Department of National Parks,
Recreation, Sport and Racing

Planned Burn Guidelines

Northwest Highlands Bioregion of Queensland

Queensland Government

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Front cover photograph: Boodjamulla National Park, Dan Kelman, Queensland Herbarium (2003).

Bp2012

Foreword

The Northwest Highlands bioregion is made up of stony hills and ranges surrounded by arable downs country. The stony hills and ranges present significant challenges to wildfire management, increasing the importance of and need for proactive planned burning. It is believed that changes in land management practices (including reduced use of fire) together with a period of wetter climate (and therefore greater grass growth) has contributed to a landscape that has become dominated by a cycle of wildfires.

The availability of spinifex grass fuels drives fire in the Northwest Highlands, and the presence of spinifex ensures fire is inevitable. Large-scale spinifex fires, currently a typical occurrence in the Northwest Highlands, have significant impacts on biodiversity. The establishment and then maintenance of mosaics of wet season and early dry season planned burns each year, to provide sufficient breaks in fuel and therefore barriers to wildfire movement, appears to be the best solution. However, this requires persistent effort by land managers and the maintenance of fire management skills and knowledge over time.

This guideline will be an important element for improving fire management in the Northwest Highlands bioregion.

Marty McLaughlin
Area Manager
Central Region
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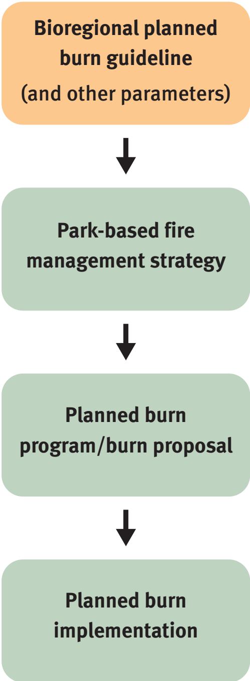
Table of contents



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 Northwest Highlands bioregion (refer to Figure 1) and covers the following fire vegetation groups: Eucalypt communities, Mitchell grasslands, acacia communities, riparian communities, and vine thickets (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Northwest Highlands. 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.

Healthy snappy gum woodland with spinifex understorey. Shrubs are scattered.
Dan Kelman, Queensland Herbarium (2009).

Figure 1: Map of the Northwest Highlands bioregion of Queensland.

Fire and climate in the Northwest Highlands bioregion of Queensland

The Northwest Highlands bioregion experiences a semi-arid climate with hot summers and mild to warm winters. Average annual rainfall is 437 millimetres (mm) but can vary from 300–900 mm. It decreases from north to south and with distance from the coast. Rainfall is generally linked to the passage of tropical monsoonal systems across the Gulf of Carpentaria or summer storms. However, unlike regions to the north and east, summer wet seasons do not occur every year.

Within the bioregion it is important to be aware of annual rainfall, when it falls and fuel curing rates. The onset and duration of the monsoon season varies considerably, and this variation has a great impact on fire weather in the region.

Low open woodlands with a substantial hummock (spinifex) grass understory dominate the vegetation communities of the Northwest Highlands bioregion. Spinifex accumulates quickly after years of above average rainfall. In contrast, dry years result in reduced grass growth, lower fuel loads, and a lesser risk of extensive wildfires. Fire intervals are heavily influence by rainfall and grass growth.

The wildfire season generally extends from August to November (depending on the year). Lightning is a frequent ignition source of wildfires at the end of the dry, or early in the wet season.

Fire risk is closely 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 37˚C with low humidity (below 15 per cent) and sustained winds greater than 16 km/hr (refer to Figure 2).

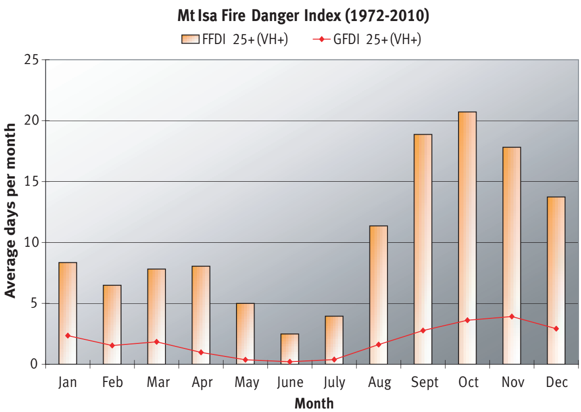


Figure 2: Fire weather risk in the Northwest Highlands bioregion.

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>.

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 open eucalypt woodland communities with a substantial ground layer of spinifex or tussock grasses. This group occurs extensively across the Northwest Highlands.

There are two main types of eucalypt communities distinguished by their ground layer, and their fire management needs differ as a result.

Eucalypt communities with spinifex

Rocky hills, plateaux's and sand plains tend to support snappy gum *Eucalyptus leucophloia*, Darwin woolybutt *Eucalyptus miniata* and small-fruited bloodwood *Corymbia capricornia*. The ground layer is dominated by spinifex species such as soft spinifex *Triodia pungens* and hard spinifex *Triodia basedowii* and *Triodia molesta*. These communities can occur as mixed shrubby woodlands or be quite open with an understorey dominated by spinifex.

Eucalypt communities with tussock grass

On floodplains, ranges and loamy plains, common species include Cloncurry box *Eucalyptus leucophylla*, silver-leafed box *Eucalyptus pruinosa* and western bloodwood *Corymbia terminalis*. Common grasses include species of aristida, heteropogon, themeda and mnesithea, band spinifex is often also present. The ground layer is generally sparse to very sparse. Trees and shrubs can range from dense to scattered.

Fire management issues

A key management concern for this fire vegetation group is extensive and/or high-severity fires impacting on biodiversity values, nearby fire-sensitive communities and property. This is exacerbated by large tracts of fire-prone landscapes (i.e. spinifex dominated communities). Spinifex can burn at almost any time of year, with good wet season rainfall significantly influencing fuel loads and therefore the likely extent of fires.

The best approach to mitigate the impacts of extensive unplanned fire is proactive use of numerous small fires annually (during the wet season). Such an approach to planned burning also addresses a key conservation issue of maintaining diversity in vegetation fire-age-classes across the landscape, therefore maximising habitat, and ensuring the persistence of long-lived obligate seed-regenerating and fire-sensitive species.

Issues:

1. Maintain healthy eucalypt dominated communities with spinifex grasses
2. Maintain healthy eucalypt dominated communities with tussock grasses
3. Manage invasive grasses
4. Limit fire encroachment into non-target communities.

Extent within bioregion: 6 438 949 hectares (ha), 85 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Boodjamulla (Lawn Hill) National Park, 273 411 ha; Lawn Hill (Stockyard Creek) Resources Reserve, 29 267 ha; Lawn Hill (Arthur Creek) Resources Reserve, 24 708 ha; Lawn Hill (Littles Range) Resources Reserve, 14 247 ha; Lawn Hill (Widdallion) Resources Reserve, 11 726 ha; Camooweal Caves National Park, 10 209 ha; Royton Timber Reserve, 7 354 ha; Lawn Hill (Lilydale) Resources Reserve, 2 595 ha; Lawn Hill (Gregory) Resources Reserve, 2 195 ha; Lawn Hill (Gorge Mouth) Resources Reserve, 462 ha; Lawn Hill (Gregory River Base) Resources Reserve, 57 ha; Lawn Hill (Creek) Resources Reserve, 7 ha.

Issue 1: Maintain healthy eucalypt dominated communities with spinifex grasses

Use landscape patch burning to maintain a broad mosaic of vegetation fire-age-classes.

Awareness of the environment

Key indicators of a healthy eucalypt community with spinifex:

- Eucalypt woodlands have a canopy of eucalypt or corymbia trees. Some young canopy species are recruiting in the understorey, enough to eventually replace the canopy.
- Tree shoots (trunk and basal sprouts) of some eucalypt spp., (e.g. snappy gum, silver-leafed box) have generally matured to a flowering age.
- Spinifex shows variation in time-since-fire across the landscape (e.g. there are older clumps interspersed with younger clumps).
- Tussock grass species may be present but spinifex dominates. Some recently burnt areas may have spinifex interspersed with annual grasses. Fire promoted short lived species such as herbs and forbs may be present.
- In shrubby areas, there is a diversity of shrub species including *Acacia chisholmii*, *Grevillea dryandra*, and *Jacksonia* spp. Shrubs are of a mixed age-class (e.g. juvenile, flowering, set-seed, senesced).
- Softwood species such as bauhinia *Lysiphyllum cunninghamii,* vine tree *Ventilago viminalis* and *Terminalia* spp. may be scattered, or form small pockets of mixed shrubby woodlands in fire sheltered areas.

Healthy snappy gum woodland with spinifex understorey. Shrubs are scattered.
Dan Kelman, Queensland Herbarium (2009).

Healthy woodland with spinifex interspersed with shrubs of varying age classes. Short lived species such as herbs and forbs may only be apparent after wet season rain. Tree canopy and trunks are healthy.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

In some areas the shrub layer may appear to be taking over. In fact, there is often a cyclic pattern where spinifex and shrub dominance will alternate. An indicator of when a fire may be required is when, across a broad area, shrubs are old or of a similar age class.
Paul Williams, Vegetation Management Science Pty Ltd, Boodjamulla (Lawn Hill) National Park (2006).

Spinifex shows a variation in time since fire across the landscape.
Leasie Felderhof, Firescape Pty Ltd, Mt Isa area (2006).

In remote and rugged areas access may be difficult. Aerial assessments can be useful in ascertaining health of eucalypt communities across the landscape. Canopy health, shrub diversity, and time-since-fire in spinifex can be efficiently observed from the air.
Mark Nemeth, DNRM, Boodjamulla (Lawn Hill) National Park (2002).

In fire sheltered areas, isolated pockets of shrubby woodland are common. Fire will occasionally trickle though sheltered sites but it will generally be of low intensity.
Dan Kelman, Queensland Herbarium (2006).

The following may indicate that fire is required to ensure landscape patchiness in spinifex dominated woodlands:

- Trees (e.g. *Eucalyptus* spp., *Corymbia* spp. and softwood species) have matured and set seed.
- Spinifex cover increases and clumps are touching or have formed continuous hummocks over a broad area. Long unburnt spinifex is considered healthy in this fire vegetation group; however, it is the extent of the long unburnt spinifex over large areas that is an indicator that fire is required to maintain a landscape mosaic.
- Spinifex is moribund (i.e. has no fresh growth, looks grey and old).
- *Acacia chisholmii* and other obligate seeders (e.g. *Acacia* spp., *Grevillea* spp. and *Jacksonia* spp.) are in the shrub layer, but are not healthy (e.g. are old or dying or of a single age-class).
- Shrubs have matured and there are a much greater number of adults and old shrubs as compared with juvenile shrubs.

Spinifex hummocks form a continuous grass layer over a broad area.
Justine Douglas, QPWS, Riversleigh Station (2012).

There is an accumulation of dead material within spinifex, with the younger leaves remaining green around the outside.

Paul Williams, Vegetation Management Science Pty Ltd, Boodjamulla (Lawn Hill) National Park (2005).

Spinifex looks old and tired. A fire will rejuvenate this community and promote fresh spinifex growth.

Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Spinifex has become moribund. When undertaking aerial assessments of vegetation health, these areas of dead spinifex (dark grey to black) are easily identified.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Eucalyptus pruinosa have been reduced a by high intensity fire. The small stunted form (main photo), is very different to the solitary-trunked tree where fire has been less frequent or less intense (insert). A low severity wet-season burn may provide an opportunity to reduce fuel loads, minimise the risk of a repeat hot fire, and help with the regeneration of this woodland community.
Dan Kelman, Queensland Herbarium (2006), Insert (2010).

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 thick enough to burn in the early years of growth. Generally, the fire return interval is four to five years or longer depending on rainfall. Be aware that spinifex can remain green throughout the year and can burn intensely even when green. After consecutive good growing seasons, a fire may, in some areas, carry across three year old spinifex.
- Recently burnt spinifex communities tend to have a greater diversity of resprouting perennials, annuals and ephemeral forbs scattered amongst the spinifex clumps.
- Shrub species diversity in spinifex dominated woodlands declines over time since fire. Conversely, the number of adult and dead shrubs increases in very long unburnt woodlands.
- Spinifex species on limestone accumulates lesser fuel loads than spinifex species on sandstone geologies. Spinifex fuel accumulation also varies with position in the landscape (e.g. increased spinifex accumulation in moist gullies, and less on stony rises).
- Mixed shrubby woodlands occur within the broader spinifex landscape. These communities contain fire-sensitive species such as *Terminalia* spp., *Brachychiton* spp. and *Lysiphyllum* spp. These communities generally occur in fire-sheltered areas.
- Maturing rates for obligate seeders have been shown to vary. Results of research in the Mt Isa area have shown that species diversity peaked the second year after fire and then decreased over time. Perennial species and obligate seeders generally commenced flowering within three years after fire (Felderhof 2007).
- In mature spinifex communities the near-endangered Carpentaria grass wren *Amytornis dorotheae* and the Kalkadoon grass wren *A. ballarae* have been recorded in monitoring surveys. Leaving areas of mature Spinifex (> 3-4 years since fire) is critical to maintaining these species, and others which rely on long unburnt spinifex patches for food, breeding habitat and shelter (Murphy et al. 2011).
- Some fauna species of spinifex communities rely on long unburnt habitats. Implementing a range of small fires annually resulting in different age classes should lead to habitat diversity for most fauna species (Felderhof 2007).
- 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 6 (Issue 3), for fire management guidelines.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Across the landscape a number of small areas are burnt annually to create a landscape mosaic of fire-age-classes.	Estimate the percentage of vegetation burnt across the landscape using: • Fire scar remote sensing data (e.g. using the North Australian Fire Information [NAFI] system). • Visual assessments from one or more vantage points, or from the air.	**Achieved:** Annually, 10–15 % of this fire association burnt. **Partially Achieved:** 15–25 % burnt. **Not Achieved:** < 10 % or > 25 % burnt.

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 300m or more 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:** 15–30 % or 60–75 % recently burnt ground. **Not Achieved:** < 15 % and > 75 % of burnt ground.
Proactive planned burning has prevented impacts of wildfire on natural/ cultural resources and infrastructure.	Using fire scar remote sensing data (e.g. NAFI), estimate the area of planned burns against wildfire on an annual basis.	**Achieved:** Annual area of planned burn prevents impacts of wildfire. **Not Achieved:** Wildfire has a significant impact.
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.

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

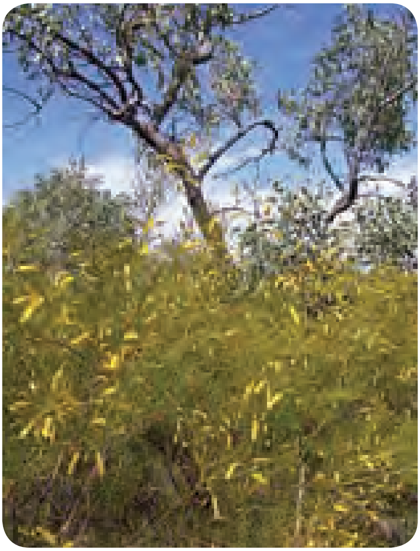
Monitoring the issue over time

Monitoring 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).

Older spinifex clumps are interspersed with recently burnt spinifex.
Lea Ezzy, QPWS, Boodjamulla (Lawn Hill) National Park (2011).

A mosaic of burnt and unburnt areas within the burn area.
Lea Ezzy, QPWS, Boodjamulla (Lawn Hill) National Park (2011).



Shrubs such as *Acacia chisholmii* can be used to help determine appropriate fire intervals. Allow several years of seed production following fire, before re-exposing to fire.

Paul Williams, Vegetation Management Science Pty Ltd, Mt Isa, Inlier (2011).

Where fire-killed shrubs are of a single age/height over a broad area, mosaic burning can be used to create a mix of age classes within the shrub layer.

Dan Kelman, Queensland Herbarium (2009).

Fire promoted short-lived species and shrubs at various fire-age-classes are present in this recently burnt spinifex community.

Dan Kelman, Queensland Herbarium, Boodjamulla (Lawn Hill) National Park (2009).

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)	<500	0.5–1.5	< 2.0	Some patchiness, most of the surface and near surface fuels have burnt. Stubble still evident. Some scorching of shrubs and small trees. Little or no canopy scorch.
Moderate (M)	500–3000	1.5–3.0	Complete standing biomass removed (ground layer).	All surface and near surface fuels burnt. Stubble burnt to blackened remnants. Upper canopy leaves may be partly scorched.

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

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

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation and previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between four and ten years for spinifex dominated woodlands.
- Ensure some areas are left long unburnt (> 10 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)

- Aim to burn 20–60 per cent

Landscape mosaic

- Do not burn more than 10–15 per cent of Spinifex dominated eucalypt communities within the same year.
- Research has shown that it is hard to get a patchy, low intensity fire in spinifex dominated landscapes at the scale required to prevent wildfires without intensive management (Felderhof 2007). However, a landscape mosaic can be achieved with a series of planned burns undertaken late in the year, after the onset of summer storms and during the wet season. This will reduce fire size and improve regenerative ability of vegetation.
- It is important to maintain an active fire program on an annual basis to achieve a landscape mosaic. Because of the issue of scale, and time before an area will re-burn, a landscape mosaic can be achieved by applying small burns every year.

Other considerations

- Seasonal rainfall and the fuel it generates are the key drivers of fire extent and frequency in spinifex dominated woodlands. Use the strength of the wet season and time-since-fire to help guide suitable inter-fire intervals.
- Due to high soil moisture with summer rainfall, wet season fires are useful to promote spinifex. Decreased spinifex growth after dry season fires results in loss of fauna habitat and can lead to erosion in some areas.
- Wildfires resulting from lightning strikes are common during the storm season.

(Left and below) Wet season burning, and suitable conditions (e.g. relative humidity, wind) on the day of the burn, is imperative to achieving conservation outcomes in spinifex communities.

QPWS, Boodjamulla (Lawn Hill) National Park (2012).

In the Northwest Highlands, the country dries out quickly after the wet season and even early dry season fires (left) can be of a high severity and/or burn over large areas. Note extensive canopy scorch, and ground-layer removal in photographs.

Left: Leasie Felderhof, Firescape Pty Ltd (2012). **Right:** Justine Douglas, QPWS (2012).

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: After first summer storms and during the wet season, to reduce fire size, increase landscape mosaic and individual burn patchiness.

FFDI: 9–22

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

Wind speed: Beaufort scale 1–2, or < 15 km/hr. Often some wind will be required to help carry a fire in spinifex, particularly where clumps are discontinuous.

What burn tactics should I consider?

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

- **Strategic annual burn planning** to manage fire size and intensity, to plan an annual patchwork of burns across the landscape. Ideally burning should be undertaken in these communities every year, varying ignition points across the landscape. Natural boundaries and previously burnt areas can be used to manage the scale of burns.
- **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). Vary ignition points as much as possible using existing road and track networks (walking, quad bike, motor vehicle) as well as aerial incendiary operations.

Aerial ignition

- Aerial ignition from a helicopter is useful in the Northwest Highlands bioregion due to the rugged inaccessible terrain.
- Aerial incendiary operations allows for variations in ignition points (as opposed to repetitive lighting of main burn operations from firebreaks), and creates a landscape mosaic and patchiness within individual burns.
- A helicopter provides the opportunity to directly target topographical features such as peaks, ridges and spurs to create a backing fire downhill or from the edges of non-target communities to burn away from the community and provide a buffer. It is recommended that an aerial incendiary plan is developed to ensure drop patterns achieve the desired burn objectives. Use of aerial photographs is recommended (stereoscopic images are particularly useful to gain an understanding of terrain) and it is good practice to plot the incendiary drop path onto a map or aerial photograph. 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. Timing of storm burns can be difficult as rainfall varies across the landscape. One way to identify if there has been sufficient rain to contain a fire is to identify areas where there has been recent stream flows in usually dry creeks.
- **Commence lighting on the leeward (smoky) edge.** This can be a useful way to create a low intensity backing fire into the burn area, or to create a containment edge for a higher severity fire ignited inside the burn area.
- **Limit fire encroachment into non-target communities.** In some cases, acacia, spring and vine thicket communities can occur adjacent to eucalypt communities. Use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community. Refer to Chapter 6 (Issue 4), regarding fire management guidelines.

Spot ignition in spinifex. Low-severity burns are desirable and help create a mosaic of burnt and unburnt areas.

Lea Ezzy, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Spot ignition using aerial incendiary.
Lea Ezzy, QPWS, Boodjamulla (Lawn Hill) National Park (2011).

During planned burn operations, aerial incendiaries can be dropped randomly within the plan burn area (rather than using a more traditional grid pattern).
Paul Williams, Vegetation Management Science Pty Ltd, Mt Isa region (2012).

The green vegetation in this aerial view remained unburnt during wet season aerial incendiary operations. The darker areas show burnt areas intermixed with areas of bare limestone rock.

Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Wet season burning can achieve a good landscape mosaic.

Paul Williams, Vegetation Management Science Pty Ltd, Sybella Creek (2012).

Issue 2: Maintain healthy eucalypt dominated communities with tussock grasses

Maintain healthy eucalypt communities with tussock grass understorey using mosaic burning.

Awareness of the environment

Key indicators of healthy tussock dominated eucalypt woodlands

- 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.
- Grasses should appear upright and vigorous.
- Common grass species are wiregrass *Aristida* spp., spear grass *Heteropogon* spp., kangaroo grass *Themeda* spp. and *Mnesithea* spp. Spinifex is sometimes present but does not dominate.
- The ground-layer generally has some bare ground showing. A diversity of herbs and forbs are found between the grass tussocks. The shrub-layer can vary from dense to sparse or can be absent.
- Where they occur, adult and juvenile corkwood wattle *Acacia sutherlandii*, beefwood *Grevillea striata*, vine tree *Ventilago viminalis* and whitewood *Atalaya hemiglauca* are scattered in their distribution and in some areas form a second tree layer.

Healthy eucalypt woodland with tussock grass ground layer.
Dan Kelman, Queensland Herbarium (2010).

Eucalypt woodland with tussock grasses. Spinifex is present but does not dominate.

Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Softwood species such as Batswing coral can sometimes co-dominate the canopy of tussock dominated communities. Softwood species can tolerate infrequent, low intensity fires.

Dan Kelman, Queensland Herbarium (2004).

Eucalypt communities with tussock grasses are generally found on loamy plains, while spinifex dominates the stoney hills. These communities are generally burnt in association with each other.

Dan Kelman, Queensland Herbarium, Riversleigh Station (2009).

The following may indicate that fire is required to maintain eucalypt woodlands with a tussock grass understory

- An accumulation of thatch (dead material), collapsing grass and grass clumps that are poorly formed.
- The diversity of the ground layer has decreased. Herbs and forbs are absent. Tussock grass species may be absent.
- Where they occur, obligate seeders (e.g. *Acacia* spp. and *Grevillea* spp.) have matured. Shrubs are generally of a single age-class (e.g. set seed, senesced).

The diversity of the shrub layer has decreased with time since fire. Most shrubs have matured and have died.

Justine Douglas, QPWS, Riversleigh Station (2012).

Note the accumulation of dead grass material, and an old shrub layer.

Dan Kelman, Queensland Herbarium (2009).

In some communities the shrub layer can be quite dense. However, this photo shows dense shrubs shading out the grassy ground layer indicating a fire may be required. A wet season burn in this community will reduce risk of high-severity fire.

Dan Kelman, Queensland Herbarium (2009).

Eucalypt woodland with a dense understorey of *Themeda* spp.

Paul Williams, Vegetation Management Science Pty Ltd, Mt Isa area (2010).

Discussion

- Ground cover in eucalypt woodlands with tussock grasses is made up with perennial tussock grasses (excluding spinifex) such as *Themeda* spp., *Aristida* spp. and *Heteropogon* spp; and annual grasses such as *Mnesithea formosa* and *Enneapogon polyphyllus*.
- The proportion of perennial and annual grasses varies across the landscape and reflects disturbance history (e.g. perennial grasses generally dominate in areas of good soil moisture and low stocking rates, and annuals grasses may dominate where heavy grazing has occurred).
- Perennial tussock grasses are encouraged by fire with species diversity declining with time since fire (e.g. greater than four years unburnt for *Heteropogon* spp.). Perennial grasses often do not burn well in their first year, except after good wet season rainfall. But in subsequent years, when they do burn, they burn hotter than annual grasses (Latz 2007).
- Burning of perennial tussock grasses is needed to remove build up of dead material and promote palatable grasses and grass seed for a range of fauna species.
- Too frequent fire can in some areas promote annual grasses over perennial grasses.
- Where they dominate, annual grasses tend to form a sparse understorey. They are usually short lived grasses that come up after rains, grow quickly and then soon dry-out. Fuel loads are therefore much lower than in areas with perennial tussock grasses. Annual grasses burn quickly and do not produce a lot of heat (Latz 2007). Fires are neither as frequent nor extensive where annual grasses dominate the ground layer.
- The invasion of buffel grass is a key issue within some tussock dominated communities. Buffel grass can increase fuel loads and sustain intense fires. If this is an issue, refer to Chapter 6 (Issue 3), for fire management guidelines.

Perennial tussock grasses in a recently burnt woodland. In this community grasses do not generally grow close enough together to carry a fire except after consecutive good rainfall seasons or in very windy conditions.

Justine Douglas, QPWS, Lawn Hill Station (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 proposal

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 or 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 25–70 % of blackened ground within the boundary of the burn area.	Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity), and estimate the percentage of burnt grass clumps.	**Achieved:** 25–70 % burnt **Partially Achieved:** 10–25 %, or 70–80 % burnt. **Not Achieved:** < 10 % or > 80 % burnt.

Germination of grasses and native legumes (herbs and forbs) promoted.	Before and after fire, select three sites (taking into account the variability of landform and likely fire intensity) walk a transect line (100 m or longer) and record presence of native grass/ legume seedlings.	**Achieved:** There were no native legume seedlings along the transect prior to the burnt and > 30 seedlings one month afterwards and after rainfall.
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 to be at various heights and stages of recovery from fire across the burn area—from one or more vantage point or form the air.	**Achieved:** Obligate seeders are present at various stages of maturity across the burn area. **Not Achieved:** Fire killed shrubs are all of a single age/height.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Patchy** to **low** 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)	« 100	< 0.5	« 2.5	High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels. Some scorching of elevated fuels. 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.
Moderate (M)	100–1500	0.5–1.5	2.0–5.0	All surface and near surface fuels burnt. All or most of the mid-storey canopy leaves scorched. Upper canopy leaves may be partly scorched.

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

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

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

- Ensure some areas containing obligate seeders are left long unburnt.
- 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 25–70 per cent burnt within the target communities

Landscape mosaic

- Do not burn more than 15 per cent of dominated eucalypt communities in the Northwest Highlands within the same year.

Other considerations

- Be aware that fuel-loads vary across the landscape. Fuel-loads tend to be higher when the ground layer is a mix of tussock and spinifex grasses.
- In the Northwest Highlands bioregion, the country dries out quickly after the wet season and even early dry season fires can become extensive.

What weather conditions should I consider?

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

Season: Late dry season with the onset of summer storms, wet season, or very early dry season. These times will help reduce fire size and provide better regenerative conditions for plants and animals. Where possible, burn in association with spinifex dominated communities.

FFDI or GFDI: 9–22

DI (KBDI): < 150 (ideally < 120)

Wind speed: Beaufort scale 2–3, or < 15 km/hr. Often some wind will be required to help carry fire through this community.

Soil moisture: Good moisture conditions to protect bases of tussock grasses, habitat tress and promote shrub regeneration. Note that tussock communities generally occur on floodplains and drainage lines, and soil moisture may remain higher in these areas than spinifex communities on adjacent well-drained soils.

What burn tactics should I consider?

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

Burn in association with adjacent Spinifex communities. Tussock woodlands occur in and around other fire vegetation groups, in particular spinifex dominated communities. Keep in mind that Spinifex communities are more flammable and carry higher fuel loads than tussock communities.

- **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 to several points, allowing individual fires to spread out. If fuels are discontinuous or areas for burning are large, multiple ignition points may be required. Spot ignition can be achieved using a range of methods including drip torches, matches or aerial ignition with incendiaries.
- **Commence lighting on the leeward (smoky) edge.** This can be a useful way to create a low intensity backing fire into the burn area, or to create a containment edge for a higher severity fire ignited inside the burn area.

Aerial ignition

- Aerial ignition from a helicopter is useful in the Northwest Highlands bioregion due to the remote inaccessible terrain.
- Aerial incendiary operations also allow for variations in ignition points (as opposed to repetitive lighting of main burn operations from firebreaks), creating variable burn patterns each year.
- It is recommended that an aerial incendiary plan is developed to ensure spacings and drop patterns achieve the desired burn objectives. To achieve the desired mosaic and burn severity, it is preferable to scatter incendiaries, rather than use a formulated grid pattern across the burn area.
- Use of aerial photographs is recommended (stereoscopic images are particularly useful to gain an understanding of terrain) and it is good practice to plot the incendiary drop path onto a map or aerial photograph and ensure lighting crews are well aware of this prior to ignition.

Limit fire encroachment into non-target communities.

- In some cases, acacia, spring and vine thicket communities occur adjacent to eucalypt communities. Use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community. Refer to Chapter 6 (Issue 4), regarding fire management guidelines.

Spot ignition from the ground was used to create a mosaic of burnt and unburnt areas. Note no canopy scorch and the presence of fire-promoted legumes.

Justine Douglas, QPWS, Riversleigh Station (2012).

Issue 3: Manage invasive grasses

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

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

Issue 4: Limit fire encroachment into non-target communities

Non-target fire vegetation groups include riparian, spring, fire-sheltered shrublands and acacia dominated communities. These communities are often found adjacent to or scattered within eucalypt communities. They are generally self-protecting as they have low fuel loads. However, when fuel loads in adjacent eucalypt communities are high, fires can enter and/or scorch the margins of these non-target communities.

Refer to Chapter 6 (Issue 4), regarding 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 hoop Mitchell *Astrebla elymoides* or barley Mitchell *A. pectinata*, with other tussock grass species and ground layer plants present. Scattered trees include *Acacia* spp., whitewood *Atalaya hemiglauca*, and coolibah *Eucalyptus microtheca*. This group occurs mainly on plains adjoining the Mitchell Grass Downs bioregion. In the Northwest Highlands, grasslands are relatively small in extent.

Fire management issues

Fire plays an integral role in maintaining healthy Mitchell grassland communities. These communities are ideally burnt in summer, when there is good soil moisture, with follow up rain predicted.

Because Mitchell grasslands are relatively limited in their extent in the Northwest Highlands, their conservation is a high priority. A decline in fire frequency has in some areas led to the encroachment of woody-stemmed plants.

The occurrence of invasive grasses such as buffel grass within Mitchell grasslands can increase available fuel loads and potentially the frequency and intensity of fires. Post fire, these species are able to rapidly form sense swards, displacing native grass species, reducing diversity and increasing the risk of late season wildfires.

Issues:

1. Maintain healthy Mitchell grassland communities
2. Manage invasive grasses.

Extent within bioregion: 36 754 ha; < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Boodjamulla (Lawn Hill) National Park, 1 303 ha; Camooweal Caves National Park, 774 ha.

Issue 1: Maintain healthy Mitchell grassland communities

Use mosaic burning to maintain healthy Mitchell grasslands.

Awareness of the environment

Key indicators of healthy Mitchell grassland

- The ground-layer is characterised by a continuous stand of Mitchell grasses *Astrebla* spp. with other ground layer species present.
- Often there is a very diverse mix of other species of grasses, forbs and legumes (particularly after good seasonal rains). Shorter tussock grasses including bottle washers *Enneapogon* spp. and wiregrasses *Aristida* spp. may replace them on drier and stonier parts.
- Occasionally, scattered low trees and shrubs may occur including whitewood *Atalaya hemiglauca*, gidgee *Acacia cambagei*, corkwood wattle *Acacia sutherlandii*.

A healthy Mitchell grass community. Note scattered trees along a seasonal watercourse.

Paul Williams, Vegetation Management Science Pty Ltd, Boodjamulla National Park (2006).

This Mitchell grassland has experienced some light grazing. However, the community is still healthy.

Dan Kelman, Queensland Herbarium, Camooweal area (2006).

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

- There is an accumulation of thatch (dead material), collapsing grasses and grass clumps may be poorly formed.
- The diversity and abundance of herbs and forbs between tussocks have declined.
- Shrubs are becoming more than scattered and are beginning to emerge above grasses.

The build up of dead material around the base of the grasses is an indicator of the need for a fire in Mitchell grasslands. Note heavy flowering from the previous wet season.

Paul Williams, Vegetation Science Pty Ltd (2006).

Six months post burn.

Paul Williams, Vegetation Management Science Pty Ltd (2002).

Discussion

- Fire is required to maintain the dominance of Mitchell grass in these communities. Fire also promotes new tillers (fresh growth) in Mitchell grass tussocks and stimulates seed production (Wilson 1992, Scanlan 1980; 1983).
- Storm burns, or wet season burns if achievable, can improve regenerative conditions for Mitchell grasses by promoting rapid post-fire regeneration. Observations have shown that planned burning when there is good soil moisture can help maintain healthy Mitchell grasslands. Burning without soil moisture reduces the ability of plants to reshoot from their bases and will often slow seedling establishment.
- A very wet year or succession of wet years can boost the growth of Mitchell grasses and results in an increase in fuel-loads. A rainfall gradient exists across the Northwest Highlands with more rainfall falling in the north of the bioregion. The grasslands to the north can therefore reach higher fuel loads more quickly than those areas to the south.
- Fire can also be used to push back the encroachment of woody stemmed plants (e.g. *Acacia* spp. and *Atalya* spp.).
- Where it occurs, corkwood wattle *Acacia sutherlandii* is scattered in some Mitchell grassland communities. Its presence may have resulted from grazing pressure or limited fire in the communities where it is found. A low severity fire, when it will carry, will minimise the risk of high-severity fires in Mitchell grasslands and help maintain this species.

Corkwood wattle is found scattered in some Mitchell grasslands. Like most acacias, this species is fire sensitive. Low severity burn in these communities will help maintain their current distribution.

Queensland Herbarium Camooweal area (2001).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 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.
75 % of woody saplings/ seedlings < 1 meter in height are scorched to the tip.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity), and estimate the percentage of saplings/seedlings scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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 four to six years.

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 (for example, 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 at the time of burning to favour grass regeneration over shrub 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: Early wet season with the onset of summer storms for internal burn patchiness and better regenerative conditions for Mitchell grassland species. Where possible, burn in association with adjacent spinifex communities.

FFDI or GFDI: 9–22

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

Wind speed: Beaufort scale 1–2, or < 15 km/hr. Often some wind will be required to help the fire carry in grasslands.

Soil moisture: Good soil moisture is critical when burning grasslands. Timing burns to coincide with follow up rain will further assist in promoting grasses. Be aware that winter burns contribute to drying-out soils.

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. The spacing of the spots may vary from one to several points, and allow individual fires to spread out. If fuels are discontinuous or areas for burning are large, multiple ignition points may be required. Spot ignition can be achieved using a range of methods including drip torches, matches and aerial incendiaries.
- **Storm burning:** When possible, aim to conduct planned burns following sufficient rain, or when storms are imminent to ensure good soil moisture throughout the site (including drainage lines), and when the likelihood of rain in the days after the burn is high.
- **Afternoon or evening ignition** generally creates milder burn conditions promoting a low to moderate severity fire. The tactic is useful in helping achieve the desired burn mosaic and individual burn patch size.
- **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.
- 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.
- **Limit fire encroachment into non-target communities.** In some cases, riparian communities can occur adjacent to grasslands. Use appropriate lighting patterns along the margin to promote a **backing fire** that burns away from the non-target community.

Spot ignition in grasslands. Individual fires will eventually join up. Storm burning is a good tactic for grasslands for achieving desired burn mosaic in open grassland communities.
QPWS (2010).

Mitchell grasslands on cracking clay plains. Take into account the adjoining highly flammable spinifex when burning Mitchell grasslands.
Queensland Herbarium (2010).

Issue 2: 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. Higher severity fire often results in significant damaging impacts upon the vegetation community. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat by altering fuel characteristics and promoting a cycle of damaging high-severity fires which gradually results in the fragmentation and overall decline of grasslands. Displacement of native species by buffel grass is also an issue in Mitchell grasslands.

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

Chapter 3: Acacia dominated communities

This fire vegetation group consists of acacia woodlands and shrublands. They are typically dominated by a single acacia species including lancewood *Acacia shirleyi*, gidgee *Acacia cambadgei/Acacia georginae* and mulga *Acacia aneura*. The understorey is generally sparse and includes grasses and shrubs. Bare patches are common.

Fire management issues

Most acacia species are fire-sensitive. They may occasionally burn with surrounding fire-adapted vegetation, but are usually not burnt intentionally. Because fuel-loads are generally low in acacia dominated communities, fires do not often occur. Years of increased rainfall can result in increased fuel-loads in some communities which may result in the acacia community being at risk of wildfire impacts.

Acacia dominated communities often occur as patches within fire adapted communities (e.g. grasslands and woodlands). Maintaining appropriate mosaic burning in surrounding fire-adapted areas is the best strategy to mitigate the spread of unplanned fire into acacia communities. In certain situations it may be necessary to more deliberately target the areas near acacia communities with low-severity fire to mitigate wildfire risk. Also, low-severity planned burns that are allowed to encroach into acacia communities can reduce ground-layer fuels without impacting on mature acacias, and can be useful to mitigate potential wildfire impacts (if the area is at risk of wildfire).

The presence of introduced invasive grasses may unexpectedly 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. Burn adjacent fire-adapted communities to maintain health of acacia dominated communities
2. Manage invasive grasses.

Extent within bioregion: 493 627 ha, 7 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Royton Timber Reserve, 74 ha.

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

Maintain a varied landscape mosaic in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging, unplanned fires encroaching into acacia dominated communities. Refer to Chapter 6 (Issue 4) for fire management guidelines.

Healthy lancewood *Acacia shirleyi* woodland in flower. It can take up to 15 years for this species to flower and set seed.

Queensland Herbarium (2006).

Gidgee woodland on seasonal river channels. Fire-sensitive river red gum *Eucalyptus camaldulensis* is often associated with this community.

Dan Kelman, Queensland Herbarium (2010).

Burning the perimeter of acacia communities with a low to moderate intensity burn can protect against wildfire.

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

Gidgee *Acacia cambagei* woodland. Acacia communities such as this are generally afforded protection from fire by sparse fine fuels in the ground layer.

Paul Williams, Vegetation Management Science Pty Ltd, Mt Isa Inlier (2011).

A patch of lancewood has been impacted by a wildfire. Some unburnt stands can be seen within the community. Planned burns in surrounding areas can assist in limiting the extent and impact of wildfires on these communities.

QPWS, Boodjamulla (Lawn Hill) National Park (2006).

Discussion

- The main concern for acacia communities is repeated, high-severity fire events of short intervals that burn into acacia communities. These fires usually originate from adjacent spinifex dominated communities.
- Fire-killed acacias such as lancewood *Acacia shirleyi* are reliant upon post fire regeneration from a viable seed bank in order for the species to persist locally. These species are hard seeded and require fire to promote germination. Although it is recommended to mitigate wildfire impacts by burning surrounding areas, the occasional (rare) wildfire may play a role in the persistence of this community in the landscape.
- Other acacias such as gidgee *Acacia cambagei/Acacia georginae* are long lived and fire-killed (or significantly top-killed). Fire plays no role in their germination, which is very occasional and follows high rainfall years.
- While fire causes increased mortality in mulga *Acacia aneura* communities, this species does have some ability to resprout or germinate after fire. However, seeds will also germinate without fire.
- Most acacia species within eucalypt woodland communities are obligate seeders. These species are often associated with eucalypt communities that are spinifex dominated (Refer to Chapter 1, Issue 1).
- *Acacia sutherlandii* is a small tree often found scattered or forming small groves within Mitchell grasslands on cracking clays. Like most acacia species it is killed by high intensity fires (refer to Chapter 2, Issue 1).
- 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.
- In areas where acacia species are encroaching into nearby grasslands, fire can be used to maintain the open grassland structure.
- Fire exclusion in acacia/eucalypt mixed open forest may result in an accumulation of fuels that promote extensive, high-severity, single event wildfires. Patchy to low-severity burns in surrounding areas that on occasion trickle into these areas is useful to reduce fuel and mitigate impacts.
- Be aware that following a fire that has affected an acacia community, a more proactive fire management approach in the surrounding areas will often be required to allow the acacia regrowth sufficient time to recover and mature.

Fire-sensitive acacia species are quite common within eucalypt communities. In order for these species to persist, some areas require a fire-free interval of about five to eight years. (refer to Chapter 1 for guidelines).

Left: Paul Williams, Vegetation Management Science Pty Ltd, Mt Isa area (2011).
Right: Justine Douglas, QPWS, Riversleigh (2011).

A wildfire killed this patch of mature lancewood.

QPWS, Boodjamulla National Park (2006).

Issue 2: Manage invasive grasses

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

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

Chapter 4: Riparian, springs and fringing communities

This fire vegetation group includes forests and woodlands on perennial and seasonal water courses, alluvial terraces, fringing wetlands and spring-fed tributaries.

Fire management issues

Most of the species in these communities are sensitive to too frequent and/or its moisture, microclimatic conditions and lack of flammable ground layer fuels—except under extremely dry conditions

Proactive fire management in surrounding fire-adapted areas will mitigate impacts of unplanned fire. When burning in adjacent fire-adapted communities, limit fire encroachment by using suitable conditions and/or burning away from their edges. This approach will also mitigate the spread of buffel grass *Cenchrus ciliaris*, and other weeds of disturbance such as stinking passionfruit *Passiflora foetida* and noogoora burr *Xanthium accidentale* which have established in some riparian communities.

Issues:

1. Limit fire encroachment into riparian, springs and fringing communities
2. Manage invasive grasses.

Extent within bioregion: 206 406 ha; 3 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Boodjamulla (Lawn Hill) National Park, 3764 ha; Royton Timber Reserve, 354 ha; Lawn Hill (Gregory) Resources Reserve, 155 ha; Camooweal Caves National Park, 59 ha; Lawn Hill (Gregory River Base) Resources Reserve, 32 ha.

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

Maintaining appropriate landscape mosaic burning in adjacent fire-adapted communities is the best strategy to limit the frequency and potential impacts of severe, unplanned fires in riparian communities. Patchy to low severity burns in surrounding areas during the wet season, that occasionally trickle into fringing communities, can be useful to reduce fuel loads and mitigate impacts of wildfire, particularly the loss of habitat trees. Refer to Chapter 6 (Issue 4), for information regarding fire management guidelines.

River red gum *Eucalyptus camlaldulensis* on springs bordering a eucalypt community. Manage fire carefully to limit potential impacts to fire-sensitive river red gum communities. QPWS, Murray Spring (2007).

A narrow band of riparian vegetation adjacent to a permanent watercourse. Burn adjacent fire tolerant ecosystems under conditions that limit encroachment into riparian vegetation. Mark Nemeth, DNRM, Boodjamulla (Lawn Hill) National Park (2003).

Riparian communities with palms are surrounded by fire-prone landscapes (spinifex). They are resilient to some fire but will not tolerate frequent or high-severity fires.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2011).

Spring-fed communities do not require fire for habitat maintenance. Any planned burning that enters should be of low severity. These communities will not tolerate frequent or severe fires.
Queensland Herbarium (2006).

Discussion

- Many riparian, fringing and springs communities contain a high proportion of fire-sensitive species and/or habitat trees. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in many such communities in order to promote structurally complex ground and mid-strata and retain mature habitat trees.
- Where they occur, species such as river red gum *Eucalyptus camaldulensis*, River pandanas *Pandanas aquatics*, *Melaleuca* spp., palms (e.g. *Livistona* spp.) and figs Ficus spp. are threatened by too frequent and/or high-severity fire which can inhibit the recruitment of seedlings, kill young plants and some mature trees.
- River pandanas provides habitat for a range of fauna species. High-severity or frequent fire may eventually lead to the elimination of local populations some plants and have flow-on effects for wildlife such as the Gulf snapping turtle *Elseya lavarackorum* that rely on these species. The Gulf snapping turtle is considered vulnerable under the Queensland *Nature Conservation Act 1992* and is endangered under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (Freeman 2010).
- There are a diversity of wetland communities and no set fire regime is provided in this guideline. Rather, be aware that many wetland communities benefit from the occasional fire as it helps maintain community structure, controls rank plant growth, encourages new plant growth, and reduces fuel-loads that may support severe fires late in the dry season. Patchy mosaic burning can be useful in managing some wetland communities. Burning while there is still standing water helps to protect bases of grasses and sedges and avoid peat fires. Avoid burning the entire wetland within a one to three year timeframe to maximise fauna refugia.

Riparian communities with river pandanas *Pandanas aquatics* are important habitats for a range of fauna.

Mark Nemeth, DNRM, Boodjamulla National Park (2003).

Purple crown fairy-wrens are restricted to riparian vegetation with a dense canopy including areas of river pandanas *Pandanas aquatics*. These habitats are vulnerable to severe fires and subsequent weed invasion.

Alistair Freeman, EHP, Boodjamulla (Lawn Hill) National Park (2010).

Riparian communities with *Melaleuca* spp., along seasonal watercourses. For much of the year these creeks and channels are dry. These communities are fire tolerant but damaged by severe fires.

Queensland Herbarium (2006).

Fire sensitive *Acacia stenophylla* in a seasonal wetland. This photo was taken towards the end of the dry season. Grazing in this area means fires have been less frequent and severe. In the absence of proactive fire management, the removal of grazing is likely to lead to increased fuel-loads, and an increase in fire frequency and severity.

Marty McLaughlin, QPWS, Green Swamp (2007).

Issue 2: Manage invasive grasses

Buffel grass *Cenchrus ciliaris* infestations are a problem in some riparian communities. Buffel grass densities can worsen with disturbance such as wildfire.

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

Chapter 5: Vine thickets

This fire vegetation group occurs as very isolated pockets of vine thickets in fire-sheltered areas and sinkholes. A sparse ground-layer of mixed tussock grasses and spinifex may be present.

In rocky areas where there is little or no soil development, *Bauhinia lysiphyllum*, *Brachychiton collinus, Ficus platypoda* and *Terminalia aridicola* may occur. While these species are often associated with vine thickets, they may sometimes occur as co-dominant species in mixed shrubby woodlands.

Fire management issues

Most of the species in these communities are fire sensitive. Do not intentionally burn.

While some species are adapted to low-severity and infrequent fire, these communities are potentially threatened by increasing fire frequency and severity. Proactive fire management in surrounding fire-adapted communities will mitigate impacts of unplanned fire.

Issue:

1. Limit fire encroachment into vine thickets.

Extent within bioregion: 19 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Camooweal Caves National Park, 4 ha.

Issue 1: Limit fire encroachment into vine thickets

Occupying rocky or moist sites, this fire vegetation group is generally protected from fire by their position in the landscape and lack of flammable grasses in the ground layer. However, fire will occasionally penetrate these communities.

Maintaining appropriate mosaic burning in surrounding fire-adapted areas is the best strategy to mitigate the spread of unplanned fire. In certain situations it may be necessary to undertake low-severity burns in surrounding vegetation. When burning adjacent fire-adapted communities, limit fire encroachment by using suitable conditions and/or burning away form the edges.

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

Softwood species on sinkholes are important habitat for fruit-eating fauna such as possums and bats. Undertake low-severity burns in adjacent fire tolerant communities to ensure this community is not damaged by unplanned fire.
Queensland Herbarium (2006).

Chapter 6: Common issues

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

Fire management issues:

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

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.

Accumulation of continuous spinifex fuels.

Justine Douglas, QPWS, Riversleigh Station (2012).

Accumulation of spinifex fuels on a property boundary.

Justine Douglas, QPWS, Riversleigh (2012).

A recent fire has created reduced fuel hazard in a protection zone. A broad mosaic of vegetation at different fire-age classes in adjacent spinifex communities is also crucial to managing fire hazards adjacent to property and infrastructure.

QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Discussion

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

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

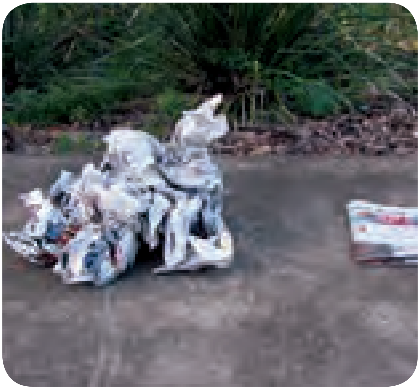


Photo 1a: The two samples above have the same **fuel load** (eighteen pages of newspaper) but a different fuel arrangement.
Troy Spinks, QPWS (2010).

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 or if visibility is good, look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

Fire frequency / interval (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:** 70–80 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: Late wet to early dry season

FFDI: < 11

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:

- minimise extent of fires in Spinifex dominated communities
- minimise impact upon habitat trees, soils and other environmental values
- reduce the likelihood of a thicket of woody species developing post fire favour native grasses over exotic.

What burn tactics should I consider?

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

- **Aerial ignition** under the right conditions (preferably during the wet season), can be used to support fuel reduction burning, particularly where vehicle access is limited and monitoring has identified high fuel loads in wildfire mitigation and protection zones; and where no natural barriers or constructed firelines are present, aerial incendiary operations can be used to create areas of reduced fuel around fire sensitive communities (e.g. acacia and fire sheltered communities).
- **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.** Caution is required if the area is small in size or a narrow strip and the two lit lines will converge, creating a hot junction zone and greater than desired severity with the chance of fire escaping through a spot-over.

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

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

Indigenous markings such as scarred trees (e.g. to make containers, canoes, or temporary shelters) 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.

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

David Cameron, DNRM, Atherton (2002).

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

David Cameron, DNRM, Bribie Island (2005).

Key indicators of European cultural heritage sites:

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

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

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

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

David Cameron, DNRM, various locations.

Discussion

- Do not disturb any cultural heritage site or artefact. Leave all materials in place and treat the location with respect. If you are not sure whether the location or artefacts have been reported, consult the cultural heritage coordination units of DATSIMA (for Indigenous sites) or EHP (for European sites). Also refer to the Duty of Care Guidelines provided in the *Aboriginal Cultural Heritage Act 2003* (Queensland Government 2004).
- When planning burns in and adjacent to sensitive cultural heritage places there is a duty of care to ensure appropriate people are involved. Appropriate people may include Traditional Owners, indigenous rangers, historical societies and cultural heritage experts. If you are unsure who the appropriate people are, refer to the DATSIMA and/or EHP cultural heritage coordination units.
- Be aware of QPWS policy and procedures for 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
Very high	Planned burn required to maintain areas of **special conservation significance.**

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

- If possible, a patchy fire will give greater overall protection to cultural heritage sites and items 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 speed: < 15 km/hr. Consider wind direction; choice of wind direction can help mitigate impacts.

Soil moisture: Ensure good soil moisture.

What burn tactics should I consider?

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

- **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 spots is preferred in this instance as it will promote a slow moving and manageable low severity fire and limits the chances of high severity junction zones developing.
- **A low severity backing fire** will help minimise fire severity and rate of spread and may reduce smoke particulates.
- Depending upon conditions on the day, **spot light the windward (clear) edge** to direct the active fireline and smoke away from the site of interest. It may be necessary to secure the edge closest to the cultural heritage site with a chipped wet line.
- **Manual fuel management.** Usually, burning in appropriate conditions should be sufficient to protect cultural heritage items. However, prior to undertaking planned burns near sites of cultural significance (e.g. scar trees and rock art sites), assess the need for manual reduction of fuel. This may include the raking, clearing (e.g. rake-hoe line), trimming, or leaf blowing of surface fuels away from the site to limit potential impacts from smoke, flame and heat radiation. Only undertake manual fuel management if required, otherwise it is preferable to leave the site completely undisturbed.

Using spot ignition and still conditions kept smoke away from this rock art site.

Mark Parsons, QPWS, Fishers Creek (2010).

Issue 3: 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 Northwest Highlands is buffel grass *Cenchrus ciliaris*. Invasive grasses are generally much taller and produce more dry matter than native grasses, increasing fuel-loads, spotting and flame height—leading to increased fire severity and rate of spread.

Awareness of the environment

Key indicators:

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

- the presence of invasive grasses, usually occurring in a dense infestation
- invasive grasses generally form single species dominated stands
- typically first appear along fire-lines and roads and similarly highly disturbed areas
- have a lot more biomass and/or dead material.

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 is starting to invade this eucalypt woodland.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Buffel grass can recover rapidly after fire and out-compete native grasses.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

Discussion

- During planned burn operations, where invasive grasses are present, the potential to either promote them or control them and their effect on fire severity must be considered. Be aware that fire will usually promote these grasses unless used in specific ways mentioned below.
- Exotic grasses are highly invasive and thrive on disturbance. They can establish where the cover of native grasses has been reduced, however some species such as buffel grass can displace native grasses and other plants.
- Regular burning off roads, tracks and other disturbed areas may create conditions suitable for the spread of invasive grasses. Where introduced grasses are present, this practice should be avoided.
- There is a relationship between fire timing, frequency and severity and the ability of invasive grasses to invade which is still poorly understood. You are encouraged to record observations regarding these species' response to fire and corresponding local seasonal conditions that trigger seedling establishment.
- 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 should be washed down after exposure.
- In many cases, it is desirable to avoid burning invasive grasses due to the likely increase in fire severity and the potential to promote them. However, landscape patch burning is needed in most fire adapted communities in the Northwest Highlands to reduce the risk of large wildfires.

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 northwest highlands. 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 to 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 where moisture is high 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.

Buffel grass has invaded this seasonal watercourse increasing fuel loads. Proactive fire management in adjacent fire-adapted communities will mitigate impacts of wildfires on riparian communities.

Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (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 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 or 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.

Reduction of fuels adjacent to non-target communities to low.	**Post fire:** use the Overall Fuel Hazard 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 monitor the potential for these grasses to re-establish.

Fire parameters

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

What burn tactics should I consider?

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

- **As part of a control program.** An initial fire to reduce the biomass of invasive grasses followed by chemical control of the new shoots can be an effective method of control.
- **Spot ignition.** Can be used effectively to alter the desired intensity of a fire where there are invasive grasses. Increased spacing between spots will result in a lower intensity. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Fire exclusion.** Where buffel grass occurs, fire exclusion may be useful in limiting its spread and dominance over native grasses. However, strategic management is needed to minimise risk of extensive wildfires particularly in spinifex dominated communities.
- **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 residence time and reduction of available fuels, particularly fine fuels, while ensuring fire intensity and rate of spread is 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) in combination with favourable weather conditions along the margin of the community to promote a low intensity backing fire that burns away from the non-target community. Undertake burning in areas adjacent to invasive grass infestations while the grass is green and not cured, under mild conditions, early morning on the dew, 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-severity 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.

Issue 4: Limit fire encroachment into non-target fire vegetation groups

Non-target fire vegetation groups include riparian, spring, vine thicket and acacia dominated communities. These communities are often self protecting if fire is used under appropriately mild conditions or due to low fuel loads. Tactics such as burning away from these communities can be used if addition protection is required. A succession of years of high rainfall 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 it may be appropriate to limit fire encroachment include communities containing buffel grass 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 invading fire sensitive communities or occurring along their edge
- the non-target community is upslope of a planned burn area
- riparian community or other fire-sensitive community is adjacent to continuous spinifex fuel.

Lancewood community after consecutive fires five years apart. Small pockets of fire-sensitive vegetation like this are scattered across the broader fire-adapted landscape. Proactive burning in adjacent areas helps protect lancewood communities.

Paul Williams, Vegetation Management Science Pty Ltd, Boodjamulla (Lawn Hill) National Park (2008).

Most trees in the riparian zone are susceptible to high-severity fires. This *Lophostemon gradiflorus* was damaged during a wildfire. However, in this case, the fire did not actually reach the riparian zone. Embers from the wildfire ignited the flood debris in the ground-layer during dry conditions.

Paul Williams, Vegetation Management Science Pty Ltd (2012).

A backing fire trickled into this fringing community where early wet season burns were used to minimise fire-severity.

Carly Greig, EHP, Musselbrook (2006).

Aerial view showing tall vegetation along narrow riparian channels. Keeping fuel loads low in adjacent spinifex communities will limit potential impacts on riparian vegetation (e.g. scorching of edges, fire damage to river red gums).

Mark Nemeth, DNRM, Boodjamulla (Lawn Hill) National Park (2003).

Discussion

- 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 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 vine thickets and acacia communities. If invasive grasses are present, use fire with caution (refer to Chapter 6 [Issue 3], for fire management guidelines).

Riparian habitats are vulnerable to intense fires. Note the opening of the canopy, thick acacia regeneration and presence of wild passionfruit invading this riparian vegetation after being exposed to a wildfire.

Justine Douglas, QPWS, Lawn Hill Station (2012).

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 or if visibility is good, look about and average the results. Estimations can be improved by returning to the same locations before and after fire, and by using counts where relevant.

Measurable objectives	How to be assessed	How to be reported (in fire report)
No scorch of margin of non-target fire vegetation group.	**After the burn** (immediately or very soon after): visual estimation of percentage of margins scorched from one or more vantage points, or from the air. **Or** **After the burn** (immediately or very soon after): walk the margin of the non-target community or representative sections (e.g. a 100 metre long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** no scorch. **Partially Achieved:** < 5 % scorched. **Not Achieved:** > 5 % scorched.

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?

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

Fire severity

- A **low**-severity fire in the adjacent fire-adapted community will help ensure the objective of limited fire encroachment is achieved. A backing fire will help ensure good coverage. 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 to limit scorch of 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 create areas of burnt fuel to mitigate the movement of later season fires.

Landscape mosaic

- 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.

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

- **Test burn** of interface to ensure non-target areas do not burn.
- **Do not create a running fire.** Use low-severity perimeter burns from the edge of non-target communities that are upslope from burn areas.
- **Wet season burning** provides the opportunity to implement low-severity burns adjacent to fire sensitive communities.
- **Commence lighting on the leeward (smoky) edge** of the non-target fire vegetation group to 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 burn in areas adjacent to non-target communities late in the afternoon. This will assist with promoting a low severity fire that may trickle along the edge of these communities and generally self extinguish due to milder conditions overnight or higher moisture differentials.
- **Aerial ignition** can be used to support wet season fuel reduction burning, particularly where vehicle access is limited. Aerial incendiary operations also provides the opportunity to directly target topographical features such as peaks, ridges and spurs to create areas of reduced fuel around fire-sensitive communities.

Issue 5: Cyclones and monsoonal depressions

The Northwest Highlands bioregion occasionally experiences the effects of rain depressions associated with tropical cyclones during the summer months. This results in increased plant growth (particularly spinifex) and rapid fuel-load accumulation. Major flood events can also have a significant impact on riparian communities, by removing ground and mid-stratum vegetation and in some cases canopy trees.

Fire management issues

A key management issue in the year/s following above average summer rainfall is a decrease in the mosaic of fire-age-classes (i.e. fuel loads accumulate faster than normal years). As a result, fuel loads increase across the landscape, thus sustaining fires over large areas. Fire-sensitive communities are potentially threatened by this increased wildfire risk.

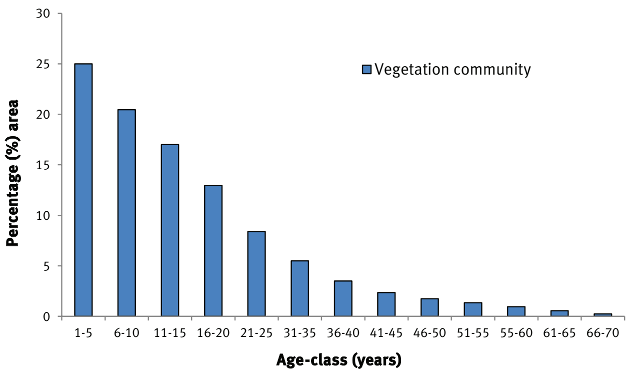
Planned burn programs may therefore need to consider increasing the percentage of vegetation (particularly spinifex communities) burnt across the landscape after wetter than normal summers. Maintaining a broad landscape mosaic of spinifex of different fire-age-classes is crucial to long-term conservation outcomes in the Northwest Highlands. Wildfires may still burn over a range of spinifex age-classes, but the extent and severity of wildfires is likely to be reduced.

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)



Terminology	Definition
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.

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

References

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

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

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

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

Felderhof L 2007, 'The fire patchiness paradigm: A case study in northwest Queensland', PhD Thesis, James Cook University, Townsville.

Freeman AB 2010, *Saving a living fossil: identification and mitigation of threats to the conservation status of the freshwater turtle*, Elseya lavarackorum, unpublished report, Department of Environment, Water, Heritage and the Arts, Canberra.

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

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

Latz P 2007, *The flaming desert, arid Australia – a fire shaped landscape,* Alice Springs, Northern Territory.

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

Miller G, Friedel M, Adam P and Chewing V 2010, 'Ecological impacts of buffel grass (*Cenchrus ciliaris* L.) invasion in central Australia – does field evidence support a fire-invasion feedback?', *The Rangeland Journal*, vol. 32, pp. 353–365.

Murphy S, Harrington G and Felderhof L 2011, *Preliminary spatial model using fire scar data to monitor Carpentarian Grasswrens*. Report by Map IT and Birds Australia North Queensland.

Northern Australia Tropical Savannas CRC 2001 (August 2001), *Northern Australia tropical savannas (NATS) CRC spatial vegetation layer*, Tropical Savannas CRC, Darwin.

Queensland Government 1992, *Queensland Nature Conservation Act 1992*, Queensland Government, Brisbane.

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

Queensland Herbarium 2010 (20 August), *Draft pre-clearing vegetation communities and regional ecosystems spatial layer*, Queensland Government, Brisbane.

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

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

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

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

Scanlan JC 1983, 'Changes in tiller and tussock characteristics of *Astrebla lappacea* (Curly Mitchell grass) after burning', *Australian Rangelands Journal,* vol. 5, pp. 13–19.

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

Appendix 1: List of regional ecosystems

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

Fire vegetation group	Hectares within the Northwest Highlands bioregion	Percentage
Eucalypt communities	6 438 949	85
Mitchell grasslands	36 754	0.5
Acacia communities	493 627	7
Riparian, springs and fringing communities	209 406	3
Vine thickets	19	0.0003
Other bioregion	383 323	5
Non-remnant	11 519	0.2
Water	4 627	0.1
TOTAL	**7 578 224**	**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 communities with spinifex		1.10.1, 1.10.2, 1.10.3, 1.10.4, 1.10.7, 1.10.8, 1.11.1, 1.11.2, 1.11.2a, 1.11.2d, 1.11.2e, 1.11.2f, 1.11.2x1, 1.11.2x1b, 1.11.2x3, 1.11.2x4, 1.11.2x4a, 1.11.2x5, 1.11.3, 1.11.3a, 1.11.3b, 1.11.3x1, 1.11.3x1b, 1.11.3x1c, 1.11.3x1d, 1.12.1, 1.12.1x1, 1.12.1x1b, 1.12.1x3, 1.12.1x4, 1.12.2, 1.5.1, 1.5.3, 1.5.4b, 1.5.4x4, 1.5.7b, 1.7.1, 1.7.1c, 1.7.1f, 1.7.1i, 1.7.1j, 1.7.1x3, 1.7.1x4, 1.7.1x5, 1.9.1x3, 1.9.2, 1.9.3, 1.9.4, 1.9.5, 1.9.5b, 1.9.5c, 1.9.6, 1.9.6a, 1.9.6b, 1.9.7. NON RE groupings used: D23, D50, D51, G3, H23, H28, J16, J19.
	2		Eucalypt communities with tussock grasses		1.11.4, 1.12.1x3b, 1.3.5, 1.3.6, 1.3.6a, 1.3.6c, 1.3.6x1a, 1.3.6x1b, 1.3.6x1c, 1.3.6x1d, 1.3.6x1e, 1.5.2, 1.5.4, 1.5.4a, 1.5.4x1, 1.5.4x1a, 1.5.4x1b, 1.5.4x2, 1.5.4x3, 1.5.4x6, 1.5.5, 1.5.5b, 1.5.6b, 1.5.7, 1.5.7x1, 1.5.7x2, 1.5.9, 1.7.1b, 1.7.1k, 1.7.2, 1.7.2b, 1.7.2x1, 1.9.1a, 1.9.1c, 1.9.1x2, 1.9.2a, 1.9.5a. NON RE groupings used: C13, C33, D20, D34, D35, D41, K17.
2	1	**Grasslands**	Mitchell grasslands		1.3.1, 1.3.1x1, 1.5.6a, 1.9.1, 1.9.1b. NON RE groupings used: C32, G17.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
3	1	**Acacia communities**	Acacia woodlands		1.10.5, 1.11.2x2, 1.11.2x2a, 1.11.2x2b, 1.12.1x2, 1.3.3, 1.3.4, 1.3.4x1, 1.5.6, 1.5.6x1, 1.5.6x2, 1.5.7a, 1.5.8, 1.5.8x1, 1.7.1d, 1.7.1e, 1.7.1g, 1.7.1h, 1.7.1x1, 1.7.1x2, 1.9.1x1, 1.9.1x4.
4	1	**Riparian, springs and fringing communities**	Riparian, springs and fringing communities		1.10.6, 1.11.5, 1.3.2, 1.3.6x1, 1.3.6x2, 1.3.7, 1.3.7a, 1.3.7b, 1.3.7c, 1.3.7d, 1.3.7e, 1.3.8, 1.3.9, 1.9.8.
5	1	**Vine thickets**	Vine thickets		1.9.4a.

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 Regional Ecosystem Description Database (REDD) system, the comments section indicates if the RE is not of a mappable size or if it has been moved. The RE's listed below 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).
NOTE: Non Regional ecosystem (Veg 1) codes were also used, where no RE codes existed as of 18–01–2012.

Unmatched regional ecosystems	1.10.2, 1.10.3, 1.10.6, 1.10.7, 1.10.8, 1.11.5, 1.3.3, 1.7.1d, 1.7.1h, 1.9.7, 1.9.8, 1.5.2, 1.7.1k, 1.9.2.

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.

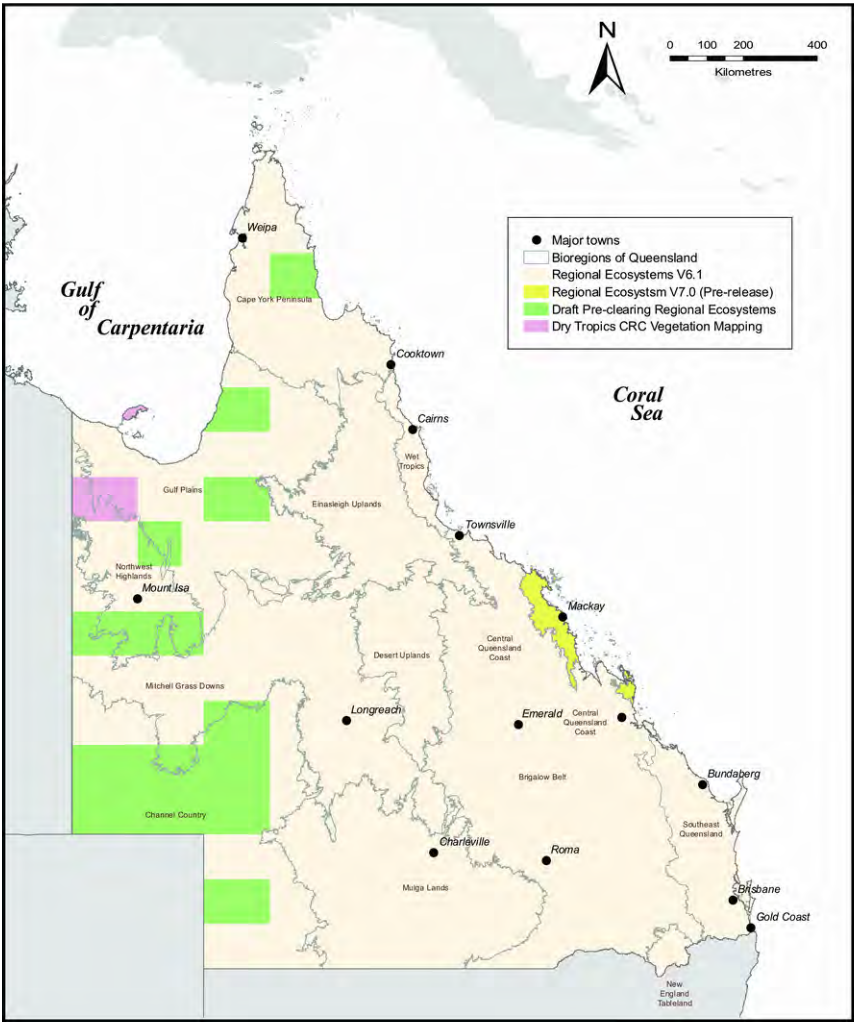


Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

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.

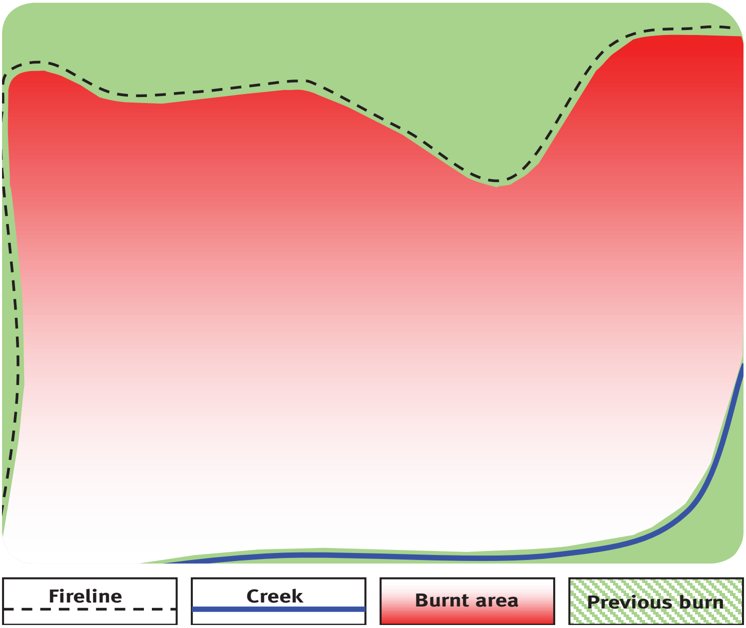


Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

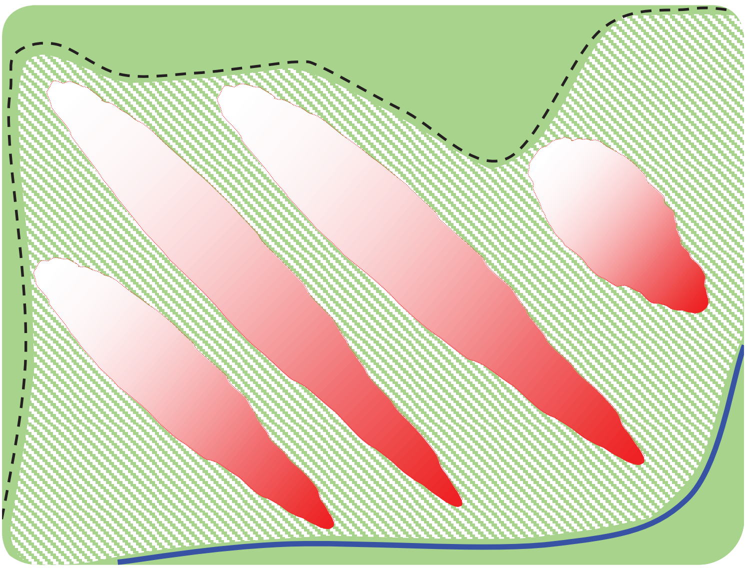


Figure 2: Planned mosaic burn—year 8.

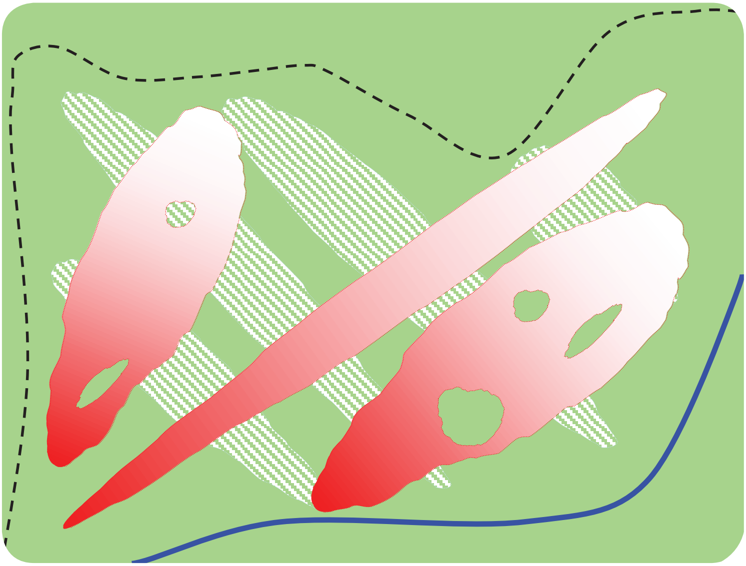


Figure 3: Planned mosaic burn—year 20.

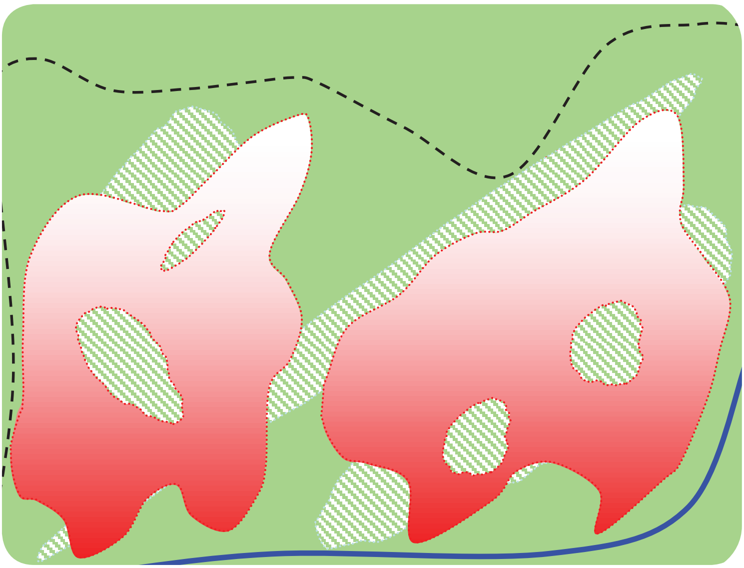


Figure 4: Planned mosaic burn—year 28.

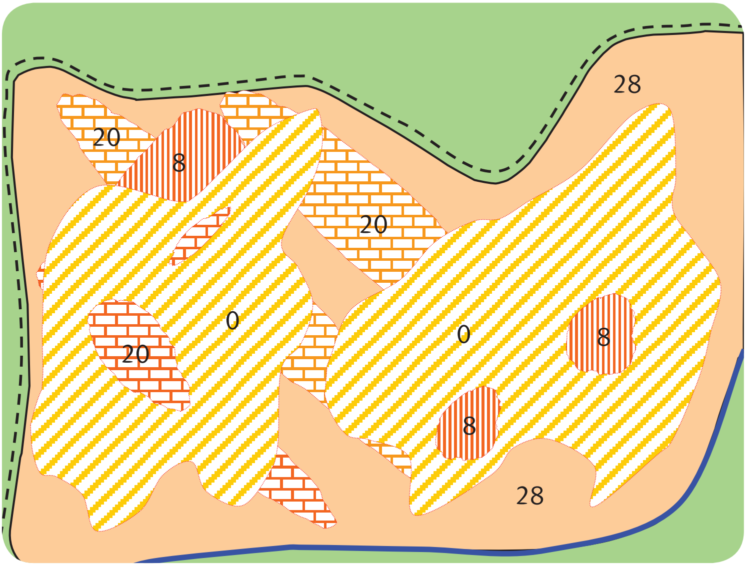
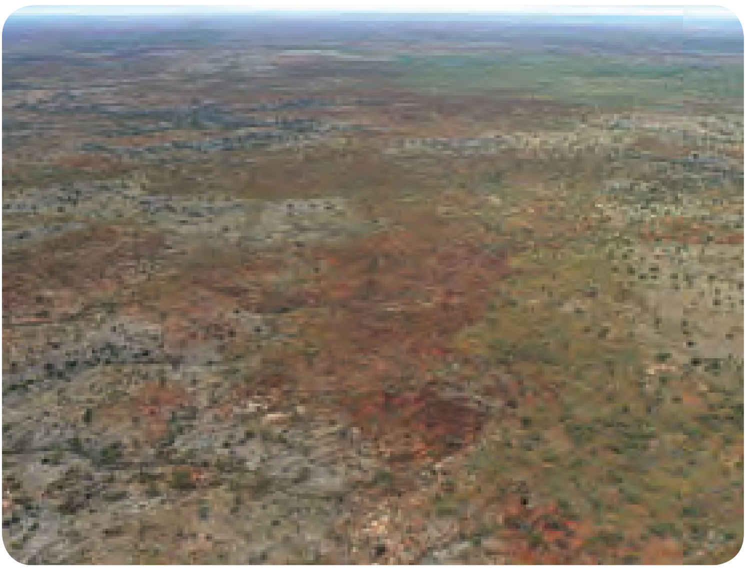


Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).



Mosaic burn showing approximately 30 per cent coverage this cycle.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

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