Department of National Parks, Recreation, Sport and Racing

Planned Burn Guidelines

Gulf Plains Bioregion of Queensland

Queensland Government

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

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Front cover photograph: Boodjamulla (Lawn Hill) Resource Reserve, Lea Ezzy, QPWS (2012).

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Foreword

At more than 22 million hectares, the Gulf Plains bioregion covers approximately 12 per cent of Queensland, yet is contained within just two geological basins — the Carpentaria and Karumba. The bioregion is characterised by extensive alluvial plains, but also includes a dynamic coastal strip; and some tablelands, hills and ranges along its margins. Covering more than six degrees of longitude and almost seven degrees of latitude, the bioregion sees highly variable rainfall, and is influenced by coastal effects, but typically has cool, dry winters and hot, wet (monsoonal) summers. Extreme weather events such as droughts, floods and cyclones can affect the whole region, with subsequent influence on the timing and intensity of fires.

The economy of the region relies heavily on the pastoral industry, as well as fishing and tourism. These activities demand robust native grasslands and savannahs, stable riparian fringes and healthy and productive wetlands. The management of protected areas in the region has similar goals.

Woody thickening and invasion by weeds such as rubber vine, prickly acacia, and mimosa bush pose a serious threat to the biodiversity and production values of the Gulf Plains. Fire plays a key role in an integrated approach to halting and reversing these processes.

Informed use of fire is one of the most cost effective tools available and it is hoped these guidelines will provide a platform from which land managers can shape and hone a kit tailored to the needs of the lands and waters under their custodianship.

Lana Little
Ranger
Northern Region
Queensland Parks and Wildlife Service.

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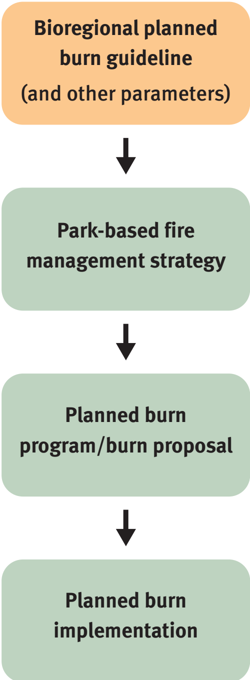


How the planned burn guideline fits into the QPWS Fire Management System.

Purpose of this guideline

This guideline was developed as part of the Department of National Parks, Recreation, Sport and Racing's (NPRSR) Queensland Parks and Wildlife Service (QPWS) Fire Management System to support the formation of fire strategies, burn proposals and on-ground planned burn implementation (supported by the Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go). They assist rangers and other land managers to:

- protect life and property
- maintain healthy ecosystems
- promote awareness of fire management issues in the field
- identify clear fire management objectives to address those issues; and how to assess objectives to assist in adaptive management
- identify suitable fire behaviour, burn tactics and weather conditions to achieve objectives
- provide information and tools to assist in implementing planned burns.

Please note that this planned burn guideline uses 'fire vegetation groups' provided in ParkInfo that assist their integration into maps and fire strategies. A fire vegetation group is a group of related ecosystems that share common fire management requirements.

Scope

- This guideline applies to the Gulf Plains bioregion (refer to Figure 1) and covers the following fire vegetation groups: eucalypt communities, grasslands and sedgelands, melaleuca communities, acacia communities, springs and dunes, vine thickets, mangrove and saltmarsh communities (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Gulf Plains bioregion. 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.

Paul Williams, Vegetation Management Science Pty Ltd, Carly's Lagoon, Finucane Island National Park (2010).

Figure 1: Map of the Gulf Plains bioregion of Queensland.

Fire and climate in the Gulf Plains bioregion of Queensland

Cool dry winters and hot wet summers with frequent cyclonic activity and prolonged rainfall characterise this bioregion. During the summer monsoon most of the region's annual rainfall occurs. This sometimes results in severe prolonged flooding (e.g. 2009 floods), that have the potential to cause widespread loss of understory species and native fauna.

While the amount of rainfall varies between years, it generally decreases from north to south and east to west. Meaning there is significant variation in the issues facing land managers and in particular those using fire as a means of managing the landscape.

Planned burning in the Gulf Plains bioregion must remain flexible to allow for variation in the timing and length of wet seasons and the impact of extreme rainfall events. Staff must be vigilant in recognising opportunities to burn and capitalising on these opportunities. It is also important to be aware of conditions prior to and following planned burns.

Fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). In the Gulf Plains bioregion these days have an average temperature 35˚C, low humidity (18 per cent) and sustained winds > 17 km/hr (refer to Figure 2).

Further information can be found in the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go and on the Bureau of Meteorology website at <www.bom.gov.au>.

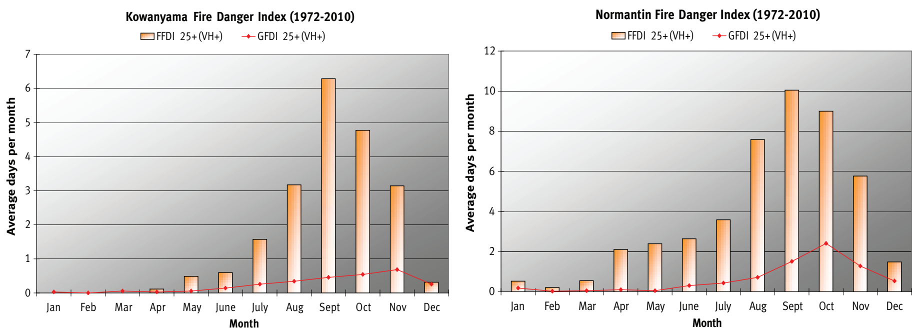


Figure 2: Fire weather risk in the Gulf Plains bioregion.

The likelihood of a fire weather day or sequence of days (FDI 25+) increases significantly from around August and persists for a few months until the start of the wet season. Data (Lucas 2010).

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 contains a broad range of open forest and woodland communities. The canopy is typically dominated by a mix of *Eucalyptus* spp. and *Corymbia* spp. with scattered shrubs and small trees, sometimes with associated paperbarks *Melaleuca* spp. The ground layer is dominated by either tussock (various species) or hummock grasses (spinifex) or a mix of the two with rushes and sedges in wetter sites. In some areas a dense shrub layer is present. This fire vegetation group also includes spinifex grasslands and riparian communities supporting eucalypt spp. such as coolibah *Eucalyptus microtheca* with grasses and rushes on alluvial flats and other communities fringing watercourses.

Fire management issues

This fire vegetation group occurs over extensive, often inaccessible areas necessitating a broad-scale approach to fire management, most efficiently achieved through aerial ignition. The key strategy is to commence planned burning early in the dry season as soon as ground fuels are sufficiently cured to carry fire (and when fire self-extinguishes in the early evening). Planned burns should continue into the mid dry season. This approach breaks-up the continuity of fuels across the landscape and mitigates impacts of late-season wildfire. In the absence of proactive planned burning, late-season wildfires can be extensive, frequent and intense, resulting in ecological impacts (such as loss of diversity) and producing an enormous amount of greenhouse gas emissions.

There is a gradient of typical fire frequency experienced across the Gulf Plains, with more frequent fires in the north-east in areas dominated by sorghum, *Sarga* spp. and annual tussock grasses. Fire frequency declines further south as perennials and hummock grasses (e.g. spinifex) dominate.

Loss of open structure through overabundant seedlings/saplings can lead to woody thickening. This process is attributed to a long absence of planned burning and/or fires repeatedly applied too early in the season (when they are not intense enough to control emerging overabundant seedlings/saplings). Thickening is thought to be more prevalent in the drier, southern areas of the bioregion (where fires are less frequent). In the Gulf Plains, thickening is often attributed to overgrazing of stock, allowing woody species to gain a competitive advantage over grasses.

Issues:

1. Maintain healthy tussock grass dominated eucalypt communities.
2. Maintain healthy shrubby or spinifex dominated communities.
3. Reduce overabundant saplings.
4. Reduce woody weeds.
5. Manage high biomass invasive grasses.

Extent within bioregion: 10 007 486 hectares (ha), 45 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Staaten River National Park, 252 114 ha; Rungulla Proposed new National Park, 50 351 ha; Errk Oykangand National Park (Cape York Peninsula Aboriginal Land), 30 030 ha; Gilbert River Proposed new National Park, 20 201 ha; Bulleringa National Park, 16 508 ha; Lawn Hill (Widdallion) Resources Reserve, 8210 ha; Blackbraes National Park, 4966 ha; Porcupine Gorge National Park, 2350 ha; Boodjamulla (Lawn Hill) National Park, 1851 ha; White Mountains National Park, 980 ha; Mutton Hole Wetlands Conservation Park, 429 ha; Lawn Hill (Arthur Creek) Resources Reserve, 355 ha; Lawn Hill (Gorge Mouth) Resources Reserve, 215 ha; Blackbraes Resources Reserve, 192 ha; The Canyon, 186 ha; Finucane Island National Park, 161 ha; Lawn Hill (Creek) Resources Reserve, 135 ha.

Issue 1: Maintain healthy tussock grass dominated eucalypt communities

Use broad-scale mosaic burning to maintain a landscape of healthy eucalypt communities.

Awareness of the environment

Key indicators of healthy tussock grass dominated eucalypt communities:

- Eucalypt communities have a very open canopy of *Eucalyptus* spp. and/or *Corymbia* spp. trees. Some young canopy species are present in the understorey (enough to eventually replace the canopy) but are not extensive enough to produce shading impacts.
- Tussock grasses dominate the understorey and are vigorous and upright.
- A diversity of herbs and forbs are found between the grass tussocks. They are more apparent during the wet season.
- In riparian eucalypt communities, grasses may be interspersed with sedges and rushes.
- *Eucalyptus* spp., *Acacia* spp. and/or *Melaleuca* spp. and in some areas currant bush *Carissa lanceolata*, quinine *Petalostigma* spp., gutta percha *Excoecaria parvifolia* or other species, appear as scattered individuals and are not so frequent that they are beginning to shade out the ground layer.
- Mistletoe is present but not common.

Healthy open woodlands should have a mix of mature canopy trees such as this bastard bloodwood *Corymbia setosa* interspersed with seedlings/saplings and young trees (enough to eventually replace the canopy).

Lana Little, QPWS, Staaten River National Park (2004).

Grassy eucalypt communities should be open and easy to walk through. These areas provide habitat for golden-shouldered parrots and black-throated finches.

Lana Little, QPWS, Staaten River National Park (2004).

A healthy cover of green grasses interspersed with herbs and forbs can be a sign of healthy grassy woodland. This woodland is habitat for the endangered golden-shouldered parrot. Termites are major detritivores, eating decaying plant matter and returning the nutrients to the ecosystem. Their mounds provide nest sites for this parrot species.

Lana Little, QPWS, Staaten River National Park (2004).

In some areas grasses are naturally sparse (such as on top of escarpments).
QPWS, Bulleringa National Park (2010).

Be aware that the abundance of some small tree species is not related to fire management, but is a result of soil and landscape characteristics. Smooth-leaved quinine *Petalostigma banksii* is often naturally abundant in the mid layer.
Mike Ahmet, QPWS, Monitoring site. Bulleringa National Park (2007).

Ipomoea spp.

Cleome spp.

Bergia spp.

Flemingia spp.

Lobelia spp.

Calandrinia spp.

Many herbs and forbs are more common following fire. An absence of these types of plants can be an indicator of the need to apply fire. Their presence will be more obvious during the wet season.

John Thompson, Queensland Herbarium.

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

- An accumulation of dead material in tussocks, collapsing grass and poorly formed grass clumps are present. Grasses are more or less continuous to allow the passage of fire (in some areas grasses are naturally less continuous).
- There is a build-up of rank or stand-over (grass with significant dead material not consumed in previous burning cycles) grasses.
- Species such as *Eucalyptus* spp., *Acacia* spp., currant bush *Carissa* spp. or other species are becoming more than scattered or are emerging above the ground layer.
- There is a lack of wet season diversity in the ground layer; forbs and herbs are infrequent or absent. These species may be naturally absent in the dry season.
- Mistletoes (Loranthaceae family) and other parasitic plants such as native cherries (Santalaceae family) and dodder-laurel vines *Cassytha* spp. becoming frequent. Mistletoes are present on lower level branches.

Dense stands of rank or stand-over grasses can be a good indicator of the immediate need to apply fire, as shown during this November storm burn. Consider burning an area with heavy fuel loads such as this under mild conditions/or high soil moisture to reduce fire severity and extent.

Lana Little, QPWS, Dunbar Station (2011).

Woody thickening can occur where fires have been absent or infrequent. This Cooktown ironwood *Erythrophleum chlorostachys* has thickened in the mid-stratum and if left unmanaged will shade out grasses.

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

Early stage thickening of eucalypts and Cooktown ironwood is much easier to manage as younger trees are much more susceptible to fire. However fuels need to be sufficient for fires to be effective. Spelling pasture prior to planned burns may be necessary.

Paul Williams, Vegetation Management Science Pty Ltd, Near Normanton (2011).

Sometimes quinine appears to have thickened below the canopy. However, in many locations it naturally occurs this way within the mid stratum/lower tree layer.

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

Darwin stringy bark *Eucalyptus tetrodonta* is thick beneath the canopy in some areas of the northern Gulf Plains; this is a natural phenomenon and more likely a result of soil and landscape characteristics than fire management.

Lana Little, QPWS, Staaten River National Park (2004).

Discussion

- A key strategy to manage the vast expanses of inaccessible eucalypt communities in the Gulf Plains is broad-scale management through aerial ignition. Ideally, this would include at least three different ignition periods on each property, each year.
- Wildfires resulting from dry storms late in the dry season or in the early wet season are frequent (one to two years) and extensive. While fires from lightning strikes are part of the natural system, they have considerable ecological impacts when early season burning has not occurred or has been insufficient to mitigate the run of a hot fire late in the dry season.
- Grasses are generally considered ready to burn when they reach 50–60 per cent cured. The North Australian Grassland Fuel Guide (Johnson 2001) may assist in determining when grasses are ready to burn. However, caution should be used and local knowledge sought as some grass species that still appear too green to burn will burn severely (and vice versa).
- Variation in burn season and short inter-fire intervals promote better habitat for many species of birds in eucalypt communities. Valentine et al. (2007) found that bird abundance dramatically increased in burnt sites soon after fire (12 months), but declined in the longer term (four years), especially for nectivores and granivores.
- Very small patches of scrub with deciduous softwood species may be present within eucalypt communities. They often occur on very low rises with sandy soils. These areas will not burn under most planned burning conditions; however late-season fires may carry into these areas on occasion. Proactive planned burning resulting in an established mosaic in surrounding fire adapted communities will assist in preventing late season wildfire incursion (refer to Chapter 6: Vine thickets).

- Most eucalypt dominated riparian and fringing communities retain fire-sensitive species. In most cases these communities will not burn readily because of a lack of ground layer fuels or humid micro-climates within them. In other areas, where there is a grassy layer present they often burn in association with the surrounding landscape. Where they occur, species such as river red gum *Eucalyptus camaldulensis*, *Melaleuca* spp. *Pandanus*, river she-oak *Casuarina cunninghamiana*, palms (e.g. *Livistona* spp.), figs *Ficus* spp. and some vine thicket species are threatened by too frequent fire. Maintaining a landscape mosaic in the surrounding fire-adapted communities mitigates the impacts of unplanned fire.
- Riparian areas with *Eucalypt* spp., provide habitat for a range of species. High severity or frequent fires may have flow-on effects to wildlife such as the goshawk *Erythrotriorchis radiatus*. The red goshawk is considered Endangered under the Queensland *Nature Conservation Act 1992* and is Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
- A key issue within some tussock grass eucalypt communities is the invasion of buffel grass *Pennisetum* ciliare and weeds such as rubber vine *Cryptostegia grandiflora*. Buffel and other invasive grasses can increase fuel loads and contribute to high severity fires resulting in tree death. Rubber vine smothers vegetation forming impenetrable thickets. If weeds are an issue, refer to Chapter 8 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**.

Riparian areas are critical habitat for the red goshawk which requires very tall trees for nesting and hunting.

John Augusteyn, QPWS, Violet Vale Station (1998).

Eucalypt spp. are often co-dominant canopy species of riparian communities and provide important habitat for a range of fauna. Care should be taken to minimise the extent, severity and frequency of fires in riparian areas.

B. Douglas, Gilbert River area (2011).

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)
Progressive burning demonstrated.	Using fire scar remote sensing data, estimate burnt and unburnt country by month, on an annual basis. Note that early burns may not be visible on NAFI, it may be necessary to combine remote sensing with points collected on GPS that mark early ignition locations.	**Achieved:** Remote sensing shows a series of progressive burns through the season. **Partially Achieved:** One to two burns achieved. **Not Achieved:** No burning has occurred.
Proactive planned burning has prevented impact by subsequent wildfire to natural/ cultural resources or infrastructure.	Using fire scar remote sensing data (e.g. NAFI), estimate area of planned burns against wildfire on an annual basis.	**Achieved:** Annual area of planned burn prevents impacts of wildfire. **Not Achieved:** Wildfire has a significant impact.
> 75 % of overabundant saplings < 2 m are reduced.	Select several sites or walk several transects, estimate the percentage of overabundant saplings (above ground components) reduced.	**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.

A number of Sav-Mon (savannah monitoring) sites are established across the bioregion and are designed to assess long-term changes in vegetation health. Queensland Herbarium CORVEG sites could be used or established (refer to Neldner et al. 2005).

Mapping and assessment of fire history through fire scars from the North Australian Fire Information (NAFI) system or other means, is useful to guide future fire planning.

Under suitable planned burn conditions, some natural barriers such as creeks, rivers and rocky outcrops are useful barriers to fire movement.

Lana Little, QPWS, Staaten River National Park (2000).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Tussock grass eucalypt communities: Low** to **moderate**, with occasional **high** severity fires.
- **Riparian areas: Low** to **moderate**.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	< 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)	100–500	0.5–1.5	2.0–5.0	All surface and near surface fuels burnt. All or most of mid-storey canopy leaves scorched. Upper canopy leaves may be partly scorched.
High (H)	500–10 000	1.5–4.0	Complete canopy scorch	All ground material affected by fire. All mid storey canopy leaves scorched or charred. All upper storey canopy leaves scorched.

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

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

- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between one and five years aiming for the lower range of this interval in most areas and the higher end in fire-adapted riparian communities.

Mosaic (area burnt within an individual planned burn)

- Most fires should be patchy; however this will vary with burn location and will need to be assessed on a case by case basis. However, it is not acceptable to completely burn all of an area and conversely it is important to burn sufficient area to impede later burns or wildfires.
- A mosaic is generally achieved with 30–70% burnt within the target area.

Other considerations

- An extensive network of river systems form a key part of mitigating wildfires as they provide areas which can act as natural fire-breaks. These areas can be can be enhanced as breaks by nearby early season proactive burning.
- The exotic plant Hyptis *Hyptis suaveolen* is often present in riparian areas on Bulleringa National Park, and may impede early burning attempts.

An early dry season burn in grassy eucalypt communities is ideal if the desired outcome is a high level of patchiness.

This photo was taken in June 2009. QPWS, Bulleringa National Park (2009).

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:

Grassy eucalypt communities

- **Soon after the wet** season when it is dry enough to carry a fire (just) but the fire will extinguish in the evening. Continue planned burning through until the **mid dry season** until fires carry into the night but not overnight. Do not burn in the late dry season.
- Occasional storm burns may be required where hot fires have been absent for a number of years. Higher severity fires caused by lightning strike are also a natural feature of these systems and are not usually a problem provided that early season burning has been conducted in a way that mitigates the extent and severity of wildfire.
- Repeated early season burns are not recommended where overabundant seedlings/saplings are an issue (refer to Chapter 8, Issue 3 for fire management guidelines).
- In some riparian areas wet season burning can reduce fuels and prevent wildfires later in the season. These areas can be used as barriers to fire movement providing sufficient early season burns have occurred both within riparian areas and surrounding fire-adapted communities.

GFDI: < 18

DI (KBDI): 80–100

Wind speed: < 23 km/hr

Soil moisture: Good soil moisture assists in protecting underground portions of vegetation (allowing quick recovery) and promotes seedling germination post-fire. This helps in restoring ground cover and preventing erosion issues.

Cooktown ironwood can expand into adjacent open woodlands and grasslands if fire has been long absent or frequently applied too early in the season.

Peter Stanton, Environmental Consultant Pty Ltd, Namarrong (1991).

Storm burning in the early wet season can assist in producing fires of limited extent and severity, as indicated by this burn in December.

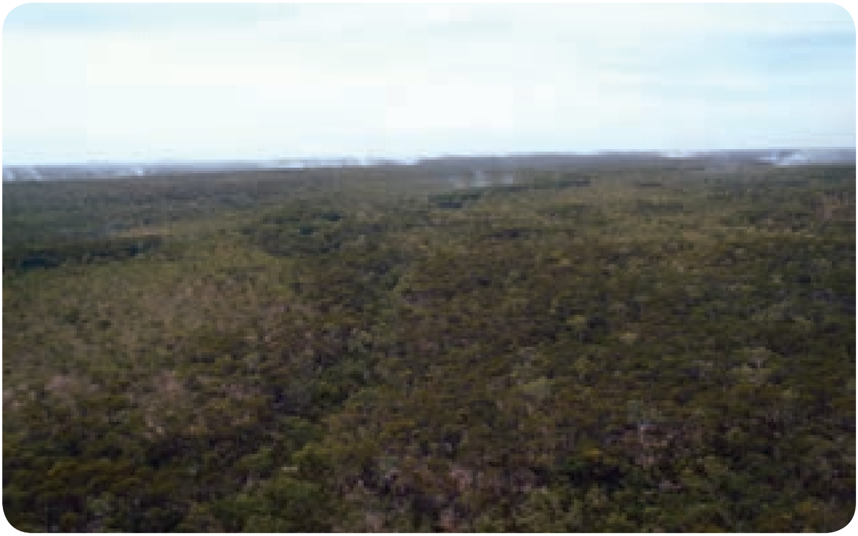
Lana Little, QPWS, Staaten River National Park (2005).

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.

- **Aerial ignition**. A landscape approach to fire management is necessary due to the size and inaccessibility of eucalypt communities. This is mostly achieved through **aerial ignition**. Early dry-season fires can be lit in either morning or afternoon depending on the desired outcome. Ignition timing would be determined by how far the fire is required to travel before self-extinguishing in evening conditions. A useful tool to determine the rate of spread is the CSIRO Grassland Fire Spread Meter for Northern Australia. Use natural features such as rivers and streams (even if there is no water, there may be sufficient moisture), areas of sparse or uncured fuel or previously burnt areas to contain fires. Also, note that these natural features may prevent fire from carrying as far as intended. Aerial ignition also provides an opportunity to burn away from non-target communities (e.g. springs, vine thickets and acacia communities) creating areas of reduced fuel protecting them from impacts of late dry-season wildfires. It is good practice to plot out an aerial incendiary path using maps, satellite images or aerial photographs and to program the path into a GPS for use in flight.
- **Spot ignition** is used to alter the desired intensity of a fire and create the desired mosaic of burnt and unburnt areas. A number of patterns of lighting can be used. The spacing of the spots affects the resulting intensity and mosaic.
- **Single point ignition** is used to create a fire of limited extent with a limited fire front. Often, this may mean lighting only at a single location for an entire burn (a number of ignition points at the same location may be required) or very widely spaced ignition points creating separate fires. If creation of a patchy fire is the objective then it is better to use successive single point ignitions creating separate fires.
- **Progressive burning** is an approach to planned burning where ignition is carried out throughout as much of the year as conditions allow. In the Gulf Plains, ignition can begin soon after the wet season as soon as fuel has cured sufficiently to carry fire, with numerous small ignitions. Progressive burning then continues into the mid dry season. Ideally multiple periods of ignition should occur in each park in each year. These burnt areas can provide opportunistic barriers to fire to support burning later in the year (e.g. storm burning) or to provide barriers to wildfire movement. They also create patchiness and fauna refuges and help create a rich mosaic of severities, burnt/unburnt areas, and seasonal variability to support habitat diversity.

- **Storm burning**. Burns undertaken in the storm season after first storms and when there is a high probability of rain after burning. Containment of storm burns relies on impending rain, natural breaks, or earlier season burning having established areas of lower fuel sufficient to impede the passage of fires.
- Use **periods of declining fire hazard** so that fires are more controllable. Daily patterns can be utilised (e.g. after 2 pm, relative humidity tends to increase and temperature and winds decrease) meaning fires become less severe and will often self-extinguish early in the season but may carry through the night later in the year.
- A **running fire** of a higher intensity, lit with the wind can help reduce overabundant seedlings/sapling. A l**ow intensity backing fire**, which is slow moving and **increases residence time**, is also useful to reduce woody weeds or overabundant seedlings/saplings. The best method is dependent on the amount of fuel available and also on the overabundant species (some species can be killed with lower severity fire with a high residence time; others species must be scorched to their tip—seek advice).
- **Line ignition**. In open woodland communities where soils retain moisture for longer it may be necessary to create a line of fire to carry fire through uncured fuels. But avoid using this approach repeatedly along tracks or roads.



Targeting rank or standover-grasses through broad-scale aerial ignition with widely spaced incendiaries. In the right conditions, techniques such as this will assist in impeding wildfires later in the season and meeting other conservation outcomes.
Nick Smith, QPWS, Bulleringa National Park (2012).

Issue 2: Maintain healthy shrubby or spinifex dominated communities

This issue applies to the management of spinifex *Triodia* spp. dominated grasslands as well as eucalypt communities with a spinifex or shrubby dominated ground layer.

Spinifex is very flammable, but can take a long time to form continuous fuel (when hummocks begin to join-up). Apply fire before the hummocks form continuous fuel over large areas, to create patchy fires and to mitigate extensive and severe wildfires.

Awareness of the environment

Key indicators of healthy spinifex or shrubby communities:

- These areas may have an open canopy of *Eucalyptus* spp. or *Corymbia* spp. Some young canopy trees are present in the understorey (enough to eventually replace the canopy).
- In spinifex grasslands, trees may be absent or present as scattered emergents.
- Spinifex shows a variation in time-since-fire across the landscape. Some more recently burnt areas have spinifex interspersed with occasional tussock grasses and forbs. A mosaic of longer unburnt areas containing spinifex with a build-up of dead and dying material should remain.
- In the first few years after fire there is a diversity of herbs, forbs and annual grasses between spinifex hummocks.
- Shrubby eucalypt communities (which occur in some areas) may have a mid-dense to dense layer of shrubs with sparse spinifex or tussock grasses in the ground stratum. They are generally found on scarps and plateaux.
- Shrubby communities are naturally very diverse, often with a number of *Eucalyptus* spp., *Melaleuca* spp., or *Acacia* spp. dominating and interspersed with a number of species of shrubs such as *Grevillea* spp. or *Jacksonia* spp.

Healthy silver leaf box *Eucalyptus pruinosa* low open woodland with a ground layer of spinifex.

John Neldner, Queensland Herbarium, south-west Nardoo Homestead (1999).

A mixture of hummock (spinifex) and tussock grasses may be present in some communities including those dominated by Darwin stringybark *E. tetrodonta* and quinine tree *Petalostigma banksii*.

Mike Ahmet, QPWS, Bulleringa National Park (2009).

In spinifex areas, herbs and forbs flourish in the year following fire. With time-since-fire, spinifex will once again dominate.

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

Ground fuels can be naturally sparse in some spinifex communities.

Gary Wilson, Queensland Herbarium, Near Tallawanta homestead (2006).

A shrubby woodland. In shrubby areas, obligate seeders (fire-killed shrubs) such as yellow flowering *Jacksonia ramosissima* should be allowed to flower and set seed a number of times before the next planned burn (this usually takes more than seven years). Observe the shrubs for evidence of accumulated seeding bodies (such as cones or pods).
Paul Williams, Vegetation Management Science Pty Ltd, Bulleringa National Park (2009).

Some shrubby communities are more open with a more continuous and diverse ground cover.
QPWS, Bulleringa National Park (2009).

The following may indicate that fire is required to maintain eucalypt communities with a spinifex or shrubby understory:

- Spinifex clumps are big enough that some have joined or almost joined so that fires will carry in some areas.
- When spinifex clumps are big enough that it becomes difficult to walk in a straight line, the fuel load has become quite high and care is required when burning.
- Parts of the spinifex hummock are grey and dry.
- Diversity of the ground layer has decreased. Herbs and forbs are absent between spinifex hummocks.
- Evidence of recent seeding such as presence of old seed stalks where seeds are absent (as seeds have dropped to the ground).
- In shrubby dominated areas, the crowns and branches of shrubs are declining in health and high proportions have dead or dying crowns or branches. Lower leaves are browning and there is a build-up of dead leaves.
- Wattles, *Grevillea* spp. and *Jacksonia* spp. which germinated after a previous fire have had several years of seed production, or are beginning to die.
- In shrubby eucalypt communities with a spinifex ground layer, some *Cassytha* spp. may begin to smother shrubs and ground layer plants.

This feathertop spinifex *Triodia bitextura* has seeded a number of times and is ready to be burnt. Ensure hummocks have seeded and are large and mature prior to burning.
Mike Ahmet, QPWS, Bulleringa National Park (2009).

As spinifex ages the hummocks begin to accumulate grey, dry material; an indication of the need to apply fire. Sometimes the hummocks collapse in the centre.
Gary Wilson, Queensland Herbarium, Neumayer Valley Station (2006).

When spinifex hummocks have become so large that they join or almost join it is an indicator of the need to apply fire. Where fuel has become more continuous like this, wet season burning could be used to minimise fire severity and extent.
John Neldner, Queensland Herbarium, South of Normanton (1999).

Although it takes several years for shrubs to mature and set seed, shrub diversity begins to decline after very long fire intervals. The build-up of lower level dead-leaves on shrubs indicates that fire is required.

Mike Ahmet, QPWS, Bulleringa National Park (2009).

Discussion

- Spinifex tends to continue to increase in size and fuel load with time-since-fire. In the years after fire, the distance between hummocks gradually decreases, allowing fire to travel more readily across the landscape. A very wet year (summer rain is better for spinifex growth than winter rain) or succession of wet years can provide a boost to the growth of spinifex (and consequent increase in fuel). This can result in severe, extensive wildfires, usually within the following two years. Fire should be applied before the hummocks join together to create patchy fires.
- Grazing can impact on the health of spinifex communities by reducing their diversity (the cattle prefer soft forbs and spinifex seed heads) and by reducing the continuity of fuels required for fire management.
- After fire some acacias will naturally form dense thickets that will thin out over time. It is not necessary to target these areas for burning in order to reduce this temporary acacia dominance.

- To achieve a patchy burn in spinifex, burns need to occur in the wet season or very soon after to take advantage of fuel and soil moisture. Be aware that spinifex can remain green throughout the year and it should not be assumed that because it is green it is safe to burn. Spinifex, while still green or even still wet from rain, will burn intensively after a few months following the last rains of the wet season (usually around April).
- Several fire-killed shrubs (e.g. wattles) require five years from germination to seed production. Some areas should be left long enough to allow fire-killed shrubs to persist. But leaving large areas unburnt for six years or more (to allow seed production by shrubs) creates a risk of extensive wildfires. Therefore, implementing small patchy burns, in the late wet season to early dry season, is the best way to mitigate against extensive wildfire and at the same time create areas that remain longer unburnt.
- Recently burnt spinifex and shrubby eucalypt communities tend to have a diversity of re-sprouting perennials, annuals and ephemeral forbs soon after fire. The number of species present tends to decline with time-since-fire.
- Fires which are too severe and occur without sufficient soil moisture result in the death of sub-soil grass bases/roots and slow post-fire recovery. Soil moisture also promotes rapid post-fire spinifex seedling establishment. Burning without soil moisture will often kill spinifex hummocks or slow seedling establishment and give a competitive advantage to weeds and woody species.

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)
Progressive burning demonstrated.	Using fire scar remote sensing data, estimate burnt and unburnt country by month, on an annual basis. Note that early burns may not be visible on NAFI it may be necessary to combine remote sensing with points collected on GPS.	**Achieved:** Remote sensing shows a series of progressive burns through the season. **Partially Achieved:** One to two burns achieved. **Not Achieved:** No burning has occurred.
Proactive planned burning has prevented impact by subsequent wildfire to natural/ cultural resources or infrastructure.	Using fire scar remote sensing data, estimate area of planned burns against wildfire on an annual basis.	**Achieved:** Annual area planned burnt prevents impact by wildfire. **Not Achieved:** Wildfire has had significant impact.

Create a fine-scaled patchy burn in spinifex communities.	Choose one of these options: a. Visual estimation of percentage of vegetation burnt—from one or more vantage points, or from the air, using landmarks as a 'size' guide. b. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the range of patch sizes.	**Achieved:** 25–75 % of spinifex hummocks remain unburnt within the burn area. **Not Achieved:** More than 75 % or less than 25 % of spinifex hummocks remain unburnt within the burn area.
Recruitment of obligate seeders (e.g. *Jacksonia* spp., *Acacia* spp.) promoted over the burn area.	6–12 months after the burn, seedlings of fire-killed shrubs can be seen in the ground layer. Within unburnt areas of the burn footprint more mature shrubs remain—visually assess from one or more vantage points or from the air.	**Achieved:** Fire-killed shrubs are present at various heights/ stages of maturity across the burn area. **Not Achieved:** Fire-killed shrubs are all of a single age/height across the burn area.

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

Monitoring the issue over time

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

A number of Sav-Mon (savannah monitoring) sites are established across the bioregion and are designed to assess long-term changes in vegetation health. Queensland Herbarium CORVEG sites could be used or established (refer to Neldner et al. 2005).

Mapping and assessment of fire history through fire scars from NAFI or other means is useful to guide future fire planning.

Very open woodland with a low spinifex ground layer, recently burnt.
Paul Williams, Vegetation Management Science Pty Ltd, Bulleringa National Park (2009).

Patchiness is enhanced by the broken, rocky ground in this eucalypt community on sandstone.
Paul Williams, Vegetation Management Science Pty Ltd, Bulleringa 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)	100–1500	0.5–2.0	2.0–5.0	All surface and near surface fuels burnt. Stubble burnt to blackened remnants.
Moderate (M)	1500–4500	2.0–4.0	Some canopy scorch may occur	Ground burnt completely. Stubble burnt to ash.
High (H)	> 4500	> 4.0	Canopy scorch will be extensive.	Ground burnt completely. Stubble burnt to ash.

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 two to seven years. Leave a mosaic of areas longer, including shrubby dominated areas. Mosaic burning will help retain areas of longer inter-fire interval.

Mosaic (area burnt within an individual planned burn)

- Fires should be as patchy as possible, however this will be difficult to achieve within some long-unburnt country due to contiguous spinifex fuel. A greater level of mosaic can be achieved by ignition of spinifex during, or very soon after the wet season and by using afternoon ignition.

Other considerations:

- Spinifex has high resin content and is extremely volatile. It can burn when wet and is not reliant upon complete curing to carry a fire. Moisture and wind are also factors in determining how effectively a burn will carry across the landscape.

What weather conditions should I consider?

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

Season:

- **Wet season** to **early dry season** for spinifex. Slightly later burns may be acceptable in shrubby areas.
- Avoid burning during **dry conditions**, with humidity less than 30 per cent and high temperatures. These conditions tend to occur just before the start of the storm season.
- **Storm burning**. Burns undertaken in the storm season after the first storms when there is a high probability of follow up rain.

GFDI: < 18

DI (KBDI): 80–120

Wind speed: < 23 km/hr

Patchy fire retains habitat features and promotes diversity in the ground stratum. Early afternoon ignition is one tactic which may assist in achieving a patchy fire, as shown by this June burn.

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

Feathertop spinifex does not seed for two to three years following fire. Avoid repeatedly applying extensive fires before several years of seed production. Note the recovering spinifex and recently burnt spinifex stubble shown in this photo taken in June.

Mike Ahmet, QPWS, Bulleringa National Park (2009).

Shrubby low woodland *Eucalyptus terminalis, Melaleuca minutifolia,* and *Melaleuca stenostachya.*

Peter Stanton, Environmental Consultant Pty Ltd, Near Reid River, Bulleringa Holding Pty Ltd (1991).

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.

- **Aerial ignition**. Broad-scale fire management using **aerial ignition** is useful in the Gulf Plains due to the size and inaccessibility of some eucalypt communities. Wet-season to early dry-season fires can be lit in the morning or afternoon depending on the desired outcome. Ignition timing will determine how far the fire travels before self-extinguishing under milder evening conditions. Use natural features such as rivers and streams (even if there is no water, there may be sufficient moisture), areas of tussock grasses which are sparse or uncured or previously burnt areas to contain fires. Also note that these natural features may prevent fire from carrying as far as intended. Aerial ignition also provides an opportunity to burn away from non-target communities (e.g. springs, vine thickets and acacia communities) creating areas of reduced fuel protecting them from impacts of late dry-season wildfires. It is good practice to plot out an aerial incendiary path using maps, satellite images or aerial photographs and to program the path into a GPS for use in flight.
- **Spot ignition** is used in spinifex communities with non-continuous hummocks to create patchiness. The spacing of the spots affects the resulting intensity and mosaic. Individual hummocks can be ignited using a drip torch or matches. Well spaced ignition spots can create a greater level of patchiness.
- **Single point ignition** is used to create a fire of limited extent with a limited fire front. Often, this may mean lighting only a single location for an entire burn (a number of ignition points at the same location may be required) or very widely spaced ignition points creating separate fires.
- **Progressive burning**. Planned burning is carried out throughout the year as conditions allow. Ignition can begin in the storm season and continue through the wet season into the early dry season, with numerous small fires creating a landscape mosaic. Ideally multiple periods of ignition should occur in each park in each year. Progressive burning helps to create a mosaic of severities, burnt/unburnt areas, and seasonal variability and reduces the risk of large scale fires late in the dry season.

- **Storm burning**. Burns undertaken in the storm season after the first storms when there is a high probability of follow up rain. Containment of storm burns relies on impending rain, natural breaks, or earlier-season burning which has established areas of lower fuel sufficient to impede the passage of later fires.
- Use **periods of declining fire hazard**, so that fires are more controllable. Daily patterns can be utilised (e.g. after 2 pm, relative humidity tends to increase and temperature and winds decrease) meaning fires become less severe and will often self extinguish early in the season.
- A **running fire** of a higher intensity, lit with the wind can help carry fire through discontinuous fuel.
- **Line ignition**. In spinifex understories line ignition can help fire carry through areas where fuel is discontinuous.

Issue 3: Reduce overabundant saplings

Overabundance of acacias, eucalypts or other native shrubs and trees may lead to woody thickening; reducing the health of the ground layer through competition and shading.

Refer to Chapter 8 (Issue 3), for fire management guidelines.

Issue 4: Reduce woody weeds

Rubber vine *Cryptostegia grandiflora* is presently found throughout the bioregion in moderate to very dense infestations. Rubber vine is fire-sensitive and eradication has been achieved in some areas using fire alone.

Refer to Chapter 8 (Issue 4), for fire management guidelines.

Ghost gum woodlands are considered 'of concern', not because of clearing, but rather the extent of rubber vine infestation. Fire can assist in managing this issue.
Carly Greig, EHP, Finucane Island National Park (2010).

Issue 5: Manage high biomass invasive grasses

High biomass grasses can be promoted by fire, and increase the severity of fire leading to impacts on ecosystems. In some cases, fire can be used as part of control.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

Chapter 2: Grasslands and sedgelands

Grasslands and sedgelands are open and treeless or contain only scattered trees or shrubs. Grasslands vary across the bioregion and dominant grass species are influenced by rainfall and soil type (and other factors). Significant diversity is added by forbs, sedges and annual grasses. Spinifex *Triodia* spp. grasslands are mapped with adjoining Eucalypt communities (refer to Chapter 1 [Issue 2]: Maintain healthy shrubby or spinifex dominated communities).

- On floodplains, drainage lines and loamy plains, common species include Australian wild rice *Oryza australiensis*, Flinders grasses *Iseilema* spp., bluegrass *Dichanthium* spp., silky browntop *Eulalia* aurea, *Astrebla* spp. *Chrysopogon fallax* and *Sarga plumosum*. Also present though rarely dominating are wiregrasses *Aristida* spp. On sandy soils *Schizachyrium* spp. and wiregrasses are present.
- Spike rushes *Eleocharis* spp. and sedges *Cyperus* spp. are present on seasonal or permanent swamps, wetlands and lagoons. Sedgelands may also contain Australian wild rice *Oryza australiensis* and other occasional grasses such as lovegrasses *Eragrostis* spp., *Ectrosia* spp. This fire regime group also includes seasonal and permanent wetlands with sparse vegetation not usually threatened by fire.

Fire management issues

Retaining open grasslands by preventing invasion by trees and shrubs is an issue in some areas. Overabundant seedlings/saplings, leading to woody thickening occurs where fire has been long absent, infrequent or repeatedly applied too early in the season (creating fires of insufficient severity to scorch seedlings/saplings). This issue can be compounded by overgrazing or not spelling a pasture after fire, allowing cattle access to the 'green pick' and thereby giving woody species a competitive advantage.

Broad-scale planned burning is the key to preventing late season wildfires that can be extensive, frequent and intense. Wildfires can also result in ecological impacts and produce an enormous amount of greenhouse gas. Commence planned burning early in the dry season, to break up the continuity of fuels across the landscape.

Sedgelands in the Gulf Plains are not actively targeted with fire. They are allowed to burn in association with the surrounding landscape but tend to burn far less often due to the presence of moisture. Permanent lakes and lagoons with fringing woodland/sedgelands rarely burn and active fire management is not required.

Be aware of the presence of invasive and high-biomass grasses as they dramatically increase fire severity, and fire can promote them. Buffel grass *Cenchrus ciliaris* is an established problem in some areas. Para grass *Urochloa mutica* and grader grass *Themeda quadrivalvis* are emerging weeds and staff should be alert to new infestations.

Woody weeds such as parkinsonia *Parkinsonia aculeata* and smothering species such as rubber vine *Cryptostegia grandiflora* are widespread in the bioregion. In some cases they are able to be managed with fire. Prickly mimosa *Vachellia farnesiana* is widespread in grasslands in some areas.

Issues:

1. Maintain healthy grasslands and sedgelands.
2. Maintain healthy spinifex grasslands.
3. Reduce overabundant saplings.
4. Reduce woody weeds.
5. Manage high-biomass grasses.

Extent within bioregion: 4 395 268 ha, 20 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Mutton Hole Wetlands Conservation Park, 1614 ha; Finucane Island National Park, 1196 ha; Errk Oykangand National Park (Cape York Peninsula Aboriginal Land), 682 ha; Lawn Hill (Gregory) Resources Reserve, 383 ha; Staaten River National Park, 112 ha; Boodjamulla (Lawn Hill) National Park, 52 ha; Rungulla Proposed new National Park, 12 ha; Lawn Hill (Gregory River Base) Resources Reserve, 5 ha.

Issue 1: Maintain healthy grasslands and sedgelands

Use fire to maintain open grasslands and sedgelands, to promote diversity and prevent extensive wildfires.

Awareness of the environment

Key indicators of healthy fire-adapted grassland:

- A diversity of grasses (including both annuals and perennials) and/or sedges and forbs are present.
- Grasslands and sedgelands are treeless and shrubless or contain only scattered trees or shrubs.

A healthy open grassland community. Note scattered trees along a seasonal watercourse. When shrubs and trees are more than scattered or are emerging above the grass layer, this may indicate fire is needed.

Gary Wilson, Queensland Herbarium, south of Armraynald Homestead (2007).

Forbs, herbs and mixed grasses should be present but perennial grasses should dominate.
Gary Wilson, Queensland Herbarium, east of the Burke Development Road (2006).

Seasonal sedgelands require occasional fires to maintain diversity. Many wetland plants will have been reduced to subsoil bulbs by the middle of the dry season— in which case fire is unlikely to carry (Williams and Greig 2010).
Carly Greig, EHP, Finucane Island National Park (2010).

Sedgelands may surround permanent lagoons and while not actively targeted with fire may burn in association with surrounding communities, during late dry-season fires.
Paul Williams, Vegetation Science Pty Ltd, Carly's Lagoon, Finucane Island (2010).

Healthy sedgelands are generally open communities. However scattered trees and shrubs may be present on their margins. Sedgelands such as this one are prone to invasion of woody weeds such as rubber vine.
Paul Williams, Vegetation Management Science Pty Ltd, Carly's Lagoon, Finucane Island National Park (2010).

The following may indicate that fire is required to maintain fire adapted grasslands or sedgelands:

- An accumulation of dead material in grasses, collapsing grass and poorly formed grass clumps are present. Or grasses have become dense.
- There is a build-up of rank or stand-over (grass with significant dead material not consumed in previous burning cycles) grasses.
- Seed heads of a variety of different grasses and herbs are visible.
- Eucalyptus spp., *Acacia* spp. and/or *Melaleuca* spp. and in some areas currant bush *Carissa lanceolata,* quinine *Petalostigma* spp., gutta percha *Excoecaria parvifolia* or other species are becoming more frequent or emerging above the ground layer.
- Weeds such as parkinsonia, rubber vine or prickly mimosa may have started to become common and saplings are becoming visible above the grasses.
- Sedges have become dry and matted.
- Rubber vine is smothering sedges within sedgelands.

This grassland is still healthy but the density of grasses indicates a fire is required in the near future to maintain grassland diversity, as grasses will outcompete other herbs and forbs in the absence of fire. Fires also reduce fuel loads and ensure shrubs and trees remain scattered.

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

Bulkaru sedgelands in the dry season.

Mike Ahmet, QPWS, Red Lily Lagoon Lakefield National Park (2009).

Discussion

- The endangered golden-shouldered parrot *Psephotus chrysopterygius* nests in termite mounds in grasslands. Their habitat is declining due to melaleuca woodland invasion that reduces nesting habitat and food sources. *Melaleuca* spp. seedlings and saplings shade-out and eventually replace open grassland communities when high-severity fires are restricted or absent. These parrots are now confined to a single population in the Gulf Plains within the upper reaches of the Staaten River mostly within Staaten River National Park (Garnett and Crowley 2002). If melaleuca thickening in northern Australia continues populations will continue to retreat and become more isolated.
- Fire is a useful method of control of some woody weed and prickly acacia *Vachellia nilotica* seedlings, but is less effective on or may have no impact on larger trees. Seeding occurs between March and June. Fire is a useful method of control of parkinsonia *Parkinsonia aculeata* but is not known to be an effective control method for prickly mimosa *Vachellia farnesiana*. If woody weeds are an issue, refer to Chapter 8 (Issue 4), for fire management guidelines.
- Fires which are too severe and occur without sufficient soil moisture result in the death of sub-soil grass bases/roots resulting in slow post fire recovery. Burning without soil moisture will give a competitive advantage to weeds and woody species.
- The common death adder *Acanthophis antarcticus* is present throughout most of the southern, central and lower-north of the bioregion. This species is currently listed as near threatened under the Queensland *Nature Conservation Act 1992*. Widespread fires with little internal patchiness can impact on this species. Mosaic burning will provide refuge areas and retain important habitat features such as unburnt grass clumps and fallen logs.

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.

Left: The grassland habitat of the golden-shouldered parrot continues to decline due to high-severity fires being restricted or absent. Within thickened areas small scale fires late in the year, or fires started by lighting (providing sufficient earlier burning has occurred) may assist.

Above: nest in a termite mound.

Left: QPWS. **Above:** Daryn Storch, QPWS, Cape York.

Mosaic burning assists in the protection of the common death adder.

QPWS.

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)
A mosaic of 25–80 % 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 areas.	**Achieved:** 25–80 % burnt. **Not Achieved:** Less than 25 % or more than 80 % burnt.
More than 75 % of emerging shrubs or trees pushed back to the ground layer.	**Before and after fire**, select three or more sites (taking into account the variability of landform and likely fire intensity), and count the number of emerging shrubs or trees (above ground components) reduced by fire.	**Achieved:** More than 75 % pushed back to the ground layer. **Partially Achieved:** 50–75 % pushed back to the ground layer. **Not Achieved:** < 50 % pushed back to the ground layer.

More than 80 % of the bases of grass clumps remain in burnt areas.	**After the burn:** select three sites (taking into account the variability of landform and likely fire intensity) and estimate percentage of grass clumps remaining.	**Achieved:** More than 80 % bases remain. **Partially Achieved:** 50–80 % bases remain. **Not Achieved:** Less than 50 % bases remain.

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

Monitoring the issue over time

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

A number of Sav–Mon (savannah monitoring) sites are established across the bioregion and are designed to assess long–term changes in vegetation health. Also Queensland Herbarium CORVEG sites could be used or established (Neldner et al. 2005).

Mapping and assessment of fire history through fire scars from NAFI (North Australian Fire Information) or other means is useful to guide future fire planning.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** and occasionally **moderate** and **high**-severity fire.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
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.
High (H)	1500–5300	1.5–4.0	Complete biomass removed.	Ground burnt completely. Stubble burnt to ash.

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

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

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between three to six years for grasslands and sedgelands south of approximately Karumba. In northern areas fires every one to three years are acceptable.
- 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)

- Using appropriate tactics and burning with good soil moisture will assist in creating a mosaic.

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 dry season (e.g. March to April possibly June following long wet seasons). Storm burns should occasionally be applied, particularly if overabundant saplings/seedlings or woody weeds are an issue. Timing burns to coincide with follow-up rain will assist in promoting grasses.

GFDI: < 20

DI (KBDI): 80–120 (ideally < 100)

Wind speed: < 23 km/hr—some wind may be required to carry fire between grass clumps.

Soil moisture: Good soil moisture is essential for assisting the protection of the underground portions of vegetation and to promote seedling germination post-fire. This will assist in restoring ground cover and preventing erosion issues.

Burning fire adapted grasslands early in the dry season is a tactic that can be used to create a low fuel buffer adjacent to fire-sensitive communities, protecting them from late dry season wildfires.

Carly Greig, EHP, Finucane Island National (2010).

What burn tactics should I consider?

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

- **Aerial ignition**. A landscape approach to fire management is necessary due to the size and inaccessibility of grassland communities. This is mostly achieved through **aerial ignition**. Early dry season fires can be lit in either morning or afternoon depending on the desired outcome. Ignition timing would be determined by how far the fire is required to travel before self-extinguishing in evening conditions. A useful tool to determine the rate of spread is the CSIRO Grassland Fire Spread Meter for Northern Australia. Utilise natural features such as rivers and streams (even if there is no water, there may be sufficient moisture), areas of sparse or uncured fuel or previously burnt areas to contain fires. Also, note that these natural features may prevent fire from carrying as far as intended. Aerial ignition also provides an opportunity to burn away from non-target communities (e.g. springs, vine thickets and acacia communities) creating areas of reduced fuel protecting them from impacts of late dry season wildfires. It is good practice to plot out an aerial incendiary path using maps, satellite images or aerial photographs and to program the path into a GPS for use in flight.
- **Progressive burning** is an approach to planned burning where ignition is carried out throughout as much of the year as conditions allow. In the Gulf Plains, ignition can begin soon after the wet season as soon as fuel has cured sufficiently to carry fire, with numerous small ignitions. Ideally multiple periods of ignition should occur in each park in each year. These burnt areas can provide opportunistic barriers to fire to support burning later in the year (e.g. storm burning) or to provide barriers to wildfire movement. They also create patchiness and fauna refuges and help create a rich mosaic of severities, burnt/unburnt areas, and seasonal variability to support habitat diversity.
- **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.
- A **running fire** of a higher intensity, lit with the wind can help reduce overabundant seedlings/sapling. A **low intensity backing fire**, which is slow moving and **increases residence time**, is also useful to reduce woody weeds or overabundant seedlings/saplings. The best method is dependent on the amount of fuel available and also on the overabundant species (some species can be killed with lower severity fire with a high residence time; others species must be scorched to their tip —seek advice).

Issue 2: Maintain healthy spinifex grasslands

In the Gulf Plains bioregion spinifex *Triodia* spp. grasslands are generally continuous with eucalypt communities with a spinifex dominated understorey.

Refer to Chapter 1 (Issue 2): Maintain healthy shrubby or spinifex dominated communities, for fire management guidelines.

Issue 3: Reduce overabundant saplings

Overabundance of acacias, eucalypts or other trees and shrubs (woody thickening) may reduce the health of the ground layer through competition and shading.

Refer to Chapter 8 (Issue 3), for fire management guidelines.

Issue 4: Reduce woody weeds

Rubber vine *Cryptostegia grandiflora* is presently found throughout the bioregion in moderate to very dense infestations. Rubber vine is fire sensitive and eradication has been achieved in some areas using fire alone. Parkinsonia *Parkinsonia aculeata* and other woody weeds are also found within the bioregion and may be abundant in some areas.

Refer to Chapter 8 (Issue 4), for fire management guidelines.

This sedgeland has become a rubber vine shrubland in the absence of fire. Fire will assist in managing the issue.

Carly Greig, EHP, Finucane Island National Park (2010).

Issue 5: Manage high-biomass grasses

High-biomass grasses can be promoted by fire, and increase the severity of fire leading to impacts on ecosystems. In some cases, fire can be used as part of control.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

Chapter 3: Melaleuca woodlands

This fire vegetation group includes all communities dominated by melaleuca, occasionally with other canopy species present such as *Eucalyptus* spp. or liniment tree *Asteromyrtus symphyocarpa*. In the Gulf Plains bioregion many of these communities occur adjacent to streams and rivers or are periodically inundated. Drier sites have a grassy understory sometimes with sparse shrubs such as smooth-leaved quinine *Petalostigma banksii* and grevillea.

Riparian areas are often dominated by *Melaleuca argentea, Melaleuca fluviatilis*, or *Melaleuca leucadendra*, usually growing amongst river red gum *Eucalyptus camaldulensis, Pandanus* spp., cabbage palm *Livistona rigida*, and with vine thicket species sometimes present. Perennial wetlands or areas which retain water for an extended period often support sedges in the ground stratum while drier areas have grasses, herbs and forbs.

Fire management issues

The main issue for melaleuca communities is maintaining a landscape mosaic (of time-since-fire) through broad-scale fire management, reducing and breaking-up fuel continuity, and therefore limiting the impacts of late-season wildfires.

Establishing and maintaining a landscape mosaic is important to protect the health and persistence of melaleuca communities.

Another issue in some areas is loss of open structure through overabundant seedlings/saplings leading to woody thickening. This process is attributed to a lack of planned burning and/or fires repeatedly applied too early in the season (when they are not intense enough to control emerging overabundant seedlings/saplings). Thickening is thought to be more prevalent in the drier, southern areas of the bioregion, although the spread of melaleuca trees into open grasslands occurs in the north (see Chapter 2: Grasslands and sedgelands). Woody thickening becomes much more severe where stock grazing is combined with repeated early-season burns (or planned burning is avoided in favour of pasture retention). Stock grazing reduces fuel loads preventing fires of sufficient severity to manage thickening and is compounded by cattle concentrating feeding on regrowth grasses in the recently burnt areas, allowing woody species the competitive advantage.

Issues:

1. Maintain healthy melaleuca communities.
2. Reduce woody weeds.
3. Manage high-biomass grasses.

Extent within bioregion: 5 344 469 ha, 24 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Staaten River National Park, 216 495 ha; Errk Oykangand National Park (Cape York Peninsula Aboriginal Land), 6655 ha; Bulleringa National Park, 1507 ha; Rungulla Proposed new National Park, 1136 ha; Gilbert River Proposed new National Park, 352 ha; Mutton Hole Wetlands Conservation Park, 7 ha.

Issue 1: Maintain healthy melaleuca communities

Awareness of the environment

Key indicators of healthy melaleuca communities:

- Melaleuca is the dominant canopy tree. A few saplings of variable size should be present to eventually replace the canopy.
- Healthy melaleuca woodlands have grasses, occasional shrubs or sedges, or any mix of these in the understorey.
- Grasses are upright and vigorous, with well formed bases. A diversity of herbs and forbs are often found between grasses.
- Melaleuca dominated riparian communities may have *Eucalypt* spp., *Pandanus* spp., cabbage palm *Livistona* spp. or vine thicket species present; and grasses interspersed with sedges and rushes.
- In some areas currant bush *Carissa lanceolata*, quinine *Petalostigma* spp., gutta percha *Excoecaria parvifolia* or other species may be scattered, but they are not so frequent that they are beginning to shade out the ground layer.

Healthy open melaleuca woodland.

Paul Williams, Vegetation Management Science Pty Ltd, Staaten River National Park (2004).

Riparian areas with melaleuca lining the banks in Bulleringa National Park. These areas are burnt in association with the surrounding country; however they tend to burn less frequently due to a lack of flammable grasses or because of humid and shaded micro-environments.
Nick Smith, QPWS, Red River (2012).

In melaleuca woodlands, grasses often dominate the ground layer.
QPWS, Staaten River National Park (2009).

The following may indicate that fire is required in melaleuca communities:

- There is a build-up of rank or stand-over (grass with significant dead material not consumed in previous burning cycles) grasses.
- The crowns and branches of shrubs are declining in health and high proportions have dead or dying crowns or branches. Lower leaves are browning and there is a build-up of dead leaves.

Melaleuca communities (appear silver in the photo) are often continuous with eucalypt or other communities and are managed in association with them.

Lana Little, QPWS, Staaten River National Park (2000).

Discussion

- A key strategy to manage the vast expanses of inaccessible melaleuca communities in the Gulf Plains is broad-scale management through aerial ignition. Ideally, this would include at least three different ignition periods on each property, each year.
- In terms of fire management, open melaleuca communities are managed in association with surrounding eucalypt woodlands. Wildfires resulting from dry storms late in the dry season or in the early wet season are frequent (one to two years) and extensive. Whilst, fires from lightning strikes are part of the natural system, they have considerable ecological impacts when early-season burning has not occurred or has been insufficient to mitigate the run of a hot fire late in the dry season.
- Although inappropriate fire management can lead to an overabundance of certain tree species in the understorey, be aware that the abundance of some tree species is not related to fire management, but is a result of soil and landscape characteristics. Knowing the fire history of an area and individual species response to fire is important in determining if thickening is an issue.
- Some melaleuca dominated riparian and fringing communities retain fire-sensitive species and burn less frequently. These are in areas where fire is less likely to penetrate and include braided channels or areas of reduced or silt-coated ground fuels (due to seasonal flooding), or have less flammable grasses and a shaded micro-climate.
- Grazing impacts may lead to further fuel reduction in these areas meaning fires are less frequent and/or severe. Sometimes the role of riparian areas as barriers to fire can be enhanced through proactive early burning in and around them.

- Other rivers within the Gulf Plains are not as self-protecting and are more likely to burn in association with the surrounding landscape. Species such as river red gum *Eucalyptus camaldulensis* or *Melaleuca* spp. dominate but *Pandanus*, river she-oak *Casuarina cunninghamiana*, palms (e.g. *Livistona* spp.) and some vine thicket species such as *Diospyros* spp. or figs *Ficus* spp. may be present. These communities are vulnerable to too frequent and high-severity fire. Managing the surrounding fire adapted communities to mitigate wildfire is important.
- Grasses are generally considered ready to burn when they reach 50–60 per cent cured. The North Australian Grassland Fuel Guide (Johnson 2001) may assist in determining when grasses are ready to burn. However, caution should be used and local knowledge sought as some grass species that still appear too green to burn will burn severely (and vice versa).

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)
Progressive burning demonstrated.	Using fire scar remote sensing data, estimate burnt and unburnt country by month, on an annual basis. Note that early burns may not be visible on NAFI it may be necessary to combine remote sensing with points collected on GPS.	**Achieved:** Remote sensing shows a series of progressive burns through the season. **Partially Achieved:** One to two burns achieved. **Not Achieved:** No burning has occurred.
Proactive planned burning has prevented impact by subsequent wildfire to natural/ cultural resources or infrastructure.	Using fire scar remote sensing data, estimate area of planned burns against wildfire on an annual basis.	**Achieved:** Annual area planned burnt prevents impact by wildfire. **Not Achieved:** Wildfire has had significant impact.
> 75 % of overabundant saplings < 2 m are reduced.	Select several sites or walk several transects, estimate the percentage of overabundant saplings (above ground components) reduced.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

Minimise canopy scorch.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity) and observe the number of trees with canopy scorch.	**Achieved:** No canopy scorch has occurred. **Partially Achieved:** Some canopy scorch has occurred. **Not Achieved:** Complete canopy scorch.

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

Monitoring the issue over time

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

A number of Sav-Mon (savannah monitoring) sites are established across the bioregion and are designed to assess long-term changes in vegetation health. Queensland Herbarium CORVEG sites could be used or established (Neldner et al. 2005). Mapping and assessment of fire history through fire scars from NAFI or other means is useful to guide future fire planning.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **moderate**.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	< 150	< 0.5	≤ 2.5 (up to 8 m on melaleuca trees)	Significant patchiness. Litter retained but charred. Humus layer retained. Nearly all habitat trees, fallen logs and grass stubble retained. Some scorching of elevated fuels. Little or no canopy scorch.
Moderate (M)	150–500	0.5–1.5	2.5–7.5 (up to 20 m on melaleuca trees)	Moderate patchiness. Some scorched litter remains. About half the humus layer and grass stubble remain. Most habitat trees and fallen logs retained. Some scorch of elevated fuels. Little or no canopy scorch.

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

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 one to three years for melaleuca woodlands. Longer fire intervals (e.g. three to five years) are acceptable in the south of the bioregion (e.g. south of about Karumba) and in some riparian areas.

Mosaic (area burnt within an individual planned burn)

- Most fires should be patchy; however this will vary with burn location and will need to be assessed on a case by case basis. However, it is not acceptable to completely burn all of an area and conversely it is important to burn sufficient area to impede extensive late dry-season burns or wildfires.

Other considerations

- Some melaleuca communities will burn later in the season due to soils retaining moisture for longer. The key is to know the country and observe fire behaviour in varying season.
- Do not burn during drought conditions as this can exacerbate drought stress on plants.

Under suitable planned burn conditions, natural barriers such as dry creeks and rocky outcrops are useful barriers to fire movement.

Mick Blackman, Friendly Fire Ecological Contractor Pty Ltd, Mitchell River (2010).

Low severity fire in melaleuca woodlands can assist in protecting nearby creek line vegetation.

QPWS, East Back Creek, Staaten River National Park (2004).

What weather conditions should I consider?

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

Season:

- **Soon after the wet season** when it is dry enough to carry a fire (just) but the fire self-extinguishes in the evening. Continue burns into the dry season until fires carry into the night but not overnight (usually this will be the mid dry season). Do not burn in the late dry season.
- Occasional storm burns may be required where hot fires have been absent for a number of years. Higher severity fires caused by lightning strike are also a natural feature of these systems and are not usually a problem provided that early season burning has been conducted in a way that mitigates the extent and severity of wildfire.
- Repeated early season burns are **not recommended** where overabundant seedlings/saplings are an issue (refer to Chapter 8, Issue 3 for fire management guidelines).
- In some riparian areas **wet-season** burning can reduce fuels and prevent wildfires later in the season. These areas can be used as fire breaks providing sufficient early season burns have occurred both within riparian areas and in surrounding fire-adapted communities.

GFDI: < 18

DI (KBDI): 80–100 but more may be acceptable in some areas

Wind speed: < 23 km/hr

Soil moisture: Good moisture conditions to protect bases of grasses, habitat trees and fallen logs, particularly in riparian areas.

What burn tactics should I consider?

Refer to Chapter 1 (Issue 1), for fire management tactics.

Issue 2: Reduce woody weeds

Rubber vine *Cryptostegia grandiflora* is presently found in a number of locations throughout the bioregion. Rubber vine is fire-sensitive and eradication has been achieved in some areas using fire alone. Parkinsonia *Parkinsonia aculeata* and other woody weeds are also found within the bioregion and may be abundant and widespread in some areas.

Refer to Chapter 8 (Issue 4), for fire management guidelines.

Issue 3: Manage high-biomass grasses

High biomass grasses can be promoted by fire, and increase the severity of fire leading to impacts on ecosystems. In some cases, fire can be used as part of control.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

Chapter 4: Acacia communities

Typically these communities are dominated by a single acacia species such as lancewood *Acacia shirleyi*¸ gidgee *Acacia cambagei* or by shoestring wattle *Acacia stenophylla*. This fire vegetation group includes other communities dominated by corkwood wattles *Vachellia* spp. whitewood *Atalaya hemiglauca*, beefwood *Grevillea striata,* bauhinia *Lysiphyllum cunninghamii* and *Thryptomene oligandra* . The sparse lower layers vary and may include shrubs and a mixture of tussock grasses, spinifex and forbs (Hodgkinson 2002). These communities are found on a variety of landforms including low rises, scarps and stony ledges, plains and depressions on plains, cracking clays, sand ridges and swales.

Fire management issues

Acacia communities are vulnerable to repeated, high severity fire. In most instances, fire should not be applied directly to these areas. Rather, manage surrounding fire-adapted areas to create a landscape mosaic of burnt and unburnt areas that mitigate the frequency, intensity and extent of unplanned fires.

Invasive grasses such as buffel grass *Cenchrus ciliaris* are one of the major threats to acacia communities. These grasses have the ability to draw fires into these areas and increase fire severity.

Issues:

1. Burn adjacent fire-adapted communities to limit fire encroachment into acacia communities.
2. Manage high-biomass grasses.

Extent within bioregion: 1 406 517 ha, 6 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Rungulla Proposed new National Park, 30 629 ha; Gilbert River Proposed new National Park, 14 510 ha; Bulleringa National Park, 11 879 ha.

Issue 1: Burn adjacent fire-adapted communities to limit fire encroachment into acacia communities

Most acacia communities are self protecting due to low or discontinuous fuel loads. Active protection is generally not required in mild conditions. Maintain a varied landscape mosaic of burnt and unburnt patches in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging, unplanned fires in acacia dominated communities.

Refer to Chapter 8 (Issue 6), regarding fire management guidelines.

Many acacia communities are essentially self-protecting due to low fuel loads or their position in the landscape.

Gary Wilson, Queensland Herbarium, west of the Tallawanta homestead (2006).

A healthy lancewood community lies adjacent to open eucalypt woodland with spinifex. Planned burning in the woodlands will assist in protecting fire-sensitive lancewood from impacts of wildfire. Notice the sharp delineation between these communities.

Nick Smith, QPWS, Bulleringa National Park (2012).

Whitewood, while generally not killed by fire, may take many years to regain its pre-fire height.

Gary Wilson, Queensland Herbarium, Neumayer Valley Station (2006).

Fallen trees and branches; these fuels may carry fire into acacia communities on occasion.
Gary Wilson, Queensland Herbarium, north of the Burke and Wills Roadhouse (2005).

Low fuel loads in some gidgee communities afford them protection from fire.
Gary Wilson, Queensland Herbarium, south of the Burketown Development Road (2006).

Discussion

- Fire-killed acacias such as lancewood are reliant on post-fire regeneration from the seed bank for the species to persist locally. These species are hard seeded and require fire to promote germination. Although it is recommended that land managers mitigate wildfire impacts by burning surrounding areas, the occasional (rare) unplanned fire may play a role in the persistence of this community in the landscape. After wildfire it is then critical to exclude further fires until the acacias reach maturity and set several seed crops. This may be at least ten years for lancewood communities.
- Other acacias such as gidgee are long lived, soft seeded, fire killed and have a very limited ability to regenerate from post-fire suckers. Fire plays no role in their germination, which is very occasional and follows high rainfall years. As a mature stand, they may be relatively self-protecting due to low fuel loads.
- Historically, fire within most acacia communities was infrequent, estimated at between ten and fifty years (though this differs where acacias are associated with grasslands). In general fires have occurred following prolonged rainfall which has resulted in substantial grass growth creating sufficient fuel to carry fire (Hodgkinson 2002) or during extensive wildfires. Changes in land use (through clearing and use of pastoral fire) and spread of invasive grasses have resulted in fires of a greater frequency and severity causing undesirable impacts.

Following good seasons it may be necessary to reduce the fuel load on the margins of these communities, to mitigate wildfire impacts.

Gary Wilson, Queensland Herbarium, west of the Neumayer Valley homestead (2006).

Gidgee are soft-seeded, long-lived and may be killed by fire. Fire plays no role in their germination which is very occasional and generally follows high rainfall years.

Gary Wilson, Queensland Herbarium, south of the Nardoo homestead (2006).

Grasses, particularly buffel grass, can carry fire into fire-sensitive gidgee communities. Applying fire early in the season on the margins of these communities may assist in preventing late season wildfire.

Gary Wilson, Queensland Herbarium, north of the Burke and Wills Roadhouse (2005).

Issue 2: Manage high-biomass 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 vegetation communities. Buffel grass *Cenchrus ciliaris* in particular poses a significant threat to acacia communities by altering fuel characteristics and promoting a cycle of damaging high-severity fires which gradually result in the fragmentation and overall decline in the extent of these areas. Grader grass *Themeda quadrivalvis* may also be an issue in some areas.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

A gidgee dominated woodland with an understorey of buffel grass.
Justine Douglas, QPWS, Moorrinya National Park (2011).

Chapter 5: Springs and dune communities

This fire vegetation group includes fringing communities on perennial springs as well as fire-sensitive dune communities. Springs are found within the south and west of the Gulf Plains bioregion and may not always be visible in regional ecosystem mapping due to their small size. In areas such as Bulleringa National Park they are found in gullies and gorges with dense grasses and some softwood species. Ferns may grow in patches on gorge walls. They are generally surrounded by open eucalypt woodland and are considered 'endangered'. Springs on alluvium, also considered 'endangered', are often dominated by river red gum *Eucalyptus camaldulensis* and/or *Melaleuca leucadendra* and sometimes have peat soils when active. Springs often have significant material and cultural importance to Aboriginal people (DERM 2005). Coastal she-oak *Casuarina equisetifolia* low open woodland is found on dunes adjacent to the estuarine zone and swamp paperbark *Melaleuca quinquenervia* open forest occurs in swales. These are fire-sensitive dune communities.

Fire management issues

The main issue when burning around springs is ensuring there is sufficient moisture to protect the peat layer and fire sensitive soft wood species. If a spring surface has become dry from reduced water flow, there is a risk that fire can spread into the underground peat layer.

Coastal she-oak trees are highly sensitive to fire and fire has a significant impact on these communities. Do not intentionally burn and actively protect them from fire.

Mitigating wildfires is also important to maintaining the health of these ecosystems. Proactive fire management in surrounding fire-adapted areas will assist in mitigating the impacts of unplanned fire.

Issues:

1. Limit fire encroachment into springs and dune communities.
2. Avoid peat fires.

Extent within bioregion: 3 333 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: None on QPWS estate.

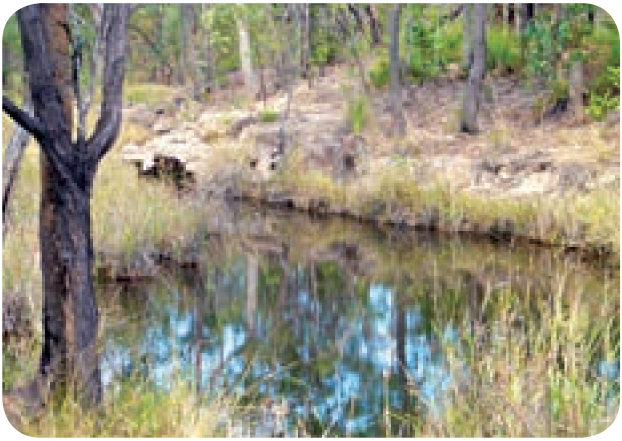
Issue 1: Limit fire encroachment into springs and dune communities

Some plants, such as some softwood species, occur in springs and are particularly fire-sensitive. Care should be taken to ensure they are retained in spring ecosystems. Peat soils may exist in springs on either sandstone or alluvium. Fire should not be applied if peat is dry and if standing water is not visible, the peat should be waterlogged (refer to Issue 2).

Patchy to low-severity burns in surrounding areas in the late wet season to early dry season, that on some occasions trickle into spring communities will be useful to reduce fuel loads and mitigate impacts of wildfire. Early dry-season burns on flood debris and fine fuels on terraces that aim to develop a mosaic of burnt areas may also be necessary to mitigate the impacts of wildfire. These should be lit annually with the aim of burning a number of small patches.

Swamp paperbark open forest may be self-protecting under mild planned burning conditions however high severity fires are potentially a threat. The presence of high biomass grasses and rubber vine may also increase fire severity.

Coastal she-oak open forest contains species highly sensitive to fire and all fires should be excluded. Ensuring fires within adjacent fire-adapted communities mitigate wildfire will assist in their protection. Where practical, a rake-hoe line dragging the blade through she-oak needles can also give added protection.



Wildfires are considered a major threat to springs at Bulleringa—softwood species are potentially vulnerable. Burn in the early dry season or in cool winter months with soil moisture.

QPWS, Donkey Springs, Bulleringa National Park.

Some parts of the spring system are naturally protected from wildfire, while others will need active protection.

QPWS, Donkey Springs, Bulleringa National Park.

Some active springs feed rivers whose banks contain riparian vegetation with different fire requirements to the spring itself. Refer to Chapters 1 and 3 for guidelines for managing riparian areas.

Nick Smith, QPWS, Red River fed by Donkey Springs (2012).

Mangrove, saltmarsh, swamp paperbark and coastal she-oak woodland communities have differing fire responses. Careful planning of fires in adjacent areas is required.
Carly Greig, EHP, Finucane Island National Park (2010).

Coastal she-oak is killed by fire and may require active protection during wildfires or nearby planned burning operations.
Carly Greig, EHP, Finucane Island National Park (2010).

Issue 2: Avoid peat fires

Some spring ecosystems gradually accumulate partially decayed, densely packed vegetation known as peat. In the absence of good soil moisture the peat is easily ignited resulting in a peat fire. Peat fires can burn for months and can have very negative impacts on the whole ecosystem. Peat takes hundreds of years to re-form.

Awareness of the environment

Key indicators of suitable conditions to avoid peat fires:

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

While standing water is visible, care should be taken to check all areas containing peat prior to implementing planned burns in or around springs.

Rod Fensham, Queensland Herbarium, Black Spring, Pelham Station (1999).

Discussion

- Due to its porous nature and high carbon content peat is easily ignited when dry, the resulting fire can damage ecosystems and burn / smoulder for an extended period of time, causing re-ignitions.
- Be aware of peat issues when burning in areas adjacent to spring ecosystems. The condition of the peat should be checked to ensure that if fire encroaches, a peat fire will not be ignited. Alternatively indicators such as running water or previous wet season rainfall may provide guidance as to the condition of the peat. If it is necessary to burn adjacent areas in less than ideal conditions, manage the fire carefully to minimise the risk of fire entering peat. Tactics such as burning away from the edges of spring areas may assist in protecting peat.
- The conservation of springs is extremely important as they have considerable environmental values (including unusual endemic flora and fauna) indigenous cultural heritage values.
- Some springs are not threatened by fire as they are not vegetated and do not form peat layers (e.g. mud springs and rocky areas).

The peat layer of this spring community is vulnerable to fire. Ensure peat is water logged or moist when applying fire in adjacent communities.

Rod Fensham, Queensland Herbarium, Black Spring, Pelham Station (1999).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- Low severity fire in the surrounding fire-adapted areas will help to manage fire encroachment.

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

- Fire frequency should be determined by the surrounding fire vegetation community.

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 dry season or winter months (cool conditions) when fuel is sufficiently cured to carry fire. Care should be taken following periods of drought as this is when peat is most likely to ignite.

FFDI: < 18

DI (KBDI): 80–120

Wind speed: < 15 km/hr

Soil moisture: Standing water, or water logged peat, is the critical factor that will avoid peat fire.

What burn tactics should I consider?

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

- **Spot ignition**. Spot ignition can be used effectively to alter the desired severity of a fire. 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 severity fire.
- **Limit fire encroachment into non-target communities.** Use appropriate lighting patterns along the margin of the non-target community to promote a low intensity backing fire that burns away from the non-target community. **Do not create a running fire.**
- In upland areas **target woodlands above the springs** early in the season, to prevent later fires entering the spring proper.

Chapter 6: Vine thickets

Vine thickets occur as low closed forest on mudstone with a sparse shrub layer or as semi-deciduous vine thickets on beach ridges (beach scrub). They are surrounded primarily by grassy open eucalypt or estuarine communities.

Fire management issues

Some of the vine thicket communities in the Gulf Plains have the biodiversity status **'of concern'**. A key conservation issue for this fire vegetation group is the further attrition of some vine thickets due to the increasing number of late dry-season fires.

Sometimes vine thickets are somewhat protected from fire by their position in the landscape or lack of flammable grasses in the ground layer. Although some individual plant species have the capacity to propagate from roots and trunks after minor fire damage, the majority of vine thicket species are generally regarded as fire-sensitive (QPWS 2007). Do not intentionally burn.

Occasionally, fire is used in vine thickets for control of woody weeds such as rubber vine. Fires to manage woody weeds in vine thicket should be of limited extent and severity. Once weed control is achieved it is important to then protect these communities from further fires.

High biomass grasses such as grader grass *Themeda quadrivalvis* exist within and around some vine thickets. High biomass grasses can increase the severity and extent of fires in previously self-protecting vine thickets.

Limit fire encroachment or scorching of vine thickets by undertaking low severity burns in adjacent fire-adapted communities.

Issues:

1. Limit fire encroachment into vine thickets.
2. Reduce woody weeds.
3. Manage high-biomass grasses.

Extent within bioregion: 3969 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: None on QPWS estate.

Issue 1: Limit fire encroachment into vine thickets

The main strategy is to undertake early dry-season, low-intensity burns in adjacent fire adapted communities. Sometimes it may be necessary to burn away from vine thicket edges.

The beach scrubs of the Gulf of Carpentaria are frequently impacted by wildfires caused by careless campers, fishers and others. These may require active protection from unplanned fire.

Refer to Chapter 8 (Issue 6), regarding fire management guidelines.

Issue 2: Reduce woody weeds

Rubber vine *Cryptostegia grandiflora* is presently found throughout the bioregion in moderate to very dense infestations including within vine thickets. Rubber vine is fire-sensitive and eradication has been achieved in some areas using fire alone. Once control of rubber vine is achieved it is important to then prevent further fires from impacting the vine thicket vegetation.

Refer to Chapter 8 (Issue 4), for fire management guidelines.

Issue 3: Manage high-biomass grasses

Some species of invasive grasses such as grader grass can invade and draw fire into vine thickets. If excluding fire from infested areas adjacent to vine thickets is not possible, a low severity backing fire at intervals not more frequently than every five years could be considered, providing follow-up herbicide treatment of invasive grasses occurs. Mossman River grass can also impact vine thickets and can be managed with fire in some cases.

Refer to Chapter 8 (Issue 5), for fire management guidelines.

Chapter 7: Mangroves and saltmarshes

Mangroves and saltmarshes are found near or within estuarine or brackish water. They are periodically inundated through tidal action and storms. Mangroves occur in stands (along tidal zones), as low trees or shrubs with very little other vegetation present. Saltmarsh is dominated by salt adapted sedges or grasses with other plants sparse.

Fire management issues

Mangroves do not require fire and are somewhat self-protecting under mild burning conditions. Sometimes mangroves can be scorched by nearby planned burning operations or wildfire. Care should be taken to burn away from the edges of mangrove communities or use high tides to assist in their protection (Williams and Greig 2010).

Saltmarsh swamp paperbark open forest is sometimes potentially flammable however it is not actively protected from fire in the Gulf Plains bioregion and probably burns occasionally in association with fires in the surrounding landscape.

Issues:

1. Limit fire encroachment into mangrove and saltmarsh communities.
2. Reduce woody weeds.

Extent within bioregion: 551 315 ha, 2 per cent; Regional ecosystems: Refer to Appendix 1 for complete list.

Examples of this FVG: Finucane Island National Park, 6 071 ha; Mutton Hole Wetlands Conservation Park, 5 315 ha.

Issue 1: Limit fire encroachment into mangrove and saltmarsh communities

Under low to moderate planned burning conditions mangroves are generally not fire-sensitive, however they can be scorched by higher-severity fire. If protection is required the main strategy is to burn at high tide or following recent rain with groundwater seepage. If these conditions cannot be achieved, use tactics such as burning away from the edges of these communities.

Grasses within saltmarsh communities are fire-tolerant and regenerate rapidly after fire, however they are usually interspersed with samphire plants that do not tolerate frequent fire (Williams and Greig 2010). Ensuring fires are not frequent and burning when soils are moist would assist in maintaining the samphire component of this community.

Refer to Chapter 8, Issue 6, for fire management guidelines.

Fire-killed mangroves. Care should be taken to burn away from these trees in planned burning operations which pose a threat of fire incursion.

Carly Greig, EHP, Finucane Island National Park (2010).

Issue 2: Reduce woody weeds

Fire can be an effective tool in the control of rubber vine *Cryptostegia grandiflora*. Rubber vine is fire sensitive and eradication has been achieved in some areas using fire alone. *Calotrope Calotropis procera* is also present but the effect fire on these species is limited due to its soft, spongy nature and ability to resprout from a lignotuber (DEEDI 2011). Some monitoring sites exist on Finucane Island which gauges the effect of fire on these weeds and the recovery of the treated vegetation communities.

Refer to Chapter 8 (Issue 4), for fire management guidelines.

Fires in salt couch/samphire forblands may assist to manage woody weeds such as rubber vine.

Carly Greig, EHP, Finucane Island National Park (2010).

Chapter 8: Common issues

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

Fire management issues

Issues:

1. Hazard reduction (fuel management) burns.
2. Planned burning near sensitive cultural heritage sites.
3. Reduce overabundant saplings and seedlings.
4. Reduce woody weeds.
5. Manage high-biomass grasses.
6. Limit fire encroachment into non-target fire vegetation communities.
7. Cyclones and severe storms.

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.

Frequent, intense late-season fires often cover vast areas. They threaten life and property and have been shown to have significant impact on conservation values and native species. The main strategy for managing these fires is through broad-scale mosaic burning within the fire-adapted landscape (for example see Chapter 1: Eucalypt communities).This hazard reduction guideline (this issue) is for the management of protection and wildfire mitigation zones, and does not cover broad-scale fire management within the broader landscape.

Awareness of the environment

Main indicators of where fire management is required:

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

Or

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

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

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

Discussion

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

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

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

- 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.

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).

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

- **Protection zones:** 90 per cent burnt.

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.

Western (drier) areas	Eastern (moister) areas
Season: Burn in the early dry seasons where overnight conditions will extinguish the fire. Daytime conditions will allow a good coverage of fire.	**Season:** Burn when conditions are dry enough to ensure a good coverage of fire. Avoid periods of increasing fire hazard in the very late dry season.
GFDI: < 11	**GFDI:** < 11
DI (KBDI): 80–100	**DI (KBDI):** 80–180
Wind speed: < 15 km/hr	**Wind speed:** < 23 km/hr

Relative humidity (RH): Burn during high relative humidity to achieve a low to moderate-severity burn. This will reduce the potential impact on infrastructure during hazard reduction burns. Cloud cover may also be of use.

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

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

What burn tactics should I consider?

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

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

Targeting rank or standover grasses through broad-scale aerial ignition with widely spaced incendiaries. In the right conditions techniques such as this will assist in impeding wildfires later in the season and meeting conservation outcomes such as retaining a level of patchiness leading to increased diversity.

Nick Smith, QPWS, Bulleringa National Park (2012).

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

- Raised mounds (especially with visible shell debris) or the presence of shell debris scattered on the ground can indicate the presence of shell middens.
- Rock shelters, especially if they have rock paintings, stone tools, artefact bundles, wrapped material or bones inside.
- Engravings on trees or rock faces.
- Arrangements of stones or raised earth patterns on the ground, or artefacts scattered on the ground.
- The presence of trees that have been scarred or carved.
- Natural features which have significant cultural meaning and are associated with stories are identified.
- The presence of burial sites.

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.

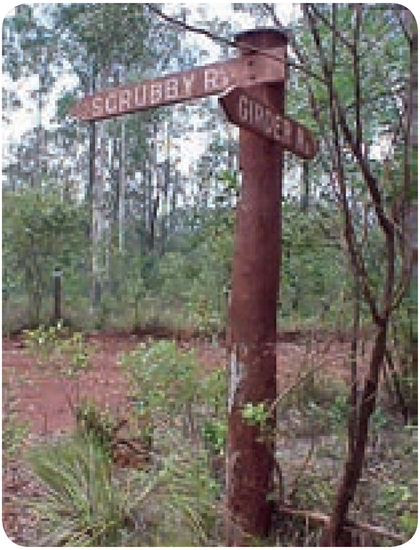
David Cameron, DNRM, Bribie Island (2005).

Key indicators of European cultural heritage sites:

- Presence of building remains, corrugated iron shacks, wooden house stumps, old fence posts, old stock yards, tombstones, wells, graves, bottle dumps, old machinery and iron debris.
- Quarries and old mine sites (sometimes deep holes covered with corrugated iron or wood).
- Forestry artefacts including marked trees (shield trees), and old machinery such as winders (timber tramways) and timber jinkers (timber lifting wagon).
- Military artefacts such as old equipment and used ammunition are found.
- Survey and trig points present.
- Historic fence-lines remain.
- Markers from early European explorers are located.

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

David Cameron, DNRM, Dogwood Creek (2005).



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

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

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

David Cameron, DNRM, various locations.

Discussion

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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)
No impact on item or site of cultural heritage significant.	Visual inspection of site or items with supporting 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.

Landscape mosaic

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

What weather conditions should I consider?

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

Season: Favour early season burning and moist conditions

FFDI: < 11

GFDI: < 18

DI (KBDI): 80–120

Wind speed: < 15 km/hr

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

Soil moisture: Ensure good soil moisture

What burn tactics should I consider?

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

- **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 are preferred in this instance as it will promote a slow moving and manageable low severity fire and limit the chance of high severity junction zones developing.
- While a low intensity backing fire is recommended, a **running fire** of a higher intensity may be required initially where there is an accumulation of surface or uncured fuels. Use with caution and be aware of environmental impacts that may result. To create higher intensity, **spot light the windward (clear) edge**.
- **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.

Natural features such as springs and waterholes can have significant meaning to Traditional Owners. A very high priority should be placed on their careful management.
QPWS, Bulleringa National Park.

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

Issue 3: Reduce overabundant saplings and seedlings

In the Gulf Plains bioregion an overabundance of *Melaleuca* spp., *Eucalyptus* spp., *Acacia* spp. and in some areas currant bush *Carissa lanceolata*, quinine *Petalostigma* spp., gutta percha *Excoecaria parvifolia*, *Gardenia vilhelmii*, or other species may reduce the health and diversity of the ground layer through competition and shading. If left unmanaged, the structure of woodlands and forests can become more closed and grasslands can become woodlands; a process known as woody thickening. As woody thickening progresses, fires become more difficult to reintroduce.

Awareness of the environment

Key indicators

- Significant numbers of young trees are beginning to emerge above ground layer plants. It is not an issue if the area affected is small or isolated or young trees are scattered.
- Overabundant young trees are in the mid stratum. The mid stratum is becoming difficult to see through.
- Grasses are becoming scattered, other ground layer plants are declining in health, diversity and abundance due to shading.

Woody thickening can occur where fires have been absent or infrequent. This Cooktown ironwood *Erythrophleum chlorostachys* has thickened in the mid-stratum and if left unmanaged will shade out grasses.

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

This gutta percha has thickened due to high grazing pressure. leading to reduced fuels for planned burning.

Bernie English, DAFF, Croydon District (2008).

Sometimes trees such as the tooth brush Grevillea can appear to have thickened. In this location it is in fact a natural canopy. Understanding the past land use and fire history of an area can assist in determining if thickening is an issue.

Lana Little, QPWS, Staaten River National Park (2009).

Discussion

- An overabundance of saplings in the understorey may be triggered in response to:
  - a lack of, or a long absence of fire
  - heavy grazing
  - a high rainfall event or severe fire event which has exacerbated thickening (due to one of the above causes).
- Certain eucalypts can germinate en masse. In the absence of fire, seed stock can build up, which is likely to lead to a mass germination event after fire. Where this has occurred in areas where past management practices have caused thickening, it is likely that more than one fire will be required to address the issue. Post fire observations are essential to monitor the kill rate and germination of these species in order to ascertain the need for subsequent fires.
- Melaleuca and eucalypt saplings are unlikely to be killed outright by fire; rather they will be reduced to below the grassy layer and regenerate from root stock. Seedlings are more vulnerable however and given sufficient fuel may be killed by fire. If seedlings are observed and appear to be thickening a fire should be applied as soon as fuel and conditions allow, as within a very short time frame (sometimes only a single year) it may no longer be possible to kill them.
- For eucalypts and some acacias and other trees, seedling recruitment is most likely to occur during high rainfall years. In areas where fires have been maintained or grazing pressure is low, this does not usually result in a problem. However, rainfall triggered seedling recruitment may compound thickening where it already occurs. Following high rainfall events, carefully observe areas where past management practices have caused thickening and consider implementing a planned burn as soon as conditions allow.
- Woody thickening becomes much more severe where heavy stock grazing is combined with repeated early season burns or a lack of fire. Stock grazing reduces fuel loads, preventing fires of sufficient severity to manage overabundant seedlings/saplings. This is further compounded by cattle concentrating on regrowth grasses in the recently burnt areas and avoiding 'toxic' plants such as some quinine trees allowing woody species the competitive advantage. Spelling pasture for a time before and after fire may assist in this issue.
- In some areas, an abundance of some shrubs and trees are part of the natural fire ecology cycle. Implementing fire management appropriate to the fire vegetation group in which they occur is adequate to maintain these areas. Knowing the fire history of an area and individual species response to fire will help determine if thickening has become a problem.

What is the priority for this issue?

Priority	Priority assessment
High	Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**.
Medium	Planned burn in areas where **ecosystem health** is **poor** but recoverable.
Low	Planned burn in areas where **ecosystem** structure and function has been **significantly disrupted**.

Fire management of young trees in a eucalypt community (December 2008). It may be that these trees resulted from flooding that occurred in early 2008.
Bernie English, DAFF, Near Mt Garnet (2008).

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 75 % of mid stratum saplings are reduced.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity), estimate the percentage of overabundant saplings (above ground components) scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.
Increase the size of grassland.	At a number of locations on the boundary of grasslands and woodlands establish photo monitoring points. Return to these locations to check if the grassland is expanding/ woodland retreating.	**Achieved:** Grassland expanding/woodland retreating. **Partially Achieved:** No change. **Not Achieved:** Grassland continues to retreat/woodland expand. * a number of fires over a long period may be required to eventually kill trees.

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?

Residence time

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

Mosaic (area burnt within an individual planned burn)

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

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

- More than one planned burn will be required to manage this issue. Monitor outcomes until overabundant saplings/seedlings are controlled.
- In some cases it may be sufficient to apply fires at the lower end of the recommended fire frequency for a time to manage overabundant saplings/ seedlings.

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

- **Moderate** for most situations where young trees are less than 1 metre tall. Where young trees are taller than 1 metre, a **high**-severity fire might be necessary. Use high-severity fire with caution. Avoid lower-severity fire, as this will exhaust fuel and reduce opportunities for subsequent higher-severity burns.
- A fire regime of repeated low-severity burns will exacerbate the issue.

Other considerations

- It is important to observe post fire germination, regeneration and kill rates to ascertain the need for subsequent fires. If the initial fire triggers a flush of new seedlings, follow-up planned burn as soon as enough fuel builds to create a moderate to high-severity fire.
- Once the area has recovered, the recommended regime for the fire vegetation group be resumed (refer to relevant chapter).

What weather conditions should I consider?

Season: Progressive burning through the year as conditions allow in surrounding healthy areas will make it much easier to achieve higher severity burns **later in the season** that will help address overabundant saplings.

GFDI: 8–18

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

What burn tactics should I consider?

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

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

Issue 4: Reduce woody weeds

Rubber vine *Cryptostegia grandiflora*, parkinsonia *Parkinsonia aculeata*, *Vachellia farnesiana* (sometimes known as prickly mimosa or mimosa bush) and prickly acacia *Vachellia nilotica* are common within the Gulf Plains bioregion. Other woody weeds such as Chinee apple *Ziziphus mauritiana* and mesquite *Prosopis* spp. are also found but are less common. Neem *Azadirachta indica* is causing considerable concern due to the rapidity of its spread. Fire may assist in the control of some species.

Parkinsonia forms dense thickets particularly along water courses, floodplains and in wetlands, endangering many threatened species and communities through displacement of native species, erosion and clogging of watercourses.

Rubber vine has the ability to smother trees and shrubs and shade out grasses making fire difficult to apply. It is usually found in riparian areas, floodplain woodland and dry creek beds.

Vachellia farnesiana (also known as **mimosa bush or prickly mimosa**) grows in similar circumstances to parkinsonia but can also invade dry open grasslands and is able to form dense stands.

Prickly acacia is particularly damaging to grasslands where it can shade out native species, form dense thickets and eventually replace grasslands with shrubland/woodlands in which fires become difficult to reintroduce.

Awareness of the environment

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

- Woody weeds occur in fire-adapted vegetation or fire extent can be limited in fire-sensitive vegetation.
- Grass or forbland fuels are still sufficiently continuous to carry fire despite the occurrence of woody weeds.
- Grass fuel crumbles in the hand meaning it is sufficiently cured to carry fire.
- Biocontrol agents may be present and increase the effectiveness of fire as a control method (e.g. rubber vine is infected with rubber vine rust or parkinsonia affected with parkinsonia dieback).

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

- Woody weeds occur in areas of insufficient fuel to sustain fire.
- Woody weeds occur in fire-sensitive vegetation and fire spread cannot be limited.
- There is a risk of fire outside the burn plot (e.g. spotting across a creek).
- Woody weeds are within or adjacent to fire-sensitive cultural sites or infrastructure.
- Control of woody weeds can not be achieved using fire alone. A combination of control methods is required.

Prickly acacia is of particular concern to native grasslands. If detected early, fire can be used to control the saplings and seedlings. However fire is much less effective on mature plants.
Kerensa McCallie, QPWS, 30 km east of Hughenden (2011).

Considerable effort has been put in to the control of parkinsonia on Moorrinya National Park.

Eleanor Collins, QPWS, Moorrinya National Park (2003).

Parkinsonia flowers.

Eleanor Collins, QPWS, Moorrinya National Park (2003).

Prickly mimosa (mimosa bush) likes wetter sites such as this dam bank. This infestation has since been eradicated.

Eleanor Collins, QPWS, Moorrinya National Park (2009).

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

Barry Nolan, QPWS, Cape Upstart (2008).

Results of successful rubber vine control in a floodplain eucalypt community. The fire was intense enough to kill mature rubber vine and smaller trees.

Carly Greig, EHP, Finucane Island National Park (2010).

Discussion

- Many species of woody weeds appear similar and care should be taken to ensure **accurate identification** before trialing any control method. Failure to do so could result in worsening the existing infestation.
- A single fire can be used to reduce or eliminate seeds, seedlings and young plants of some woody weeds where sufficient fuel is available (success rate is dependant on species). Follow-up fires may be required should some seeds survive in the seed bank or plants resprout.
- Care needs to be taken to identify infestations of new weeds, as they are much easier to control at early stages.
- Young plants/seedlings of woody weeds are more easily controlled with fire than mature plants.
- Planned burning in areas with woody weeds should always be conducted when the soil is moist to allow native species, especially grasses and forbs, the best chance of re-establishing.
- In areas where rubber vine or parkinsonia have shaded out native grasses, mechanical or chemical control may be necessary. A combination of fire and chemical control could also be useful where grasses abut an infestation. A backing fire into the woody weeds may reduce the area requiring chemical treatment or increase accessibility.

- Care should be taken using fire where fire-adapted communities abut fire-sensitive communities. Dead plant material or high severity fire could draw fire in to these communities.
- Be aware of weed hygiene issues when burning in areas with woody weeds. Fire vehicles and machinery can aid seed spread along firelines roads and tracks and should be washed down after exposure.

Parkinsonia

- Parkinsonia is broadly distributed within the bioregion with most areas affected to varying degrees. When trialing fire to control parkinsonia, record observations, as this information is useful to guide future fire management (there is still much to learn about fire and parkinsonia).
- Fire will kill seeds on or close to the ground and has been shown to reduce the viability of seeds remaining suspended on the plant.
- Where 'parkinsonia dieback' (a soil-borne fungus) is present, fire seems to promote the rapid spread of this pathogen amongst the surviving plants. Parkinsonia affected with the dieback will appear to be dying back from the tips of the branches, with dead leaves remaining attached to the plant. Brown staining within the stems and branches may also be a good indicator of die back. In well established areas of dieback, the fungus will spread through the soil infecting nearby trees. Parkinsonia plants with dieback may be more susceptible to control with fire.

Rubber vine

- Fire is known to be very successful in killing rubber vine. Therefore fire should be considered part of rubber vine control. But in fire-sensitive areas use fire with care and limit fire spread (it may not be possible to use fire in these areas depending on fuel availability and likely impacts on fire-sensitive species, and chemical control may be a better option).
- Rubber vine is not restricted to disturbed vegetation and prefers a good layer of organic material in the soil. It is restricted to areas where fires are absent or infrequent (Mackey et al. 1996).
- A 'heli-torch' can be used to control rubber vine in fire-sensitive communities, inaccessible areas or where chemical use is not viable. The flammable petroleum based gel is applied directly to the plant then ignited. In some areas this method has been very successful but mixed results in other areas have been reported. See tactics below.
- Using fire to control rubber vine is more successful in areas where rubber vine rust occurs. While rarely killing mature plants, leaf-drop caused by the rust increases fuel depth below infected plants and opens the canopy allowing grasses to grow. If this fuel occurs adjacent to the stems it can increase residence time or carry the fire through areas where it may previously have extinguished, which may increase the effectiveness of fire as a method of control.

Prickly acacia

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

Mimosa bush or prickly mimosa

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

Mesquite

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

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.

Like other woody weeds chinee apple, seedlings are susceptible to fire but mature plants may quickly regrow.

Kerensa McCallie, QPWS, Chillagoe (2012).

Assessing outcomes

Formulating objectives for burn proposals

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

Choose from below as appropriate:

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

Significant reduction in abundance of woody weeds.	Seek advice from resource staff and/or publications such as the Parks Victoria Pest Plant Mapping and Monitoring Protocol (Parks Victoria 1995). One option is given here. **Before and after the burn** (after suitable germination/establishment conditions and growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–50 % cover) = 1/4 weed cover to equal proportions of weed to native species. • Medium-dense (51–75 %) = equal proportions of native to ¾ weed cover. • Dense (> 75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation 'drops' two 'density categories' (e.g. goes from medium-dense before the fire to light after the fire). **Partially Achieved:** Weed infestation 'drops' one 'density category'. **Not Achieved:** No change in density category or weed density gets worse.

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

Monitoring the issue over time

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

Photo monitoring points are established on Finucane Island National Park to monitor the reduction in rubber vine.

Rubber vine can be dense in areas on Bulleringa National Park. Notice the scrambling nature of the rubber vine as it reaches into the tree. Without control it will smother the tree, eventually killing it.

QPWS, Bulleringa National Park (2010).

Fire parameters

What fire characteristics will help address this issue?

Key factors

- The principal factor in successful control is residence time. Slow-moving fire is required to kill mature trees although severity can also be important (to scorch plants). This is species dependant.
- Seeds, seedlings and saplings of most woody weeds are the life stages most vulnerable to fire. Planned burning should be conducted as soon as possible once an infestation is detected to increase its effectiveness.

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

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

Fire severity

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

What weather conditions should I consider?

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

Season: Early to mid dry and occasionally late dry

GFDI: < 20

DI (KBDI): 80–180

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

Other considerations: In some western areas, greater woody weed control has been achieved using low humidity and high temperatures (e.g. 20 per cent humidity and 30°C). In the southern gulf successful burns targeting rubber vine have been conducted at 30–40°C and 40–60 per cent humidity, following rain.

What burn tactics should I consider?

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

- **Storm burning**. Burns undertaken in the storm season around the time of the first rains. Containment of storm burns relies on impending rain, natural breaks or earlier-season burning having established areas of lower fuel sufficient to impede the passage of later fires.
- A **running fire** of a higher severity may be required to carry fire through areas of low fuel or dense thickets or increase scorch of trees.
- **As part of a control program**. In areas where dense woody weeds shade out grasses limiting fuel available for fire, initial herbicide treatment or mechanical methods could be used. Care should be taken when applying fire to dead rubber vine plants which remain hanging in the canopy as they may act as elevated fuels.
- **A low to moderate severity backing fire.** Where woody weeds are scattered in the understorey, a slow moving, low to moderate-severity backing fire with good soil moisture (and presence of sufficient surface fuels), ensures a greater residence time at ground level and has proven to be successful in killing seeds, seedlings, young and some mature plants.
- **Aerial incendiary with a 'heli-torch'** may help control the issue. This involves aerial incendiary using gelled gasoline to ignite the plants directly in fire sensitive areas. In riparian areas the surrounding vegetation needs to be moist to wet to ensure the fire doesn't spread. A balance will need to be met between ensuring the surrounding vegetation is moist enough that it will not ignite while the woody weeds are dry enough to burn. In fire adapted communities with dense infestations other techniques such as 'central lighting' could possibly be used with caution. Etheridge Shire Council (2011) has details of this and other successfully used tactics for the management of rubber vine.

Issue 5: Manage high-biomass grasses

Exotic grasses are capable of outcompeting native species to form dominant stands. High-biomass grasses of concern in the Gulf Plains are gamba grass *Andropogon gayanus*, buffel grass *Cenchrus ciliaris* and grader grass *Themeda quadrivalvis*. The latter two are currently present. Gamba grass, already well established in Cape York, is climatically suited to the Gulf Plains and a serious concern. Other high-biomass grasses considered emerging weeds are olive hymenachne *Hymenachne amplexicaulis* cv. *Olive*, para *Urochloa mutica*, Guinea *Megathyrsus maximus* and thatch grass *Hyparrhenia rufa*. These grasses have the ability to increase fuel loads, fire intensity, spotting and flame height which leads to increased fire severity and spread. This results in greater tree death and loss of habitat features with flow on effects to species. Exotic grasses can carry fire into fire-sensitive vegetation resulting in considerable damage.

While fire may not be a recommended management tool for some grass species, it can be effective as part of a control program. It is important to know which grass you are dealing with and what its fire response is prior to burning. They tend to occur as a result of disturbance and spread along firelines, roads, water courses and utility easements.

Awareness of the environment

Key indicators

- The presence of high-biomass grasses, usually occurring in a dense infestation.
- Presence of single species dominated stands.
- Generally taller than native species.
- Lots of mass and/or dead material.

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

Grader grass seed head.

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

A close up of the flowering head and clump mass of buffel grass.

Paul Williams, Vegetation Management Science Pty Ltd, Normanton (2011).

Discussion

- Be on the look out for newly forming stands and be especially vigilant in disturbed areas, particularly those where disturbance is ongoing (e.g. roadsides) and areas adjacent to or down stream from existing high biomass grass infestations (Melzer and Porter 2002). Control is often easier if their presence is detected and addressed early before it has become established.
- In many cases, it is desirable to avoid burning high biomass invasive grasses due to the likely increase in fire severity and the potential to promote them; however the risk of wildfire later producing an even higher severity fire must be considered. In some situations, burning high biomass grasses under mild conditions with planned fire is more desirable than allowing them to burn with wildfire.
- Prior to undertaking planned burns in areas where high biomass grasses occur become familiar with the response of the grass to fire (e.g. if it is promoted or killed) and other factors such as fire severity type and weather conditions which may favour and further its spread.
- High biomass and other invasive grasses cause the progressive loss of fire sensitive communities and also increase the risk of wildfires (particularly during dry conditions) carrying into the canopy of the community and causing the loss of mature trees. This contributes to the gradual decline and fragmentation of the extent and/or loss of a population, of fire sensitive communities. Be aware that a combination of dense invasive grasses (not just high biomass grasses in mostly monospecific stands) is also potentially damaging to fire sensitive communities.
- There is a relationship between fire timing, frequency and severity and the ability of these grasses to invade which is still poorly understood. You are encouraged to record observations regarding these species' response to fire and record them in ParkInfo or report the information to Biosecurity Queensland.
- 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.
- Once an area has been impacted by invasive grasses (in particular within fire sensitive communities) the aim of the land manager often becomes one of fuel management. This may involve implementing mild or 'cool' fires both within the site and in surrounding areas by implementing appropriate tactics to burn away from the non-target community and limit edge effects on the margin. Other techniques which may be effective include slashing, spraying with herbicide and in some instances grazing (Melzer and Porter 2002; Butler and Fairfax 2003).

Buffel grass *Cenchrus ciliaris*

- Buffel grass is a long-lived perennial invasive grass (individual tussocks may live up to 15–20 years), that has become widespread in the Gulf Plains. 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).
- The regenerative traits of Buffel grass means that it has a competitive advantage over native grasses which are shorter lived and rely on conditions suitable for germination (e.g. good soil moisture). Buffel grass has the ability to carry a fire at much shorter intervals than native grasses (Miller et al. 2010). It cures later in the dry season thus promoting late season wildfires.
- Fire alone is not known to be an effective tool to manage buffel grass. A 'positive feedback' loop has been described for the relationship between buffel grass and hot fires (Butler and Fairfax 2003), in which buffel increases fuel loads and thus damage to remnant vegetation, at the same time creating a disturbance which favours its spread. The same phenomenon has been observed to occur with increased grazing pressure (Eyre et al. 2009). Buffel grass is further promoted by fire as seeds germinate more quickly when sown on burnt ground. Grass seeds sown on unburnt ground can take up to two years to germinate.
- The use of fire to control buffel grass is often debated. While not a direct control measure, 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.
- Where buffel grass occurs within or adjacent to fire sensitive communities, it poses a threat by altering fuel dynamics (connectivity, biomass and height).
- At the end of the growing season, buffel grass is more susceptible to fire as it stores reserves at that time. Late summer fires may reduce its ability to compete with native species over time (Chamberlain 2003).
- The curing rate for buffel grass differs from that of native tussock grasses and tends to remain greener for longer periods of time. Careful 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 plan burns at differing times of the year (e.g. earlier or later in the season).

Grader grass

- Grader grass has been recorded in the northern gulf plains adjacent to the coast north of about Normanton and within the Gilbert and Walsh River catchments (but does occur elsewhere). Be aware of new infestations which can quickly take hold and ensure they are dealt with as a matter of priority.
- Grader grass is a weed of disturbance. Soil disturbance (e.g. road grading) can expose seed allowing favourable conditions for establishment and spread.
- Fire is not considered to be an effective tool to manage grader grass. Unless the fire can be implemented prior to annual seed set in late February/March, the burning will open up the ground layer and encourage seed germination. If fire can not be avoided in areas of grader grass, the fire frequency should be limited to > five years.
- Seedlings which germinate following fire should be sprayed with herbicide.

Para grass

- Found in wetter areas such as sedgelands and springs.
- Fire can be used with partial success for the management of para grass where it occurs in swamps and drainage lines. Fire kills a small proportion of para grass plants and by temporarily removes the large bulk of para grass biomass. Fire is more effective where the para grass is within ephemeral swales which have dried out (limited windows of opportunity in the late season). Burning has been found to be more effective if used in combination with post-fire chemical control of sucker shoots.

Guinea and thatch grass

- Fire is not known to be an effective tool to manage Guinea and thatch grass. However, frequent fire (every one to two years) promotes their spread through disturbance mechanisms and possibly through reducing canopy cover.
- Post fire herbicide control has been effective but needs to be ongoing.
- If guinea grass must be burnt, timing is a critical factor. Avoid burning late in the season for a variety of reasons including the risk of creating high severity fire and encroachment into riparian zones.

Buffel grass can recover quickly after fire and outcompete native grasses.
Justine Douglas, QPWS, Boodjamulla (Lawn Hill) National Park (2012).

A buffel grass infestation in a gidgee *Acacia cambagei* woodland. The presence of buffel grass will increase fire intensity and flame height, contributing to tree death.
Paul Williams, Vegetation Management Science Pty Ltd, Cloncurry area (2012).

Grader grass forming a monospecific stand amongst native grasses is easy to spot due to its height and distinctive reddish colour when in fruit.
Mike Ahmet, QPWS, Blackbraes National Park (2008).

Guinea grass is much taller than most native grass species and greatly increases fire severity when burnt.
Kerensa McCallie, QPWS, Jubilee Pocket (2012).

What is the priority for this issue?

Priority	Priority assessment
High	It is important to be aware of the presence of invasive grasses (particularly where it is a new infestation) so that their negative effects can be managed and the potential for effective control can be considered.

Assessing outcomes

Formulating objectives for burn proposals

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

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Distribution of invasive grass has not increased as the result of the burn.	**Before and after the burn** (after suitable germination/ 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) or no change. **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 Assessment Guide (Hines et al. 2010b), or Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations.	**Achieved:** Fuel hazard has been reduced to low. **Not Achieved:** Fuel hazard has not been reduced to low.

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

Monitoring the issue over time

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

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

Fire parameters

Varies depending on species, refer to the discussion above.

What burn tactics should I consider?

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

- **Limit fire encroachment into non-target communities.** Use appropriate lighting patterns (e.g. spot lighting with matches) along the margin of the community in combination with favourable weather conditions, to promote a low intensity backing fire that burns away from the non-target community. Undertaking burning in areas adjacent to invasive grass infestations while the grass is green, under mild conditions, early morning with dew, late afternoon or at night will assist in creating a low severity fire that burns away from the non-target community. Where the non-target community is present in low lying areas e.g. drainage lines, use the surrounding topography to create a low intensity backing fire that travels down slope towards the non-target community. In both instances, ensure good soil moisture is present within the non-target community.
- **As part of a control program.** An initial fire to reduce the biomass of invasive grasses followed up by chemical control of the new shoots has been an effective method of control. Similarly, grazing can also reduce fuel loads.
- **Spot ignition.** Can be used effectively to alter the desired intensity of a fire, particularly where there is a high biomass grass infestation. Increased spacing between spots will result in a lower intensity. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **A low intensity backing fire.** A slow moving, low intensity backing fire (against the wind or down slope) will generally result in a more complete coverage of an area and a better consumption of available fuels. This tactic ensures the fire has a greater amount of residence time and reduction of available fuels, particularly fine fuels, while ensuring fire intensity and rate of spread are kept to a minimum. Lighting fires at night can assist in decreasing fire intensity.
- **Fire exclusion**. In some cases it is possible to completely exclude fire, reducing the opportunity for some grasses to spread or become increasingly dense.

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

Non-target fire vegetation groups include spring, vine thicket, acacia, mangrove and some dune communities. These communities are sometimes self-protecting if fire is used under appropriately mild conditions and/or due to factors such as moisture or internal micro-climates and low fuel loads. But where these communities are vulnerable, the tactics presented here such as burning away from them, can enhance their protection. Their vulnerability to fire is increased if successive years of high rainfall have promoted fuels, or where fire-promoting weeds or cyclone damage occurs.

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 the fire vegetation group.
- Invasive grasses or woody weeds are invading fire-sensitive communities.
- The non-target community is upslope of a planned burn area.
- The non-target community is within or adjacent to a planned burn area.

Springs are particularly vulnerable to even low severity fire when peat is dry. Ensure standing water is present or peat is waterlogged. Refer to Chapter 5: Springs, for guidelines to avoid peat fire.

Rod Fensham, Queensland Herbarium, Currajong.

Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (high fuel loads due to successive high rainfall years), it has the potential to damage non-target and fire-sensitive fire vegetation groups. Proactive broad-scale management of surrounding fire-adapted areas with mosaic burning is one of the best ways to reduce impacts of unplanned fire on non-target and fire-sensitive communities.
- Under appropriate planned burn conditions with good soil moisture, some fire-sensitive communities tend to self protect and additional protective tactics may not be required.
- The presence of invasive grasses increases the severity of fire and may contribute to the contraction of fire-sensitive communities such as riparian areas. If high biomass grasses are present, use fire with caution (refer to Issue 5).
- 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 and lead to greater production of fine fuel (mainly grass) and hence an increase in the fire hazard. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in many riparian communities in order to promote structurally complex ground and mid-strata while retaining mature habitat trees.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
No scorch of margin of non-target fire vegetation group.	**After the burn** (immediately or very soon after): visual estimation of percentage of margins scorched from one or more vantage points, or from the air. **Or** **After the burn** (immediately or very soon after): walk the margin of the non-target community or representative sections (e.g. a 100m long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** No scorch. **Partially Achieved:** < 25 % scorched. **Not Achieved:** > 25 % scorched.
Fire penetrates no further than one metre into the edge (if there is a well defined edge).	**After the burn** (immediately or very soon after): visual assessment from one or more vantage points, or from the air. **Or** **After the burn** (immediately or very soon after): walk the margin of the non-target community, or representative sections (e.g. a 100 metre long section of the margin in three locations) and determine whether the fire has penetrated further than one metre into the edge.	**Achieved:** Fire penetrates no further than one metre into the edge. **Not Achieved:** Fire penetrates further than one metre into the edge.

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

Fire parameters

What fire characteristics will help address this issue?

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

Fire severity

- A **low**-severity fire in 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)

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

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 the relevant fire vegetation group

DI (KBDI): Refer to the relevant fire vegetation group

Wind speed: < 15 km/hr

Soil moisture: Refer to the relevant fire vegetation group.

What burn tactics should I consider?

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

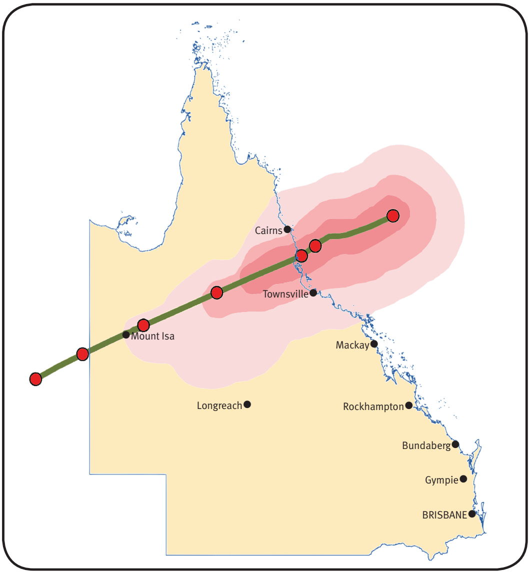
- **Broad-scale fire management.** Refer to tactics in Chapter 1 'Eucalypt communities' for specific guidelines on establishing and maintaining a mosaic across large areas.
- **Test burn** of interface to ensure non-target areas do not burn.
- **Do not create a running fire.** Use low intensity perimeter burns from the edge of low lying communities to protect margins when burning in adjacent 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 burning in areas adjacent to non-target communities undertaken 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.
- **Limit fire encroachment into non-target communities.** Where the non-target community is present in low lying areas e.g. riparian system, use the surrounding topography to create a low intensity backing fire that travels down slope towards the non-target community. If conditions are unsuitable (e.g. the non-target community is too dry to ensure fire will self-extinguish on its boundary or it is upslope of a potential run of fire) use appropriate lighting patterns along the margin of the non-target community. This will promote a low-intensity backing fire that burns away from the non-target community.

Issue 7: Cyclones and severe storms

In the event of a severe tropical cyclone (Category 3 or higher) or severe storm event, the canopy of trees and shrubs may be stripped, accumulating on or suspended above the ground as leaves, fine leaf shred and branches. Snapped limbs can be left hanging in the canopy creating ladder fuel. Many fallen trees can also be expected, increasing heavy fuel loads, impeding fire line access or allowing fires to carry across areas which previously acted as fire breaks. In the Gulf Plains, cyclones and severe storms may increase fire severity in some ecosystem types, particularly heavily wooded forests and woodlands and vegetation communities on hilltops and ridges.

The changed fuel conditions following a cyclone or severe storm may lead to:

- the potential for extensive or high severity wildfires
- an increased fuel hazard near to assets and infrastructure
- altered fire behaviour during planned burning operations in the two years following a cyclone
- the need to restore canopy health prior to further stress (e.g. avoid canopy scorch)
- fire-sensitive communities becoming vulnerable to fire encroachment during certain dry periods
- opportunity to re-introduce fire into areas that have been transitioning to closed forest
- an inability to conduct planned burns or reduced wildfires in some areas due to absent/silted fuels for a time.



Illustrating the extensive region of wind damage caused by tropical cyclone Yasi which devastated the Cassowary Coast in February 2011. Note the destructive winds area continued well into the Einasleigh Uplands bioregion.

David Clark, QPWS (2011).

The impacts of cyclone Yasi (February 2011) were felt hundreds of kilometres inland with extensive damage to vegetation as indicated above.

Justine Douglas, QPWS, Blackbraes National Park (2011).

Fires could burn into the tree canopy by way of the broken tree branches that are hanging down.

Leasie Felderhof, Firescape Pty Ltd, Blackbraes National Park (2011).

Open woodland damage by cyclonic winds. A low intensity burn (five months post cyclone) at Blackbraes National Park with heavy timber remaining after the burn.

Leasie Felderhof, Firescape Pty Ltd, Blackbraes National Park (2011).

Discussion

- After a severe tropical cyclone, people may not naturally think about planned burning. However, without a fuel reduction strategy, there is a risk of extensive wildfires in the following dry season and a risk of fires that will impact on an already stressed canopy (refer to Chapter 8, Issue 1, for fire management guidelines).
- The canopy of trees damaged by severe cyclones is particularly susceptible to further impacts (such as canopy scorch), and may lead to tree death. Until the health of the canopy is restored, fires which may impact them should be avoided.
- In heavily timbered areas, the wildfire hazard following cyclonic events is likely to be higher than open country where wider spacing reduces the chances of an intense fire front developing (Felderhof and Poon 2011). There are fallen trees and branches in open country, but the wider spacing reduces the chances of an intense fire front developing.
- The low, flat topography of much of the Gulf Plains make the bioregion susceptible to prolonged flooding. Understory vegetation can be killed by silt deposition or a lack of light and oxygen (Noble and Murphy 1975). While fire guidelines following prolonged flooding are unavailable, it is thought that ceasing or limiting planned burning, at least for a while, to enable recovery of the understory vegetation would be prudent. In any case, should the ground fuel be absent following flooding, fires will be impossible for some period after the event. In addition storm surges during cyclones can inundate vegetation communities that are not salt tolerant. Storm surges can breach dunes and rush up waterways and may result in the death of plants less tolerant of salt. In areas, the combined impact of wind and salt water incursion may increase the heavy fuel load and result in greater wildfire risk.
- The best time to act on post-cyclone fuel reduction is soon after rain. Moist and humid conditions create slow moving, trickling fires with good residence time. Such fires have good fuel consumption, are of low severity, easy to control and allow disorientated and distressed fauna to find refuge areas. Also, they are less likely to stress canopy. The next best time to utilise moist conditions is the following storm season.
- Early, low intensity burns may not 'clean up the country' and it will take a number of years for the fallen timber to be removed. These burns are necessary however to reduce the spread of late season wildfires in some areas. A trade-off is required between fires of low intensity to reduce fuel to protect against wildfire and more intense fires to remove woody debris (Felderhof and Poon 2011).

- Expectations of how fire behaves in a normal year must be reconsidered post cyclone or even after a severe storm. It is likely programmed fire management can continue, but only after re-assessment of planned burn areas. Be aware that increased finer fuels, native or invasive grass cover, suspended and aerated fuel, open canopies and continuous fuel will change the way fire behaves. Fire will be more severe and may carry where it would not normally (e.g. over gullies, over streams, over firelines, and over wetlands). Conversely, fires may be of a lower severity or unable to carry the expected distance due to a lack of understory fuels in areas which have suffered prolonged flooding.
- In some locations cyclones may provide a rare opportunity to reintroduce fire into grasslands or open forests and woodlands which are in the late stages of transition to closed forest communities through shrub or tree invasion. Species found in eucalypt forest and woodland in particular need abundant light and bare soil to establish. Temporarily reducing the understory through planned burning may allow seedlings of canopy trees such as eucalypts to establish and thus halt or slow the transitioning process.
- Strategic planned burning with high soil moisture, avoiding burning in dry conditions and reviewing scheduled planned burns to make use of moister seasonal conditions are strategies to compensate for changed fuel conditions.

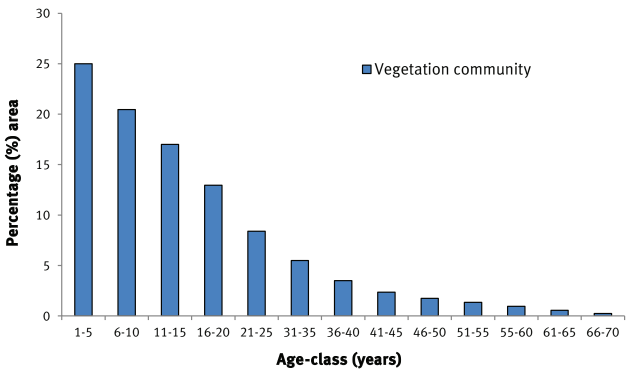
Open woodlands are also effected by cyclones. Ensuring fire breaks are cleared and fences are intact is important.

Paul Williams, Vegetation Management Science Pty Ltd, near Mt. Garnett post Cyclone Yasi (2011).

Glossary of fire terminology

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

<table>
<tr><th>Terminology</th><th>Definition</th></tr>
<tr><td>Aerial ignition</td><td>The lighting of fine fuels for planned burning by dropping incendiary devices or materials from aircraft.</td></tr>
<tr><td>Available fuel</td><td>The portion of the total fuel that would actually burn under current or specified conditions.</td></tr>
<tr><td>Age-class distribution</td><td>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)

</td></tr>
<tr><td>Burn severity</td><td>Relates to the amount of time necessary to return to pre-fire levels of biomass or ecological function.</td></tr>
<tr><td>Backing-fire</td><td>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.</td></tr>
</table>

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.

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Appendix 1: List of regional ecosystems

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

Fire vegetation group	Hectares within Gulf Plains bioregion	Percentage
Eucalypt communities	10 007 486	45
Grasslands and sedgelands	4 395 268	20
Melaleuca communities	5 344 469	24
Acacia communities	1 406 517	6
Springs and dune communities	3 333	0.01
Vine thickets	3 969	0.02
Mangrove and saltmarsh communities	551 315	2
Other areas	154 969	1
Other bioregions	356 970	2
TOTAL	**22 232 102**	**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 community (tussock grass dominated)		2.2.2, 2.3.19, 2.3.20, 2.3.20a, 2.3.20b, 2.3.20c, 2.3.20d, 2.3.20e, 2.3.20g, 2.3.20h, 2.3.20i, 2.3.20j, 2.10.3, 2.3.14, 2.3.18a, 2.3.21, 2.3.21a, 2.3.21b, 2.3.21c, 2.3.21d, 2.3.21e, 2.3.21f, 2.3.21g, 2.3.21x1, 2.3.21x12, 2.3.21x13, 2.3.21x2, 2.3.22, 2.3.22x11, 2.3.22x11a, 2.3.22x11b, 2.3.23, 2.3.23b, 2.3.23x1a, 2.3.23x1b, 2.3.23x1c, 2.3.25, 2.3.25b, 2.3.25c, 2.3.25x1, 2.3.25x2, 2.3.25x3, 2.3.26, 2.3.26a, 2.3.27, 2.3.35, 2.3.37, 2.3.5, 2.3.6, 2.3.6x1a, 2.3.6x1b, 2.5.1, 2.5.1a, 2.5.1b, 2.5.1c, 2.5.1d, 2.5.1x10, 2.5.1x11, 2.5.1x11b, 2.5.10, 2.5.12, 2.5.12a, 2.5.12b, 2.5.12c, 2.5.2x2, 2.5.2x3, 2.5.2x4, 2.5.3b, 2.5.4, 2.5.5, 2.5.5x11, 2.5.5x11a, 2.5.5x11b, 2.5.5x12, 2.5.5x13, 2.5.5x14a, 2.5.5x14b, 2.5.6, 2.5.6b, 2.5.6c, 2.5.6x1, 2.5.6x10a, 2.5.6x10b, 2.5.6x10c, 2.5.6x10d, 2.5.6x10e, 2.5.6x10f, 2.5.7, 2.5.8, 2.5.9, 2.5.9a, 2.5.9x50, 2.5.9x50b, 2.5.9x51, 2.9.1x90, 2.9.1x93, 2.9.2x2, 2.9.3, 2.9.3a, 2.9.7, 2.9.7x1, 2.9.7x2, 2.9.7x90, 2.3.33, 2.3.33x3, 2.3.33x4, 2.3.8, 2.3.9, 2.3.9b, 2.3.9c, 2.3.9d, 2.3.9e, 2.3.15, 2.3.17, 2.3.17a, 2.3.17b, 2.3.17c, 2.3.17d, 2.3.17e, 2.3.10, 2.3.10a, 2.3.10b, 2.3.10c, 2.3.10d, 2.3.10e, 2.3.10f, 2.3.10x11, 2.3.10x11a, 2.3.10x11b, 2.3.10x12, 2.3.10x13, 2.3.10x40, 2.3.10x41, 2.3.11, 2.3.11a, 2.3.11ax1, 2.3.11b, 2.3.11bx1, 2.3.11bx2, 2.3.11c, 2.3.11d, 2.3.11e, 2.3.11f, 2.3.11g, 2.3.11h, 2.3.11i, 2.3.11k, 2.3.11x1, 2.3.11x40. **NON RE groupings used:** C13, D32, C33, D20, D34, D35, D41, K17.
	2		Eucalypt communities (spinifex or shrub dominated)		2.10.4, 2.10.4b, 2.10.4x1, 2.10.4x2, 2.10.7, 2.11.1, 2.11.1a, 2.11.1b, 2.11.1c, 2.5.11, 2.5.11b, 2.5.11c, 2.5.11d, 2.5.13, 2.5.3, 2.5.3a, 2.7.3, 2.7.3b, 2.7.3c, 2.7.3d, 2.7.3e, 2.7.3f, 2.7.3g, 2.7.3i, 2.7.3x1, 2.7.4, 2.7.5, 2.10.1, 2.10.1a, 2.10.2, 2.10.2a, 2.10.2b, 2.10.2c, 2.10.2d, 2.10.2x1, 2.10.2x11, 2.10.2x12, 2.10.2x2, 2.12.1, 2.12.1x1, 2.8.1. **NON RE groupings used:** D23, D50, D51, G3, H23, H28, J16, J19.
2	1	**Grasslands and sedgelands**	Grasslands and sedgelands		2.2.2a, 2.2.2e, 2.3.3, 2.3.3a, 2.3.3ax40, 2.3.3b, 2.3.3x40, 2.3.4, 2.3.4a, 2.3.4x40, 2.3.4x41, 2.3.4x41a, 2.3.4x42, 2.3.4x43, 2.3.4x44, 2.3.4x50, 2.9.1, 2.9.1a, 2.9.1ax40, 2.9.1ax42, 2.9.1ax43, 2.9.1ax44, 2.9.1x91, 2.9.2, 2.9.3b, 2.9.3d, 2.3.32, 2.3.32x11, 2.3.16, 2.3.2, 2.3.1, 2.3.1a, 2.3.1b, 2.3.1c, 2.3.1e, 2.3.1x2a, 2.3.1x2b, 2.3.1x2c, 2.3.1x30, 2.3.1x31, 2.3.1x51, 2.3.12, 2.3.12x4, 2.3.34, 2.3.34x31, 2.3.34x32, 2.3.38. NON RE groupings used: 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	**Melaleuca communities**	Melaleuca communities		2.10.6, 2.10.6x1, 2.3.24, 2.3.24a, 2.3.24b, 2.3.24x1, 2.3.24x11, 2.3.24x12, 2.3.24x12c, 2.3.24x13, 2.3.24x2, 2.3.24x2a, 2.3.28, 2.3.28a, 2.3.28b, 2.3.28c, 2.3.28d, 2.3.28e, 2.3.28f, 2.3.28g, 2.3.28x1, 2.3.28x11, 2.3.28x12, 2.3.28x13, 2.3.28x15, 2.3.28x16, 2.3.28x17a, 2.3.28x17b, 2.3.28x40, 2.3.30, 2.3.31, 2.3.36, 2.5.14, 2.5.14a, 2.5.14x1, 2.5.14x50, 2.5.14x51, 2.5.15, 2.5.15a, 2.5.15b, 2.5.15c, 2.5.15d, 2.5.15e, 2.5.15x2, 2.5.15x7, 2.3.29, 2.3.29x1, 2.3.29x2, 2.3.29x40, 2.3.29x40a, 2.3.29x40b, 2.3.29x41, 2.3.29x42, 2.5.16, 2.5.16a, 2.5.16b, 2.5.16x40, 2.7.1x3a, 2.7.1x3b, 2.7.1x3c, 2.7.1x4, 2.9.1x92, 2.9.6, 2.9.6a, 2.9.6b, 2.9.6x40.
4	1	**Acacia communities**	Acacia communities		2.2.2b, 2.2.2c, 2.2.2x1, 2.3.18, 2.3.18b, 2.3.3c, 2.10.5, 2.10.5a, 2.10.5x1, 2.10.5x2, 2.3.13, 2.3.7, 2.3.7a, 2.3.7b, 2.3.7c, 2.5.2, 2.5.2x1, 2.7.1, 2.7.1x1, 2.7.1x2, 2.7.1x2b, 2.7.2, 2.7.2a, 2.7.2b, 2.7.2c, 2.7.2d, 2.7.2x1, 2.7.2x2, 2.7.2x2a, 2.7.2x2c, 2.7.2x2d, 2.7.2x3, 2.7.2x4, 2.9.1b, 2.9.1bx40, 2.9.1cx40, 2.9.4, 2.9.4a, 2.9.4ax40, 2.9.4b, 2.9.4c, 2.9.4d, 2.9.4dx40, 2.9.4e, 2.9.4f, 2.9.4x1, 2.9.4x1a, 2.9.4x1b, 2.9.5.
5	1	**Springs and dune communities**	Springs		2.3.39, 2.10.8, 2.3.33x1, 2.3.33x2.
	1	**Springs and dune communities**	Dune communities		2.2.1, 2.2.2d, NON RE groupings used: B4.
6	1	**Vine thickets**	Vine thickets		2.2.2f, 2.9.3c.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
7	1	Mangrove and saltmarsh communities	Mangrove		2.1.2, 2.1.3, 2.1.3b, 2.1.1, 2.3.1x1. **NON RE groupings used:** A1.
	1		Saltmarsh		2.1.4 **NON RE groupings used:** A3.

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) and the Draft Pre-clearing Vegetation Communities and Regional Ecosystems layer (20 August 2010). NOTE: Non-regional ecosystem (Veg 1) Queensland Herbarium codes were also used, where no regional ecosystem codes existed as of 18 January 2012.

Unmatched regional ecosystems	2.1.1, 2.3.13, 2.3.15, 2.3.19, 2.3.27, 2.3.30, 2.3.5, 2.3.8, 2.5.8, 2.8.1, 2.2.2d, 2.3.31

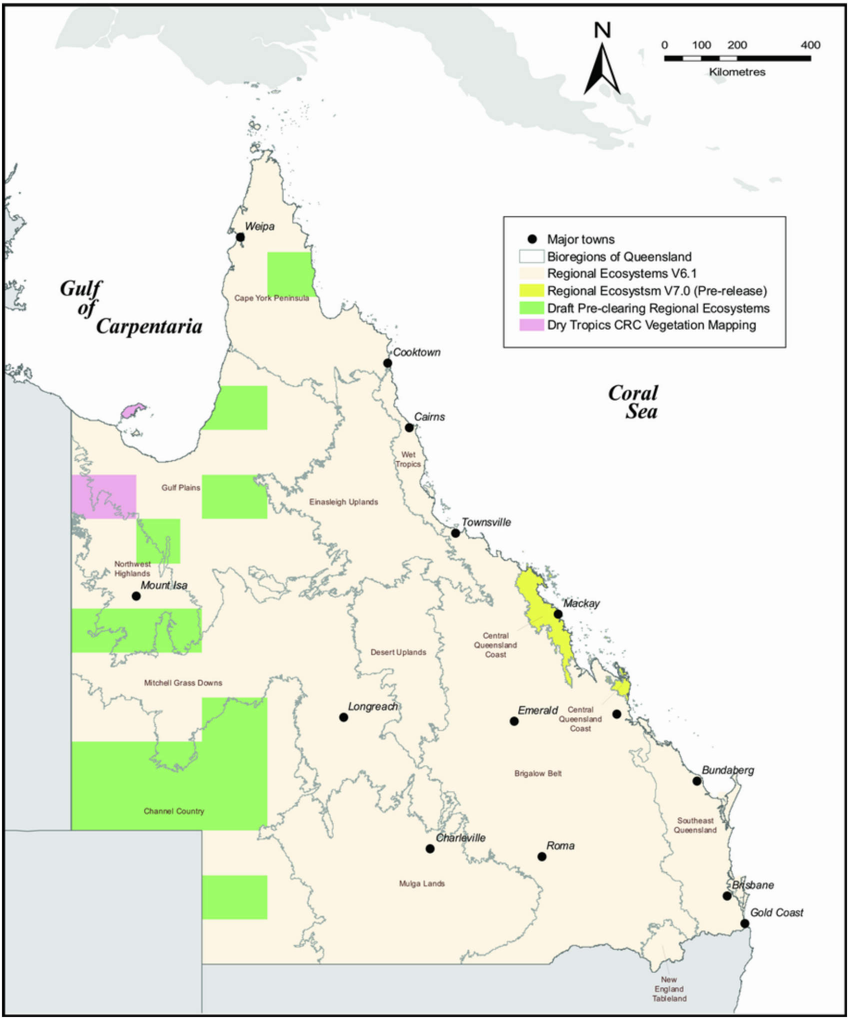

Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

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.

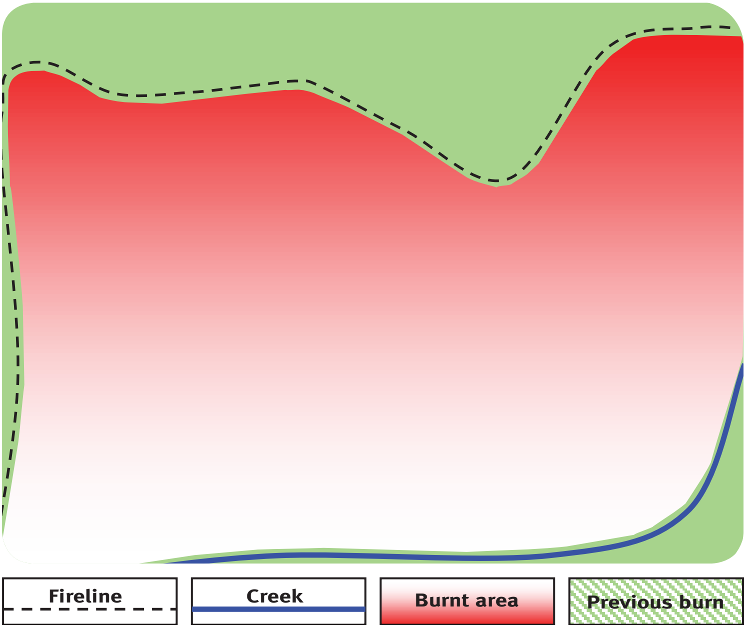

Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

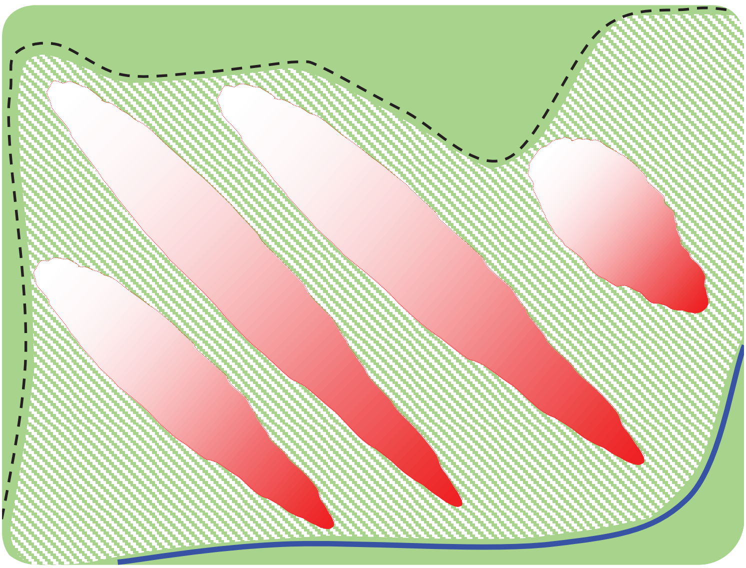

Figure 2: Planned mosaic burn—year 8.

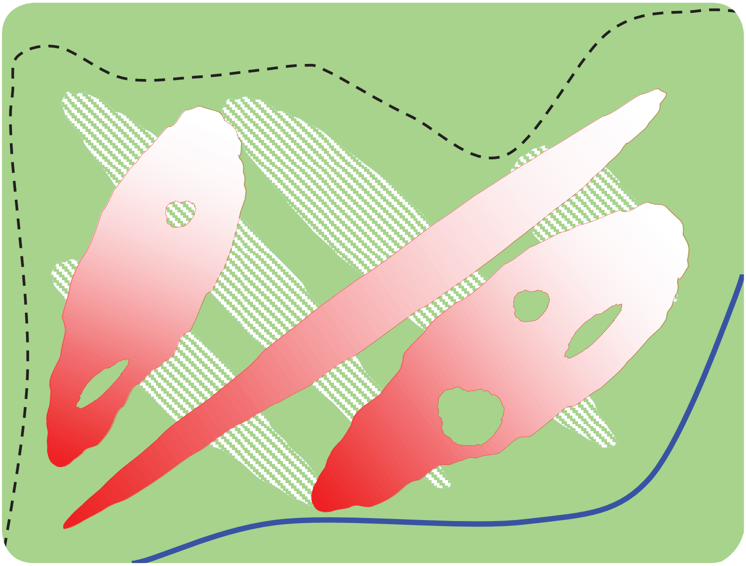

Figure 3: Planned mosaic burn—year 20.

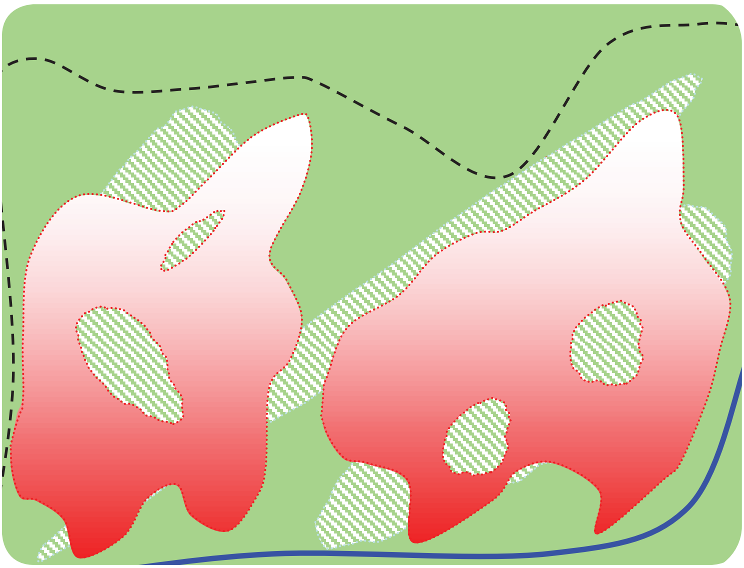

Figure 4: Planned mosaic burn—year 28.

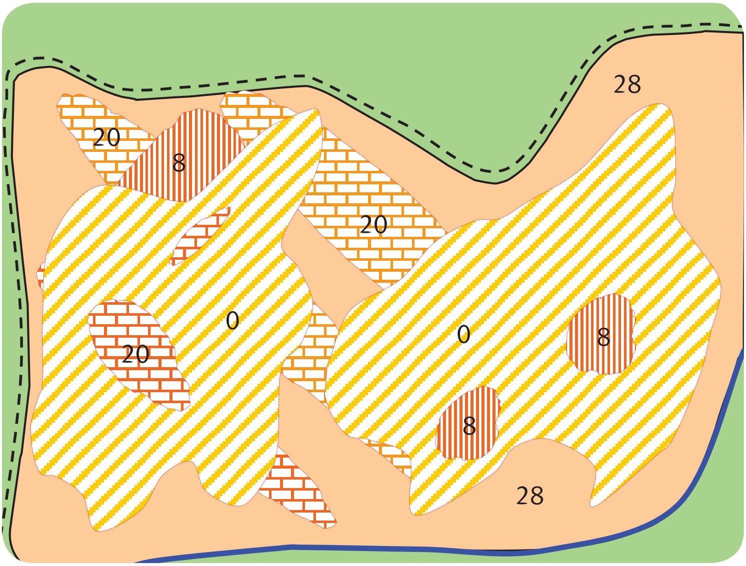

Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).