growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–50 % cover) = 1/4 weed cover to equal proportions of weed to native species. • Medium-Dense (51–75 %) = equal proportions of native to ¾ weed cover. • Dense (> 75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation ‘drops’ two ‘density categories’ (e.g. goes from medium-dense before the fire to light after the fire). **Partially Achieved:** Weed infestation ‘drops’ one ‘density category’. **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?

Key factors

- Seeds, seedlings and saplings are most vulnerable to fire. Planned burning should be conducted as soon as possible once an infestation is detected to increase its effectiveness.

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

- In some cases, applying the recommended fire frequency for the fire vegetation group in which woody weeds occur may be sufficient to control the issue.
- Apply a follow up burn if the observations indicate that the issue is not under control (e.g. mature plants have re-sprouted or seedlings emerged from the seed bank). In some cases further fires may be required to completely remove the infestation. Once resolved, re-instate the recommended fire regime for the fire vegetation group. Continue Monitoring the issue over time.

Fire severity

- For some species, a **moderate** to **high**-severity fire may be required to ensure the canopy is scorched.
- **Low** to **moderate**. In other species best results have been achieved utilising a slow moving backing fire with good residence time at the base of the plant, in combination with high soil moisture. Fire severity should generally remain within the recommendations for the fire vegetation group in which the woody weed occurs.

What weather conditions should I consider?

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

Season: Early to mid-dry and occasionally late-dry season.

GFDI: < 20

DI (KBDI): 80–180

Wind speed: < 23 km/hr. Variable depending on objective and density of the infestation (denser infestation may require some fanning by wind so that the fire will carry).

Other considerations: In some western areas, better outcomes have been achieved using low humidity and high temperatures (e.g. 20 per cent humidity and 30 °C).

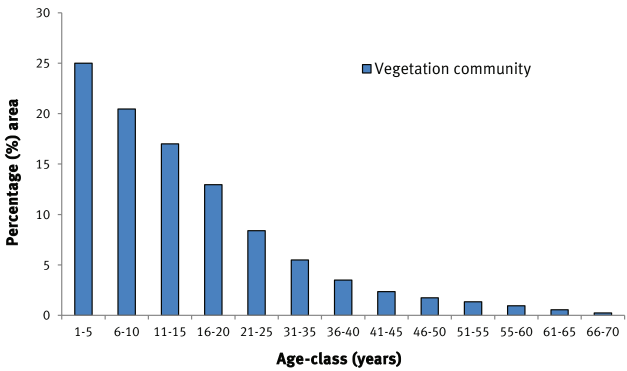
What burn tactics should I consider?

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.

- **Storm burning** may provide suitable conditions for woody weed control with follow-up moisture to encourage grass re-establishment.
- **A running fire** of a higher severity may be required to carry fire through areas of low fuel or dense thickets or increase scorch of trees.
- **A low to moderate-severity backing fire.** Where woody weeds are scattered in the understorey, a slow moving, low to moderate severity backing fire with good soil moisture (and presence of sufficient surface fuels), ensures a greater residence time at ground level and has proven to be successful in killing seeds, seedlings, young and some mature plants.
- **As part of a control program.** In areas where dense woody weeds shade out grasses limiting fuel available for fire, initial herbicide treatment or mechanical methods could be used.

Glossary of fire terminology

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

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

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

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

<table>
<tr><th>Terminology</th><th>Definition</th></tr>
<tr><td>Clarification over the terms

‘fire vegetation group’ and ‘fire management zone’.</td><td>The fire management requirements within a conservation fire management zone are based on the fire vegetation groups (FVGs)—groups of related ecosystems that share common fire management requirements. Fire regimes for FVGs are identified in the Bioregional Planned Burn Guidelines and are reflected in fire strategies. Other fire management zones (e.g. protection, wildfire mitigation, special conservation, sustainable production, rehabilitation, exclusion, and reference) will have specific management objectives that override the FVG fire regime requirements. Further, if there are a number of these other zones within a strategy they are identified as fire management subzones (FMSz) (e.g. P1, P2, P3, WM1, WM2, etc) each with specific fire management requirements.

<table>
<tr><th>Fire management zone</th><th>Fire management sub-zone or Fire vegetation group</th></tr>
<tr><td rowspan="2">Conservation</td><td>FVG1</td></tr>
<tr><td>FVG2</td></tr>
<tr><td rowspan="2">Protection</td><td>P1</td></tr>
<tr><td>P2</td></tr>
<tr><td rowspan="2">Wildfire mitigation, etc</td><td>W1</td></tr>
<tr><td>W2</td></tr>
</table>
</td></tr>
<tr><td>Fire perimeter</td><td>The outer containment boundary in which fire is being applied.</td></tr>
<tr><td>Fire regime</td><td>The recommended use of fire for a particular vegetation type or area including the frequency, intensity, extent, severity, type and season of burning.</td></tr>
<tr><td>Fire regime group (FRG)</td><td>A group of related ecosystems that share a common fire management regime including season, severity, recommended mosaic etc. These are a sub-grouping of the fire vegetation groups to provide more detail about specific fire management requirements. Fire regime groups are provided as a more detailed alternative for use with fire strategies or in mapping.</td></tr>
</table>

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

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

Terminology	Definition
Mosaic burn	An approach which aims to create spatial and temporal variation in fire regimes. This can occur within an individual burn and at a landscape level (refer to Appendix 2).
Obligate seeders (obligate seed regenerating species)	Shrubs that are killed by fire and rely on soil-stored seed bank to regenerate. In fire ecology, the time it takes obligate seeders to mature and establish a seed bank often indicates the minimum frequency with which a vegetation community should be burnt in order to avoid the local extinction of these species.
Patchiness	A percentage or proportion of the ground layer vegetation (grasses, herbs and trees/shrubs less than one metre) not affected by fire (i.e. 20 per cent patchiness = 80 per cent burnt).
Perennial plants	Plants that last for more than two growing seasons, either dying back after each season as some herbaceous plants do, or growing continuously like many shrubs.
Planned burn	The controlled application of fire under specified environmental conditions to a pre-determined area and at the time, intensity, and rate of spread required to attain planned resource management objectives. In the context of QPWS operations: a fire that is deliberately and legally lit for the purposes of managing the natural and/or cultural and/or production resources of the area (e.g. reducing fire hazard, ecological manipulation), and protecting life and property.
Progressive burning	Progressive burning is an approach to planned burning where ignition is carried out throughout much of the year as conditions allow. In northern Queensland, ignition can begin early in the year after heavy seasonal rain, with numerous small ignitions creating a fine scale mosaic. These burnt areas can provide opportunistic barriers to fire for burning later in the year. They also provide fauna refuge areas. Progressive burning helps create a rich mosaic of intensities, burnt/unburnt areas, and seasonal variability. Be aware of how fire behaves differently in different seasons.
Rate of spread (ROS)	The forward progress per unit time of the head fire or another specified part of the fire perimeter, defined as metres per hour.

Terminology	Definition
Relative humidity (RH)	The amount of water vapour in a given volume of air, expressed as a percentage of the maximum amount of water vapour the air can hold at that temperature.
Scorch height	Is the height to which former green leaves still suspended on plants are turned brown by the heat of a fire.
Strip burning	Setting fire to a narrow strip of fuel adjacent to a fire-line and then burning successively wider adjacent strips as the preceding strip bums out.
Test fire	A controlled fire of limited extent ignited to evaluate fire behaviour.

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Appendix 1: List of regional ecosystems

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

Fire vegetation group	Hectares within the Channel Country bioregion	Percentage
Acacia dominated communities	6 095 787	26.17
Non-remnant	37 804	0.16
Eucalypt woodlands	556 530	2.39
Forbland and shrubland communities	6 842 485	29.38
Grasslands	9 551 637	41.01
Other Bioregion	209 040	0.90
Grand Total	**23 293 392**	**100**

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
1	1	**Eucalypt woodlands**	Eucalypt woodlands		5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.6, 5.3.7, 5.3.8, 5.3.8a, 5.3.8b, 5.3.8c, 5.3.20, 5.3.20a, 5.3.20b, 5.3.20c.
2	1	**Grasslands**	Spinifex grasslands		5.6.5, 5.6.5b, 5.6.6, 5.6.6a, 5.6.6b, 5.6.7, 5.6.8, 5.6.8a, 5.6.8b, 5.7.3, 5.7.4.
	2		Tussock grasslands		5.9.3x1, 5.7.10, 5.7.9, 5.9.3, 5.9.3a, 5.9.3b, 5.9.4, 5.9.4x1.
3	1	**Forbland and shrubland communities**	Forblands and shrublands		5.3.21, 5.3.22, 5.3.22a, 5.3.22b, 5.3.22c, 5.6.1, 5.7.11, 5.3.12, 5.3.12a, 5.3.12b, 5.3.13, 5.3.13a, 5.3.13b, 5.3.14, 5.3.15, 5.3.15a, 5.3.15b, 5.3.16, 5.3.16a, 5.3.16b, 5.3.17, 5.3.17a, 5.3.18, 5.3.18a, 5.3.18b, 5.3.19, 5.9.5.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
4	1	Acacia dominated communities	Acacia communities		5.3.9, 5.3.9a, 5.3.9b, 5.3.9x1, 5.3.10, 5.3.11, 5.5.1, 5.5.2, 5.5.3, 5.5.4, 5.5.5, 5.5.6, 5.5.6a, 5.5.6b, 5.6.2, 5.6.3, 5.6.4, 5.6.4a, 5.7.1, 5.7.7, 5.7.7x1, 5.7.12, 5.7.13, 5.7.14, 5.7.2, 5.7.5, 5.7.6, 5.9.3c, 5.7.8, 5.9.1, 5.9.1x1, 5.9.2.
5	1	Springs	Springs		5.3.23.

The spatial data is based on version 6.1 of the “Queensland Remnant Vegetation Cover 2006” layer (16 September 2011) and the “Draft Pre-clearing with Regional Ecosystems” layer (20 August 2010) (refer to Figure 1).

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

The RE’s listed below do not have any matching records in the spatial data of version 6.1 of the Survey and Mapping of 2006 Remnant Vegetation Communities and Regional Ecosystems of Queensland spatial layer (16 September 2011) and the Draft Pre-clearing Vegetation Communities and Regional Ecosystems layer (20 August 2010).

Unmatched regional ecosystems	5.3.1, 5.3.17a, 5.3.23, 5.3.9a, 5.3.9b, 5.3.9x1, 5.5.6b, 5.6.5b, 5.6.8a, 5.6.8b, 5.9.3b, 5.9.3c, 5.9.4x1, 5.3.15b, 5.7.10.

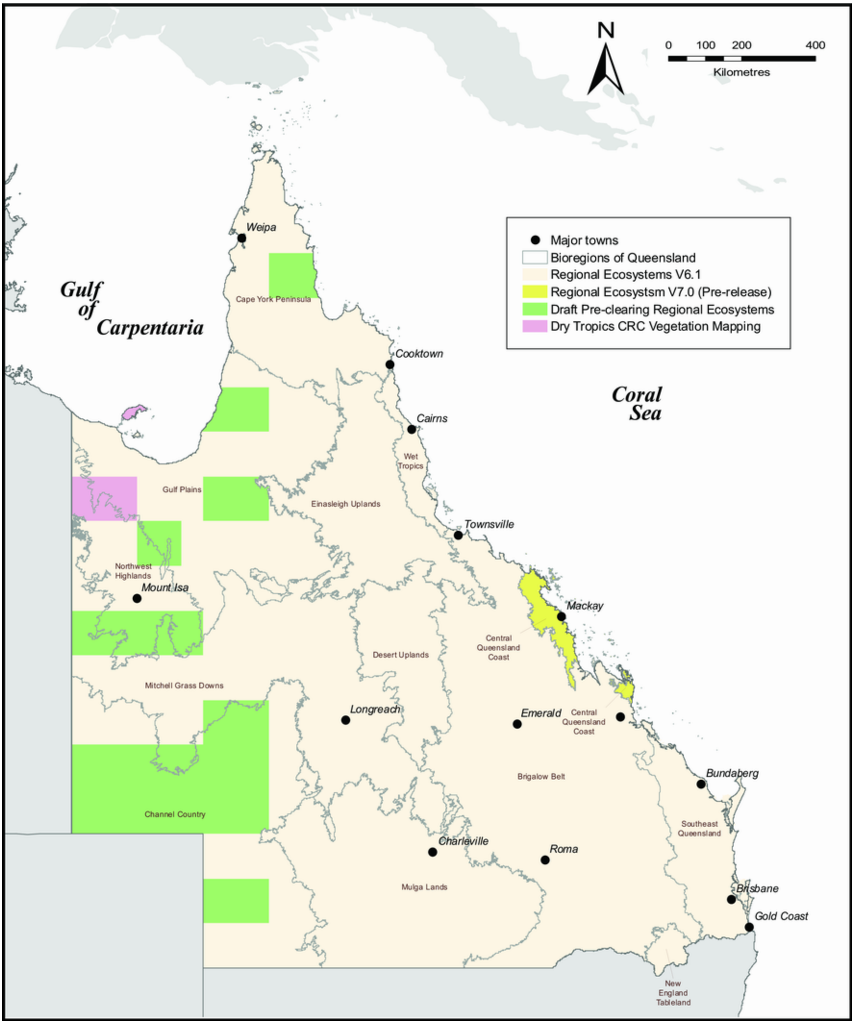


Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

Appendix 2: Mosaic burning

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

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

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

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

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

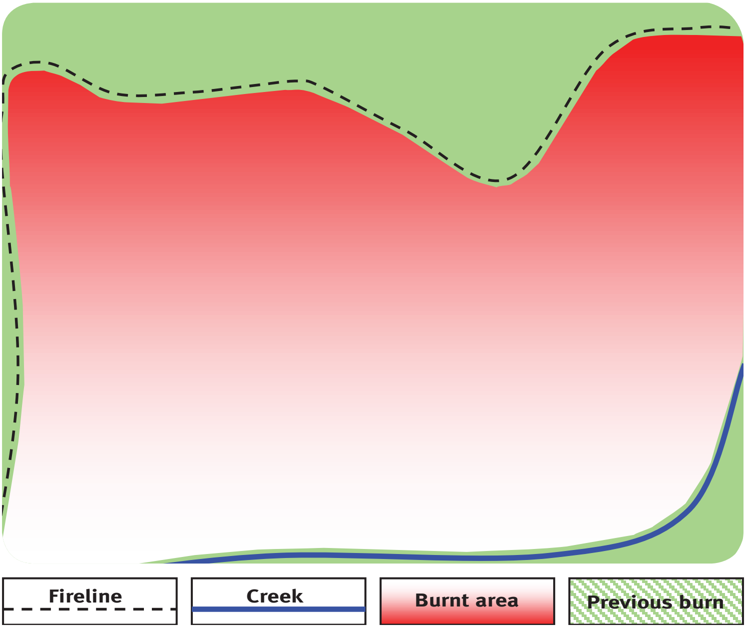


Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

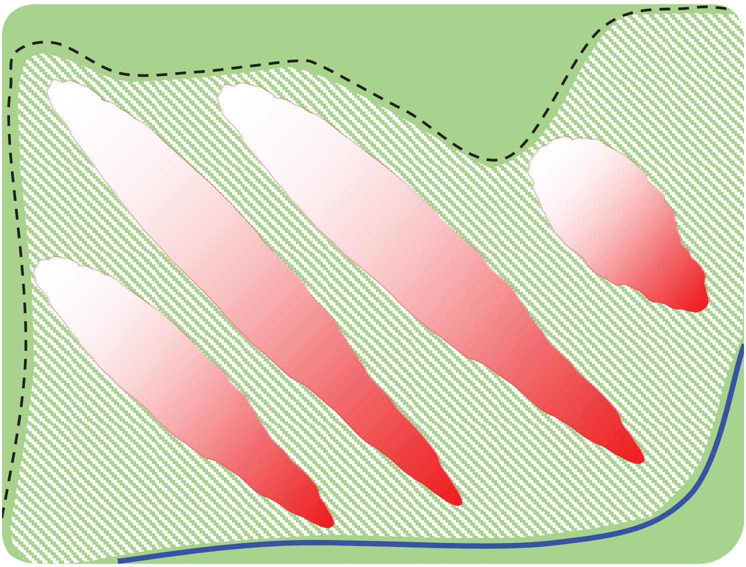


Figure 2: Planned mosaic burn—year 8.

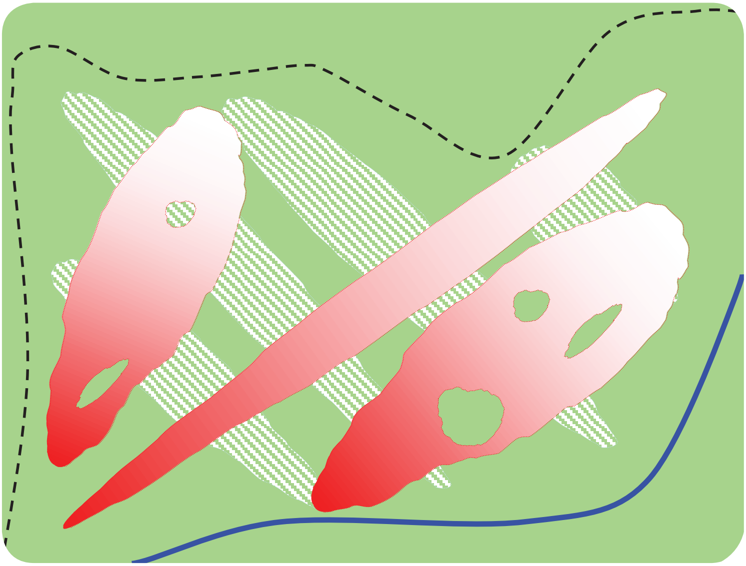


Figure 3: Planned mosaic burn—year 20.

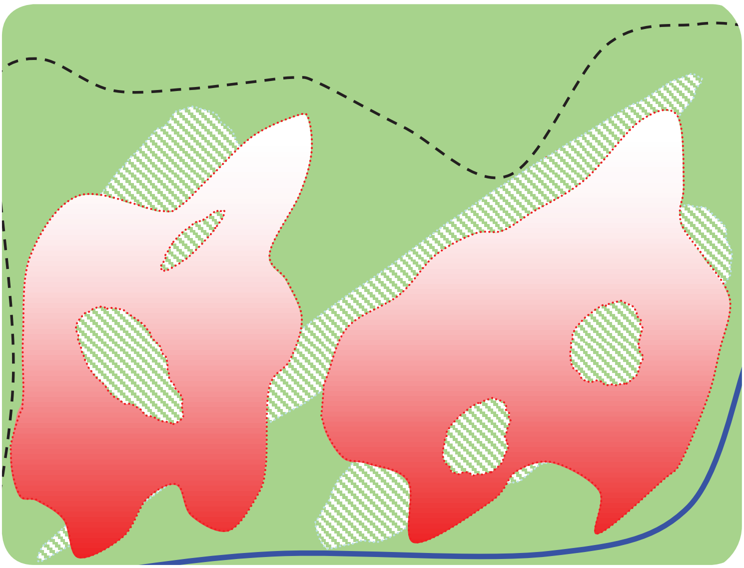


Figure 4: Planned mosaic burn—year 28.

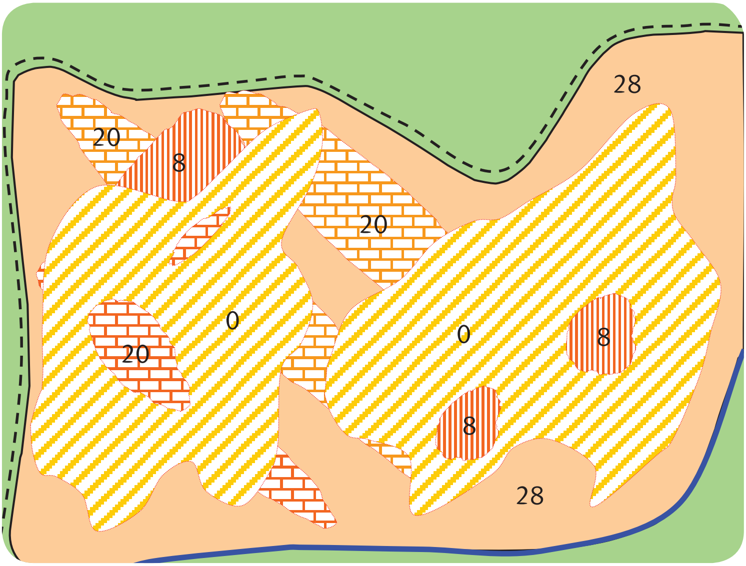
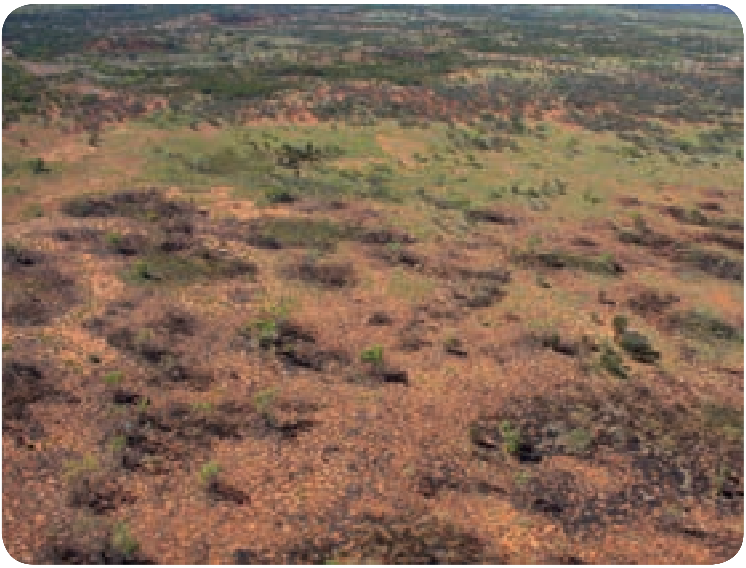


Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).



Mosaic burn on Bladensburg National Park (spinifex community) showing ~ 60 per cent coverage across the landscape.
Alicia Whittington, QPWS, Bladensburg National Park (2010).

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