Department of National Parks,
Recreation, Sport and Racing

Planned Burn Guidelines

Einasleigh Uplands 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: Blackbraes National Park, Michael Ahmet (2006).

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Foreword

The Einasleigh Uplands bioregion primarily straddles the Great Dividing Range in north-eastern Australia. It contains a diversity of landscapes from the highlands of the Great Dividing Range and associated ranges to the adjacent woodlands and grasslands. The bioregion is characterised by volcanic rocky landscapes, basalt, granite and sandstone geology and features lava tubes, limestone caves, lakes/wetlands and perennial springs. It rises from an altitude of 100 metres to over 1100 metres and contains the headwaters of major river systems including the Burdekin, Flinders, Gilbert, Normandy and Mitchell.

Rangeland cattle grazing exists over most of the bioregion. The bioregion once hosted forestry production and is relatively rich in minerals. One of the biggest issues facing this bioregion is altered burning practises. Although not producing a major visible effect today, altered fire management practises have the potential to greatly change the landscape over a long period of time.

The challenge within the Einasleigh Uplands is to determine fire regimes that will provide the best opportunities to maintain ecosystem diversity. The landscape requires fire in order to nurture its native vegetation communities. A great extent of the Einasleigh Uplands is prone to lightning strikes. These strikes ignite fires towards the end of the dry season which burn uncontrolled across the landscape until the first wet storms extinguish the flames. This is a natural process and many plant species require fire as part of their life-cycle, including for germination of seeds.

However, too frequent or extensive wildfires can have undesirable impacts on biodiversity. The extent and frequency of wildfire can be mitigated with earlier safe burns, to create a better balance of planned burns and wildfires for improved biodiversity outcomes.

The aim of these planned burn guidelines is not only to provide guidance and assistance in understanding the role and application of fire but also to promote fire as a legitimate conservation tool.

Grant Anchen
Ranger-in-Charge
Northern Region
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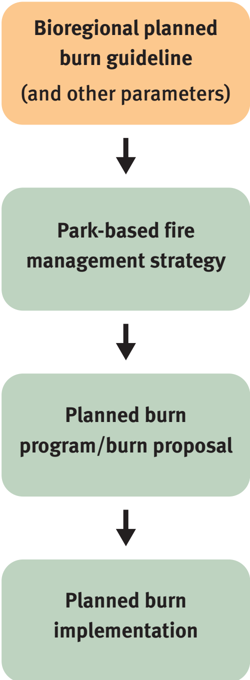
Purpose of this guideline

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.



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

Scope

- This guideline applies to the Einasleigh Uplands bioregion (refer to Figure 1) and covers the following fire vegetation groups: eucalypt, melaleuca, acacia, riparian communities and vine thickets (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Einasleigh Uplands 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.

Grant Anchen, QPWS, Blackbraes National Park (2011).

Figure 1: Map of the Einasleigh Uplands bioregion of Queensland.

Fire and climate in the Einasleigh Uplands bioregion of Queensland

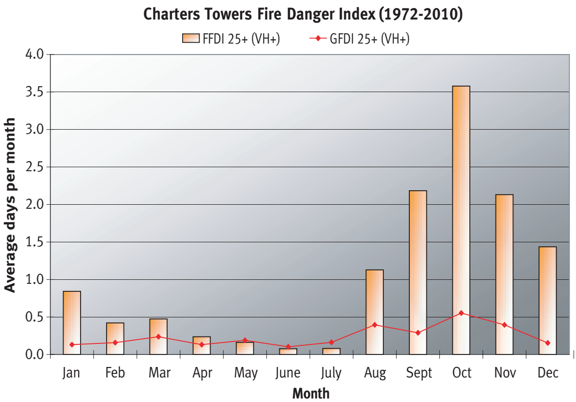
The Einasleigh Uplands is characterised by hot humid summers (wet season), cool dry winters and hot dry periods with storm activity leading into the wet season. About 90 per cent of the bioregions rainfall is associated with the passage of tropical depressions on the coast. Annual rainfall can vary (400 millimetres (mm) to 1000 mm) and decreases from north to south and distance from the coast. The variability of the wet season (i.e. when it commences, its duration and summative rainfall) can alter the timing of the 'normal' fire season.

Wet years usually lead to a flush of grass growth which cures during winter and creates increased fuel loads. In contrast, dry years result in reduced grass growth, lower fuel loads, and a lowered risk of extensive wildfires.

Planned burning in Einasleigh Uplands generally commences early in the dry season (around April) to take advantage of partially cured grasses and soil moisture from the previous wet season. These conditions create low-severity burns. Planned burning must remain flexible to allow for variation in the timing and length of wet seasons. Strong south-easterly winds are common between August and October and reduce the window of opportunity for planned burning. It is also important to be aware of conditions prior to and following burns. Frosts which can occur during the winter months quickly cure fuels across the landscape increasing flammability.

The wildfire season generally extends from September to January (seasonally dependant). Lightning is a frequent ignition source of wildfires at the end of the dry season or very early wet season.

Fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high +/FDI 25+). The average temperature on these days is often above 34°C with humidity (~ 17 per cent) and winds ~15 km/hr (refer to Figure 2).



The likelihood of a fire weather day or sequence of days (FDI 25+) increases significantly from August to December. Data (Lucas 2010).

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

Figure 2: Fire weather risk in the Einasleigh Uplands bioregion

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

Eucalypt forest and woodland communities are the dominant fire vegetation group in the Einasleigh Uplands bioregion. The composition and structure of these communities varies significantly depending on rainfall, altitude and soil type:

- On hills, ranges and alluvial plains common species include ironbarks, bloodwoods and box species, generally with a sparse mid-story of juvenile canopy trees and shrubs and a well-developed understorey of grasses.
- Very open woodland with patches of grasslands are minor components of the landscape and are generally found on basalt and alluvial plains and on low lying areas where they occur as marshes.
- Open eucalypt forests of smooth-barked gums, stringy barks and mahogany occur in elevated areas and on moist hills and ranges close to the Wet Tropics boundary.
- Eucalypt woodlands with a shrubby understorey generally occur on sandstone, granite and acid volcanic soils.

Fire management issues

A key management concern for this fire vegetation group is frequent and often extensive wildfires. These fires impact on the area's biodiversity values, nearby fire-sensitive communities and property. This is exacerbated by large tracts of fire-prone landscapes and contemporary land use practices which have seen a decline in planned fires.

An issue threatening the structure of this fire vegetation group in some areas is overabundant saplings in the mid-stratum that shade out the grassy understorey (species can include *Eucalyptus* spp., *Melaleuca* spp., *Acacia* spp., and *Cypress* spp.). Often this is associated with overgrazing, but it can also be attributed to a long absence of fire. Another issue is that the diversity of shrub species in woodlands that exist on sandstone can decline if not protected from high-severity, frequent fires.

Weed species such as buffel grass *Cenchrus ciliaris*, grader grass *Themeda quadrivalvis*, gamba grass Andropogon gayanus and lantana *Lantana camara* pose significant threats, particularly to grassy eucalypt communities.

Issues:

1. Maintain healthy grassy eucalypt communities.
2. Maintain healthy shrubby eucalypt communities.
3. Manage invasive grasses.
4. Manage rubber vine, lantana and other woody weeds.

Extent within bioregion: 10 233 539 hectares (ha), 87 per cent; **Regional ecosystems**: Refer to Appendix 1 for complete list.

Examples of this FVG: Wairuna Station (Proposed addition to Girringun National Park), 64 420 ha; Undara Volcanic National Park, 59 672 ha; The Canyon, 42 786 ha; Girringun National Park, 33 419 ha; Blackbraes National Park, 30 496 ha; Blackbraes Resources Reserve, 14 993 ha; Palmer Goldfield Resources Reserve, 14 142 ha; Mount Windsor National Park, 9 019 ha; Mount Rosey Resources Reserve, 6 550 ha; Bilwon Forest Reserve, 5 853 ha; Paluma Range National Park, 5 565 ha; Retreat Valley/Diggers Creek, 5 181 ha; The Bluff State Forest, 5 179 ha; Bulleringa National Park, 4 111 ha; Mount Flagstone Forest Reserve, 4 034 ha; Bilwon State Forest, 4 003 ha; Upper Granite Normanby (Under Negotiation With Aboriginal Land and National Park), 3 765 ha; Forty Mile Scrub National Park, 3 628 ha; White Mountains Resources Reserve, 3 373 ha; The Bluff Forest Reserve, 2 940 ha; Chillagoe-Mungana Caves National Park, 2 622 ha; Mount Lewis National Park, 2 455 ha; Mingela State Forest, 2 097 ha; Ngalba Bulal National Park, 2 085 ha; Kuranda West Forest Reserve, 2 010 ha; Kinrara National Park, 1 844 ha; Porcupine Gorge National Park, 1 638 ha; Dalrymple National Park, 1 579 ha.

Issue 1: Maintain healthy grassy eucalypt communities

Maintain healthy grassy eucalypt communities with mosaic burning.

Awareness of the environment

Key indicators of a healthy grassy eucalypt forest and woodland:

- Eucalypt communities have a grassy understory with scattered canopy species in the mid and lower stratums (enough to eventually replace the canopy) but **are not** having a noticeable shading effect on ground-layer plants.
- The ground layer has a good cover and diversity of annual and perennial native grasses, herbs and legumes. Grasses may be continuous, upright and vigorous.
- The shrub layer is generally sparse to absent. Where shrubs are present, such as smooth-leaved-quinine *Petalostigma banksii*, bushman's clothes peg *Grevillea glauca*, and silver oak *G. parallela*, they are generally scattered in their distribution.
- Patches of grassland (where they occur), have scattered trees and shrubs.
- Spinifex (where it occurs), shows a variation of time-since-fire across the landscape (e.g. there are older clumps interspersed with younger clumps).
- The forest or woodland is easy to walk through or see through.

Healthy open ironbark woodland with a grassy understorey. Trees are of various heights and ages.

Eleanor Collins, QPWS, Blackbraes National Park (2006).

Open woodland with a healthy understory of annual and perennial native grasses. Monitoring grass-layer diversity and vigour can be used to help determine fire frequency.
Lana Little, QPWS, Chillagoe- Mungana Caves National Park (2000).

Mixed eucalypt woodlands sometimes have an open sub-canopy of juvenile canopy trees and tall shrubs.
Nola Jefferys, Einasleigh area (2011).

Very open bloodwood/ironbark woodland on basalt. Native themeda grasses dominate the ground layer but buffel grass is present.
Justine Douglas, QPWS, Dalrymple National Park (2011).

Low open woodland of *Eucalypt shirleyi*. On sandy, shallow soils, grasses naturally appear sparse and less vigorous.
Justine Douglas, QPWS, Blackbraes National Park (2011).

Woodlands can vary from open to very open; where they sometimes merge into small patches of grasslands.

Grant Anchen, QPWS, Blackbraes National Park (2011).

Open eucalypt forest on hills adjacent to the wet tropics boundary. Whilst canopy species and shrubs are present in the understorey, they are not yet shading-out the ground layer.

Mark Newton, DSITIA, Irvenbank area (2006).

Old spinifex clumps are interspersed with recently-burnt spinifex. A wet season burn was used to achieve this patchy mosaic.
QPWS, Porcupine Gorge National Park (2007).

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

- Eucalypts, acacias, melaleuca, cypress and/or casuarina are beginning to emerge in abundance (up to approximately waist height) and are shading out the ground layer.
- Grass clumps are poorly-formed. There is an accumulation of dead material and/or grasses have collapsed. Ground-layer diversity is declining.
- In wetter areas where open forests occur, rainforest pioneers may begin to emerge in the ground stratum. Grasses are becoming scarce.
- There is a build up of fine fuels such as dead grass material, leaf litter, suspended leaf litter, bark and twigs.
- Where present, exotic woody weeds such as lantana, rubber vine and calotrope are beginning to expand in open woodland communities.
- Where it occurs, spinifex cover increases and clumps are touching or have formed continuous hummocks over a broad area. Spinifex clumps have little fresh growth, look grey and dry.

Eucalypt and melaleuca saplings are emerging in abundance. Maintaining fire in this community will ensure some saplings are thinned and others are retained for canopy recruitment.

Justine Douglas, QPWS, Hervey's Range (2011).

This very open ironbark woodland is still healthy but an accumulation of grasses may indicate that a fire is required. Because there are very few canopy species in the mid and lower stratums, use early dry season burns of low severity to encourage the regeneration of canopy species.

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

Grevillia pteridifolia thickening in the midstorey is starting to shade out the ground layer of this open woodland community.
Grant Anchen, QPWS, Blackbraes National Park (2011).

Cypress pine is often found scattered within eucalypt woodland communities. Dense regeneration of cypress in these communities can indicate fire is required.
Justine Douglas, QPWS, Blackbraes National Park (2011).

Smooth-leaved quinine *Petalostigma banksii* is naturally abundant in the shrub layer of some woodland communities. However, overabundance can eventually lead to shading-out of the ground layer if left unburnt for long periods.

Mike Ahmet, QPWS, Bulleringa National Park (2007).

Rubber vine is fire-sensitive. Most plants can be killed with high-severity fires. Because the grass fuels are continuous there is enough fuel to carry a high-severity fire and kill a large percentage of rubber vines in this open woodland.

Mike Ahmet, QPWS, Undara National Park (2007).

Discussion

- A major conservation issue in the Einasleigh Uplands bioregion is the incidences of late dry-season wildfires. These wildfires have negative impacts on the biodiversity values of open grassy forest and woodland communities. Wildfires also pose a risk to life, property and primary production. A key strategy to minimise the impacts of these extensive wildfires is to undertake a mosaic of low-intensity, early dry-season fires to reduce fuel loads and create a mosaic of burnt and unburnt patches across the landscape.
- Whilst shrubs are generally sparse to absent, sometimes small pockets of mid-stratum dense shrubs (e.g. quinine, currant bush) can occur within open woodland. Do not confuse this issue with woodland thickening.
- Many of the protected areas in the Einasleigh Uplands bioregion were (until relatively recently) used for cattle grazing (e.g. Blackbraes in 1998 and Undara National Park in 1990). These areas may still contain some disturbed ecosystems (e.g. woody thickening from clearing or overgrazing, loss of native grasslands, presence of high-biomass pasture grasses, absence of trees and shrubs at different age classes). In these cases, as long as the structure of the understorey appears healthy, implementing this guideline should re-establish a more healthy system over time. Fire can also play a role in the regeneration of native grass communities that were once dominated by exotic pasture grasses (refer to Chapter 6 (Issue 3), for management guidelines).
- Fuel accumulates quickly within grassy eucalypt woodlands. Monitoring has shown that fuel loads in these areas reach a maximum level after two or three years, with no addition to grass fuel loads with greater time-since-fire. The available fuel tends to be uniform and primarily in the ground layer (Williams et al. 2009).
- 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. Caution should be used and local knowledge sought as some grass species which still appear too green to burn will burn severely and vice versa.
- In the moister areas adjacent to the Wet Tropics boundary, rainforest species are often present in open forest communities. Rainforest species can quickly grow into the midstratum in the absence of fire, shading-out juvenile eucalypt woodland species and grasses. System change from open to closed forest can be rapid in these areas.

- Cypress pine *Callitris* spp. occurs naturally in some eucalypt communities as scattered plants or small clumps, and persists well in fire sheltered areas. It generally survives low-intensity fires but is considered fire-sensitive as adult trees can die when their crown is scorched.
- Be aware that flushes of *Eucalyptus* spp. and *Melaleuca* spp. can be influenced by prolonged flooding (e.g. a flush of coolabah seedlings around wetlands may be a response to a flood and associated silt deposition rather than fire). Where this thickening is expanding into adjacent open woodlands and grasslands, consider fire management.
- It is important to note that visual signs of poor health in this fire vegetation group could be a sign of drought and not necessarily due to changed fire regimes. Ironbark species are sensitive to drought. In the 1990s a massive dieback of ironbarks during severe drought was recorded near Charters Towers. Avoid burning when ironbark communities are stressed.

Note the rapid accumulation of grassy fuels in ironbark woodland over a three year cycle. Fuel load accumulation will vary with seasonal rainfall, soil type and grass species, generally reaching a maximum fuel load two to three years after fire.

QPWS, Blackbraes National Park (2001, 2002, 2003).

What is the priority for this issue?

Priority	Priority assessment
High	Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**.
Medium	Planned burn in areas where **ecosystem health** is **poor** but recoverable.

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Over several hectares, a mosaic of 30–70 % of burnt ground within the boundary of the burn.	Choose one of these options: 1. Visual estimation of percentage of fire association burnt—from one or more vantage points, or from the air. 2. Map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the percentage of area burnt. 3. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating percentage of ground burnt within visual field.	**Achieved:** 30–70 % burnt. **Partially Achieved:** between 20–30 % or 70–80 % burnt. **Not Achieved:** < 20 % or > 80 % burnt.

> 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 complete 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.

An example of how fire was used to scorch overabundant eucalypt saplings.
Justine Douglas, QPWS, Blackbraes National Park (2011).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** and with the occasional **moderate**. An occasional moderate-severity fire helps to ensure emerging overabundant trees are managed. It is important to strike a balance between tree reduction and canopy tree recruitment.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	< 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)	100–150	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.

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 five years for eucalypt woodlands with a grassy understorey.

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 30–70 per cent burnt within the target communities.

Landscape mosaic

- Do not burn more than 40 per cent of this fire vegetation group in the Einasleigh Uplands within each year.

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 burns	Season: Storm burns
GFDI: < 8	**GFDI:** 8–14
DI (KBDI): 80–160	**DI (KBDI):** < 80
Wind speed: < 23 km/hr	**Wind speed:** < 23 km/hr

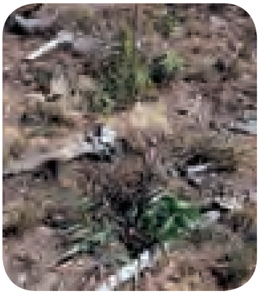
Soil moisture:

Good soil moisture is critical for a range of aspects:

- It protects and retains the bases of grasses, ensuring they have a competitive advantage over invasive grasses and woody weeds.
- Good soil moisture minimises loss of habitat features such as hollow-bearing trees.
- It limits the opening of bare ground which can result in erosion and the encroachment of weeds.
- Good soil moisture encourages species regeneration soon after fire.
- It promotes a mosaic of burnt and unburnt patches.

Woodlands with a native grassy understorey dominated by kangaroo grass are habitat for species such as the rufous bettong. A mosaic of burnt and unburnt patches provides diurnal refuge areas and food resources. Late dry-season wildfires can lead to the removal of ground-cover habitat features for this species.

QPWS (2009).



Species regeneration in the ground-layer soon after a low-severity burn soon after the wet season. Note that little canopy scorch has occurred.

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

Other considerations:

- Heavy dews can influence the spread of early-season fires.
- Frosts can occur during the winter months and will quickly reduce fuel moisture levels. Fires may not self-extinguish in affected communities even in the early dry season when good soil moisture is present. Consider reviewing fire management programs after frost events.
- Strong south-easterly winds are common from about August to October. Avoid burning during these months.
- Tropical cyclones and severe storms have the potential to change fuel conditions which may alter fire behaviour. Fallen fuels (e.g. trees, branches and leaf litter) not only increase fuel loads but can impede fireline access. Strategic planned burning of the effected areas may therefore be required (refer to Chapter 6 (Issue 5), regarding fire management guidelines).
- After a long wet summer, grassy fuel loads will be higher than normal. As a result, late season wildfires are common across the Einasleigh Uplands. Ensure planned burn programs are a high priority after a big wet season.

Widespread frosts can occur any time between May and September, most commonly at altitude. Early frosts can shorten the planned burn season.

Grant Anchen, QPWS, Blackbraes National Park (2010).

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 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

- Aerial ignition from a helicopter is often used in the Einasleigh Uplands bioregion due to the scale of areas being managed and its often inaccessible terrain.
- Helicopters provide the opportunity to directly target topographical features such as peaks and ridges which create a backing fire downhill or to create a buffer that burns away from the edges of non-target communities.
- Aerial incendiary operations also allow for variations in ignition points (as opposed to repetitive lighting of main burn operations from firebreaks).
- It is recommended that an aerial incendiary plan is developed to ensure spacing and drop patterns achieve the desired burn objectives. To achieve the desired mosaic and burn severity, it is preferable to scatter incendiaries rather than use a formulated grid pattern across the burn area.
- In some instances this tactic may be implemented in conjunction with ground ignition to secure an edge around the area being burnt.
- It is good practice to plot the incendiary drop path onto a map or aerial photograph. Use of aerial photographs (stereoscopic images) is useful to gain an understanding of terrain.
- **Progressive burning.** Fires (of varying extent, severity and over various times) are lit in fire-adapted communities from early in the year when conditions allow.
- **Spot ignition** can be used to alter the intensity of a fire and create the desired mosaic of burnt and unburnt areas. This can be achieved by using a range of methods including matches, drip torches and incendiaries. The spacing of the spots may vary throughout the burn due to variations in topography, fuel loads, fuel moisture and weather conditions.
- **Commence lighting on the leeward (smoky) edge.** This can be a useful way to create a low-intensity backing fire into the burn area or create a containment edge for a higher-severity fire ignited inside the burn area.
- **Afternoon or evening lighting** generally creates milder burn conditions, promoting a low to moderate-severity fire. This tactic is useful when burning adjacent to non-target communities, when burning later in the dry season or when burning adjacent to adjoining properties. Dew can be useful to extinguish fires overnight.

- **Storm burning** can be used as a strategy to address habitat requirements (e.g. manage woody thickening, some weed control programs and to maintain grasslands). Storm burns are undertaken after the first storms and when there is a very high chance of rain after burning. A minimum of about 50 mm of rain is recommended before burning. The undertaking of storm burns, in often unpredictable weather conditions can pose risks to habitats and property.
- **Wet season burning** provides the opportunity to achieve landscape mosaics in spinifex dominated communities. This tactic also reduces the risk of extensive fires in the dry season.
- **Boundary burning** is an ignition strategy undertaken to reduce late season fires entering a property or to contain fires within boundaries. Where accessible, this strategy may include slashing boundaries as soon as possible after the wet season and burning the slashed grass as soon as it is cured. This could be two to three days after slashing or later on the same day. Boundary burning can also be achieved by particular aerial burning techniques, in inaccessible areas (seek advice).
- **Limit fire encroachment into non-target communities.** Where required, use appropriate lighting patterns along the margin of the non-target community to promote a low-intensity fire that burns away from the non-target community. (Refer to Chapter 6 (Issue 5), regarding fire management guidelines).

The spacing of incendiaries is important and helps achieve the desired fire intensity and burn mosaic.

Mark Parsons, QPWS, Princess Hills (2003).

Low-severity burns in grassy woodland communities.
Nick Smith, QPWS, Undara National Park (2011).

Timing of early dry-season burns will vary annually due to variations in seasonal conditions. In some areas, dry-season burning can commence as early as March.
Mark Parsons, QPWS, Princess Hills (2006).

Issue 2: Maintain healthy shrubby eucalypt communities

Maintain healthy shrubby eucalypt communities with mosaic burning.

Awareness of the environment

Key indicators of healthy shrubby communities:

- Eucalypt communities have a canopy of eucalypt or corymbia trees. Some young canopy species are recruiting in the understorey (enough to eventually replace the canopy) but are not extensive enough to produce shading impacts.
- There is a diversity of shrub species including acacia, hop bush *Dodonaea* spp., *Jacksonia ramosissima*, Townsville wattle *Acacia leptostachya*, *Comesperma pallidum*, toothbrush grevillea *Grevillea pteridifolia*, *Acacia ramiflora* and *Leptospermum pallidum*.
- Shrubs are of a flowering age.
- Fire-promoted short-lived species may be present.

Healthy *Eucalyptus chartaboma* woodland with a shrubby understorey.
Paul Williams, Vegetation Management Science Pty Ltd, Bulleringa National Park (2009).

Shrubby eucalypt woodland.

Peter Stanton, Environmental Consultant Pty Ltd, estate: formally Bulleringa Pastoral Holdings Pty Ltd, now Bulleringa National Park (1991).

Fire-killed shrubs (*Grevillea decora and Acacia* spp.) dominate the understory of this open eucalypt woodland. This area has been unburnt for eight years.

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

The following may indicate that fire is required to maintain open shrubby eucalypt woodland

- *Acacia* spp. and *Jacksonia ramosissima*, which germinated after a previous fire are beginning to die or are dead.
- Fire-germinated seedlings such as some *Acacia* spp. and *Grevillea* spp. have matured and set-seed numerous times.
- The diversity of the ground layer has decreased with time. Herbs and forbs are absent between spinifex hummocks.
- Where they occur, spinifex cover has increased and clumps are beginning to form continuous hummocks.
- Fuel loads are sufficient to carry a moderate to hot fire.

Shrubs such as the rare *Acacia ramiflora* (above) display fire-triggered germination. These plants can be used to indicate appropriate fire intervals, based on allowing several years of seed production following fire.

Paul Williams, Vegetation Management Science Pty Ltd, Bulleringa National Park (2005 and 2006).

Discussion

- Within the Einasleigh Uplands bioregion there are only small areas of this fire vegetation group. They contain a large number of shrubs that germinate after fire and whose seedlings require a number of years to mature.
- The main concern is repeated fires of short intervals and of high severity that burn extensive areas of shrubby eucalypt communities. These fires generally originate from down-slope adjacent open grassy woodlands that burn during drier times when natural barriers to fire are less reliable.
- Shrub species diversity declines and some disappear in very long-unburnt woodlands. At Bulleringa National Park, plant diversity increases in the first few years after fire and declines due to short-lived fire promoted species, particularly herbs (Williams and Tran 2009).

Species diversity in this shrubby woodland is starting to decline.
Paul Williams, Vegetation Management Science Pty Ltd, Bulleringa National Park (2009).

Jacksonia ramosissima flowering (2007) and later dying in this long-unburnt shrubby woodland (2009).

Paul Williams, Vegetation Management Science Pty Ltd, White Mountains National Park.

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)
Over several hectares a mosaic of 25–50 % of blackened ground within the boundary of the burn.	Chose one of these options: a. Visual estimation of percentage of vegetation burnt—from one or more vantage points, or from the air. b. Map the boundaries of burn area with GPS, plot on GIS and thereby determine the percentage of area burnt. c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 m or more through planned burn area estimating percentage of ground burnt within visual field.	**Achieved:** 25–50 % burnt. **Not Achieved:** < 25 % or > 50 % burnt.

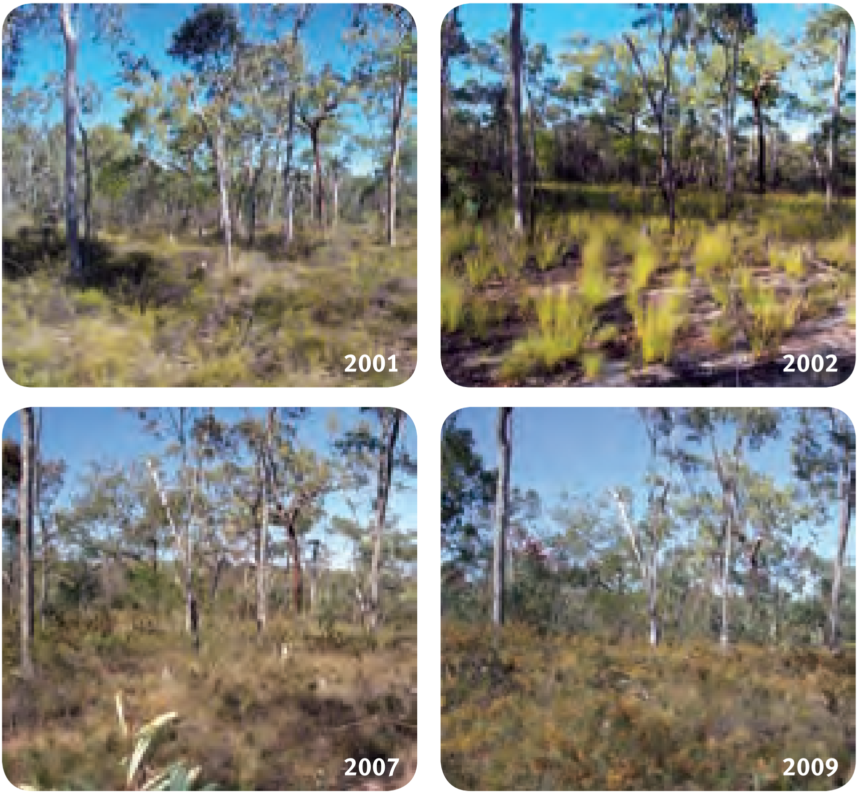
Recruitment of obligate seeders (e.g. *Jacksonia* spp. and *Acacia* spp.) promoted over the burn area.	Chose one of these options (six months to a year after the burn): a. Obligate seeders such as acacias, *Jacksonia* spp. or grevilleas can be seen to be at various heights and stages of recovery from fire —from one or more vantage points, or from the air. Fire reports and fire history mapping, where available, can provide guidance. b. Across the burn area, both seedlings and mature flowering or seeding trees of obligate seeder shrubs can be seen.	**Achieved:** Obligate seeder shrubs are present at various heights/stages of maturity across the burn area. **Not Achieved:** Obligate seeder shrubs are all of a single age/height across the burn area.

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

Monitoring the issue over time

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

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



(Clockwise from top left) A photo-monitoring site in a shrubby eucalypt community. This sequence illustrates shrub diversity decline after a long fire-free interval (2001). This is followed by a series of images of shrub regeneration post-fire. In this final photo the area has matured sufficiently to carry a fire and was recommended for burning in the 2009–2010 fire season.

QPWS, Bulleringa National Park (2001, 2002, 2007, 2009).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** and with the occasional **moderate** or **high**. An occasional moderate-severity fire helps to ensure the regeneration of shrubs.

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)	100–150	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.

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 plan 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 five to ten years.
- Be aware that shrubs vary in their maturing rates.

Mosaic (mosaic of an individual planned burn)

- A mosaic is achieved with generally 25–50 per cent burnt within the target communities. Some shrubs are fire-killed but rely on post-fire recruitment. Seedlings require several years to mature (less than five years). Therefore, broad-scale frequent burning is undesirable.
- In rocky areas this fire vegetation groups tends to burn patchily because of the non-continuous grass layer. In some places where there is a dense understory of grasses such as spinifex, fuel loads and fire severity may be increased. However, overall severity is generally low to moderate.

What weather conditions should I consider?

It is important to be aware of weather predictions prior to and following burns, as part of the planning and so that undesirable conditions and weather changes can be avoided.

Season: Early dry season burns	**Season: Wet season burns**
GFDI: < 8	**GFDI:** 8–14
DI (KBDI): 80–160	**DI (KBDI):** < 80
Wind speed: < 23 km/hr	**Wind speed:** < 23 km/hr

What burn tactics should I consider?

Burn in association with the surrounding landscape. Shrubby eucalypt woodlands have a longer inter-fire interval than surrounding fire-adapted communities. Therefore burning of surrounding communities (generally open grassy woodlands) has to be planned with these communities in mind.

Aerial ignition

- Aerial ignition from a helicopter is recommended for remote, rugged inaccessible terrain generally associated with sandstone ridges and escarpments typical of shrubby eucalypt communities.
- Helicopters provide the opportunity to directly target topographical features such as peaks, ridges and spurs to create a backing fire that travels downhill or away from the edges of the non-target community. This creates a buffer and burns away from the community.
- The spacing of incendiaries is important. It is recommended that an aerial incendiary plan is developed to ensure the spacing and drop patterns achieve the desired burn objectives. Monitor the fires' movements.
- Use of aerial photographs is recommended (stereoscopic images are particularly useful to gain an understanding of terrain). It is good practice to plot the incendiary drop path onto a map or aerial photograph and ensure lighting crews are well aware of the plan prior to ignition.
- **Progressive burning.** Using a combination of techniques (ground and aerial) and at various times from early in the year when conditions allow, creating a varied mosaic across the planned burn area. It also gives managers a greater opportunity to implement planned burns throughout the year when conditions are suitable. Use in tandem with good soil moisture and landscape features such as moist gullies, drainage lines and recently burnt areas.
- **Spot ignition** can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of volatile fuels. This tactic may help create a mosaic burn, thereby reducing the risk of broad scale wildfire.
- **Afternoon or evening lighting** generally creates milder burn conditions promoting a low to moderate severity fire.
- **Commence lighting on the leeward or smoky edge.** This can be a useful way to create a low severity backing fire into the burn area, or to create a containment edge for higher severity fires, or to create a barrier to later season fires.

Issue 3: Manage invasive grasses

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

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

Issue 4: Manage rubber vine, lantana and other woody weeds

Rubber vine *Cryptostegia grandiflora* and lantana *Lantana camara* are aggressive weeds that invade open woodland, vine thickets and riparian communities. The presence of weeds such as these may require an altered approach to fire management or for well-established infestations, the integrated use of fire and herbicide.

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

Chapter 2: Melaleuca communities

This fire vegetation group occurs throughout the Einasleigh Uplands as woodlands communities. In low-lying areas, melaleuca communities are dominated by broad-leaved paperbark *Melaleuca viridiflora*, *Melaleuca nervosa*, or black tea-tree *Melaleuca bracteata*. Scattered patches of narrow-leafed paperbark *Melaleuca citrolens, Melaleuca stenostachya and Melaleuca monantha* occur in drier areas. Where they form fringing communities around wetlands, springs and water courses, they often share the canopy with eucalypt species. Melaleuca species are also a common sub-canopy species of open forests and woodland communities.

Fire management issues

There are differences in how melaleuca communities occur in the landscape (e.g. restricted low-lying areas or as open woodlands) and fire management issues differ as a result.

Where melaleuca occurs as isolated stands within the broader fire-adapted landscape, the focus is on managing surrounding areas under appropriate conditions when melaleuca communities are moist, allowing fire to carry into melaleuca communities on some occasions.

Fringing forests can be damaged by fire and require protection. Swamp communities are generally fire-sensitive and fire should not be directly applied. However some can tolerate occasional low-severity fire.

Where they occur as woodlands or shrublands, a more active approach to fire management may be required (refer to Issue 1).

Issues:

1. Maintain healthy melaleuca communities.
2. Limit fire encroachment into melaleuca fringing communities.

Extent within bioregion: 131 051 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Undara Volcanic National Park, 1 960 ha; Blackbraes National Park, 415 ha; Wairuna Station (Proposed addition to Girringun National Park), 413 ha; Bulleringa National Park, 146 ha; Girringun National Park, 115 ha; Blackbraes Resources Reserve, 114 ha; Mount Rosey Resources Reserve, 91 ha; Porcupine Gorge National Park, 81 ha; Great Basalt Wall National Park, 80 ha; Pinnacles National Park, 61 ha; Mount Lewis National Park, 44 ha; Paluma Range National Park, 35 ha; The Canyon, 29 ha. and other locations see map.

Issue 1: Maintain healthy melaleuca communities

Maintain healthy melaleuca communities with fire management.

Awareness of the environment

Key indicators of a healthy melaleuca community:

- Melaleuca is the dominant canopy tree.
- Healthy melaleuca communities have a healthy canopy with an understorey of grasses, sedges, shrubs (or a mix of these) and a few canopy species of variable sizes (enough to eventually replace the canopy).
- Weed species are uncommon.

The following may indicate that fire is required:

- The crowns and branches of shrubs are declining in health and a high proportion of these have dead or dying crowns or branches. Lower leaves are browning and there is a build-up of dead leaves.
- Grasses are becoming sparse where they were once abundant or the grass clumps are poorly-formed. There is an accumulation of dead material and grasses are beginning to collapse.

Melaleuca typically grows in association with open woodland communities. Burn in association with the surrounding country.

Lana Little, QPWS, Chillagoe-Mungana Caves National Park (2011).

Melaleuca monantha woodland with a sparse understorey. The naturally-sparse ground layer means fires are infrequent.

Mark Newton, DSITIA, Near Mount Carbine (1999).

Black tea-tree *Melaleuca bracteata* often occurs in areas of impeded drainage. These communities are not fire-sensitive but generally do not burn because they have good soil moisture or free standing water.

Fiona O'Grady, QPWS, Blackbraes National Park (2011).

Fires are unlikely to carry far into melaleuca communities with sparse ground layer and/or high soil moisture content.

Mark Newton, DSITIA, Mount Carbine area (1999).

Discussion

- Due to the patchy nature and remoteness of melaleuca communities across the Einasleigh Uplands, aim to manage fire in association with the surrounding vegetation communities.
- Fires are unlikely to carry very far into melaleuca communities that have a sparse ground layer and/or high soil moisture.
- Melaleuca woodlands are fire-adapted, but high-severity or frequent fires may slow or prevent regeneration.
- The main fire management approach for melaleuca communities is burning surrounding fire-adapted areas with a good awareness of moisture conditions within the melaleuca community to limit fire spread and severity. If an area has not burnt for a long time, direct targeting of melaleuca areas with fire management may be required.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Woodland: 30–60 % of melaleuca woodland burnt within management area.	From one or more vantage points or from the air, estimate burnt and unburnt country on an annual basis.	**Achieved:** 30–60 %. **Partially Achieved:** 20–30 % or 60–80 %. **Not Achieved:** < 20 % or > 80 %.
> 75 % of *Melaleuca viridiflora* maintains its canopy height and is not pushed back to basal suckers.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity); estimate the percentage of saplings/seedlings scorched.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

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

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

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.

Early dry-season burns

GFDI: < 8

DI (KBDI): 80–100

Wind speed: < 23 km/hr

Soil moisture: Burn when good soil moisture exists in melaleuca communities

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 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.

- **Progressive burning** is a useful tactic to create variation, mosaics and take advantage of different conditions. This may also assist with fuel load management and reduce the severity and extent of wildfires. Fires (of varying extents, severity and at various times) are lit in fire-adapted communities from early in the year when conditions allow.
- **Spot ignition** is useful to alter the desired severity of a fire. Well-spaced spot lighting adjacent to melaleuca stands is preferred as it limits the chance of hot damaging junction zones forming within the community.
- **A backing fire with good residence time.** A slow-moving backing fire (lit against the wind on the smoky edge or down-slope) will generally result in the more complete coverage of an area. It ensures the fire has a greater amount of residence time and ensures fire intensity and rate of spread are kept to a minimum. Greater residence time is useful in reducing overabundant trees.

Issue 2: Limit fire encroachment into melaleuca fringing communities

Melaleuca fringing communities require protection from too-frequent and/or severe fires.

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

Chapter 3: Acacia dominated communities

This fire vegetation group contains acacia forests and woodlands that are typically dominated by small stands of a single acacia species (e.g. lancewood, gidgee and brigalow). The understorey is generally sparse and includes grasses and shrubs. Small patches of low acacia shrublands are restricted to rock and sandstone pavements.

Fire management issues

Acacia species are vulnerable to frequent and high-severity fires. In most instances, fire is not applied directly to acacia dominated communities (e.g. planned burns) rather; burn surrounding fire-adapted vegetation to mitigate the intensity and extent of unplanned fires impacting upon acacia communities.

Introduced invasive grasses pose the greatest threat to fire-sensitive communities. These grasses draw fires into the areas and increase the fire severity. Species such as buffel grass alter fuel characteristics at the site (Butler 2007) and influence the potential for frequent and damaging fires.

Issues:

1. Burn adjacent fire-adapted communities to maintain the health of acacia-dominated communities.
2. Manage invasive grasses.

Extent within bioregion: 512 585 ha, 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Bulleringa National Park, 19 222 ha; The Canyon, 5 536 ha; Wairuna Station (Proposed addition to Girringun National Park), 3 904 ha; Undara Volcanic National Park, 3 385 ha; Porcupine Gorge National Park, 1 308 ha; Great Basalt Wall National Park, 602 ha; Gilbert River Proposed new National Park, 127 ha; Girringun National Park, 69 ha; The Bluff Forest Reserve, 14 ha; Blackbraes National Park, 7 ha.

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

Maintain a varied landscape mosaic of burnt and unburnt patches in adjacent fire-adapted communities to limit the frequency and potential impacts of damaging, unplanned fires encroaching into acacia dominated communities.

A healthy lancewood-dominated forest. Fire-killed acacias such as lancewood regenerate post-fire via seedlings. However, it can take 6¬–20 years before the trees set-seed.
Gary Wilson, Queensland Herbarium, Bulleringa National Park (2006).

Acacia-dominated communities are generally well-represented with fire-sensitive shrub species.
Justine Douglas, QPWS, White Mountains National Park (2011).

Acacia communities are often afforded protection from fire by natural features such as bare rock, steep relief, poor soils and sparse fine fuels in the ground layer.
Fiona O'Grady, QPWS, Porcupine Gorge National Park (2011).

Sparse fuels and bare ground mean fire is only likely to trickle though this fire-sensitive gidgee community.
Mark Newton, DSITIA, Hughenden area (2010).

A Boree-dominated community. This species is fire-killed and does not need fire for its regeneration.
Mark Newton, DSITIA, Great Basalt Wall (2006).

Discussion

- Fire-killed acacias such as lancewood *Acacia shirleyi* are reliant upon post-fire regeneration from a viable seed bank in order for the species to persist locally. These species are hard-seeded and require fire to promote germination. Although it is recommended to mitigate wildfire impacts by burning the surrounding areas, the occasional (rare) wildfire may play a role in the persistence of this community in the landscape. It is then critical to exclude further fires until the acacias reach maturity and set several seed crops.
- Other acacias such as gidgee *Acacia cambagei*, pink gidgee
- Acacia crombiei and boree *Acacia tephrina* are long-lived and fire-killed (or significantly top-killed). Germination is very occasional and generally follows high rainfall years. Fire plays no role in the germination of these species.
- Historically, fire within most acacia communities was infrequent, estimated at between ten and 50 years (though this differs where acacias are associated with grasslands). In general fire has occurred during extensive wildfire events and/or following prolonged rainfall which has resulted in substantial grass growth creating sufficient fuel to carry fire (Hodgkinson 2002). Changes in land use (in particular a decline in planned fires) and the spread of invasive grasses have resulted in fires of a greater frequency and severity, causing undesirable impacts.
- Acacia species such as *Acacia johanis, Acacia leptostachya* and *Acacia longispicata* are obligate-seeders and require fire-free intervals of at least five to eight years to maintain community structure. Acacia shrubland communities are restricted in their range and are generally protected by the landscape where they grow (rock pavements, sandstone scarps, sparse fine-fuel layers). Fire will naturally enter these communities occasionally and should maintain obligate-seeders. Do not intentionally apply fire in these communities.
- Be aware that after a fire that has affected an acacia community, a more proactive fire management approach in the surrounding areas will often be required to allow the acacia regrowth sufficient time to recover and mature.
- Fire exclusion in acacia-dominated communities may result in an accumulation of fuels that promote high-severity, single-event wildfires. Patchy to low-severity burns in surrounding areas that on occasion trickle into these areas is useful as they reduce fuel levels and mitigate the impacts.
- When conducting planned burns in areas adjacent to acacia communities it is important to be aware of the dominant acacia species, their response to fire and in particular the presence of invasive species (e.g. buffel grass).

A patchy burn has trickled into a gidgee-dominated community. Whilst gidgee is extremely fire-sensitive, it can withstand occasional, mild and patchy fires. Note minimal scorching of mature gidgee trees.

Justine Douglas, QPWS, Toomba Station (2011).

Fire-killed *Acacia longispicata* regeneration post-fire via seedlings. These initially form dense clumps.

Fiona O’Grady, QPWS, Porcupine Gorge (2010).

A lancewood community. Note the number of dead mature lancewood trees and the absence of seedlings. This indicates the community is long-unburnt.

Mark Newton, QPWS, Einasleigh area (2009).

Issue 2: Manage invasive grasses

It is important to be aware of the presence of invasive grasses as they can dramatically increase fire severity, are often promoted by fire and may result in significant impacts upon the vegetation community.

Buffel grass *Cenchrus ciliaris* in particular poses a significant threat to acacia-dominated communities by altering fuel characteristics and promoting a cycle of damaging high severity fires which gradually result in the fragmentation and overall decline of the extent of acacia-dominated communities.

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

Chapter 4: Riparian, springs and fringing communities

This fire vegetation group includes open forests on stream channels, river banks and intermittent creeks, riverine wetlands, springs and fringing eucalypt forests.

Fire management issues

Most of the species in these communities are fire-sensitive. Whilst they can tolerate an occasional low-severity fire, do not intentionally burn them. Many of these communities are subject to weed invasion, in particular rubber vine and lantana which create thickets in riparian vegetation. Rubber vine and lantana are both fire-sensitive and in some cases it may be necessary to use fire to control these invasive weeds (refer to Chapter 6). Thermal springs occur throughout the bioregion and have the biodiversity status **'of concern'**. These springs are generally protected by fire because there is usually freestanding water present.

Issues:

1. Limit fire encroachment into riparian, springs and fringing communities.

Extent within bioregion: 282 081 ha, 2 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Wairuna Station (Proposed addition to Girringun National Park), 2 583 ha; Girringun National Park, 751 ha; Paluma Range National Park, 454 ha; Bulleringa National Park, 415 ha; The Canyon, 242 ha; Mount Windsor National Park, 236 ha; Palmer Goldfield Resources Reserve, 229 ha; Retreat Valley/Diggers Creek, 129 ha; The Bluff State Forest, 117 ha; Chillagoe-Mungana Caves National Park, 96 ha; Dalrymple National Park, 81 ha; The Bluff Forest Reserve, 54 ha; Gilbert River Proposed new National Park, 49 ha; Bilwon Forest Reserve, 47 ha; White Mountains Resources Reserve, 44 ha; Kuranda State Forest, 37 ha; Mount Lewis National Park, 34 ha; Porcupine Gorge National Park, 33 ha; Dinden State Forest, 31 ha; Great Basalt Wall National Park, 22 ha; Bilwon State Forest, 20 ha; White Mountains National Park, 15 ha; Nettle Creek Historic Tin Site, 14 ha; Pinnacles National Park, 12 ha; Dinden West Forest Reserve, 12 ha; Evelyn Creek Conservation Park, 11 ha; Upper Granite Normanby (Under Negotiation With Aboriginal Land and National Park), 5 ha.

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

Many riparian and fringing communities contain a high proportion of fire-sensitive species such as river she-oak *Casuarina cunninghamiana, Melaleuca leucadendra*, and *Melaleuca argentea* and other habitat trees. Too frequent and/or severe fire removes or inhibits the development of structurally complex ground and mid-strata vegetation and may open up the canopy. This increases the risk of weed invasion and soil erosion and leads to a greater production of fine fuel (mainly grass) and therefore an increase in the fire hazard.

Patchy to low-severity burns in surrounding areas during the late wet season to early dry season (e.g. March to June) that occasionally trickle into fringing communities will reduce fuel loads and mitigate the impacts of wildfire (and the loss of habitat trees).

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

Melaleuca species such as *Melaleuca leucadendra* are common along watercourses. While these species can tolerate the occasional fire, intense fires can degrade the structure of these riparian communities.

Lana Little, QPWS, Chillagoe area (2012).

Seasonal watercourses provide significant habitat as drought refuge, wildlife corridors and for arboreal animals.

Justine Douglas, QPWS, Dalrymple (2011).

In some areas fires will trickle into riparian zones. By keeping fuel loads low in adjacent woodlands, fire-severity in these communities will remain low and the scorching of their margins will be reduced.

Grant Anchen, QPWS, Blackbraes National Park (2011).

Chapter 5: Vine thickets

This fire vegetation group occurs as vine thicket remnants in rocky gullies, sheltered sites on basalt flows, granite outcrops and limestone bluffs.

Fire management issues

Vine thickets are generally protected from fire by their position in the landscape and 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 them.

Smaller isolated patches of vine thickets are more susceptible to the impacts of fire than larger undisturbed stands (as they have a greater exposure to edge effects including increased fuel loads and fires of greater intensity and frequency). Scorching of margins may occur where it has been subjected to disturbance or where invasive species such as high-biomass grasses and lantana have established.

Most of the vine thicket communities in the Einasleigh Uplands have the biodiversity status **'of concern'**. A key conservation issue for this fire vegetation group is the further attrition of vine thickets due to the increasing number of late dry season fires impacting on their margins. Occasionally, fire is used in vine thickets for specific weed control (refer to Chapter 6). Limit fire encroachment or scorching by undertaking low-severity burns in adjacent fire-adapted communities.

Issues:

1. Limit fire encroachment into vine thickets.

Extent within bioregion: 136 122 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Great Basalt Wall National Park, 33 297 ha; Kinrara National Park, 5 845 ha; Forty Mile Scrub National Park, 2 583 ha; Girringun National Park, 1 823 ha; Undara Volcanic National Park, 1 483 ha; Chillagoe-Mungana Caves National Park, 775 ha; Mount Flagstone Forest Reserve, 530 ha; Mount Rosey Resources Reserve, 296 ha; Paluma Range National Park, 183 ha; Pinnacles - land adjacent to Mingela State Forest, 123 ha; Mingela State Forest, 100 ha; Pinnacles National Park, 98 ha; Dalrymple National Park, 43 ha; Calcium Land, 42 ha; Mount Lewis National Park, 12 ha; Kuranda State Forest, 1 ha.

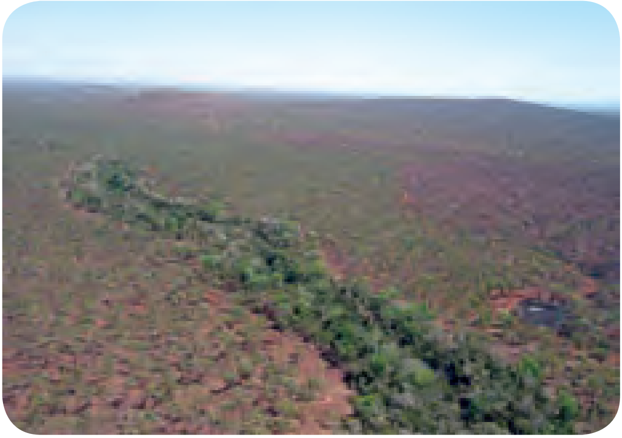
Issue 1: Limit fire encroachment into vine thickets

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

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

Isolated pockets of vine thickets are susceptible to scorching at their margins. Undertake low-severity burns in adjacent fire-adapted communities.

Gary Wilson, Queensland Herbarium, Chillagoe National Park (2002).



A vine thicket on a basalt flow. Manage fire in adjacent woodland communities to limit its encroachment into vine thickets.

Lana Little, QPWS, Undara National Park (2009).

A semi-evergreen vine thickets on a limestone

outcrop. These communities are generally protected from fire by their lack of surface fuels and position in the landscape.

Mark Newton, DSITIA, South of Greenvale (2010).

Under very hot, dry conditions, vine thickets are susceptible to wildfire, particularly where invasive weeds such as lantana camara have established.

Nick Smith, QPWS, Forty Mile Scrub.

Chapter 6: Common issues

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

Fire management issues

1. Hazard reduction (fuel management) burns.
2. Planned burning near sensitive cultural sites.
3. Manage invasive grasses.
4. Manage rubber vine, lantana and other woody weeds.
5. Limit fire encroachment into non-target fire vegetation groups.
6. 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.

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 (refer to 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.

A build-up of continuous grass fuels. Extensive areas of continuous fuels increase the risk of large-scale fires with little burn patchiness.

Mike Ahmet, QPWS, Royal Arch National Park (2005).

Consider burning an area that has a continuous heavy fuel load under mild conditions and/or with high soil moisture. This will reduce the fire severity.

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

A build-up of continuous surface fuels indicates the need for a hazard reduction burn. Note that fallen timber is likely to smoulder for sometime after the main fire front has passed and create a re-ignition risk.

Mike Ahmet, QPWS, Forty Mile Scrub (2008).

A build-up of grasses, leaves, branches and logs will carry a fire in this lancewood community. Retaining fuel loads in adjacent fire-adapted communities will ensure the protection of this fire-sensitive community.

Mark Newton, DSITIA, Georgetown area (2009).

Discussion

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

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

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

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

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

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

- It is important to maintain a simplified vegetation fuel structure in protection zones and wildfire mitigation zones, which means addressing issues such as suspended and elevated fuel and overabundant saplings and seedlings.
- Fire management that favours grasses will assist in achieving an open structure suitable for wildfire management and mitigation. Moist conditions and low-severity burns that retain the bases of grasses will give them a competitive advantage over woody species.
- In wildfire mitigation zones it is essential to maintain ecosystem health. Ensure the use of appropriate conservation objectives for the fire vegetation group in addition to a fuel reduction objective (refer to fuel reduction objectives below).
- When establishing protection zones or wildfire mitigation zones favour fire vegetation groups that support a simplified vegetation fuel structure. Where possible avoid fire vegetation groups containing species that naturally produce high-severity fire during wildfire conditions (e.g. heath).
- It is not always possible to contain planned burns within the protected area due to the location of park boundaries (firelines may not exist along park boundaries as they are often in inaccessible areas and have continuous fuel levels. Cooperative fuel reduction burns with neighbours are often the only way to achieve the objectives of protection and wildfire mitigation zones. Refer to the QPWS Good neighbour policy and Notifying external parties of planned burn operations procedural guide.
- Planned burning often creates a smoke management issue particularly where burns are undertaken close to residential areas or commercial operations (e.g. agriculture, airports, major roads and high voltage power lines). Planning needs to consider factors such as fuel type, fuel hazard, temperature inversion and wind speed and direction all of which can have significant effects on the quantity of smoke generated and how it is distributed.
- Cyclones and severe storms will leave branches and leaves accumulated on the ground which increases fuel loads. Dead or fallen trees will allow fires to smoulder for some time creating re-ignition risks. Refer to Chapter 6 (Issue 6), for fire management guidelines.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

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

What weather conditions should I consider?

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

Season: Late wet to early dry season

FFDI: < 11

DI (KBDI): < 100 for soil moisture

Wind speed: < 15 km/hr

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

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

What burn tactics should I consider?

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

- **Aerial ignition** can be used to support early dry-season and late wet-season fuel reduction burning (particularly where vehicle access is limited due to wet conditions). Under the right conditions (where no natural barriers or constructed firelines are present) aerial incendiary operations can be used to create areas of reduced fuel around fire-sensitive communities (e.g. acacia communities).
- **Spot ignition** can be used effectively to alter the desired intensity of a fire particularly where there is a high accumulation of available and volatile fuels. Spots closer together will result in a line of a greater intensity (as spots merge and create hot junction zones) while increased spacing between spots will result in a lower intensity fire. The spacing of the spots will regularly vary throughout the burn due to changes in weather conditions, topography, fuel loads, etc.
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low intensity backing fire. Depending on available fuels and the prevailing wind on the day, use either spot or strip lighting or a combination of both.
- **A low intensity backing fire** is usually slow moving, and will generally result in a more complete coverage of an area and a better consumption in continuous fuel. This tactic ensures the fire has a greater amount of residence time and reduction of available fuels, particularly fine fuels (grasses, leaf litter, twigs, etc), while minimising fire severity and rate of spread.
- While a low intensity backing fire is recommended, a **running fire** of a higher intensity may be required in discontinuous or elevated fuel. Use with caution and be aware of environmental impacts that may result. To create higher intensity, contain the smoky side first, then **spot light the windward (clear) edge**. Caution is required if the area is small in size or a narrow strip and the two lit lines will converge, creating a hot junction zone and greater than desired severity with the chance of fire escaping through a spot-over.

Burning downhill creates a slower-moving, low-intensity fire. Fuel loads are reduced and ecosystem health is maintained. Ground ignition from the base of slopes can lead to scorching.

Nick Smith, QPWS, Undara National Park (2005).

A running fire can help reduce fuel hazard. This will protect boundaries, support annual burning programs and reduce elevated fuels.

Mark Parsons, QPWS, Princess Hills National Park (2010).

Issue 2: Planned burning near sensitive cultural 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.

Key indicators of Indigenous cultural heritage sites:

- Arrangements of stones, raised earth patterns or artefacts scattered on the ground (sometimes exposed following a planned burn or wildfire) are present.
- Trees that have been scarred or carved (e.g. a scar in the shape of a canoe) exist.
- Rock shelters with rock paintings, stone tools, artefact bundles, wrapped material or bones inside are present.
- There are engravings on trees or rock faces.

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).

Awareness of the environment

Key indicators of European cultural heritage sites:

- The existence 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) are present.
- Forestry artefacts including marked trees (shield trees) and old machinery such as winders (timber tramways) and timber jinkers (timber lifting wagon) exist.
- Military artefacts such as old equipment and used ammunition exist.
- Survey and trig points exist.
- The presence of historic fence-lines.

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 limit the spread and severity of wildfires giving better protection to cultural heritage artefacts and sites.
- The key risks to cultural heritage sites and artefacts from fire are direct contact with flames, radiant heat and smoke (e.g. radiant heat can exfoliate the surface of rock art sites, flame can crack or burn items and smoke can damage paintings).
- To manage impacts from flame and radiant heat, consider reducing fuel levels though manual, mechanical, or herbicide means or a combination of these. If it is not necessary to reduce fuel it is preferable to leave the site completely undisturbed.
- For larger culturally significant sites it may be necessary to create a secure burnt edge by backing fire away from these locations. Use this tactic prior to broader-scale planned burns.
- For sites that may be impacted by smoke (e.g. rock paintings and rock shelters) use wind to direct smoke away from the site.

What is the priority for this issue?

Priority	Priority assessment
Highest	Fuel management through the implementation of planned burns within **protection zones** to protect life, property, and conservation values.
Very high	Burns protecting **significant cultural heritage sites**.

Assessing outcomes

Formulating objectives for burn proposals

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 cultural heritage sites.

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

- Be guided by the recommendations in the fire vegetation groups.

Mosaic (mosaic of an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

Season: Favour early season burning and moist conditions

FFDI: < 7

DI (KBDI): < 160

Wind speed: < 15 km/hr

Wind direction: Consider wind direction—choice of wind direction can help mitigate impacts

Soil moisture: Ensure good soil moisture

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

What burn tactics should I consider?

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

- **Spot ignition.** Can be used effectively to alter the desired intensity of a fire particularly where there is an accumulation of available and volatile fuels next to a site of interest. Widely spaced spots is preferred in this instance as it will promote a slow moving and manageable low severity fire and limits the chances of high severity junction zones developing.
- **A low-severity backing fire.** A slow-moving backing fire will help minimise fire severity and rate of spread and may reduce smoke particulates.
- Depending upon conditions on the day, **spot light the windward (clear) edge** to direct the active fireline and smoke away from the site of interest. It may be necessary to secure the edge closest to the cultural heritage site with a chipped wet line.
- **Manual fuel management.** Burning in appropriate conditions will usually 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 the potential impacts from smoke, flame and heat radiation. Only undertake manual fuel management if required—it is preferable to leave the site completely undisturbed.

Issue 3: Manage invasive grasses

Exotic grasses are capable of outcompeting native species to form dominant stands. Invasive grasses of concern in the Einasleigh Uplands are buffel grass *Cenchrus ciliaris*, grader grass *Themeda quadrivalvis* and gamba grass *Andropogon gayanus*. Invasive grasses are generally much taller and produce more dry matter than native grasses. This increases fuel loads, fire intensity, spotting risk and flame height which leads to increased fire intensity and rate of spread. Greater tree death and loss of habitat features often result and this has flow-on effects to species. Exotic grasses can carry fire into fire-sensitive vegetation and result in considerable damage which gradually results in further fragmentation and overall decline in the extent of fire-sensitive vegetation such as acacia and vine thicket communities. Ponded pasture grasses can choke streams and replace native vegetation, destroying waterbird breeding habitats.

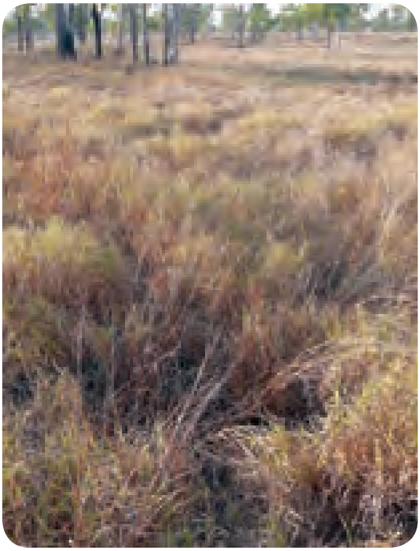
Fire can be used as part of the control for some exotic grasses. At the same time, invasive grasses both promote fire and many are promoted by fire. They tend to occur as a result of disturbance and spread along firelines and utility easements. It is important to be aware of the presence of invasive grasses during planned burn operations.

Awareness of the environment

Key indicators:

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

- The presence of invasive grasses, usually occurring in a dense infestation.
- Invasive grasses generally form single species dominated stands.
- Typically first appear along fire-lines and roads and similarly highly disturbed areas.
- Generally taller than native species.
- Have a lot more biomass and/or dead material.



Buffel grass is interspersed with native themeda grass in this grassy eucalypt woodland.

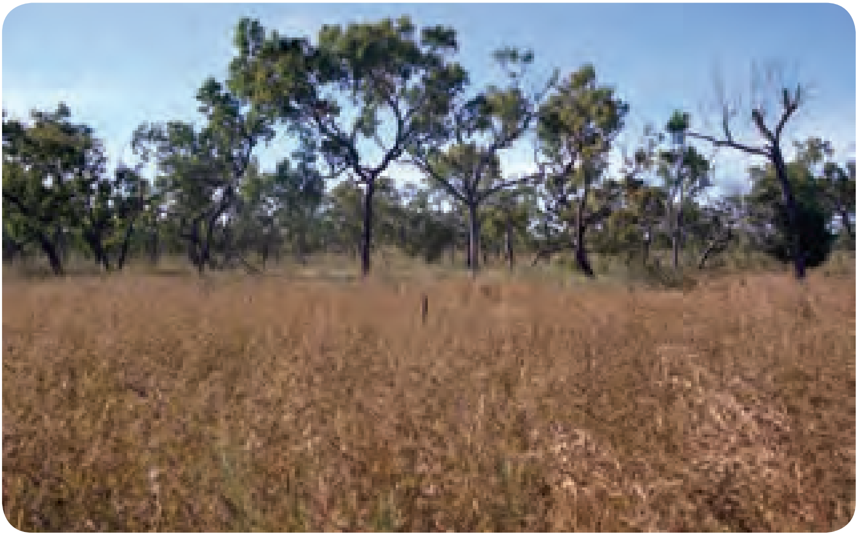
Justine Douglas, QPWS, Dalrymple National Park (2011).

Buffel grass dominates the ground-layer of a floodplain community.

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

Native grasses struggle to compete with the stylo *Stylosanthes* spp. The removal of cattle grazing has lead to the rapid regeneration of the introduced pasture species at this site. Fire can be used to manage the balance between native grasses and stylo.

QPWS, Chillagoe National Park (2007).



Grader grass invading an Open woodland community.
Mike Ahmet, QPWS, Undara National Park (2006).

Grader grass is easily identifiable in this grassy woodland community. Towards the end of dry season, grader grass has matured and collapsed.
Grant Anchen, QPWS, Blackbraes National Park (2011).

Discussion

- Where invasive grasses are present, planned burn operations have the potential to either promote or control them—their effect on fire severity must be considered. Be aware that fire will usually promote these grasses unless used in specific ways mentioned below.
- Invasive grasses thrive on disturbance. Regular burning of these grasses off roads, tracks and other disturbed areas may create conditions suitable for the spread of invasive grasses into non invaded areas. This practice should be avoided where these grasses are present.
- There is a relationship between fire timing, frequency and severity and the ability of these grasses to invade, which is still poorly understood. You are encouraged to record observations regarding these species' response to fire.
- Be aware of weed hygiene issues when conducting planned burns in areas with high-biomass grasses. Fire vehicles and machinery can aid seed spread along firelines—vehicles should be washed down after exposure.
- In many cases, it is desirable to avoid burning invasive grasses as they are likely to increase the fire severity and be promoted by fire. 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.
- For some species, the application of fire or the exclusion of fire are known to be important aspects of control. Specific information is offered below:

Buffel grass *Cenchrus ciliaris*

- Fire is not known to be an effective tool to manage buffel grass. Buffel grass increases fuel loads and thus increasing fire severity at the same time creating a disturbance which favours its spread. Buffel grass is of particular concern to fire sensitive communities. This species can penetrate and establish in gidgee/lancewood woodlands increasing fuel loads in these communities.
- 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 herbicide control. 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 grass should be of a **low**-severity. Using night burns when moisture is high may assist in achieving a low-severity burn.
- The curing rate for buffel grass differs from that of native grasses and it tends to remain greener for longer periods of time.

Grader grass *Themeda quadrivalvis*

- Grader grass is an annual (its life cycle occurs within one year). However the viability of the seed in the soil has been observed to drop off after two to three years.
- Fire is not considered to be an effective tool to manage grader grass as it can encourage seed germination. Fire should be excluded for four to five years (if fire is applied while the seed is still viable, grader grass will be promoted). When using fire, aim to time its application prior to the grader grass setting seed or before the seed matures (typically in March).
- When fire is re-applied in these infestations, ensure there is good soil moisture as it will aid the re-establishment of native grass species.
- Grader grass is a weed of disturbance. Too frequent or severe fire will promote the spread of grader grass. Grader grass infestations need to be monitored carefully to assess the effects of fire on its spread. Map grader grass infestations to determine the most suitable method of control (through herbicide, fire exclusion or both).

Gamba grass *Andropogon gayanus*

- Gamba grass is an emerging weed in the Einasleigh Uplands bioregion. Be aware of new infestations which can quickly take hold and ensure they are dealt with as a matter of priority.
- Gamba grass produces flammable material up to five times greater than fuel loads in native grasses and maintains a tall upright structure when cured. Gamba grass seed longevity is short, with only one per cent of seed remaining viable by the start of the wet season (Setterfield et al. 2004).

Other invasive grasses

- Many of the protected areas in this bioregion were once pastoral lands. In heavily disturbed areas, invasive grasses have replaced native perennials. Indian couch *Bothriochloa pertusa* is one introduced species that has replaced native grasses where heavy grazing has occurred. Stylo *Stylosanthes* spp. is a pasture species that can outcompete native grass species in woodland communities. Grazing reduces dense regeneration of stylo. Regular fire regimes are also likely to keep this species from dominating the ground layer. Where dense stands occur however, it is difficult for fire to penetrate. Knowledge of fire response of many of these introduced grasses/pasture species in native vegetation communities needs to be improved.

Ponded pasture grasses

- Ponded pasture species such as para grass *Urochloa mutica* and hymenachne *Hymenachne amplexicaulis* are often associated with springs and dams and the woodlands on basalt. Successful control of all of the weed species requires an integration of fire management, herbicide control and stock exclusion.
- Fire can be used as a cost effective means of reducing hymenachne infestations. Burning can generally only be done during the dry season when plants have dried out sufficiently to provide suitable fuel. Be aware that hymenachne can create large fuel loads that promote intense, hot fires that can destroy native riparian vegetation. Fire will destroy seed on the soil surface but will not destroy buried seed. The heat of the fire may even stimulate germination of the buried seed and the resulting seedlings would need to be treated by herbicide.
- Fire can be used with partial success for the management of para grass where it occurs in swamps and drainage lines. Fire is more effective where the para grass has dried out. Burning has been found to be more effective if used later in the year or in combination with chemical control. If left unburnt, para grass develops a thick thatch underneath that prevents any other plants from germinating (Anchen et al. 2006).

Olive hymenachne is a significant threat to wetlands as it will outcompete and smother native grasses and choke-up waterways.

Mike Ahmet, QPWS, Wiaruna (2010).

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 of control can be considered.

Assessing outcomes

Formulating objectives

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

Choose from below as appropriate:

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

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 complete 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. This will ensure the objectives of the burn have been achieved and will ensure the invasive grasses do not recover to their original density.

Roadside disturbance has led to this grader grass infestation (above) Grader grass was progressively replaced by native themeda grasses through a combination of fire exclusion and herbicide control (below). Where grader grass is present, fire frequencies should not be less than three years.

QPWS, Photo monitoring plot (10), Princess Hills (1996 and 2007).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- This will depend on the species of invasive grass being targeted. In general, invasive grasses should be burnt in ways that minimise fire severity. A **high**-severity fire may be required for specific objectives (e.g. when targeting para grass that is starting to become abundant in wetlands and swamps).

Mosaic (mosaic of an individual planned burn)

- Dependant upon species and objective of burn, refer to discussion above.

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

- Dependant upon species and objective of burn, see discussion above.

What burn tactics should I consider?

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

- **As part of a control program.** An initial fire to reduce the biomass of invasive grasses, followed by the chemical control of new shoots can be an effective method of control. Similarly, grazing can also reduce fuel loads.
- **Spot ignition.** Can be used to effectively alter the desired intensity of a fire, particularly where there is a high-biomass grass infestation.
- **A low intensity backing fire.** A slow moving, low intensity backing fire (against the wind or down slope) will generally result in a more complete coverage of an area and a better consumption of available fuels. This tactic ensures the fire has a greater residence time and reduction of available fuels, particularly fine fuels, while ensuring fire intensity and rate of spread is kept to a minimum.
- **Fire exclusion.** Fire exclusion from an infested area may provide the opportunity for native grasses to outcompete invasive grasses (e.g. grader grass).

Issue 4: Manage rubber vine, lantana and other woody weeds

Rubber vine *Cryptostegia grandiflora* and lantana *Lantana camara* are woody weeds found within the Einasleigh Uplands bioregion. Rubber vine has the ability to smother trees and shrubs and shade out grasses making fire difficult to apply. It is usually found in riverine areas, floodplain communities and dry creek beds. Lantana is a major threat to vine thickets and riparian communities. In the Einasleigh Uplands lantana mainly occurs to the east of the bioregion or on basalt flows. Fire is known to be an affective control method for woody weeds both alone and in combination with other treatments such as herbicide application.

Awareness of the environment

Key indicators where woody weeds can be managed with fire:

- Lantana/rubber vine and other woody weeds occur as a scattered understory plant in open woodland communities.
- Grass fuels are continuous enough to carry fire (despite the occurrence of woody weeds).
- Control with fire is limited where woody weeds are growing in fire-sensitive vegetation (e.g. riparian, vine thickets).
- Bio control or herbicide control efforts may increase the effectiveness of fire as a control method where infestations have become dense.

Discussion

Lantana

- A series of fires (with increased fire frequency) can be used to control lantana as a sole management method. This can be effective to reduce abundance and density of lantana, or can reduce the size of individual plants so native ground covers can compete. Fire may be the only practical method of control where lantana is widespread. Implementing the recommended fire regime for the fire vegetation group is effective in the management of the density and occurrence of lantana where it is scattered as an understorey plant.
- In areas where lantana density is high but where some native grasses remain beneath it, the introduction of a low to moderate-severity fire on its own may be sufficient to control lantana and favour the native grasses.
- In areas where lantana has become a dense infestation of a limited size, an approach combining fire and herbicide becomes more practical, though fire on its own may prove sufficient.
- The use of fire in inappropriate conditions may promote lantana or scorch fire-sensitive communities (particularly where lantana occurs along rainforest margins). If lantana has been promoted, a follow-up low to moderate-severity backing fire in moist conditions may be required to favour the recruitment of native grasses and at least reduce the lantana back to root stock.

A lantana infestation in what was once a vine thicket community, previously subject to wildfire disturbance.

Mike Ahmet, QPWS, Forty Mile Scrub National Park (1995).

A lantana infested vine thicket. Because vine thickets are fire-sensitive and there is an absence of grass or fine fuels, a different approach to fire management is required.

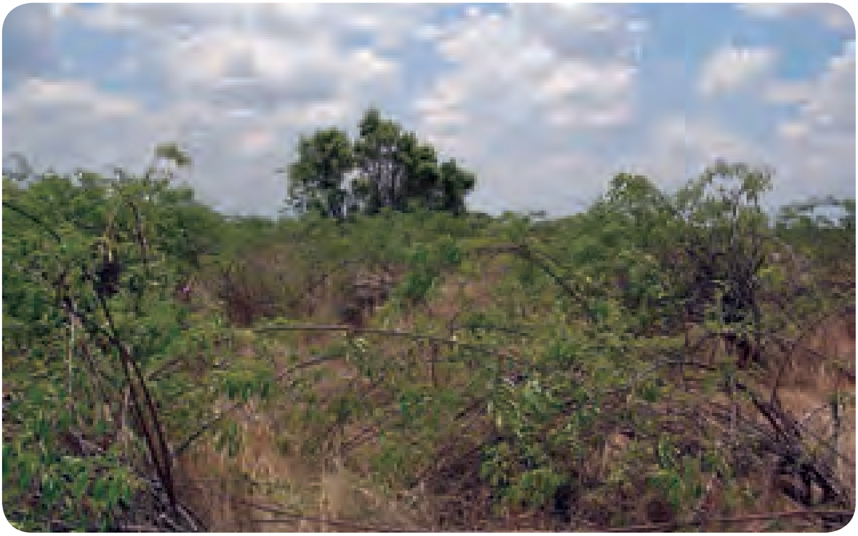
Nick Smith, QPWS, Forty Mile Scrub National Park (2006).

Rubber vine

- A single fire can often be useful to reduce or eliminate rubber vine seeds, seedlings and plants where sufficient fuel is available. It may also promote native grass recruitment. A follow-up fire may then be required to treat any remaining seedlings or plants.
- Plants should be scorched to the tip or all leaves completely browned. More mature plants require increased residence time to allow the sap to boil, which will kill the plant. Insufficient residence time or fire severity will not kill mature rubber vine plants—they are able to re-grow from undamaged material at the base of the plant.
- A combination of fire and herbicide control could also be useful where grasses abut an infestation. A running fire into the rubber vine may reduce the area requiring chemical treatment or increase accessibility.
- A heli torch can be used to control rubber vine in fire-sensitive communities or in inaccessible areas. The success of this method is generally reliant upon the moisture content of rubber vine which needs to be high to effectively cause the sap to boil and kill the plant. In some areas this method has been very successful but mixed results in other areas have been reported.
- Using fire to control rubber vine is more successful in areas where rubber vine rust occurs or where herbicide has been previously applied.

Other woody weed species

- Giant milkweed *Calotropis procera* is a woody weed that invades open woodlands, monsoonal forests and watercourses. This species resprouts prolifically after fire and is known to spread rapidly unless there is competition from other ground covers. Fire is therefore not likely to be a control method for this species. Monitor for infestations in fire-adapted communities.
- Successful fire management techniques for other woody weed species in the Einasleigh Uplands are not yet established and will require experimentation. The examples above might be useful as a starting point.



A rubber vine infested woodland. Rubber vine is relatively fire-sensitive as long as the base of the stem of each plant is heated.
Mike Ahmet, QPWS, Undara National Park (2004).

A high mortality of adult rubber vine plants. In this instance a fire of high-severity was successful in reducing a large percentage of adult rubber vine plants.
Mike Ahmet, QPWS, Undara National Park (2004).

Above (June, 2006) shows rubber vine starting to invade an open grassy woodland community. Below a combination of fire and herbicide control, rubber vine has been almost removed from this site (June, 2009). The area will need monitoring to prevent new infestations.

Mike Ahmet, QPWS, Royal Arch National Park.

What is the priority for this issue?

Priority	Priority assessment
High	Planned burns to **maintain ecosystems** in areas where **ecosystem health** is **good**.
Medium	Planned burn in areas where **ecosystem health** is **poor** but recoverable.

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
>90 % 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 have been killed. **Or** If using the 'heli-torch' method, retrace the flight path in three locations and estimate the percentage of mature rubber vine plants killed.	**Achieved:** >90 % plants killed*. **Partially Achieved:** 75–90 % plants killed*. **Not Achieved:** <75 % plants killed*. *It is not necessarily a good outcome if you have killed most of the rubber vine 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 if using cover— a growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Parks Victoria 1995]): • Rare (0–4 % cover) = Target weed plants very rare • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–50 % cover) = 1/4 weed cover to equal proportions of weed to native species • Medium-Dense (51–75 %) = equal proportions of native to ¾ weed cover • Dense (>75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation 'drops' two 'density categories' (e.g. goes from medium-dense before the fire to light after the fire). **Partially Achieved:** Weed infestation 'drops' one 'density category'. **Not Achieved:** No change in density category or weed density gets worse.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Key factors

- The principal factor in successful control is residence time and repetitive fire. Slow moving fire is required to kill mature trees although intensity is also important.
- The seeds, seedlings and saplings of most woody weeds are the life stage that is most vulnerable to fire. To increase its effectiveness, planned burning should be conducted as soon as an infestation is detected.

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

- In some cases, applying the recommended fire frequency for the fire vegetation group in which woody weeds occur may be sufficient to control the issue. Increasing the fire frequency for a period of time may further assist control.
- 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) apply a follow-up burn in the following year (or within two to three years). In some cases a third fire may be required to completely remove the infestation. Once resolved re-instate the recommended fire regime for the fire vegetation group. Continue monitoring the issue over time.
- Where lantana is a scattered understorey plant, it may be sufficient to apply the standard recommended fire frequency for the fire vegetation group in which it occurs. In any case, increasing fire frequency for period of time will assist control. Monitor the situation.

Fire severity

- **Low** to **moderate**. Best results have been achieved using 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.
- For a dense infestation, **moderate** to **high**-severity fire may initially be required. Be aware of the potential damage to sensitive vegetation (e.g. vine thickets and riparian 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.

Season: Different approaches are possible and include burning early in the year with good moisture or progressive burning to secure a late season burn under dry conditions

FDI: < 12 and occasionally up to 18 for higher severity fires

DI (KBDI): 80–120

Wind speed: < 23 km/hr. The wind speed is variable and depends on the objectives and the density of the infestation (denser infestation may require some fanning by the wind for the fire to carry)

What burn tactics should I consider?

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

- **Line or strip ignition** is used when the objective is to implement a fire of higher-severity (generally due to factors such as moist fuels, mild weather conditions and inconsistent fuels). This tactic may be required where the rubber vine infestation is of such a density that spot ignition will not be sufficient or there are minimal surface fuels available (e.g. grasses).
- **A low to moderate-severity backing fire.** Where rubber vine is 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. This tactic has proven to be successful in killing seeds, seedlings, young and some mature rubber vine plants.
- **Subdividing rubber vine infestations.** Dividing an infestation into sections by hand or with heavy equipment can improve access and aeration and allowing the infestation to be burnt in sections to manage fire severity and behaviour.
- **As part of a control program. An initial herbicide treatment can be used** in areas where dense rubber vine shades-out grasses and limits the fuel available for fire. Care should be taken when applying fire to dead rubber vine plants which remain hanging in the canopy as they can act as elevated fuels. The biological control rubber vine rust rarely kills mature plants on its own. Rubber vine rust can defoliate the rubber vine and allow the fuel loads (beneath it) to increase so that fire can be applied.
- **Aerial incendiary using a 'heli-torch'.** In areas where rubber vine has invaded communities where fire is either not required or desired, such as those which are fire sensitive, applying fire using a heli-torch may help control the issue. This involves aerial incendiary using gelled gasoline to ignite the rubber vine directly. The surrounding vegetation needs to be moist to wet, to ensure the fire doesn't spread.

Fire should be avoided in fire-sensitive communities. However, might be appropriate for particular weed control issues, if used with caution.

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

Issue 5: Limit fire encroachment into non-target fire vegetation groups

Non-target fire vegetation groups include riparian, spring, vine thicket and acacia dominated communities. These communities are often self-protecting if fire is used under appropriately mild conditions, or due to low fuel loads. Tactics such as burning away from these communities can be used to protect them. A succession of years of high rainfall can promote fuels in otherwise self-protecting communities. Care should be taken to manage fuel around fire-sensitive communities under these conditions. Other areas where you may wish to limit fire encroachment include communities containing buffel grass or other fire vegetation groups which are not ready to burn.

Awareness of the environment

Indicators of fire encroachment risk:

- Conditions are not mild enough or fuels sufficiently sparse to ensure the 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.
- Riparian communities or other fire-sensitive communities are adjacent to a planned burn area.

River she-oak is common along rivers and seasonal streams. This species is fire-sensitive. Burn adjacent fire tolerant ecosystems under conditions that limit the potential impacts on this community (e.g. scorching of edges).

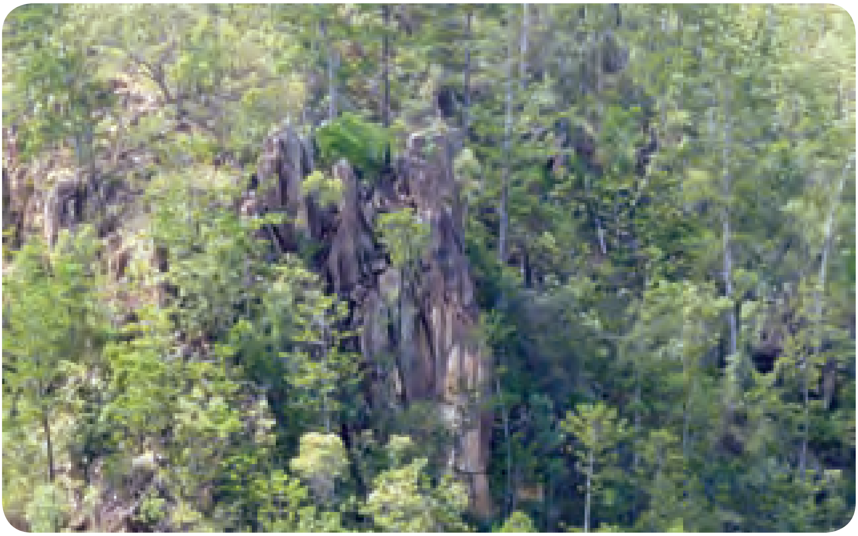
Justine Douglas, QPWS, Blackbraes National Park (2011).

Wetland with fringing eucalypt /melaleuca woodland. Implementing planned burns in the surrounding fire-adapted community in the recommended season will ensure only low-severity burns enter these communities.

Justine Douglas, QPWS, Toomba Nature Refuge (2011).

Marsh communities are generally self-protecting, however under drought conditions; intense fire may enter and degrade vegetation structure.

Peter Stanton, Environmental Consultant Pty Ltd, estate: formally Bulleringa Pastoral Holdings Pty Ltd, now Bulleringa National Park (1991).

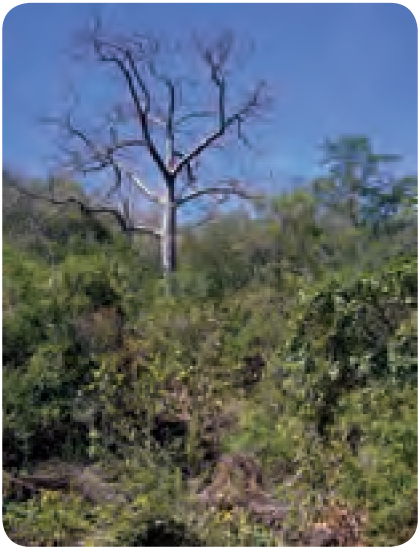


Fire-sensitive Hoop pine *Araucaria cunninghamii* communities are generally protected from fire by their position in the landscape.

Russel Best, QPWS, Return Creek (2012).

Lancewood forests and vine thicket species.

Peter Stanton, Environmental Consultant Pty Ltd, estate: formally Bulleringa Pastoral Holdings Pty Ltd, now Bulleringa National Park (1991).



Fire-sensitive communities like this one are generally self-protecting. However, to avoid fire entering or scorching the margins keep fuel loads low in adjacent fire-adapted communities.

Jeanette Kemp, Queensland Herbarium (2006).

Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (e.g. high fuel loads due to successive high rainfall years) it has the potential to damage non-target and fire-sensitive vegetation communities. Proactive broad-scale management of the surrounding fire-adapted areas with mosaic burning is one of the best ways to reduce the impacts of unplanned fire on non-target communities.
- Most fire-sensitive communities tend to be self-protecting and additional protective tactics may not be required. Sometimes where a fire-sensitive community occurs at the top of a slope, it is necessary to avoid running fires upslope even in ideal conditions.
- If suitable conditions can not be achieved, specific tactics may be required to protect the non-target vegetation groups. See the tactics section at the end of this chapter.
- Sometimes lantana forms a thicket that can draw fire into vine thicket communities. Reduction of lantana may be advisable prior to burning to reduce biomass and avoid scorching rainforest or riparian edges (refer to Chapter 6 (Issue 4): Manage lantana, rubber vine and other woody weeds).
- Many riparian communities contain a high proportion of fire-sensitive species and/or habitat trees. Too frequent and/or too severe fire removes or inhibits the development of structurally complex ground and mid-strata vegetation 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 vegetation and retain mature habitat trees.
- The presence of invasive grasses increases the severity of a fire and may contribute to the contraction of vine thickets and acacia communities. If invasive grasses are present, use fire with caution (refer to Chapter 6 (Issue 3): Manage invasive grasses).

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 100 metre long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** no scorch. **Partially Achieved:** < 5 % scorched. **Not Achieved:** > 5 % scorched.

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 the scorch of non-target areas.

Mosaic (mosaic of individual planned burn)

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

Wind speed: < 15 km/hr

Soil moisture: Refer to relevant fire vegetation group

What burn tactics should I consider?

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

- **Test burn** the interface to ensure the 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 the available fuels and the prevailing wind on the day, this may require either spot or strip lighting or a combination of both.
- **Afternoon ignition.** Planned burn in areas adjacent to non-target communities late in the afternoon. This will assist with promoting a low-severity fire that may trickle along the edge of these communities and generally self-extinguish due to milder conditions overnight or higher moisture differentials.
- **Aerial ignition** can be used to support early dry season and late wet season fuel reduction burning, particularly where vehicle access is limited. Aerial incendiary operations by also provide the opportunity to directly target topographical features such as peaks, ridges and spurs. This creates areas of reduced fuel around fire-sensitive communities (e.g. acacia and vine thicket communities).

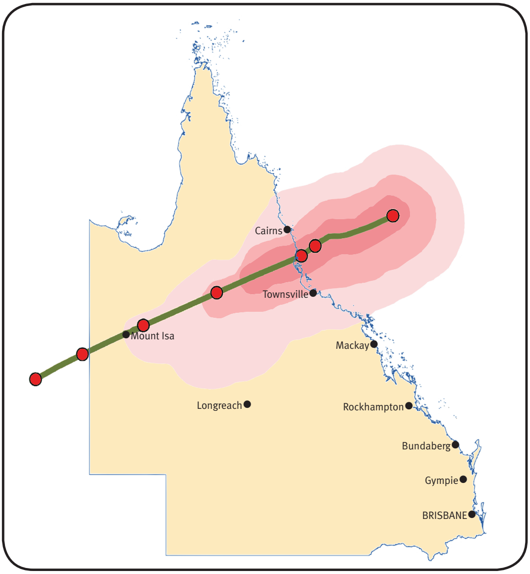
Issue 6: Cyclones and severe storms

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. A high level of fallen tree damage can also be expected, increasing heavy fuel loads and impeding fireline access. In the Einasleigh Uplands, cyclones and severe storms may increase the fire severity in some ecosystems particularly heavily-wooded forests and woodlands, vegetation communities on hilltops and ridges and melaleuca communities.

Fire management issues

Once dry, 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 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
- the opportunity to re-introduce fire into areas that have been transitioning into a closed forest



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).

Fires can burn into the canopy from broken branches that hang down.
Leasie Felderhof, Firescape Pty Ltd, Greenvale area (2011).

The impacts of cyclone Yasi (February 2011) were felt hundreds of kilometres inland with extensive damage to vegetation as shown in these photographs.
Justine Douglas, QPWS, Blackbraes National Park (2011).

Open woodland damage by cyclonic winds.
Leasie Felderhof, Firescape Pty Ltd, Blackbraes National Park (2011).

A low-intensity burn (five months post cyclone) at Blackbraes National Park. Heavy timber still remains after the burn.
Leasie Felderhof, Firescape Pty Ltd, Blackbraes National Park (2011).

Discussion

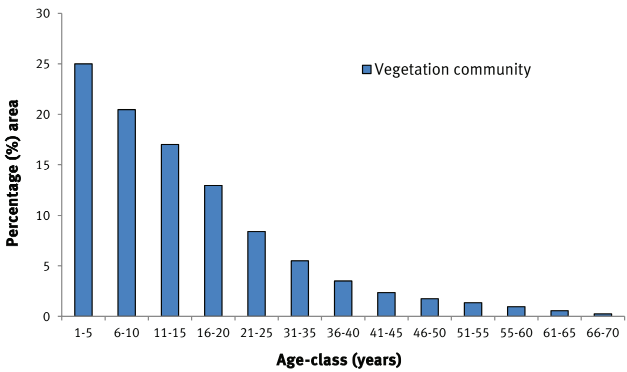
- After a severe tropical cyclone, people may not naturally think about planned burning. However, without a fuel reduction strategy, there is a risk of extensive wildfires in the following dry season and a risk of fires that will impact on an already stressed canopy.
- The canopy of trees damaged by severe cyclones are particularly susceptible to further impacts (such as canopy scorch) and may lead to tree death. Until the health of the canopy is completely restored, fires which may impact the canopy should be avoided.
- In tall or 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).
- 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, are easy to control and allow disoriented and distressed fauna to find refuge areas. These fires are also less likely to stress the canopy. The following storm season can be used as the next most opportune time to burn.
- Early, low-severity 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. A trade-off is required between fires of low-severity to reduce fuel to protect against wildfire on the one hand; and more intense fires to remove woody debris on the other (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 that 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).
- In some locations cyclones may provide a rare opportunity to reintroduce fire into open forests and woodlands which are in the late stages of transition to closed forest communities (through shrub and vine forest 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.

Extensive tree damage has increased fuel loads in this melaleuca shrubland.
Leasie Felderhof, Firescape Pty Ltd, near Goshen Station (2011).

Ironbarks on basalt were particularly susceptible to damage from cyclonic winds during cyclone Yasi.
Paul Williams, Vegetation Management Science Pty Ltd, Mount Garnett area (2011).

Glossary of fire terminology

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

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

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

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

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

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

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

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

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

Terminology	Definition
Mosaic burn	An approach which aims to create spatial and temporal variation in fire regimes. This can occur within an individual burn and at a landscape level (refer to Appendix 2).
Obligate seeders (obligate seed regenerating species)	Shrubs that are killed by fire and rely on soil-stored seed bank to regenerate. In fire ecology, the time it takes obligate seeders to mature and establish a seed bank often indicates the minimum frequency with which a vegetation community should be burnt in order to avoid the local extinction of these species.
Patchiness	A percentage or proportion of the ground layer vegetation (grasses, herbs and trees/shrubs less than one metre) not affected by fire (i.e. 20 per cent patchiness = 80 per cent burnt).
Perennial plants	Plants that last for more than two growing seasons, either dying back after each season as some herbaceous plants do, or growing continuously like many shrubs.
Planned burn	The controlled application of fire under specified environmental conditions to a pre-determined area and at the time, intensity, and rate of spread required to attain planned resource management objectives. In the context of QPWS operations: a fire that is deliberately and legally lit for the purposes of managing the natural and/or cultural and/or production resources of the area (e.g. reducing fire hazard, ecological manipulation), and protecting life and property.

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 Einasleigh Uplands bioregion	Percentage
Eucalypt communities	10 233 539	87
Melaleuca communities	131 051	1
Acacia dominated communities	512 585	4
Riparian, springs and fringing communities	282 081	2
Vine thickets	136 122	1
Other bioregion	192 613	2
Non-remnant and other	268 288	3
TOTAL	**11 756 278**	**100**

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
1	1	**Eucalypt communities**	Eucalypt communities (grassy)		9.3.16, 9.3.19a, 9.3.19b, 9.3.2, 9.3.20, 9.3.21, 9.3.22a, 9.3.22b, 9.3.3a, 9.3.3b, 9.3.3c, 9.3.3d, 9.3.3e, 9.3.5, 9.3.6a, 9.3.6b, 9.3.8, 9.4.1, 9.4.2, 9.5.16, 9.5.3a, 9.5.3b, 9.5.4, 9.5.5a, 9.5.5b, 9.5.5c, 9.5.5d, 9.5.5e, 9.5.5f, 9.5.5g, 9.5.6a, 9.5.6b, 9.5.7a, 9.5.7b, 9.5.1, 9.5.10a, 9.5.10b, 9.5.10c, 9.5.11, 9.5.12, 9.5.15, 9.5.15x1, 9.5.8, 9.5.9a, 9.5.9b, 9.5.9c, 9.7.1a, 9.7.1c, 9.7.3a, 9.7.3b, 9.7.3c, 9.7.5, 9.8.1a, 9.8.1b, 9.8.1c, 9.8.11, 9.8.12, 9.8.13, 9.8.2a, 9.8.2b, 9.8.2c, 9.8.4a, 9.8.4b, 9.8.4c, 9.8.5a, 9.8.5b, 9.8.9, 9.8.10, 9.11.12, 9.11.13, 9.11.14, 9.11.15a, 9.11.15b, 9.11.16, 9.11.17, 9.11.18, 9.11.19, 9.11.21, 9.11.22, 9.11.23a, 9.11.23b, 9.11.23c, 9.11.23d, 9.11.24a, 9.11.24b, 9.11.24c,9.11.25, 9.11.26a, 9.11.26b, 9.11.29, 9.11.3a, 9.11.3b, 9.11.3c, 9.11.3d, 9.11.3e, 9.11.3f, 9.11.32, 9.11.4a, 9.11.4b, 9.11.5, 9.11.7a, 9.11.7b, 9.12.1a, 9.12.1b, 9.12.1c, 9.12.1d, 9.12.1f, 9.12.10, 9.12.11, 9.12.12, 9.12.13a, 9.12.13b, 9.12.13c, 9.12.15, 9.12.16, 9.12.17, 9.12.18, 9.12.19,9.12.2, 9.12.21, 9.12.22, 9.12.23, 9.12.24a, 9.12.24b, 9.12.24c, 9.12.26, 9.12.27, 9.12.28, 9.12.31a, 9.12.31b, 9.12.32, 9.12.32x1, 9.12.33a, 9.12.33b, 9.12.33c, 9.12.6a, 9.12.6b, 9.12.6d, 9.12.6e, 9.12.7a, 9.12.7b, 9.12.7c, 9.3.25, 9.3.25a, 9.3.25b, 9.3.26, 9.3.26a, 9.3.26b, 9.3.27, 9.3.27a, 9.3.27b.
	2		Eucalypt communities (shrubby)		9.7.6, 9.10.1a, 9.10.1b, 9.10.1c, 9.10.4, 9.10.5, 9.10.6, 9.10.7a, 9.10.7b, 9.10.7c, 9.10.8, 9.11.1a, 9.11.1b, 9.11.10, 9.11.2, 9.11.2a, 9.11.2b, 9.11.2c, 9.11.2d, 9.11.2e, 9.12.1e, 9.12.14, 9.12.20, 9.12.25, 9.12.29, 9.12.3, 9.12.30a, 9.12.35, 9.12.4a, 9.12.4b, 9.12.4c, 9.12.41, 9.12.42, 9.12.5.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
2	1	**Melaleuca communities**	Melaleuca woodlands		9.3.24, 9.5.13a, 9.5.13b, 9.5.13c, 9.5.14, 9.5.15a, 9.5.15b, 9.7.1b, 9.12.39, 9.12.40, 9.12.6c.
	2		Melaleuca wetland and fringing communities		9.3.4, 9.3.7, 9.3.10, 9.3.10a, 9.3.10b, 9.3.11, 9.3.11a, 9.3.11b.
3	1	**Acacia dominated communities**	Acacia woodlands		9.10.3a, 9.10.3b, 9.10.9, 9.11.28a, 9.11.28b, 9.11.28c, 9.11.30a, 9.11.30b, 9.12.30b, 9.12.36a, 9.12.36b, 9.12.36c, 9.12.37, 9.12.38a, 9.12.38b, 9.12.9, 9.3.23, 9.3.9, 9.4.3, 9.7.2a, 9.7.2b, 9.7.4, 9.8.6.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
4	1	**Riparian spring and fringing communities**	Fringing woodland		9.3.1, 9.3.12a, 9.3.12b, 9.3.13, 9.3.14a, 9.3.14b, 9.3.15a, 9.3.15b, 9.3.17a, 9.3.17b, 9.3.17c, 9.3.18.
	1		Springs		9.8.8, 9.10.2.
5	1	**Vine thickets**	Vine thickets		9.5.2, 9.8.3, 9.8.7, 9.8.7a, 9.8.7b, 9.11.31, 9.11.8a, 9.11.8b, 9.11.9, 9.12.34, 9.12.43a, 9.12.43b, 9.12.8a, 9.12.8b.

The spatial data is based on version 6.1 of the "Queensland Remnant Vegetation Cover 2006" layer (16 September 2011) data (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 are those REs from the classifications listed above that 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).

Unmatched regional ecosystems	9.3.25a, 9.3.25b, 9.3.26b, 9.5.15a, 9.5.15x1, 9.5.5d, 9.5.5e, 9.5.5f, 9.5.5g, 9.8.7a, 9.8.7b, 9.8.8, 9.10.8, 9.11.2e, 9.12.25, 9.12.36c, 9.12.6c

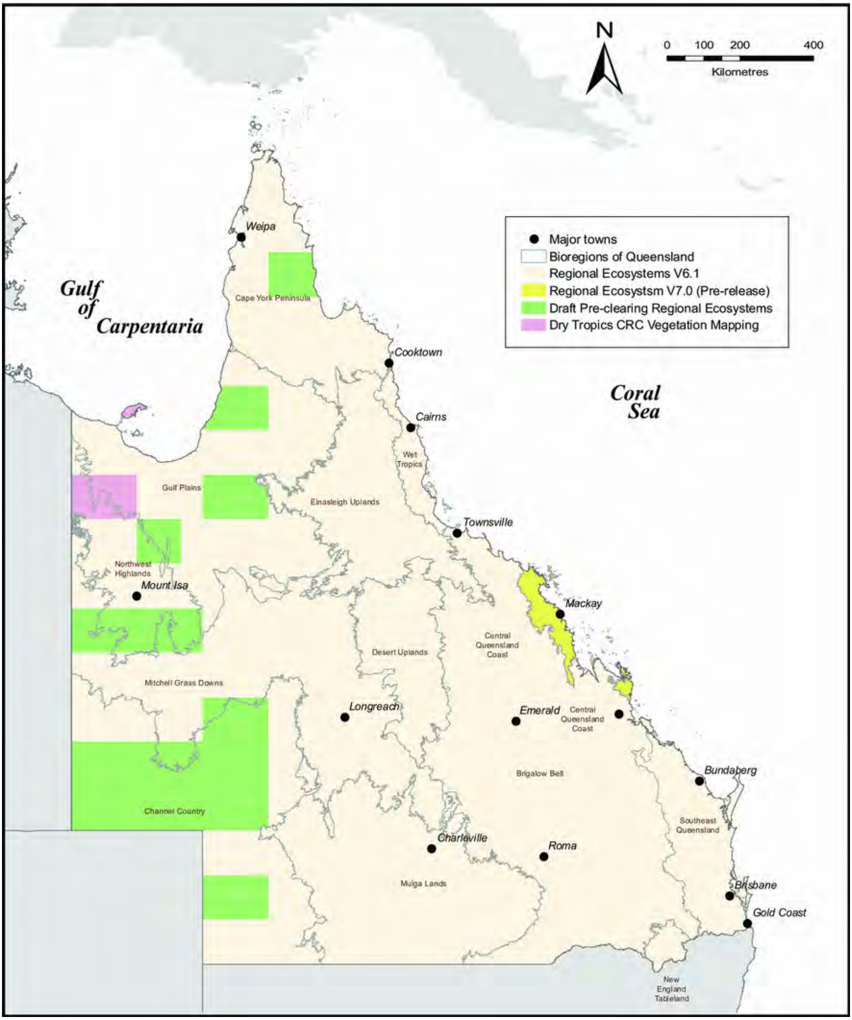

Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

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.

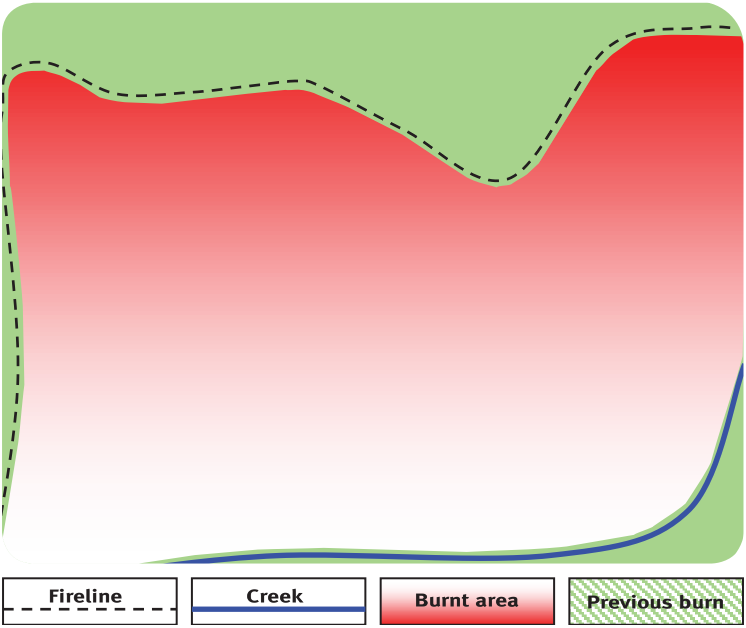

Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

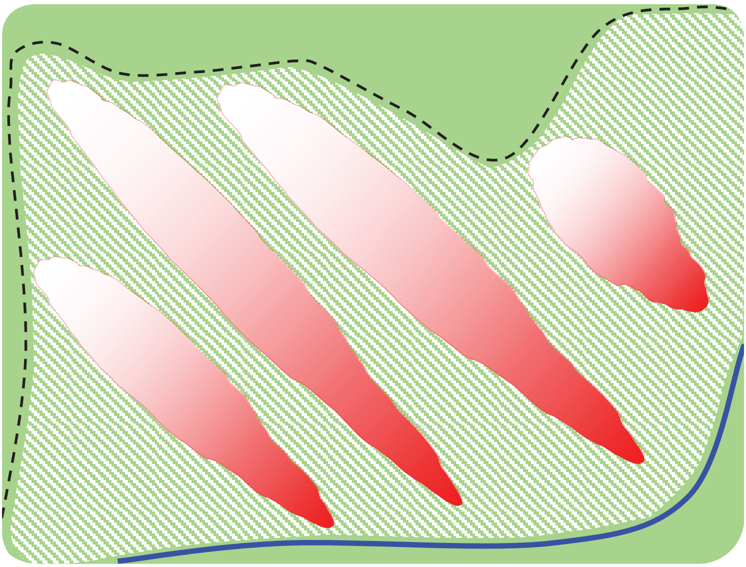

Figure 2: Planned mosaic burn—year 8.

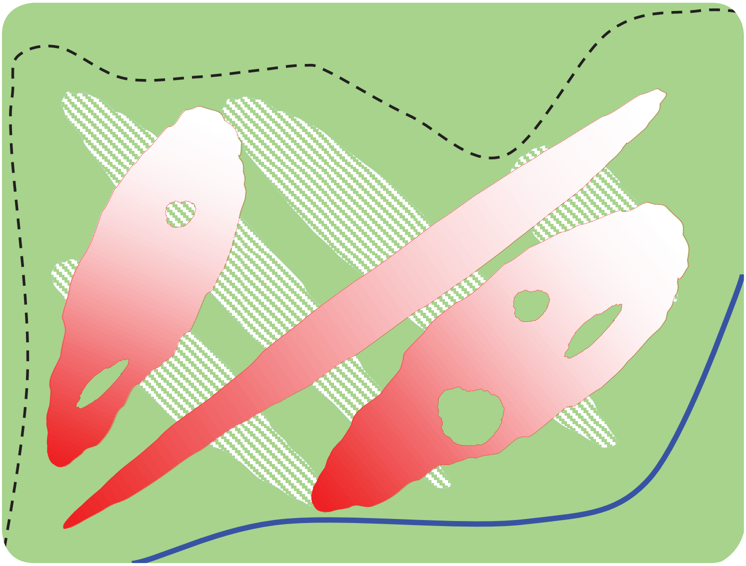

Figure 3: Planned mosaic burn—year 20.

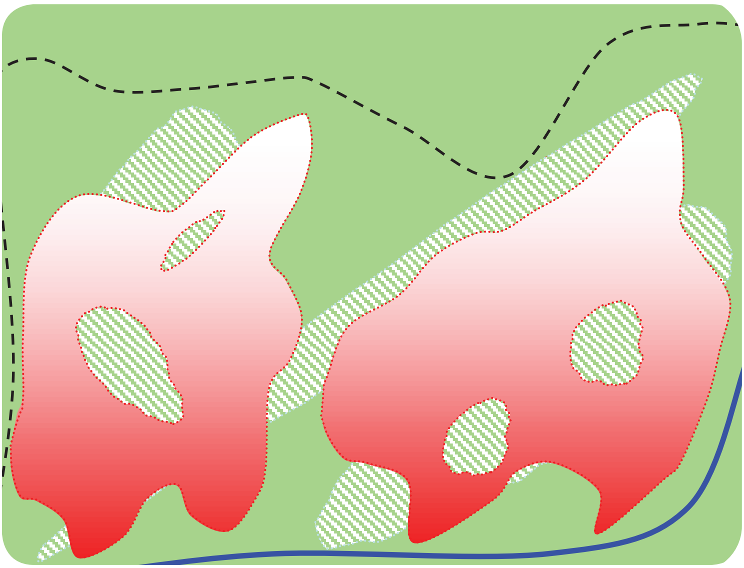

Figure 4: Planned mosaic burn—year 28.

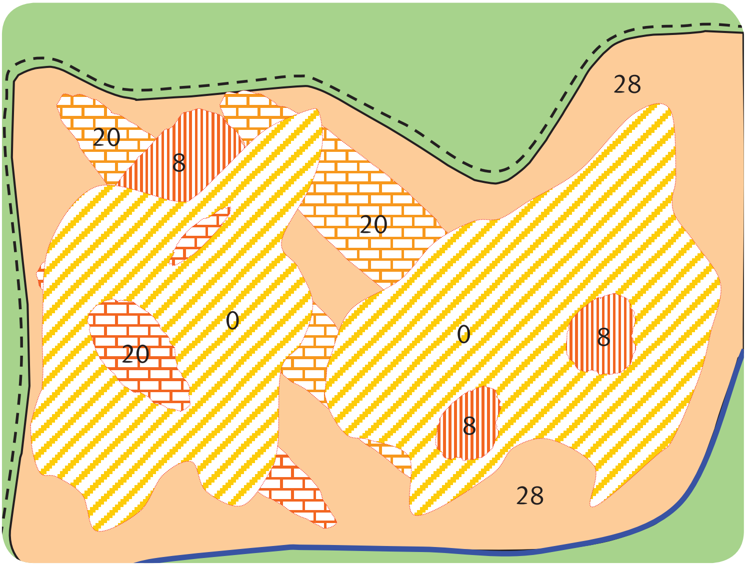

Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

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