Department of National Parks, Recreation, Sport and Racing

Planned Burn Guidelines

Mitchell Grass Downs Bioregion of Queensland

Queensland Government

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

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Front cover photograph: View of Mitchell Grass Downs from Starlight's Lookout, 50 km north-east of Longreach, John Augusteyn, QPWS (2009).

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Foreword

The Mitchell Grass Downs bioregion is characterised by extensive treeless plains dominated by Mitchell tussock grasses with occasional gorges, rocky plateaus and drainage features. The Mitchell Grass Downs bioregion has a dry, semi-arid climate in the south, transitioning towards a sub-tropical climate in the north. The semi-arid areas, and to a lesser extent the sub-tropical areas, are characterised by many years of drought followed by significant wet seasons. Fire is generally only possible (or desirable), after an adequate wet season which promotes sufficient vegetative growth.

When burnt with adequate soil moisture, Mitchell grass responds well to fire and is known to seed profusely after recovering from a burn. Despite this, the bioregion is rarely being widely burnt, due to the high fodder value of Mitchell grass species. The lack of burning in times of good grass growth, has sometimes led to extreme fire events as well the invasion of some acacia species into the grasslands. Lack of fire, or fire regimes that allow or promote the encroachment of woody species are detrimental to the grazing and biodiversity values of the Mitchell Grass Downs.

Encouraging the implementation of a fire regime which incorporates a patchy mosaic is essential to restore and maintain ecosystem health. It is anticipated that this Planned Burn Guideline will provide a starting point for people to consider burning by critically analysing their country, providing parameters to apply fire in the landscape and allow for future revision as continual research and practical knowledge increases our understanding of this dynamic bioregion.

Alicia Whittington
Senior Conservation Officer
Central Region
Queensland Parks and Wildlife Service.

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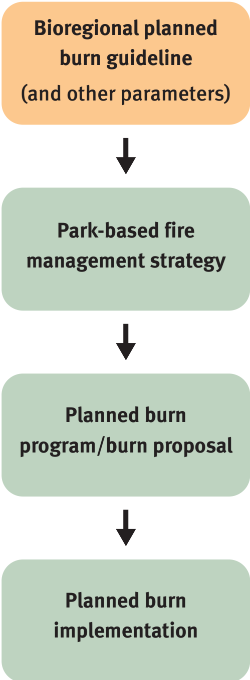


How the planned burn guideline fits into the QPWS Fire Management System.

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 Mitchell Grass Downs bioregion (refer to Figure 1) and covers the following fire vegetation groups: eucalypt communities, grasslands, acacia communities, and riparian spring and fringing communities (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Mitchell Grass Downs. In some cases, there will be a need to include issues in fire strategies or 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.

Dan Kelman, Queensland Herbarium, Camooweal area (2001).

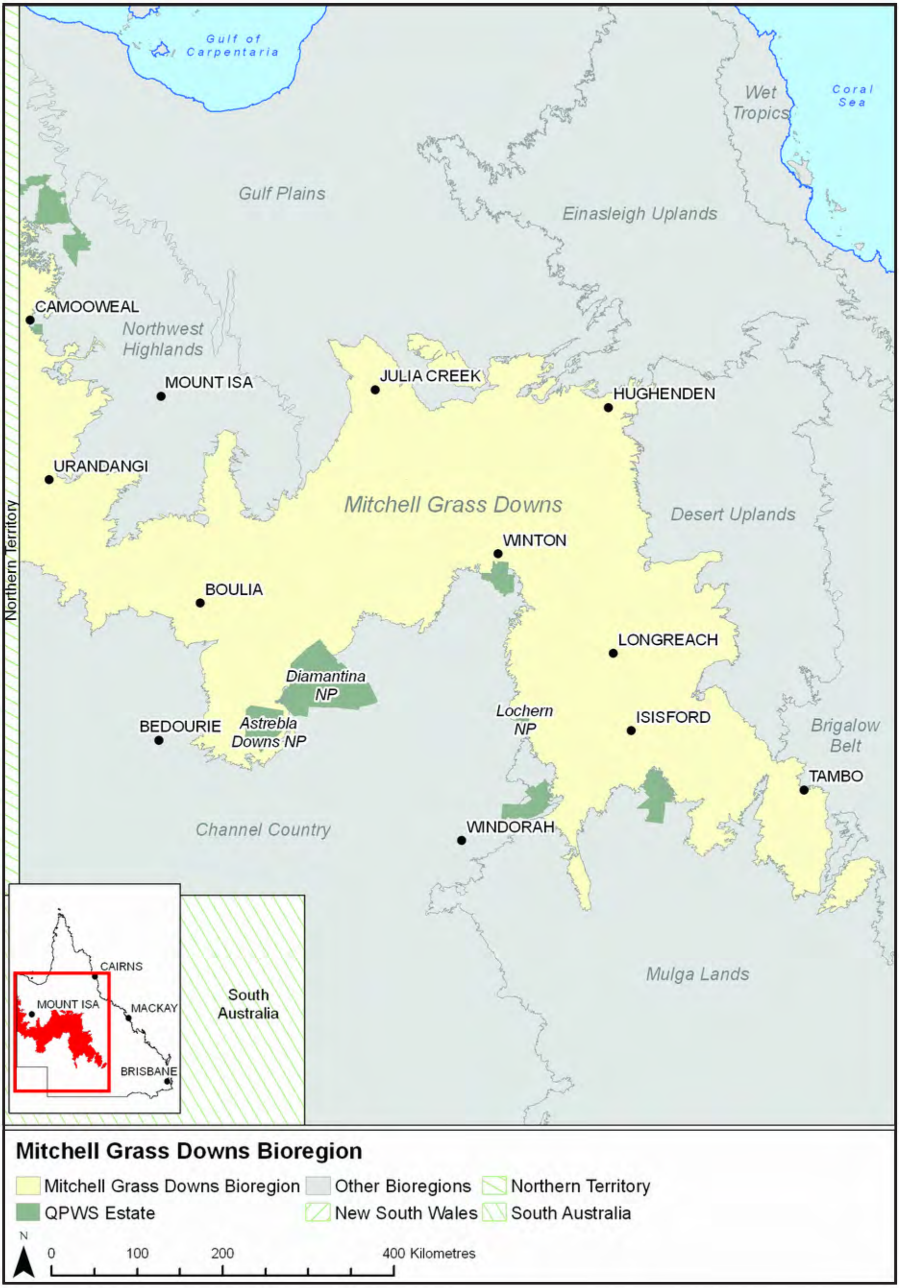


Figure 1: Map of the Mitchell Grass Downs bioregion of Queensland.

Fire and climate in the Mitchell Grass Downs bioregion of Queensland

As with most semi-arid areas rainfall in this bioregion is very unreliable and wet years alternate with dry. Mean rainfall is less than 300 mm a year in the west (263 mm at Boulia), increasing towards the east and south. Most rain falls during summer (December and March).

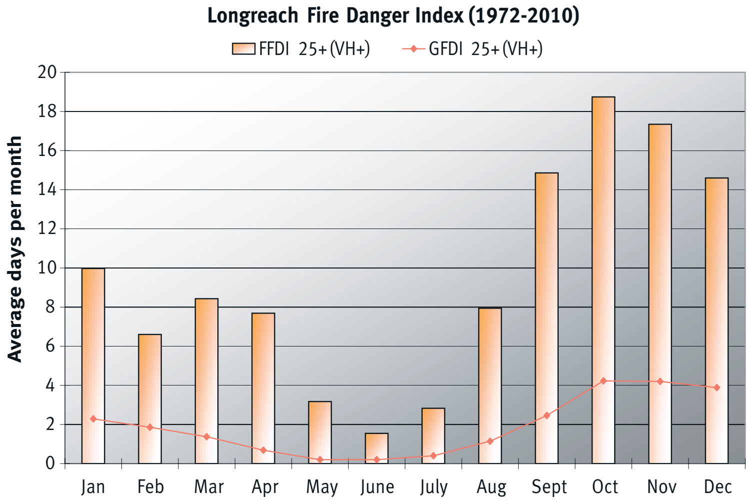
Following a series of very wet years, fuel can build sufficiently for significant fires to occur. Grazing in normal seasons can reduce fire spread, however in particularly good seasons, grazing is not sufficient to reduce fuel loads to limit fire spread. Such fuel build-up cures rapidly in the Mitchell Grass Downs and then much of the desiccated material tends to naturally dissipate. Wildfires have also been a part of the country for a very long time and most species have developed a resistance to extended dry periods and occasional fires.

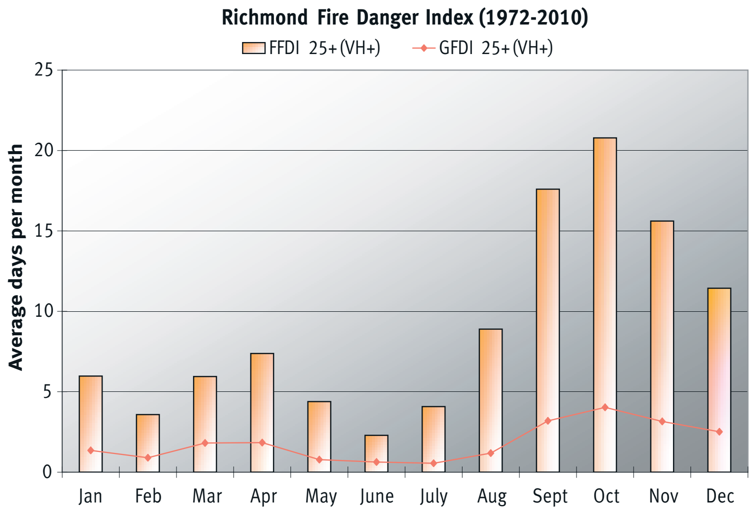
Fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). The average temperature on these days is often above 35˚C with low humidity (below 17 per cent) and sustained winds of more than 16 km/hr (refer to Figure 2). These days are common within the bioregion.

The seasons described by Christie (1998) can be broadly classified into three distinct seasons:

- Mid-summer to mid-autumn. Moist, northern air from predominantly south-easterly to north-easterly winds gives rise to increased wet periods. Approximately 60 per cent of the average annual rainfall falls during summer to early autumn.
- Late autumn to winter. Fine clear days and cold nights with predominantly strong southerly and westerly winds. The proportion of the annual rainfall during late autumn to winter is about fifteen per cent.
- Spring to early summer. The storm season with hot weather from northern and inland Australia alternating with humid weather from the north east. Generally about twenty-five per cent of the annual rainfall falls during spring to early summer.

Figure 2: Fire weather risk in the Mitchell Grass Downs bioregion.





The likelihood of a fire weather day or sequence of days (FDI 25+) increases significantly from September to December. 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>.

Spot ignition in a Mitchell grassland.
Tony Salisbury, QPWS, Moorrinya National Park (2008).

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 communities

This fire vegetation group includes low open woodland communities with one or a few eucalypt or corymbia species such as desert bloodwood *Corymbia terminalis*, Normanton box *Eucalyptus normantonensis* or Cloncurry box *Eucalyptus leucophylla*. If a shrub layer is present it is generally scattered to sparse.

There are two main types of eucalypt communities distinguished by their ground layer:

Eucalypt communities with spinifex consist of open woodland to shrubland with a ground layer dominated by spinifex *Triodia* spp. with other grasses, herbs and forbs between hummocks.

Eucalypt communities with generally sparse ground layer dominated by grasses such as Mitchell grasses *Astrebla* spp., wire grass *Aristida* spp., silky brown top *Eulalia aurea* or *Enneapogon* spp. Ground layer density is often seasonally variable and not continuous, with some bare or stony ground areas interspersed with occasional grasses. Even after a season of high growth this community would rarely have enough fuel for a significant planned fire to carry.

Fire management issues

A key management issue for this fire vegetation group is extensive wildfires impacting 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.

Overabundant acacia saplings in the mid-stratum can lead to woody thickening. Often this is associated with along absence of fire or germination events associated with successive good growing seasons.

Weed species such as buffel and grader grass are invasive grasses, which pose a significant threat to eucalypt community health and may increase fire severity.

Issues:

1. Maintain healthy eucalypt communities with spinifex
2. Manage eucalypt woodlands where understorey fuels are not usually continuous
3. Manage invasive grasses.

Extent within bioregion: 719 349 hectares (ha), 3 per cent; Regional ecosystems: Refer to Appendix 1 for complete list.

Examples of this FVG: Bladensburg National Park, 2 568 ha; Diamantina National Park, 889 ha; Boodjamulla (Lawn Hill) National Park, 38 ha.

Issue 1: Maintain healthy eucalypt communities with spinifex

Use mosaic burning to maintain healthy eucalypt communities with spinifex

Awareness of the environment

Key indicators of healthy eucalypt communities with spinifex:

- Eucalypt communities have a canopy of eucalypt or corymbia trees. Some young canopy species are recruiting in the understorey (enough to eventually replace the canopy). Trees may have commenced flowering.
- Spinifex shows a variation in time-since-fire across the landscape. (There are areas of older clumps interspersed with younger clumps)
- Fire promoted herbs and forbs may occur between spinifex hummocks and are particularly visible following a good wet season. Tussock grasses may be present but spinifex dominates.
- In shrubby areas there is a diversity of shrub species including grevillea, hakea and acacia species. Shrubs are of a mixed ae class (e.g. juvenile, flowering, set seed, or senescing).

A healthy snappy gum community with spinifex understorey.

John Nelder, Queensland Herbarium, Djara region (1985).

A eucalypt shrubland with *Acacia* spp. Due to the sparse nature of spinifex, fires will only very occasionally trickle though fire sheltered sites such as this and will generally be of low intensity.

John Nelder, Queensland Herbarium, Swords Range (1985).

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

- Spinifex cover increases and clumps are touching or have formed continuous hummocks over a broad area. Parts of the spinifex hummock look grey and dry.
- The diversity of the ground layer has decreased. Herbs and forbs are absent between spinifex hummocks even following good seasonal rainfall.
- 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).

Spinifex hummocks form a continuous grass layer over a board area. Parts of the spinifex hummock are grey and dry.

Rob Murphy, QPWS, Bladensburg National Park.

Long unburnt spinifex is considered healthy; however, it is the extent of the long unburnt spinifex over large an area that is an indicator that fire may be required to maintain a landscape mosaic.

John Nelder, Queensland Herbarium, north-west Winton (1985).

Discussion

- 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 after fire. 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.
- Spinifex will not usually be contiguous enough to burn in the early years of growth. Generally, the fire-return interval is four to five years or longer depending on rainfall. After consecutive good growing seasons, a fire may, in some areas, carry across three year-old spinifex hummocks.
- Be aware that spinifex can remain green throughout the year and it should not be assumed that because it is green it will not burn with a high intensity.
- Recently burnt spinifex communities tend to have a greater diversity of resprouting perennials, annuals and ephemeral forbs scattered amongst the spinifex clumps.
- Eucalypt shrublands occur within the broader spinifex landscape, and are often found on plateaus. These communities often contain fire-sensitive acacia species such as lancewood *Acacia shirleyi*, mulga *Acacia aneura* and bendee *Acacia catenulate*. These communities generally occur in fire sheltered areas (sparse spinifex fuels) but should be protected from wildfire.
- A range of fire age classes across the landscape will lead to habitat diversity for most fauna species. Leaving areas of mature spinifex is critical to maintaining species which rely on long unburnt spinifex for food and breeding habitats and shelter.
- The invasion of buffel grass is a key issue within some spinifex communities. Buffel grass adds to continuous cover and can increase fuel loads and consequently increase fire severity. If this is an issue, refer to Chapter 5 (Issue 5), for fire management guidelines.

What is the priority for this issue?

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

Mountain yapunyah *Eucalyptus thozetiana* growing in association with fire-sensitive bendee *Acacia catenulate*. These areas are generally self-protecting due the to sparse ground layer, howevere after good seasons spinifex fuels accumulate— wildfire may then threaten these communities

John Nelder, Queensland Herbarium, Longreach region (1986).

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)
Within individual burn areas, a mosaic of burnt and unburnt areas.	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.	**Achieved:** 20–60 % recently burnt ground. **Partially Achieved:** 15–20 % or 60–75 % recently burnt ground. **Not Achieved:** < 15 % and > 75 % of burnt ground.
Recruitment of obligate seeders promoted over the burn area.	6–12 months after the burn, obligate seeders such as acacias and grevilleas can be seen both in the ground layer and as unburnt examples across the burn area – from one or more vantage point or from the air.	**Achieved:** obligate seeders are present at various stages of maturity across the burn area. **Not Achieved:** Obligate seeders are of a single age/ height.

Minimise canopy scorch across the planned burn area.	Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity) and estimate number of mature trees. Determine the percentage of canopy scorched.	**Achieved:** > 50 % of trees have not had extensive canopy scorch. **Partially Achieved:** 50–70 % have not had extensive canopy scorch. **Not Achieved:** > 70 % have had extensive canopy scorch.

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.

- 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 obligate seed regenerating species can assist in ensuring fires are sufficiently patchy and that some areas remain long unburnt so that these species are able to mature and set seed (and thus are retained in the landscape).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **moderate**. Spinifex communities may naturally burn with a higher severity in some areas.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	50–100	0.3–0.5	≤ 2.5	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 (ground layer)	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 to for a discussion)

- Fire frequency should primarily be determined **through on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between ten to fifteen years.
- Ensure some areas are left long unburnt (> 15 years) but not to the extent that they are threatened by widespread wildfire.
- Be aware that some years will be wetter or drier than normal. Fuel accumulation, vegetation health and the need to mitigate wildfire are the most important factors.

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 20–60 per cent burnt within the target 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. Drought conditions may also lead to poor results and/or wildfires.

Season: Burn during the wet season to early-dry season, while the soil retains moisture.

GFDI: 9–20

DI (KBDI): 80–120 (ideally < 100)

Wind speed: < Beaufort scale 1–2, < 15 km/hr

Soil moisture: Use good soil moisture where possible as it protects the underground portion of vegetation and promotes seedling germination post-fire. Burning under conditions of good soil moisture will help restore ground cover and prevent erosion.

What burn tactics should I consider?

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

- **Spot ignition** can be used to alter the intensity of a fire and create the desired mosaic of burnt and unburnt areas. Spot ignition is the primary ignition tool in this fire vegetation group. The spacing of the spots may vary from one single point of ignition, to several points. Allow individual fires to spread out. Spots closer together will result in a line of greater intensity (as spots merge and create hot junction zones).
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low-intensity backing fire. Depending on available fuels and the prevailing wind on the day this may require either spot or strip lighting or a combination of both. Do not burn repeatedly from the same fireline/s.
- 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.
- **Wet season burning** provides the opportunity to achieve landscape patchiness in spinifex dominated communities and reduce the risk of extensive fires in the dry season. Wet season burning can be undertaken as a series of small burns throughout the wet season.
- **Limit fire encroachment into non-target communities.** In many cases, acacia communities occur adjacent to eucalypt communities. Where feasible, use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community. Refer to Chapter 5 (Issue 6), for fire management guidelines.

Mature spinifex is important habitat for fauna species that require long unburnt spinifex within their home range. Mosaic burning that leaves some areas long unburnt can help provide fauna refugia areas after fire.

Leasie Felderhof, Firescape Pty Ltd, Mt Isa area (2010).

A backing fire in a spinifex community.

QPWS, Welford National Park (1993).

Issue 2: Manage eucalypt woodlands where understorey fuels are not usually continuous

This fire vegetation group contains communities that, in most years, naturally have very sparse understoreys. Common canopy species include coolibah *Eucalyptus microtheca*, silver leaf ironbark *Eucalyptus melanophloia*, poplar box *Eucalyptus populena* and *Corymbia terminalis*.

Fire management issues

Fuel-loads are generally low in these communities and fires do not often occur. They may occasionally burn with surrounding fire-adapted vegetation, but they are not 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 more deliberately target the areas with low-severity fire to mitigate wildfire risk. The presence of introduced invasive grasses may increase the severity of fires. Invasive grass species such as buffel grass *Cenchrus ciliaris* can alter fuel characteristics and influence the potential for frequent and damaging fires in this fire vegetation group.

Coolibah *E. microtheca* woodlands. Do not target for burning, rather burn these communities in association with surrounding country to create a mosaic of burnt and unburnt areas.

John Nelder, Queensland Herbarium, Camooweal area (1999).

A eucalypt community with acacia and whitewood *Atalaya hemiglauca* that has been heavily grazed. Grasses do not generally grow close enough together to carry a fire except after consecutive good seasons.

John Nelder, Queensland Herbarium, south-west of Boulia (1986).

Because fuel loads are generally low in floodplain communities, fires rarely carry in these areas.

John Nelder, Queensland Herbarium, Urandangie (1986).

Issue 3: Manage invasive grasses

It is important to be aware of the presence of invasive grasses as they can dramatically increase fire severity and are often promoted by disturbance, including 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 5 (Issue 5), for fire management guidelines.

Chapter 2: Mitchell Grasslands

Mitchell grasslands are open and treeless or contain only scattered trees and shrubs. They are dominated by one or a few of the Mitchell grasses including bull Mitchell *Astrebla squarrosa*, hoop Mitchell *Astrebla elymoides*, barley Mitchell *Astrebla pectinata* or curly Mitchell *Astrebla lappacea*. Scattered trees include *Acacia* spp., *Grevillea* spp., supplejack *Ventilago viminalis*, whitewood *Atalaya hemiglauca* and coolibah *Eucalyptus microtheca*. In rare cases, grasslands may be dominated by *Dichanthium* spp., *Aristida* spp. and *Eulalia aurea* — with Mitchell, other grasses and forbs between tussocks.

This group occurs on alluvial plains, cracking clays and associated drainage lines. Mitchell grasslands are by far the largest fire vegetation group within the bioregion.

Fire management issues

The main fire management issue in Mitchell grasslands is maintaining their open structure by preventing an overabundance of seedlings and young trees. Overabundant native seedlings/saplings (leading to woody thickening) occur where fire has been long-absent, infrequent or repeatedly applied too early in the season (creating fires of insufficient severity to scorch seedlings/saplings). The presence of woody weeds and invasive grasses may also require an altered approach to fire management.

Issues:

1. Maintain healthy Mitchell grassland communities
2. Reduce overabundant saplings and seedlings
3. Reduce woody weeds
4. Manage invasive grasses.

Extent within bioregion: 17 388 046 ha, 71 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Astrebla Downs National Park, 173 493 ha; Diamantina National Park, 87 737 ha; Bladensburg National Park, 12 330 ha; Lochern National Park, 8 899 ha; Idalia National Park, 4 909 ha; Camooweal Caves National Park, 2 423 ha; Boodjamulla (Lawn Hill) National Park, 602 ha; Lark Quarry Conservation Park, 166 ha; Welford National Park, 29 ha; Combo Conservation Park 1, 8 ha; Combo Conservation Park 2, 3 ha; Elizabeth Springs Conservation Park, 2 ha.

Issue 1: Maintain healthy Mitchell grassland communities

Use regular low intensity mosaic fires to maintain Mitchell grass communities.

Awareness of the environment

Key indicators of healthy tussock grass communities:

- Ground layer is characterised by a continuous stand of Mitchell grasses.
- There are no or very scattered native trees and shrubs present. Often there is a very diverse mix of other species of grasses, forbs and legumes (particularly after good seasonal rains).

A diverse mix of grasses, forbs and legumes may be present within Mitchell grass dominated communities.

Maree Rich, QPWS, Bladensburg National Park (2009).

Healthy tussock grassland community. after consecutive good seasons.
Alicia Whittington, QPWS, Lochern National Park (2011).

A healthy Mitchell grass community with trees scattered along seasonal watercourses
Dan Kelman, Queensland Herbarium, Camooweal area (2001).

Rainfall decreases from north to south of the bioregion. As a result grassy fuels tend to accumulate more rapidly in the north.
Dan Kelman, Queensland Herbarium, Barkly Tablelands (2001).

Corkwood wattle is found scattered in some Mitchell grasslands. Like most acacia species, it is fire- sensitive. Low-severity burns in these communities will help maintain their current distribution by preventing widespread wildfires.
Dan Kelman, Queensland Herbarium, Camooweal area (2001).

The following may indicate that fire is required to maintain Mitchell grassland communities:

- 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).
- 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 *Acacia nilotica*, parkinsonia *Parkinsonia aculeata* and mesquite *Prosopis* spp. are abundant and emerging above grasses, especially after high rainfall events.
- Grass tussocks are more or less continuous across the ground layer, allowing passage of fire.

A build up of grassy fuels in this Mitchell grass community indicates a fire may be required.
Rosie Kerr, QPWS, Forest Den (2011).

After consecutive good growing seasons, the spread of woody weeds such as prickly acacia may become an issue. Fire may be used to control saplings and seedlings of woody weeds if there is sufficient fuel to carry a fire.

John Nelder, Queensland Herbarium, McKinlay area (1986).

Whilst this Mitchell grassland is still healthy, it is important to monitor encroachment of native seedlings from adjacent woodland communities.

H. Cartan, Queensland Herbarium (2001).

Discussion

- Native species such as gidgee or mulga, or weeds such as prickly acacia or prickly mimosa can produce a flush of seedlings following good seasonal rain or high rainfall events which can shade-out or out-compete ground layer diversity. Fires applied when these trees are young will have more success in reducing their density. For guidance on addressing overabundant saplings/seedlings refer to Chapter 5 (Issue 3).
- Corkwood wattle *Vachellia sutherlandii* is scattered in some Mitchell grasslands. A low-severity fire, when it will carry, will minimise the risk of high severity fires in Mitchell grasslands and help maintain corkwood wattle trees.
- Fire is useful in the control of some woody weeds but is less effective (or may have no impact) on other species. If woody weeds are an issue, refer to Chapter 5 (Issue 4), for fire management guidelines.
- 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.
- Grassland composition can decline with time-since-fire. Annuals begin to dominate the ground stratum and perennial grasses (such as Mitchell grass) decline.
- Dunnarts such as the endangered Julia Creek dunnart *Sminthopsis douglasiar* are known to inhabit Mitchell grasslands, sheltering in crevices within the cracking clay soils or in grasses when rain prohibits the use of crevices. Woody weeds such as prickly acacia, mesquite *Prosopis* spp., parkinsonia and overabundant native shrubs are a major threat to the Julia Creek dunnart as they shade out the grasses required for shelter, as well as providing shelter for feral and native predators. Maintaining regular, patchy fire in areas impacted by woody weeds and native shrubs can help control the issue (refer to Chapter 5 (Issue 4), for fire management guidelines).
- Woody thickening becomes much more severe where stock grazing is combined with repeated early season burns. Stock grazing reduces fuel loads and prevents fires of sufficient severity to manage overabundant seedlings/saplings. This is further compounded by cattle concentrating their feeding on regrowth grasses in the recently burnt areas which allows woody species the competitive advantage.
- Removal of grazing pressure means that increased fuel loads following periods of high rainfall may lead to an increased incidence of wildfire and promotion of a homogenous fire age leading to a lack of diversity.

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.

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)
Over several hectares, a mosaic of 25–60 % of blackened ground within the boundary of the burn area.	Choose one of these options: 1. Visual estimation of percentage of fire association burnt – from one or more vantage points, or from the air. 2. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. 3. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating percentage of ground burnt within visual field.	**Achieved:** 25–60 % reduced. **Partially Achieved:** 15–25 %, or 60–80 %. **Not Achieved:** < 15 % or > 80 %.

> 75 % of shrubs or saplings reduced.	Select several sites or walk several transects, estimate the percentage of overabundant saplings (above ground components) reduced.	**Achieved:** > 75 % reduced. **Partially Achieved:** 50–75 % reduced. **Not Achieved:** < 50 % reduced.
> 90 % of the bases of grass clumps remain in burnt areas.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate grass basses remaining after fire.	**Achieved:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 75 % bases remain.

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

Monitoring the issue over time

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

Monitoring the diversity of species within grasslands to ensure a mix of older, less diverse grassy areas are interspersed within a mosaic of more recently burnt areas with a mix of grasses and forbs.

It is important to regularly monitor Mitchell grasslands to ensure the encroachment and establishment of introduced and native trees and shrubs is minimised. Be prepared to implement fire to address this issue when possible. Monitor the cover of Mitchell grass clumps versus annual grass clumps such as wiregrass *Aristida* spp. Fire has been absent too long when annuals begin to dominate.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** and occasionally **moderate**

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

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

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

- Fire frequency should primarily be determined **through on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between ten to fifteen years.
- Concentrate the greater proportion of burning during wet years. Do not burn during drought years. If overabundant saplings/seedlings are an issue, fires at the lower end of the fire frequency are recommended until the issue is under control

Mosaic (area burnt within an individual planned burn)

- Due to the continuous nature of fuel associated with Mitchell grasslands, the entire planned burn area can burn with little internal patchiness. Be aware that a mosaic will only be possible by applying appropriate tactics 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

- Do not plan to burn more than 25 per cent of these communities within the same year.

Other considerations

- A moderate severity fire may be required when targeting woody species that are starting to become overabundant. Ensure good soil moisture so as not to exacerbate the issue and to favour grass regeneration.

What weather conditions should I consider?

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

Season: Burn during the late wet season to mid dry season and concentrate efforts after years of good rainfall.

FFDI or GFDI: 9–11

DI (KBDI): < 120 (ideally < 100)

Wind speed: Beaufort 2-3, < 20 km/hr. Depending on fuel connectivity, some wind may be required to help the fire carry in grasslands

Soil moisture:

- Good soil moisture will assist in retaining grass bases, encourage species regeneration after fire and promote a mosaic of burnt and unburnt patches.
- Heavy dew at night is preferred when burning grassland, as often this will cause the fire to extinguish overnight. It is important to have a good understanding of local weather conditions and monitor the weather forecast in the days leading up to and following the fire.

Retaining the grass bases through implementing burns of a low intensity when there is sufficient soil moisture is important for the recovery of grasses after fire.
Paul Williams, Vegetation Management Science Pty Ltd, Moorrinya National Park (2011).

Mitchell grasslands on cracking clay plains. Take into account the adjoining highly flammable spinifex when burning Mitchell grasslands, and vice versa.
Dan Kelman, Queensland Herbarium (2010).

What burn tactics should I consider?

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

- **Spot ignition** is often used to alter the 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. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- In the late **wet season**, patches of limited extent can be created by spot ignition late in the afternoon, using overnight dew to self-extinguish the fire.
- **Progressive burning** is an approach to planned burning where ignition is carried out throughout as much of the year as conditions safely allow. In the Mitchell grasslands, ignition can begin soon after the wet season (providing fuel has cured sufficiently to carry fire). Numerous small ignitions can create a fine-scale mosaic. Continue burning until fires carry well into the night, but not overnight. These burnt areas can provide an opportunistic or targeted barrier to fire, to support burning later in the year and provide important fauna refuges. Progressive burning helps create a rich mosaic of severities, burnt/unburnt areas and seasonal variability.
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low-intensity backing fire. Depending on available fuels and the prevailing wind on the day this may require either spot or strip lighting (or a combination of both). Do not burn repeatedly from the same fire-line, road or track.
- **Limit fire encroachment into non-target communities.** In some cases, riparian, lancewood and springs communities can occur adjacent to fire-adapted communities. 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 or assist in carrying the fire through sparser fuels.

Spot ignition in a Mitchell grassland. These fires will eventually join. Burning with good soil moisture should result in a level of internal patchiness.

Tony Salisbury, QPWS, Moorrinya National Park (2008).

Patchiness in grasslands can be difficult to achieve without good soil moisture or subtle landscape variation. Using overnight conditions can help.

Rosie Kerr, QPWS, Forest Den (2011).

Issue 2: Reduce overabundant saplings and seedlings

An overabundance of saplings and seedlings of native trees such as *Acacia* spp., *Eucalypt* spp. and false sandalwood *Eremophila mitchelli* is a serious issue in some Mitchell grassland communities. The overabundance of saplings and seedlings can lead to woody thickening changing the structure of the community from open grassland to woodland. Fires applied when these trees are seedlings or young saplings will have a better chance of reducing their density. As this issue progresses, the trees and shrubs will shade out the ground layer, reducing ground layer diversity and making fires more difficult to apply.

Refer to Chapter 5 (Issue 3), regarding fire management guidelines.

Issue 3: 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 Mitchell grassland 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 5 (Issue 4), regarding fire management guidelines.

The woody weed Prickly acacia, *Vachellia nilotica* is spreading into this Mitchell grassland. This area has been subjected to heavy grazing pressure.

John Nelder, Queensland Herbarium, Near Stamford siding (1986).

Issue 4: Manage invasive grasses

It is important to be aware of the presence of invasive grasses as they can dramatically increase fire severity and are often promoted by disturbance, including 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 5 (Issue 5), for fire management guidelines.

Chapter 3: Acacia communities

This fire vegetation group consists of acacia woodlands and shrublands. The main canopy trees are gidgee *Acacia cambagei*, Georgina gidgee *Acacia georginae*, and lancewood *Acacia shirleyi*. However scattered areas of mulga, *Acacia aneura* and brigalow *Acacia harpophylla* also occur. Acacia communities may occur as pure stands or in association with eucalypts or grasslands. The ground layer is generally sparse and may include tussock grasses, spinifex and shrubs.

Fire-sensitive species such as dead finish *Archidendropsis basaltica* and northern sandalwood *Santalum lanceolatum* are often associated with acacia communities. Acacia dominated communities are the second largest fire vegetation group within the Mitchell Grass Downs bioregion

Fire management issues

Acacia species are vulnerable to frequent and high-severity fires. In most instances, fire is not applied directly to acacia dominated communities rather; surrounding fire-adapted communities are managed to mitigate the intensity and extent of unplanned fires impacting upon acacia communities. In some cases it is recognised that fuel loads within more open grassy acacia communities may require infrequent patchy burns to protect them from wildfire later in the season or promote ground layer diversity. Years of increased rainfall can result in increased fuel loads in some communities which may result in the acacia community becoming more at risk of wildfire impacts.

The presence of introduced invasive grasses may increase the severity of fires. Invasive grass species such as buffel grass, *Cenchrus ciliaris* can alter fuel characteristics and influence the potential for frequent and damaging fires in this fire vegetation group.

Issues:

1. Use fire to maintain open grassy acacia communities
2. Limit fire encroachment into lancewood communities
3. Manage invasive grasses.

Extent within bioregion: 3 688 299 ha, 15 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Diamantina National Park, 20 458 ha; Lochern National Park, 10 517 ha; Bladensburg National Park, 4 063 ha; Welford National Park, 572ha; Idalia National Park, 65 ha; Elizabeth Springs Conservation Park, 2 ha.

Issue 1: Use fire to maintain open grassy acacia communities.

Use low severity mosaic burning to maintain grassland diversity in grassy acacia communities to reduce impacts of wildfire.

Awareness of the environment

The following may indicate that fire is required to maintain open grassy acacia communities:

- A cover of native grasses is present below an open mature canopy.
- There is an accumulation of thatch (dead material), collapsing grass and the grass clumps are poorly formed.
- Herbs in the ground layer have become very sparse.
- Gidgee or mulga is thickening and is having shading impacts on the ground layer.
- There is a cover of ground layer fine-fuels, such as grasses, leaf litter, sedges and forbs that is likely to carry fire.
- Where it occurs, spinifex clumps are touching or have formed continuous hummocks over a broad area.

Open healthy gidgee woodland with tussock grasses. Note gidgee regeneration in the understorey.

E.J. Thompson, Queensland Herbarium (1998).

A patchy burn in a eucalypt community with gidgee *Acacia cambagei*. Whilst gidgee is fire-sensitive, it can withstand occasional, mild and patchy fires. Note minimal scorching of gidgee trees.

Chris Crafter, QPWS, Bladensburg National Park (2010).

Flinders grass dominates the understorey of this black gidgee *Acacia argyrodendron* woodland. While fire plays no role in the recruitment of black gidgee, a low-severity fire may occasionally be required to protect it from high-severity wildfires.

Rosie Kerr, QPWS, Forest Den (2011).

A mulga community. Note the dominance of old mulga trees and an absence of seedlings. This indicates the community is long unburnt. Grassy ground-layer fuels have accumulated increasing wildfire risk.

Rosie Kerr, QPWS, Idalia National Park.

There is an accumulation of dense grasses adjacent to this mulga community. Burn adjacent grasslands under conditions that limit impacts to acacia communities.

Rosie Kerr, QPWS, Idalia National Park (2010).

Mulga shrubland with spinifex. Acacia communities such as this are generally afforded protection from fire by sparse fine fuels in the ground layer. Care should still be taken when burning surrounding fire- adapted communities.

John Nelder, Queensland Herbarium, De Little Range.

Mulga dominated woodland. Fire-sensitive species such as Dead finish *Archidendropsis basaltica* is often associated with this community.

H. Cartan, Queensland Herbarium (1998).

Sparse ground layer fuels in this fire-sensitive Waddy wood community.
John Nelder, Queensland Herbarium, Near Marion Downs (1986).

Brigalow communities on sandy plains such as this one are generally afforded protection by the sparse ground fuel loads. Fire is unlikely to impact this community.
QPWS, Idalia National Park (1998).

Discussion

- Some acacia communities can have a dense and diverse grass layer that requires occasional fire to maintain ground layer diversity and reduce fuel loads. However, fire severity needs to be kept 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, brigalow, mulga and waddy wood Acacia peuce are long-lived and susceptible to frequent and intense fire. Fire plays no role in their germination which is very occasional and generally follows high rainfall years. These species often resprout from root suckers and take many years to mature.
- Waddy wood Acacia peuce is considered vulnerable under the Queensland *Nature Conservation Act (1992)*. As recruitment only occurs following occasional high rainfall events, it is 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).
- Newly gazetted estates may contain disturbed systems that are recovering from previous land management (e.g. clearing and grazing). In these systems, the canopy may be more open and have fewer larger trees (including habitat trees), dense acacia saplings and young trees may be present (whipstick acacia) or the area may not contain sufficient recruiting canopy species of various ages. As long as the structure of the understorey appears healthy, implementing this guideline should create a more varied and mature ecosystem over time.
- Be aware that in the long-absence of fire, the canopy of acacia communities may close and become somewhat self-protecting. 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.
- Where woody thickening is an issue (e.g. *Acacia latifolia, Acacia cambagei*), implement burns soon after high rainfall events, before woody seedlings become established.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Choose from the below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Over several hectares, a mosaic of 20–30 % of blackened ground within the boundary of the burn area.	Chose one of these options: a. Visual estimation of percentage of vegetation burnt - from one or more vantage points, or from the air. b. Map the boundaries of burn area with GPS, plot on GIS and thereby determine the percentage of area burnt. c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating the percentage of ground burnt within visual field.	**Achieved:** 20–30 % reduced. **Partially Achieved:** 15–20 %, or 30–50 %. **Not Achieved:** < 15 % or > 50 %.
Proactive planned burning has prevented impacts of wildfire on acacia communities	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.
>75 % of overabundant woody seedlings are reduced	Select several sites or walk several transects, estimate the percentage of overabundant woody seedlings reduced.	**Achieved:** >75 % **Partially Achieved:** 25–75 % **Not Achieved:** < 25 %

Minimal canopy scorch of mature acacia species.	**After the burn** (immediately or very soon after): visual estimation of percentage of acacia scorched from one or more vantage points, or from the air.	**Achieved:** No scorch. **Partially Achieved:** < 25 % scorched. **Not Achieved:** > 25 % scorched.

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

Monitoring the issue over time

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

Fires under mild conditions are ideal to create a patchwork of burnt and unburnt areas adjacent to acacia communities — that on occasion trickle in.

Rosie Kerr, QPWS, Forest Den National Park (2010).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Patchy (P)	<< 100	< 0.5	<< 2.0	High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels, some scorching of elevated fuels (no higher than two metres). No canopy scorch.
Low (L)	< 100	< 0.5	< 2.0	Some patchiness, most of the surface and near Surface fuels have burnt. Some scorching of elevated fuels. Little or no canopy scorch.

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

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

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between six to ten years for open acacia communities with a grassy understorey.
- Ensure areas of mulga, brigalow and waddy wood is left long unburnt (often greater than 10 years).
- Seasonal rainfall and the fuel it generates are the key drivers of fire extent and frequency in acacia communities with a grassy understorey

Mosaic (area burnt within an individual planned burn)

- 20–30 per cent burnt— to limit the severity and extent of potential future wildfires.

What weather conditions should I consider?

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

Season: Burn during the wet season to early-dry season, while the soil retains moisture

FFDI: < 11

DI (KBDI): < 80

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

Soil moisture: Good soil moisture is essential as it helps protect the underground portion of the vegetation, promotes seedling germination post-fire and prevents erosion issues.

What burn tactics should I consider?

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

- **Spot ignition** is often used to alter the 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 close together will result in a line of a greater intensity (as spots merge they create hot junction zones). Spots further apart or alternatively a single spot ignition will result in a lower-intensity fire and greatly varied mosaic of unburnt and burnt patches. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- In the late **wet season**, patches of limited extent can be created by spot ignition late in the afternoon using overnight dew to self-extinguish fires.
- **Progressive burning** is an approach to planned burning where ignition is carried out throughout as much of the year as conditions safely allow. In the Mitchell Grass Downs, ignition can begin soon after or even during the wet season providing the fuel has cured sufficiently enough to carry a fire. Numerous small ignitions create a fine-scale mosaic. Continue lighting until fires are beginning to carry well into the night but not overnight. These burnt areas can provide opportunistic or targeted barriers to fire to support burning later in the year as well as providing refuge areas for fauna. Progressive burning helps create a rich mosaic of severities, burnt/unburnt areas and seasonal variability.
- **A low-intensity backing fire.** A slow-moving, low-intensity backing fire will generally result in the more complete coverage of an area. This tactic ensures the fire has a greater amount of residence time while the fire intensity and rate of spread are kept to a minimum.

Issue 2: Limit fire encroachment into lancewood communities.

Some acacia communities are particularly fire-sensitive and should be protected from fire. Lancewood *Acacia shirleyi*, is extremely sensitive to fire and although fire helps promote the germination of seedlings, all but the lowest-severity fires will kill trees. Management of the surrounding fire-adapted communities to limit fire encroachment into lancewood communities assists in their protection.

Lancewood on the top of the plateau, with spinifex on slopes and eucalypt at the base.
John Nelder, Queensland Herbarium (1986).

Discussion

- Repeated, frequent, high-severity fires can have devastating impacts on lancewood communities. These fires usually originate from adjacent fire-adapted communities such as grasslands and eucalypt woodlands. To minimise fire encroachment into these communities, undertake burning, if possible, in adjacent areas under mild conditions when there is good soil moisture. Use appropriate lighting patterns (e.g. spot lighting with matches) along the margin of the non-target community to promote a low intensity backing fire that burns away from the non-target community creating a buffer zone.
- Lancewood is reliant upon post-fire regeneration from a viable seed bank to persist locally. Although it is recommended to mitigate wildfire impacts by burning surrounding areas, the occasional wildfire does play a role in the persistence of these communities in the landscape.
- Be aware that following a fire that has affected a lancewood community, a more proactive fire management approach in the surrounding areas will often be required to allow the regenerating lancewood sufficient time to recover, mature and for a seed bank to be replenished in the soil (DERM 2002).

A lancewood community with a sparse spinifex understorey on slopes. Pockets of fire-sensitive communities like this are scattered across the fire-adapted landscape.
John Nelder, Queensland Herbarium, Near Winton (1998).

Even mature lancewood is susceptible to high-severity fire.
Paul Williams, Vegetation Management Science Pty Ltd, Moorrinya National Park (2007).

Issue 3: Manage invasive grasses

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

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

Chapter 4: Riparian, springs and herbfield communities

This fire vegetation group includes springs, riparian areas and open woodlands on drainage lines and floodplains. It also includes herbfields, claypans and saltpan scald areas (which generally will not burn due to their low fuel loads).

Fire management issues

Most of the species in these communities are fire-sensitive— do not intentionally burn them. Elizabeth Springs (Diamantina National Park) has a biodiversity status of '**endangered**' and rare and threatened flora/fauna species are associated with this spring community. Hunter's Gorge on the Diamantina River has been identified as a wetland of national importance and requires special care.

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 using tactics such as burning away from the edges.

This approach will also mitigate the spread of buffel grass *Cenchrus ciliaris*, and other weeds of disturbance such as noogoora burr *Xanthium occidentale* and mimosa bush *Vachellia farnesiana* which have established in some riparian communities.

Issues:

1. Limit fire encroachment into riparian, springs and herbfield communities
2. Reduce woody weeds.

Extent within bioregion: 1 167 920 ha, 5 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Diamantina National Park, 5 944 ha; Lochern National Park, 4 482 ha; Bladensburg National Park, 2 137 ha; Camooweal Caves National Park, 250 ha; Elizabeth Springs Conservation Park, 97 ha; Combo Conservation Park 2, 20 ha; Combo Conservation Park 1, 18 ha.

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

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

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 riparian communities.

Patchy to low severity burns in areas surrounding riparian vegetation may be useful to reduce fuel loads and mitigate impacts of wildfire, particularly the loss of habitat trees. These fires should be implemented late in the wet season to early dry season (when there is good soil moisture) and occasionally be allowed to trickle into fringing river red gum *Eucalyptus camaldulensis* or coolabah *Eucalyptus coolabah* communities.

River red gum on drainage lines. Do not target for burning, but fire should be allowed to occasionally trickle into these communities to reduce extent and severity of wildfires in fire- sensitive riparian vegetation.

Bruce Wilson, Queensland Herbarium, Barkly Tablelands (2008).

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

Bruce Wilson, Queensland Herbarium, Elizabeth Springs Conservation Park (2008).

Fringing community with coolabah. Manage adjacent fire-adapted vegetation to protect riparian areas.

Bruce Wilson, Queensland Herbarium, Elizabeth Springs Conservation Park (2008).

Vegetation within riparian zones provide critical refuge for fauna species. Intense fires can degrade vegetation and destroy fauna habitats.

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

Mixed chenopod herbland dominated by roly-poly *Salsola kali* with the endangered *Austrobryonia argillicola* plants bottom left. Fire is unlikely to be a threatening process in this environment as there is rarely enough fuel to burn them.

Maree Rich, QPWS, Astrebla Downs (2011).

Claypans will generally not burn due to the sparse nature of fuels.

QPWS, Diamantina National Park (2005).

Issue 2: Reduce woody weeds

Woody weeds in particular parkinsonia *Parkinsonia aculeate*, mimosa bush *Vachellia farnesiana* or weeds of disturbance such as noogoora burr *Xanthium occidentale*, are known to be an issue in some riparian 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. Noogoora burr may take advantage of bare ground caused by fire to establish or expand the size of an infestation within riparian communities. In addition many native species within these communities are fire-sensitive and control methods other than fire should be considered in the first instance.

Refer to Chapter 5 (Issue 4), regarding fire management guidelines.

Chapter 5: Common issues

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

Fire management issues

Issues:

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

Issue 1: Hazard reduction (fuel management) burns

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

Awareness of the environment

Main indicators of where fire management is required

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

or

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

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

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

Discussion

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

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

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

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

Photo 1a: The two samples above have the same **fuel load** (eighteen pages of newspaper) but a different fuel arrangement.
Troy Spinks, QPWS (2010).

Photo 1b: The fuel arrangement contributes to the difference in **fuel hazard.**
Troy Spinks, QPWS (2010).

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

- **Protection zones:** 90 per cent burnt
- **Wildfire mitigation zones:** 60–80 per cent burnt

What weather conditions should I consider?

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

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

FFDI: < 12

DI (KBDI): < 100

Wind speed: < 15 km/hr

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

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

What burn tactics should I consider?

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

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

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

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

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

David Cameron, DNRM (2004).

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

David Cameron, DNRM, Unspecified location.

Stones arranged around a well. Cultural sites or artefacts are not to be disturbed during fires or while protection measures are undertaken.

Dale Richter, Queensland Herbarium (2011).

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 mine 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).

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

David Cameron, DNRM, Dogwood Creek (2005).

Some historic sites may be particularly at risk due to the flammable nature of the building materials.

QPWS, Mayne Hotel Ruins and diggings, Diamantina National Park (2005).

Other heritage structures should be protected from fires that could damage their integrity.

Dale Richter, Queensland Herbarium (2011).

Afghan cameleers planted date palms at strategic locations. These should not be burnt.

David Cameron, DNRM, Marion Downs (2004).

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	Burns protecting **significant cultural heritage sites**.

Assessing outcomes

Formulating objectives for burn proposals

As required, choose three or more locations that will be good indicators for the whole burn area. Estimations can be improved by returning 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. **Not Achieved:** there was some impact on site or item.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

- If possible, a patchy fire will give greater overall protection to cultural heritage sites and items unless burning in adjacent areas where the object is to reduce fuel, in which case a good coverage of fire is recommended.

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?

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: Favour early season burning and moist conditions

FFDI: < 7

DI (KBDI): < 160

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

Using spot ignition and still conditions directed smoke away from this rock art site.
Mark Parsons, QPWS, Fishers Creek (2010).

What burn tactics should I consider?

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

- **Manual fuel management**. Prior to undertaking planned burns near sites of cultural significance (e.g. scar trees and rock art sites), manual reduction of fuel may be required. This may include the raking, clearing (e.g. rake-hoe line), trimming or leaf blowing the surface fuels away from the site to limit potential impacts. If it is not necessary to manually reduce the fuel level, it is preferable to leave the site completely undisturbed.
- **Spot ignition**. Can be used 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.

Issue 3: Reduce overabundant saplings and seedlings

In the Mitchell Grass Downs bioregion overabundance of gidgee *Acacia cambagei*, boree *Acacia tephrina*, mulga *Acacia aneura*, whitewood *Atalaya hemiglauca*, false sandalwood *Eremophila mitchellii*, *Senna* spp., and occasionally other species may reduce the health and diversity of the ground layer through competition and shading. If left unmanaged, the structure of woodlands and forests can become more closed and grasslands can become woodlands; a process known as woody thickening. As woody thickening progresses, fires become more difficult to reintroduce.

Awareness of the environment

The following may indicate that fire is required to reduce overabundant saplings and seedlings:

- Seedlings and young saplings are beginning to rise above ground layer plants and are becoming more than scattered.
- The mid stratum is becoming difficult to see or walk through.
- Ground layer plants are beginning to decline in health (are poorly formed and collapsing), diversity and abundance due to shading, however fuel loads remain sufficient to carry a fire.

A natural thickening cycle

Some shrubs and trees may thicken in response to an occasional high-severity fire or high rainfall years. In healthy country (where fire has been maintained and in the absence of heavy grazing) this is not a problem. Providing appropriate fire continues to be applied within and around these areas, they will naturally thin with time maintaining a balance of open and woodland areas across the landscape.

Why are saplings and seedlings overabundant?

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

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

Discussion

- Mass germination: In the absence of fire, seed stocks of acacia can build-up which may lead to a mass germination event after fire. Where this has occurred, it is likely that more than one fire will be required to address the issue. Post-fire observations are essential to monitor the kill rate and germination of acacias in order to ascertain the need for subsequent fires. In the Mitchell Grass Downs bioregion there may be insufficient fuel accumulation in the two to three years after seed-set in acacias, meaning the opportunity to burn before this time is reduced.
- Woody thickening becomes much more severe where stock grazing is combined with repeated early season burns or a lack of fire. Stock grazing reduces fuel loads, preventing fires of sufficient severity to manage overabundant seedlings/saplings. This is further compounded by cattle concentrating on regrowth grasses in the recently burnt areas, allowing woody species the competitive advantage.
- Seed germination and recruitment of some species in the Mitchell Grass Downs bioregion may be linked to rainfall events (which possibly only occur every decade or so) and may occur in the absence of fire. These species include: Gidgee *Acacia cambagei* and *Acacia latifolia*. Some of the trees which establish are then thought to dieback in years of drought.
- A thickening of trees may result in a lower diversity of plants within the understorey due to shading.
- Canopy species in the understorey are necessary for the eventual replacement of canopy. Continued observation will ascertain if the canopy species are becoming overabundant (are beginning to shade out the understory).

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.
Low	Planned burn in areas where **ecosystem** structure and function has been **significantly disrupted.**

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 75 % of mid stratum saplings are reduced.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity), estimate the per cent of overabundant saplings (above ground components) scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.
Increase the size of a grassland	At a number of locations on the boundary of grasslands and woodlands establish photo monitoring points. Return to these locations within a year of each burn to check the grassland is expanding/woodland retreating.	**Achieved:** Grassland expanding/woodland retreating. **Partially Achieved:** grassland not expanding/woodland not retreating. **Not Achieved:** Grassland continues to retreat/woodland expand.

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?

Residence time

- Slower-moving backing fires that create a high residence time around the base of overabundant saplings/seedlings are a good management technique for some species, where fuel loads are available.

Fire severity (refer to relevant chapter for the severity table):

- **Moderate** for most situations where young trees are less than one metre tall. Avoid lower-severity burns, as this will exhaust fuel and reduce opportunities for subsequent higher-severity burns. For saplings greater than one metre tall, a **high**-severity fire might be required (do not use high-severity fire in acacia communities).

Mosaic (area burnt within an individual planned burn)

- Burn as much of the area dominated by mid-stratum saplings as possible.

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

- It is likely that more than one planned burn will be required to manage this issue. Monitor the outcomes until the overabundant saplings/seedlings are controlled.
- *Eremophila* spp. are resistant to annual spring burns but can be killed by two consecutive autumn burns (Bull 2002). While this strategy has been successful in south-west Queensland, it's effectiveness within the bioregion is yet to be trialed.

Other considerations

- It is important to observe post-fire germination, regeneration and kill rates to ascertain the need for subsequent fires. If the initial fire triggers a flush of new seedlings, follow-up with a planned burn within two years using a **moderate**-severity fire.
- If a fire has triggered a flush of eucalypt seedlings, allow the fuels to accumulate so that the fire will kill the seedlings. Be aware that some seedlings will be required to eventually replace the canopy. Occasional seedlings of canopy trees are not an issue.
- Once the area has recovered, the recommended regime for the fire vegetation group can be resumed (refer to relevant chapter).

What weather conditions should I consider?

Season: Late dry season after first storms to manage acacia thickening in grasslands.

FFDI: 8–18

Wind speed: < 23 km/hr. Winds greater than 15 km/hr can help fire carry where fuels are low.

What burn tactics should I consider?

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

- While a moderate-severity fire is recommended to address this issue, this is largely dependant upon the height of the saplings. A **running fire** of a higher intensity may be required initially where there is a lack of surface and near-surface fuels (due to shading or if the thicket is well developed). **Line or strip ignition** can be used to create a fire of higher intensity or to help fire carry through moist or inconsistent fuels. In this instance a follow-up planned burn will be required in the one to three years post-fire to kill the surviving and new seedlings/saplings. Poorer soils will take longer to accumulate sufficient fuel to carry a fire.
- **A backing fire with good residence time.** For some species a slow-moving backing fire (lit against the wind on the smoky edge) ensures a greater amount of residence time at the base of the plant, while fire intensity and rate of spread are kept to a minimum. Greater residence time is useful in reducing these overabundant seedlings/saplings.

Issue 4: Reduce woody weed invasion

Parkinsonia *Parkinsonia aculeata*, prickly mimosa *Vachellia farnesiana*, prickly acacia *Vachellia nilotica*, rubber vine *Cryptostegia grandiflora* and mesquite *Prosopis* spp. are woody weeds found within the Mitchell Grass Downs bioregion. Fire may assist in the control of these 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.
- **Prickly mimosa** (also known as **mimosa bush**) grows in similar circumstances to parkinsonia but can also invade dry open grasslands and is able to form dense stands.
- **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.
- **Rubber vine** has the ability to smother trees and shrubs and shade out grasses making fire difficult to apply. It is usually found in riverine areas, floodplain woodland and dry creek beds.
- **Mesquite** is considered one of Australia's worst weeds due to its ability to form impenetrable thickets, displacing native vegetation. Its potential distribution is up to seventy per cent of the Australian mainland.

Awareness of the environment

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

- Fire management can be used where woody weeds occur in fire-adapted vegetation or where the fire extent can be limited in fire-sensitive vegetation.
- The grass fuels are sufficiently continuous to carry fire, despite the occurrence of woody weeds.
- The grass fuel crumbles in the hand indicating it is cured sufficiently to carry a fire.
- Biocontrol agents are present (rubber vine is infected with rubber vine rust or parkinsonia is affected with parkinsonia dieback). These increase the effectiveness of fire as a control method.

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.
- Woody weeds occur in fire-sensitive vegetation.

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).

Parkinsonia is spreading into Mitchell grasslands. This area is located near a bore and has been heavily grazed. Spelling this area until a good body of fuels form may assist in managing the parkinsonia.

John Nelder, Queensland Herbarium, Stamford siding (1986).

Discussion

- 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 dependent on species). Follow-up fires may be required should some seeds survive in the seed bank or plants resprout.
- While most woody weeds described here are not presently common in all parks within the Mitchell Grass Downs bioregion, monitor and identify new infestations as they emerge. Young plants/seedlings are more easily controlled with fire than mature plants.
- Planned burning in areas with woody weeds using soil moisture, allows native species, especially grasses and forbs, the best chance of re-establishing.
- In areas where parkinsonia or prickly acacia 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 into the area.
- Care should be taken when using fire where fire-adapted communities abut fire-sensitive communities. Dead plant material, continuous ground fuels or high-severity fire could draw fire into fire-sensitive areas.

Parkinsonia

- Parkinsonia is widespread within the bioregion with most areas affected to varying degrees. It is found in varying densities across most of the bioregion (DPIF 2011). It is presently found at Lochern National Park (Johnstone and Wylkes 1999), Bladensburg National Park (Christie 1998), Diamantina/Astrebla Downs National Parks and Elizabeth Springs Conservation Park (Bourke and Mostert 2003).
- Fire will kill seeds on or close to the ground and has been shown to reduce the viability of the seeds remaining 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 from the tips of the branches— dead leaves remaining attached to the plant. Brown staining within the stems and branches can also be an indicator of dieback. In well-established areas of dieback, the fungus will spread through the soil infecting nearby trees.
- Record the results of fire trialed on parkinsonia plants/infestations and use this information to guide future fire management.

Rubber vine

- Rubber vine is not restricted to disturbed vegetation and prefers a good layer of organic material in the soil. It is restricted to areas where fires are absent or infrequent (Mackey et al. 1996). Rubber vine is common to occasionally abundant north of Longreach (DPIF 2011).
- A 'heli-torch' can be used to control rubber vine in fire-sensitive communities, inaccessible areas or where chemical use is not viable (e.g. riparian areas). The flammable petroleum based gel is applied directly to the plant then ignited. In some areas this method has been very successful but mixed results in other areas have been reported. See tactics below.
- Using fire to control rubber vine is more successful in areas where rubber vine rust occurs. While rarely killing mature plants, leaf-drop caused by the rust means fuel depth is greater below infected plants and opens the canopy allowing grasses to grow. If this fuel occurs adjacent to the stems it can increase residence time or carry the fire through areas where it may previously have extinguished, which may increase the effectiveness of fire as a method of control.

Prickly acacia

- Prickly acacia occurs predominantly in the north and west of the bioregion. In some areas the infestations are widespread and abundant (particularly to the northwest of Longreach) becoming common and occasional further to the south (DPIF 2011).
- Prickly acacia seedlings and saplings 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.
- Prickly acacia is considered a major threat to the Julia Creek dunnart *Sminthopsis douglasi* as it causes changes to the botanical compositions of Mitchell grass ecosystems (Lundie-Jenkins and Payne 2002). The Julia Creek dunnart is considered endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999) and the *Queensland Nature Conservation (Wildlife) Regulations* (1994).

Rubber vine usually starts along creeks and river systems and spreads into adjacent open woodlands and grasslands.
Justine Douglas, QPWS (2011).

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).

Prickly mimosa

- Prickly mimosa is mistakenly considered by some a native species and because of this its management is sometimes contentious. For graziers it is considered a useful drought fodder and generally only controlled when it becomes so dense that it impedes access to watering points. The Queensland Herbarium considers this species introduced.
- Prickly mimosa is widespread and abundant, particularly in the area between Blackall and Longreach
- Fire can be used to reduce this species to ground level and may assist in control by allowing native grass species to compete. Regular fire may be required to keep this species low in the ground stratum.

Mesquite

- Mesquite is found in predominantly localised infestations throughout the bioregion (DPIF 2011).
- Fire can be used to control mesquite and is most effective on the tree-form of mesquite *Prosopis pallida*, but can also be used in the control of some shrub-form species. It is more effective 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 following wet season 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.

Large areas of grasslands in the Mitchell Grass Downs bioregion have been invaded by mesquite.
Jenny Milson, DAFF (2012).

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)
> 75 % 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 per cent saplings have been killed. **Or** If using the 'heli-torch' method, retrace the flight path in three locations and estimate the percentage of mature rubber vine plants killed.	**Achieved:** > 75 % plants killed*. **Partially Achieved:** 40–75 % 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 density of woody weeds.	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 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

- The principal factor in successful control is residence time. Slow moving fire is required to kill mature trees although intensity is also important.
- Seeds, seedlings and saplings of most woody weeds are the life stage 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. Increasing fire frequency (if possible) for a while may further assist control.
- Apply a follow-up planned burn the following year (where fuel loads are sufficient) 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 a third fire may be required to completely remove the infestation. Once resolved, re-instate the recommended fire regime for the fire vegetation group. Continue Monitoring the issue over time.
- Due to the low fuel loads in many communities of the Mitchell Grass Downs bioregion, it may be necessary to implement burns following high rainfall events to ensure sufficient fuels for fire to carry.

Fire severity

- **Low** to **moderate**. 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 conditions prior to and following burns so that undesirable conditions and weather changes can be avoided, or to help with burn planning.

Season: Different approaches are possible including burning early in the year with good moisture, or storm burning.

GFDI: < 11

DI (KBDI): 80–160

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, greater woody weed control has been achieved using low humidity and high temperatures (e.g. 20 per cent humidity and 30ºC).

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.

- **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 sufficient surface fuels), ensures a greater residence time at ground level. This has proven to be successful in killing seeds, seedlings, young and some mature plants.
- A **running fire** of a higher-severity may be required to carry fire through areas of low fuel or dense thickets.
- **As part of a control program.** In areas where dense woody weeds shade-out grasses and limit the fuel available for fire, initial herbicide treatment or mechanical methods can be used. Care should be taken when applying fire to dead rubber vine plants which remain hanging in the canopy as they may act as elevated fuels.
- **Aerial incendiary using a 'heli-torch'**. Applying fire using a heli-torch may help control woody weeds that have invaded communities where fire is either not required or desired (such as those which are fire-sensitive). This tactic involves an aerial incendiary drop using gelled-gasoline to directly ignite the base of the plants. The surrounding vegetation needs to be moist to wet to ensure the fire doesn't spread. Aim to strike a balance between ensuring the surrounding vegetation is moist enough that it will not ignite and ensuring the woody weeds are dry enough that it will.

Issue 5: Manage invasive grasses

Exotic grasses are capable of out-competing native species to form dominant stands. The main high biomass grass of concern in the Mitchell Grass Downs 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. Grader *Themeda quadrivalvis* and rats tail grass *Sporobolus* spp. are emerging weeds within the bioregion. 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.

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

Discussion

- Be on the look out for newly forming stands and be especially vigilant in disturbed areas, particularly those where disturbance is ongoing (e.g. roadsides) and areas adjacent to or down stream from existing high biomass grass infestations (Melzer and Porter 2002). Control is often easier if their presence is detected and addressed early before it has become established.
- Prior to undertaking planned burns in areas where 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 type and weather conditions which may favour and further its spread.
- The closed canopy of healthy, mature acacia stands will often suppress and prevent the encroachment and establishment of invasive grasses. Healthy eucalypt forests with a native grassy understorey that fringe acacia communities which are maintained in a healthy condition will often also act as a preventive buffer that limits the spread of invasive grasses into acacia communities.
- Invasive grasses 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.
- 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 Mitchell Grass downs 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 species 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.
- The curing rate for buffel grass differs from that of native grasses and tends to remain greener for longer periods of time. Consideration should be given to burning adjacent areas when there is good soil moisture and when buffel grass is green and unlikely to carry a fire. This may provide the opportunity to conduct planned burns at differing times of the year.

Grader grass *Themeda quadrivalvis*

- Grader grass is an emerging weed in the Mitchell Grass Downs bioregion.
- Be aware of new infestations which can quickly take hold and ensure they are dealt with as a matter of priority.
- Grader grass is a weed of disturbance. Soil disturbance (e.g. road grading) can expose seed allowing favourable conditions for establishment and spread.
- Fire is not considered to be an effective tool to manage grader grass as it can encourage seed germination. If fire can not be avoided in areas of grader grass, the fire interval should be limited to more than five years.

A buffel grass infestation within gidgee *Acacia cambagei* woodland. The presence of buffell grass will increase fire intensity and flame height, contributing to tree death.
Paul Williams, Vegetation Management Science Pty Ltd, Mt Isa Inlier (2011).

Buffel grass often out- competes native grasses.
Jenny Milson, DAFF (2012).

Grader grass has progressively replaced native themeda grasses. Grader grass infestations need to be monitored carefully to assess effect of fire on its spread.
Jenny Milson, DAFF (2012).

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

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

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Distribution of invasive grass has not increased as the result of the burn.	**Before and after the burn** (after suitable germination/ establishment conditions): GPS the boundary of the invasive grass in the area or take photographs. Compare the pre and post burn distribution of the weed species.	**Achieved:** No increase in the distribution of the weed. **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.
Reduce fuels adjacent to non-target communities to low.	**Post fire:** use the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b), or Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations.	**Achieved:** Fuel hazard has been reduced to low. **Not Achieved:** Fuel hazard has not been reduced to low.

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

Monitoring the issue over time

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

When using fire to reduce the density of invasive grasses, it is important to continue to monitor the site to ensure the objectives of the burn have been achieved and to ensure invasive grasses do not recover their original density.

Fire parameters

The recommended fire parameters vary depending on species, see discussion above.

What burn tactics should I consider?

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

- **As part of a control program.** An initial fire to reduce the biomass of invasive grasses, followed by chemical control of the new shoots has been an effective method of control. Similarly, grazing can also reduce fuel loads.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire, particularly where there is a high-biomass grass infestation. Increased spacing between spots will result in a fire of lower-intensity. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **A low-intensity backing fire.** A slow-moving, low-intensity backing fire (against the wind or down 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, reduction of available fuels (particularly fine fuels) and ensures the fire intensity and rate of spread are kept to a minimum. Lighting fires at night can assist in decreasing fire intensity.
- **Limit fire encroachment into non-target communities**. Use appropriate lighting patterns (e.g. spot lighting with matches) along the margin of the community in combination with favourable weather conditions to promote a low-intensity backing fire that burns away from the non-target community. Undertaking burning in areas adjacent to invasive grass infestations while the grass is green, under mild conditions, early morning with dew, late afternoon or at night will assist in creating a low-severity fire that burns away from the non-target community. Where the non-target community is present in low-lying areas (e.g. drainage lines) use the surrounding topography to create a low-intensity backing fire that travels down slope towards the non-target community. In both instances, ensure good soil moisture is present within the non-target community.
- **Fire exclusion**. Excluding fire from buffel grass infestations may provide the opportunity for species such as brigalow or other acacias to out-compete the buffel grass. Ideally the acacia community will remain unburnt long enough to form a closed canopy that shades out and disadvantages the buffel grass. This requires active fire management in the surrounding fire-adapted communities to prevent unplanned fire.

Issue 6: Limit fire encroachment into non-target fire vegetation groups

Non-target fire vegetation groups include riparian and fringing woodlands, springs, chenopod shrublands and fire-sensitive acacia communities. When healthy these communities are sometimes self-protecting if fire is used under appropriately mild conditions or due to low fuel loads. Tactics such as burning away from these communities should be used to protect them. 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. Other areas where you may wish to limit fire encroachment include communities containing invasive grasses or other fire vegetation groups which are not ready to burn.

Awareness of the environment

Indicators of fire encroachment risk:

- Conditions are not mild enough or fuels sufficiently sparse to ensure fire extinguishes on the edge of fire vegetation group.
- Invasive grasses or woody weeds are invading fire-sensitive communities.
- The non-target community is upslope of a planned burn area.
- Riparian community or other fire-sensitive community is adjacent to 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.
- Most fire-sensitive communities tend to be self protecting and additional protective tactics may not be required. Sometimes where a fire-sensitive community occurs at the top of a slope, it is necessary to avoid running fires upslope even in ideal conditions.
- Many riparian communities contain a high proportion of fire-sensitive species and/or habitat trees. Too frequent and/or severe fire removes or inhibits the development of structurally complex ground and mid-strata and may open up the canopy. This in turn may increase the risk of weed invasion and soil erosion.
- 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 (refer to Chapter 5 (Issue 5), for fire management guidelines).

What is the priority for this issue?

Priority	Priority assessment
Very high	For burn proposals in areas with non-target communities, it is important to avoid encroachment of fire.

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)
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:** In 90 % of area surveyed fire penetrates no further than 1 m into the edge. **Not Achieved:** Fire penetrates further than 1m into the edge in > 10 % of area surveyed.

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

Fire parameters

What fire characteristics will help address this issue?

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

Fire severity

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

FFDI: Refer to relevant fire vegetation group

DI (KBDI): Refer to relevant fire vegetation group

Wind speed: < 15 km/hr

Soil moisture: Refer to relevant fire vegetation group

What burn tactics should I consider?

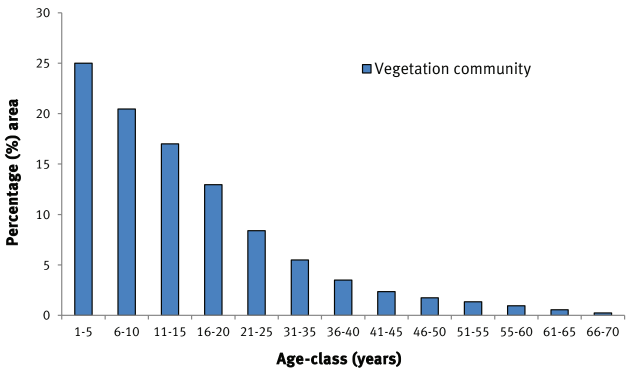
Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). Also, during the burn tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit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

- **Limit fire encroachment into non-target communities**. Where the non-target community is self-protecting (e.g. in low lying areas or is moist), utilise the surrounding topography to create a **low-severity backing fire** that travels (e.g. down slope) towards the non-target community. But if conditions are unsuitable for fire to self-extinguish, use appropriate lighting patterns along the margin of the non-target community to promote a backing fire that burns away from the non-target community. **Do not create a running fire**.
- **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 of the non-target community 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.

Damaged riparian zone eight months after a wildfire. Keeping fuel loads low in adjacent communities will limit potential impacts on riparian vegetation.
Alicia Whittington, QPWS, Bladensburg National Park (2010).

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 Mitchell Grass Downs bioregion	Percentage
Eucalypt communities	719 349	3.0
Grasslands	17 388 046	71.0
Acacia communities	3 688 299	15.0
Riparian, springs and herbfields	1 167 920	5.0
Other bioregion	244 564	1.0
Non-remnant	1 372 409	6.0
TOTAL	**24 581 603**	**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 communities	Eucalypt woodlands (Spinifex)		4.5.5, 4.5.8, 4.5.8a, 4.5.8b, 4.7.2, 4.7.7, 4.7.8. NON RE groupings used: G3, H28.
1	2	Eucalypt communities	Eucalypt communities (sparse fuels)		4.3.10, 4.9.12, 4.9.12x1, 4.9.18. NON RE groupings used: K17.
2	1	Grasslands	Mitchell grasslands		4.3.14, 4.3.14a, 4.3.14b, 4.3.15, 4.3.16, 4.3.17, 4.3.17a, 4.4.1, 4.4.1a, 4.4.1b, 4.4.1x2, 4.4.1x3, 4.4.1x4, 4.4.2, 4.9.1, 4.9.1a, 4.9.2, 4.9.2a, 4.9.4, 4.9.4x1, 4.9.5, 4.9.5a, 4.9.6, 4.9.7, 4.9.7a, 4.9.7x1, 4.9.8, 4.9.8a, 4.9.8b, 4.9.9, 4.9.19, 4.9.20, 4.3.13, 4.3.18, 4.3.19, 4.3.20. NON RE groupings used: C32
3	1	Acacia communities	Acacia woodland (grassy)		4.3.6, 4.3.9, 4.3.21, 4.3.23, 4.5.1, 4.5.2, 4.5.3, 4.5.6, 4.5.7, 4.7.4, 4.7.6, 4.9.10, 4.9.10a, 4.9.11, 4.9.16, 4.3.8, 4.3.8a, 4.3.8b, 4.3.8c, 4.3.8d, 4.9.14, 4.9.14x1, 4.9.15, 4.9.17, 4.5.4, 4.5.4a, 4.5.9, 4.7.3, 4.9.13.
3	2	Acacia communities	Acacia (lancewood)		4.7.1.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
4	1	Riparian, springs and herbfield communities	Riparian and fringing communities		4.3.1, 4.3.1x1, 4.3.2, 4.3.3, 4.3.3a, 4.3.3b, 4.3.4, 4.3.4a, 4.3.4x1, 4.3.5, 4.3.11, 4.3.11a, 4.3.11b, 4.3.11c.
	1		Herbfields		4.3.12, 4.3.12b, 4.3.12c, 4.3.12d, 4.3.24.
	1		Springs		4.3.22.

The spatial data is derived from version 6.1 of the "Survey and Mapping of 2006 Remnant Vegetation Communities and Regional Ecosystems of Queensland" layer (16 September 2011), the "Draft Pre-clearing Vegetation Communities and Regional Ecosystems" layer (20 August 2010) and the Northern Australia Tropical Savannas CRC Vegetation layer (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 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 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). NOTE: Non-regional ecosystem (Veg 1) Queensland Herbarium codes were also used, where no regional ecosystem codes existed as of 18 January 2012.

Unmatched regional ecosystems	4.3.11a, 4.3.11b, 4.3.12b, 4.3.12d, 4.3.14a, 4.3.14b, 4.3.1x1, 4.3.3a, 4.3.4a, 4.3.4x1, 4.3.6, 4.3.8a, 4.3.8b, 4.3.8c, 4.4.1x2, 4.5.8a, 4.9.12x1, 4.9.2a, 4.9.7x1, 4.9.8b.

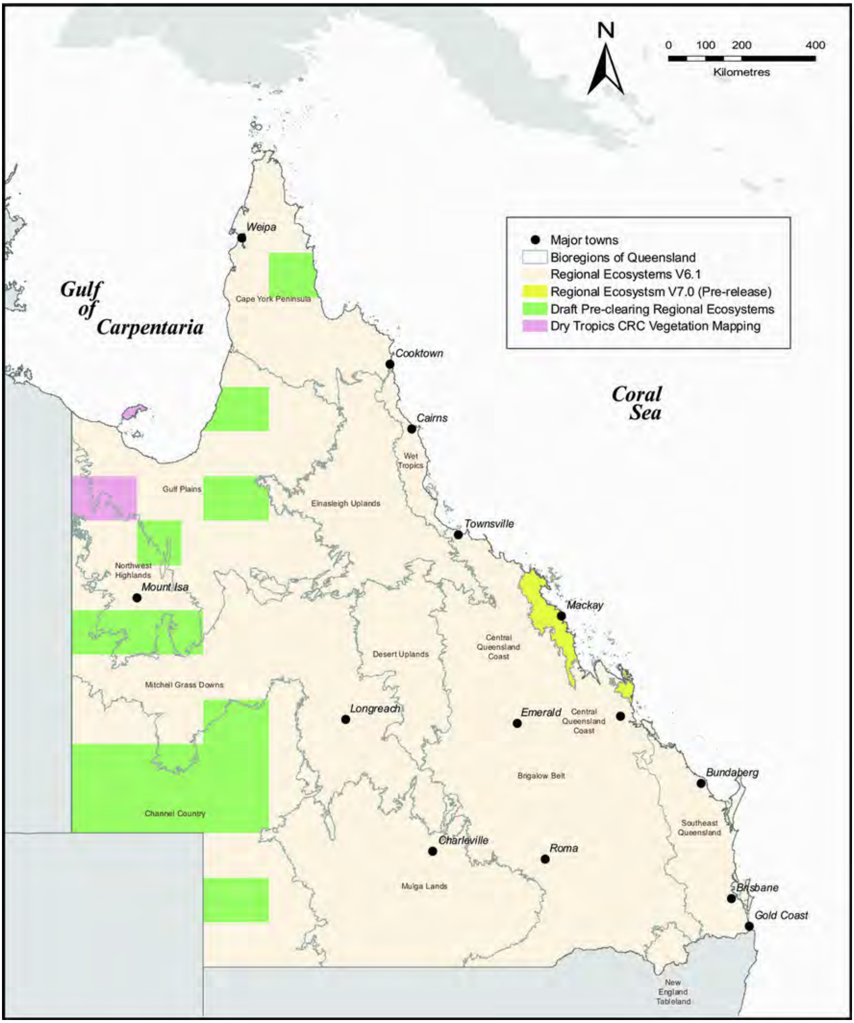


Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

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.

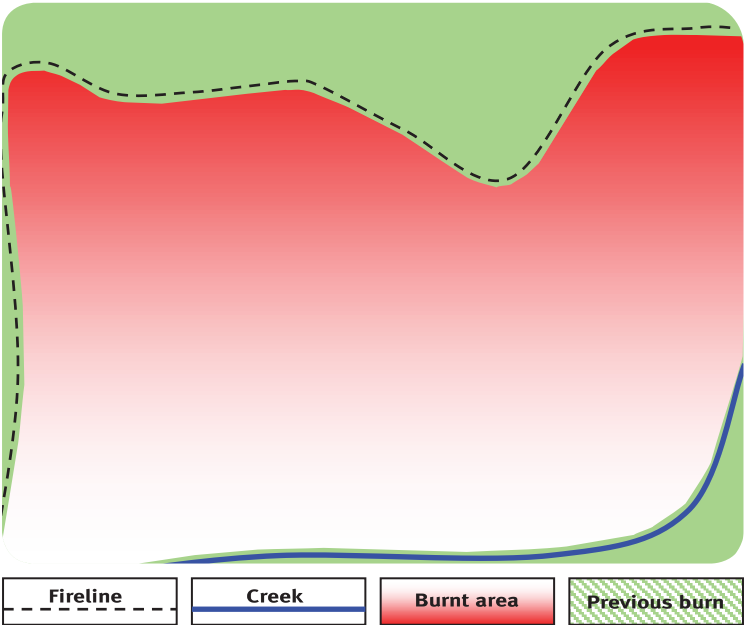


Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

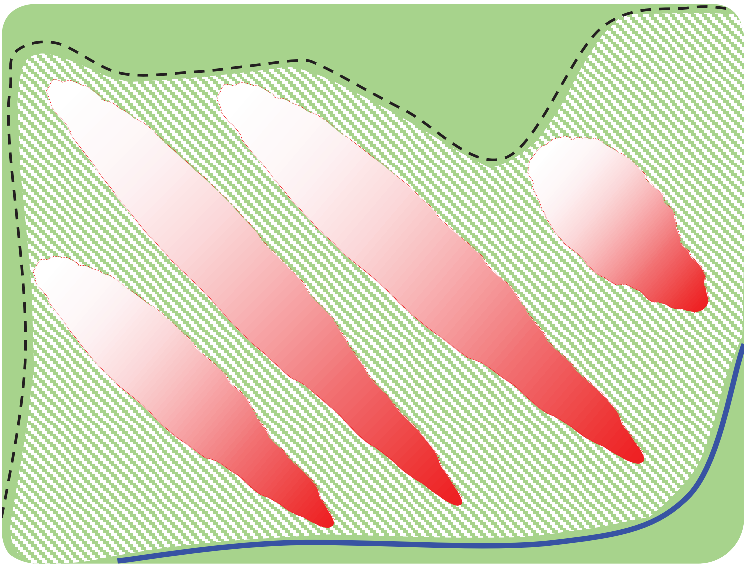


Figure 2: Planned mosaic burn—year 8.

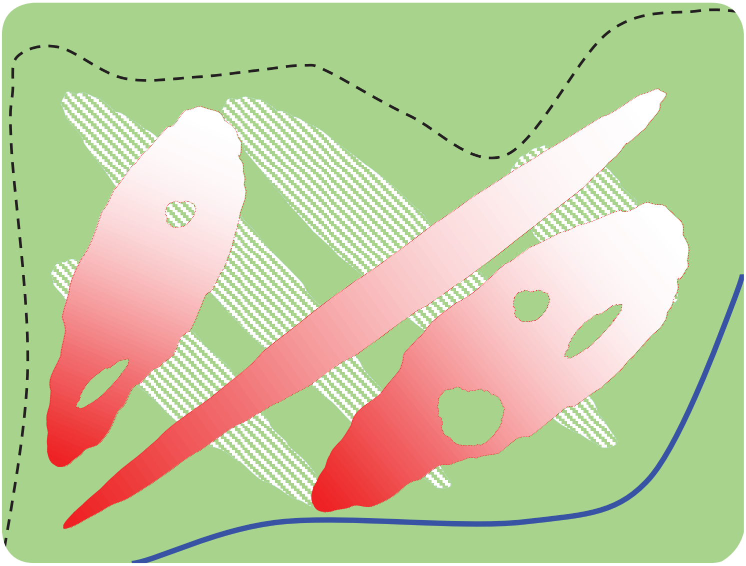


Figure 3: Planned mosaic burn—year 20.

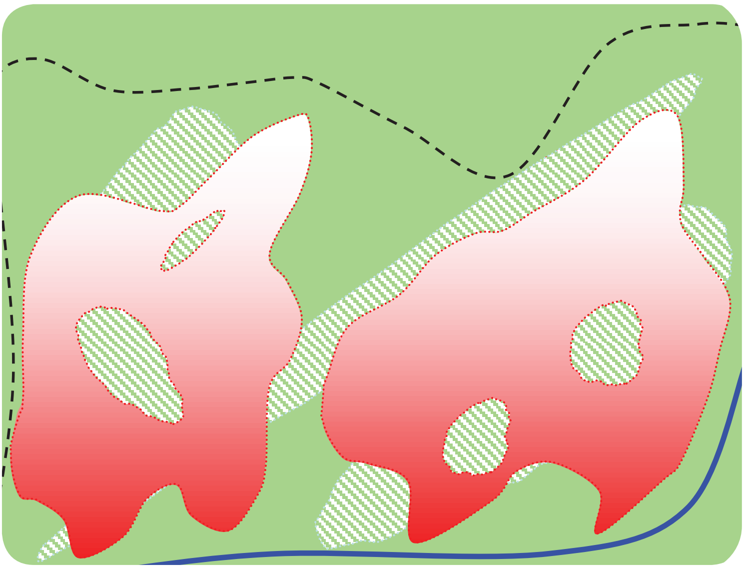


Figure 4: Planned mosaic burn—year 28.

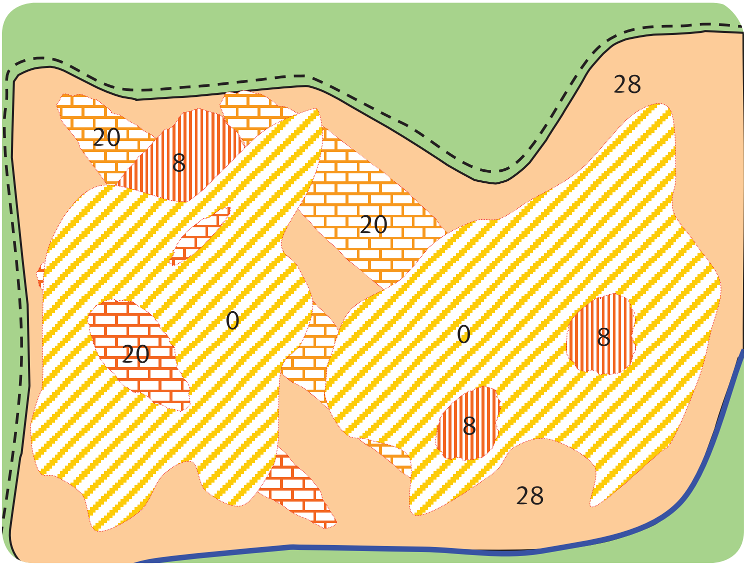
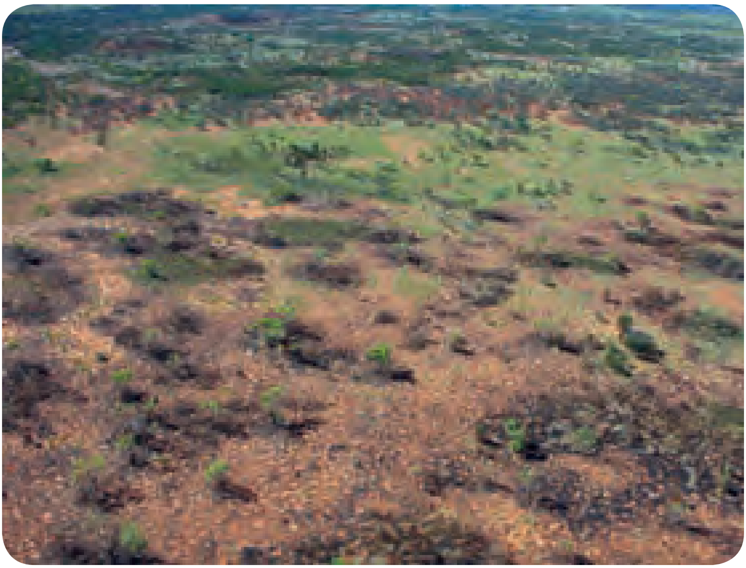


Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).



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