Department of National Parks,
Recreation, Sport and Racing

Planned Burn Guidelines

Central Queensland Coast 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).

© The State of Queensland Department of National Parks, Recreation, Sport and Racing 2012. Copyright enquiries should be addressed to <copyright@nprsr.qld.gov.au> or the Department of National Parks, Recreation, Sport and Racing, 41 George Street, Brisbane Qld 4000.

First published May 2013
Published by the Department of National Parks, Recreation, Sport and Racing

National Library of Australia Cataloguing-in-Publication

Planned Burn Guidelines – Central Queensland Coast Bioregion of Queensland
First edition.
Bibliography
ISBN 978-1-7423-0927
1. Planned Burn – Guideline 2. Fire Management 3. Bioregion – Queensland

Disclaimer

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

Acknowledgements

The following people made substantial contributions to the intellectual content of this planned burn guideline based on experience and/or expert knowledge with regard to fire management in the Central Queensland Coast bioregion. QPWS staff include: Dr Rhonda Melzer, Dr Bill McDonald, Michael Koch, Irene Champion, Tony Frisby, Frank Mills, Leanne Simpson, John Lynn, Barry Nolan, Jeanette Kemp, Paul Harris, John Atkinson, Tina Ball, Graeme Bulley, Rod Mackenzie and Bruce Higham.

This guideline has been developed and produced by the QPWS Enhanced Fire Management Team: Kerensa McCallie, David Shevill, Wayne Kington, Jenise Blaik, Troy Spinks, Mark Cant and Justine Douglas; supported by David Clark, Caroline Grayson, Ellen Thyer and Tim Killen. Following a successful pilot project (QPWS South East Region Planned Burn Guidelines) initiated and developed by QPWS staff: Wayne Kington, David Kington and Mark Burnham.

Front cover photograph: Chance Bay, Whitsunday Island, Justin Heitman (Whitsunday Digital Pty Ltd, T/A Blue Turtle Digital) (2009).

Bp2015

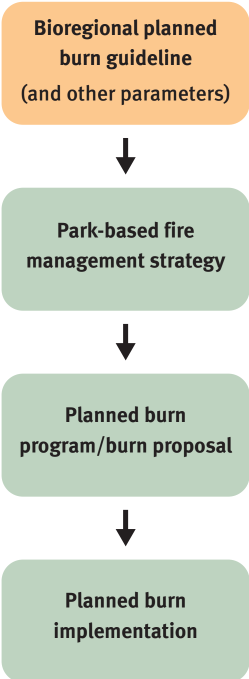
Foreword

Comparatively small in area (some 1 800 000 hectares) this bioregion is centred on the high-rainfall coastal lowlands, ranges and islands of Central Queensland. Open forests and woodlands characterise the foothills and lowlands while rainforest and tall eucalypt forests are predominant in the ranges. The QPWS estate is comprised of a series of somewhat small isolated mountains and hills in the lowlands and larger contiguous areas in the ranges surrounded by intensive agriculture and a number of continental and coral islands off the coast. With the move towards green harvesting of cane and the subdivision of larger parcels of land into smaller 'lifestyle' sized blocks, fire management of this fragmented estate is becoming more challenging.

The use of fire on our estate and across the landscape will continue to be the single-most effective management tool to maintain and enhance the integrity for those fire-dependant ecosystems. I hope these guidelines will provide one of the tools that will assist in developing the most appropriate fire regimes to achieve this. I encourage you to take a proactive approach to fire management, use these guidelines as a basis, gather sound information through observations and monitoring and provide feedback on their application. It is through this adaptive management approach that we will be able to further develop our knowledge of fire in the landscape.

Michael Koch
Senior Ranger
Central Region
Queensland Parks and Wildlife Service.

Table of contents



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

Purpose of this guideline

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

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

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

Scope

- This guideline applies to the Central Queensland Coast bioregion (refer to Figure 1) and covers fire vegetation groups including eucalypt forests and woodlands, tall open forests, grasslands and sedgelands, heath and shrublands, melaleuca, dune communities, rainforests, mangroves and saltmarshes (refer to Appendix 1 for regional ecosystems contained in each fire vegetation group).
- It covers the most common fire management issues arising in the Central Queensland Coast 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.

Joy Brushe, QPWS, Mt Westall (1997).

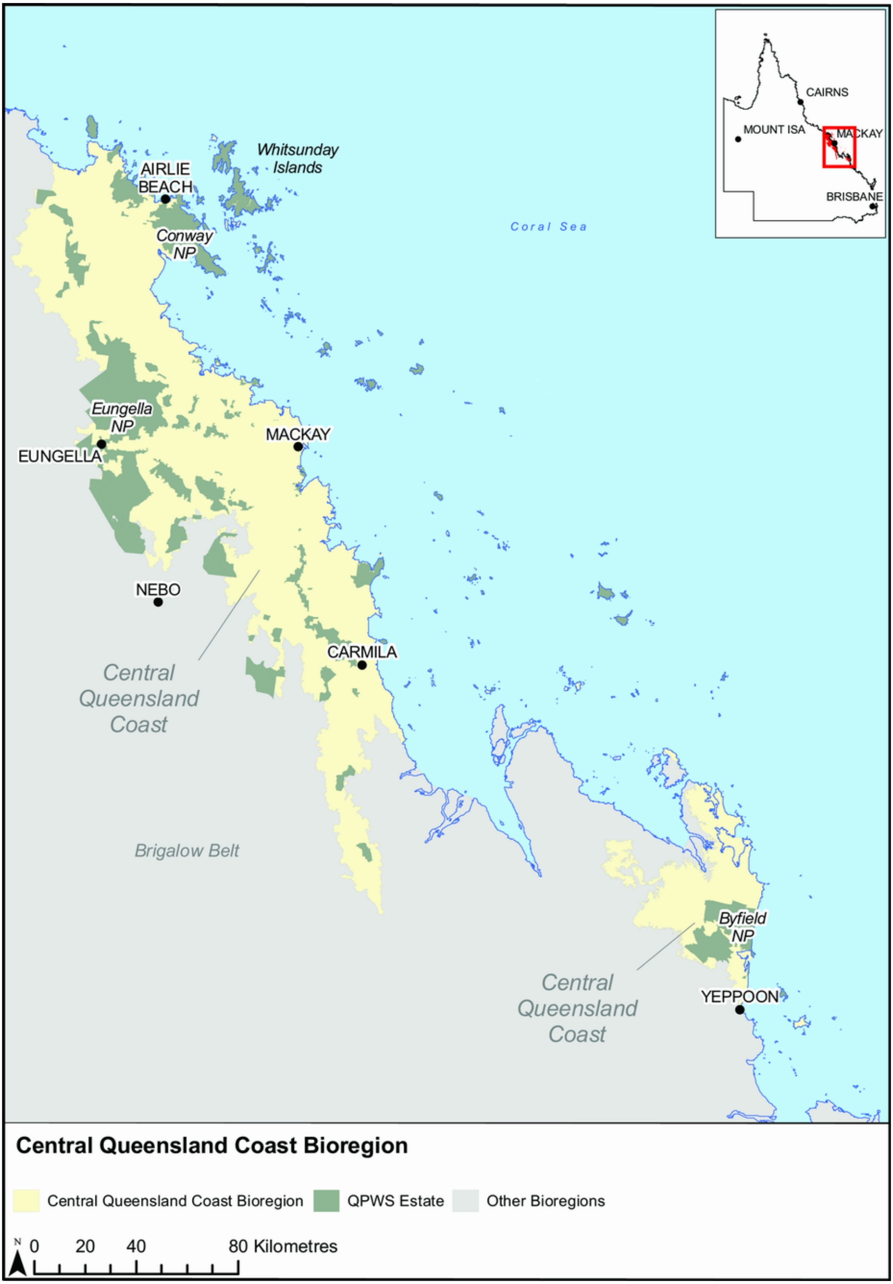


Figure 1: Map of the New England Tableland bioregion of Queensland.

Fire and climate in the Central Queensland Coast bioregion

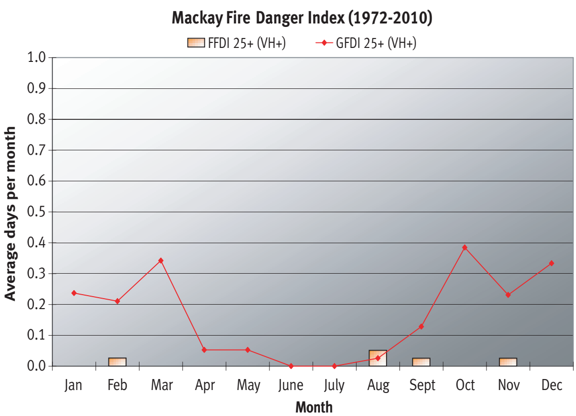
The Central Queensland Coast bioregion is characterised by high rainfall (1300–2000 mm per year) with ranges that surround lowlands adjacent to the coast. Distinct wet and dry seasons characterise the climate and the area is periodically affected by cyclones and flooding. The wet season (during which more than half the annual rainfall occurs) extends from about November to April with gradual drying of the land from about April until the start of the next wet season. The start or end of the wet season can vary by up to a few months in any year.

The ranges support areas of wet sclerophyll and rainforest vegetation while lower slopes and lowlands are predominantly eucalypt woodland and semi-deciduous vine forests.

Summers can be hot (up to 33°C) and humid, but temperatures are generally lower on the ranges and close to the coast. Winter days can be warm and dry, but evenings cool to cold (as low as 0°C) with frosts inland.

The 'fire' season normally begins around April as the wet season ends and fuels begin to cure. Nominally, April to mid-June is defined as the early dry, mid-June to early September as the mid dry and the late dry from then until the start of the wet season around November to December but which may be as late as January. Accelerated curing can occur in the winter (May/June) as early cold snaps quickly cure the fine fuels. Wildfires can occur at almost any time during the dry season but become more severe and difficult to control as fuels cure and are most severe in the late dry season.

Fire risk is linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). In the Central Queensland Coast bioregion these days have an average temperature above 30°C, low humidity (less than 20 per cent) and sustained winds of more than 20 km/hr (refer to Figure 2).



A fire weather day or sequence of days (FDI 25+) rarely occurs in this bioregion. 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 Central Queensland Coast 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 forest and woodland

Eucalypt forests and woodlands dominate the landscape in the Central Queensland Coast bioregion and fire management is critical to maintain their health. The canopy is usually dominated by a mix of eucalypt and corymbia species (such as Queensland blue gum *Eucalyptus tereticornis*, Moreton Bay ash *Corymbia tessellaris* or pink bloodwood *Corymbia intermedia*), but may also be dominated by a single species. The ground layer is generally dominated by a mix of grasses including kangaroo *Themeda triandra* , blady *Imperata cylindrica* and spear grasses *Aristida* spp., but may also contain lilies, sedges, legumes and scattered shrubs such as grasstrees, cycads and wattles. This fire vegetation group is found on the Clarke-Connors Ranges, Proserpine-Sarina lowlands and coastal ranges and islands (for fire management guidelines for eucalypt communities on dunes refer to Chapter 6).

Fire management issues

A major fire management issue for eucalypt forest and woodland communities is lack of fire. A lack of fire promotes the overabundance of pioneer rainforest saplings/seedlings which can have undesirable impacts on diversity.

In other areas fires have been too frequent, severe or applied at the wrong time, leading to a change in vegetation structure or promotion of weeds (including some high biomass grasses). *Lantana camara* may be present, causing an increase in elevated fuel and therefore fire severity, or the inability to maintain fire due to a lack of ground layer fuels.

Issues:

1. Maintain healthy eucalypt forests and woodlands.
2. Reduce overabundant saplings.
3. Manage high-biomass grasses.
4. Reduce *Lantana camara*.
5. Reduce rubber vine.

Extent within bioregion: 645 472 hectares (ha), 44 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Byfield State Forest, 11 836 ha; Eungella National Park, 10 204 ha; Crediton State Forest, 8 747 ha; Mia Mia State Forest, 8 099 ha; Whitsunday Islands National Park, 8 034 ha; Proserpine State Forest, 7 424 ha; Epsom State Forest 2, 5 524 ha; West Hill State Forest, 5 337 ha; Cathu State Forest, 5 322 ha; Dryander National Park, 4 538 ha; Byfield National Park, 4 123 ha; West Hill Forest Reserve, 3 821 ha; Conway National Park, 3 590 ha; Crediton Forest Reserve, 3 585 ha; Epsom State Forest 3, 3 426 ha; Ben Mohr Forest Reserve, 2 980 ha.

Issue 1: Maintain healthy eucalypt forests and woodlands

Awareness of the environment

Key indicators of healthy eucalypt forest or woodland:

- Canopy species of variable sizes (enough to eventually replace the canopy) and a healthy canopy exist. Stags or live trees with hollows are present.
- Lower and mid stratum trees are scattered (e.g. eucalypts, wattles, rainforest species and she-oaks) but **are not** having any noticeable shading effects on the ground stratum plants.
- Native grasses appear upright and vigorous and may be interspersed with occasional legumes, lilies and sedges.
- Shrubs (where present) have healthy foliage.
- Lantana (where present), is limited to scattered individuals or occurs in isolated small clumps.
- Logs in various stages of decay are present.

This eucalypt woodland has a healthy mix of native grass species.
Kerensa McCallie, QPWS, Homevale National Park (2011).

This Eucalypt community has a mix of grasses and shrubs in the understorey.
Kerensa McCallie, QPWS, Homevale National Park (2011).

The presence of logs in various stages of decay can be a good indicator of a healthy eucalypt forest and woodland.
Joy Brushe, QPWS, Shoalwater Bay (1997).

Grasses are upright and vigorous in this open forest.

Jeanette Kemp, Queensland Herbarium (2002).

A mixture of grasses and grasstrees may dominate the ground stratum.

Jeanette Kemp, Queensland Herbarium (2002).

A mix of annual and perennial grasses is present in the ground layer of this eucalypt community.

Jeanette Kemp, Queensland Herbarium, near Clairview (2004).

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

- Grasses are thinning, collapsing or appearing matted with a build-up of dead material.
- Pioneer rainforest species such as *Macaranga* spp., swizzle bush, *Larsenaikia jardinei, Alphitonia excelsa*, *Alyxia spicata*, or *Glochidion* spp. are beginning to emerge above the ground layer plants. Where this has progressed, and shading begins to impact on the diversity and health of understorey plants, refer to Issue 2 for guidelines.
- Grass trees where present, have accumulated brown skirts.
- There is a build-up of fine-fuels such as dead grass material, leaf litter, suspended leaf litter, bark and twigs. There is an accumulation of elevated fuels.
- The diversity of mid/ground stratum species (grasses, herbs, sedges and shrubs) has declined.
- Shrubs have sparse crowns and/or beginning to die. There is limited or no recruitment of new shrubs (lack of juvenile shrubs).
- Lantana may be becoming more frequent.

Brown skirts on *Xanthorrhoea* spp. provide habitat for invertebrates and skinks. However, as the skirts build-up they indicate the need for fire management to maintain a forest with an open structure. Microhabitat such as this, and also dead matted grass, dense pockets, fissured bark etc. develop again over time—although fire initially reduces them, it also maintains the forest that allows them to exist. In the absence of fire, such open forest habitat features would eventually perish. With appropriate planned burn conditions, unburnt patches and habitat features remain—in contrast to wildfires, which burn extensive areas.

Kerensa McCallie, QPWS, Byfield National Park (2011).

A build-up of fuel in eucalypt woodlands can indicate a need to consider planned burning. This grassy understory shows build-up of fine fuel and thinning of grasses, after eight years without fire.

Frank Mills, QPWS, Byfield State Forest (2010).

A shrubby understorey in decline due to absence of fire. Note dead shrubs and shrub crowns beginning to die.

David Kington, QPWS, D'Aguilar National Park.

Discussion

- Fire generally keeps rainforest species low in the profile and forces them to resprout from the base (although in some cases they also germinate from seed) (Williams and Tran 2009). In the absence of fire, with suitable geological conditions, rainforests species can grow into the mid stratum and begin to shade-out grasses, herbs and seedlings of trees and shrubs. Eventually it is difficult to reintroduce fire and the ecosystem is likely to transition to a closed forest. System change to closed forest can be very rapid in this fire vegetation group.
- Although pockets of rainforest are desirable, there should not be an abundance of rainforest pioneers colonising beyond these pockets into the open forest generally.
- Be aware that signs of poor health can also be a result of drought. Implementing fire during drought conditions is not recommended as this could compound health problems. Consider whether the area has naturally poor soil and therefore grasses may always appear less vigorous.
- Where relevant, grazing pressure may need to be alleviated in the year prior to burning to allow for the accumulation of fuel.
- The frequency and season of a burn can affect the species composition of grasses. Regular, late dry season fires may disadvantage kangaroo grass and favour black spear grass *Heteropogon contortus*. The reverse may occur with regular early dry season burns.
- The endangered northern quoll *Dasyurus hallucatus* (*Environment Protection and Biodiversity Conservation Act 1999*) is threatened by fires which are too extensive, severe or frequent. Ideally, planned burns should be conducted soon after the wet season to promote a patchy fire, avoid the reproductive period and maintain habitat (Lynn 2009).
- The glossy black cockatoo *Calyptorhynchus lathami* is considered vulnerable in Queensland and is found on the Clarke Range and at Shoalwater Bay / Byfield. This species has a very restricted diet, feeding only on the seeds of she-oaks (*Casuarina* and *Allocasuarina* spp.). Care should be taken to maintain food trees where they exist by ensuring some patches remain unburnt and are around the maximum end of the recommended fire frequency, allowing these species to mature and set-seed.

- Swamp rats *Rattus lutreolus* are found in only a few locations within the Clarke Ranges and are considered locally significant. In swamp rat habitat, longer fire frequencies allow grasses to develop a thatch layer in which swamp rats can establish a network of tunnels as protection from predators. Tactics such as ensuring high fuel moisture to encourage fine scale mosaics and using landscape features such as creeks to break up burnt and unburnt areas will assist in maintaining patches of long unburnt grasses.
- While the near-threatened Eungella honeyeater *Lichenostomus hindwoodi* predominantly inhabits rainforest, between July and September they are known to forage for insects in nearby woodlands which contain lemon-scented gum *Corymbia citriodora*, gum-topped box *Eucalyptus moluccana*, Queensland blue gum, ironbarks and/or pink bloodwood. If fire is required during this period, low-severity patchy burns will help retain food resources.

The endangered northern quoll.
Queensland Museum.

Lemon-scented gum woodland provides habitat for arboreal mammals such as the yellow-bellied glider and is a seasonal food source for the Eungella honeyeater.
Joy Brushe, QPWS, Shoalwater Bay (1997).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Select from below as most appropriate to the site or burn outcomes:

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 75 per cent of saplings < 2 m are scorched to the tip.	After fire select three or more sites (taking into account the variability of landform and likely fire intensity) count the number of saplings scorched to the tip.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.
> 90 % of grass clumps remain as stubble.	**Before the burn:** select three sites (taking into account the variability of landform and likely fire intensity) and mark a central point. **Before and after the burn** (immediately-very soon after): count the grass clumps in a radius of at least five metres around the central point. Determine the percentage retained after fire.	**Achieved:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 75 % bases remain.

> 95 % of standing dead trees and standing live hollow-bearing trees (habitat trees) retained.	Before and after fire*, select three or more sites (taking into account the variability of landform and likely fire intensity) and count the number of habitat trees. Determine the percentage retained after fire.	**Achieved:** > 95 % retained. **Partially Achieved:** 9–95 % retained. **Not Achieved:** <90 % retained.
> 95 % of fallen logs retained.	Select one or more sites or walk one or more transects* (taking into account the variability of landform and likely fire intensity) and count the number of logs before and after burn. Determine the percentage retained after fire.	**Achieved:** > 95 % logs retained. **Partially Achieved:** 90–95 % retained. **Not Achieved:** < 90 % logs retained.
Create a fine-scaled patchy burn (spatial mosaic) with multiple burn patches < 20 ha.	Choose one of these options: a. Fire scar remote sensing data (e.g. using the North Australian Fire Information [NAFI] system). b. Visual assessments from one or more vantage points, or from the air. c. Where practical, map the boundaries of burnt areas with GPS, plot on GIS and thereby determine the range of patch sizes.	**Achieved:** fine scale mosaic produced with no burn patches > 20 ha in size. **Partially Achieved:** Some (up to 10 %) burn patches > 20 ha in size. **Not Achieved:** More than 10 % of burn patches are > 20 ha in size.

*__It is important to return to the same location before and after the fire.__ If using a line transect, a peg and a compass bearing can assist in relocating the original count location.

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.

Retaining stags and logs is important to maintain habitat for many vertebrate and invertebrate species.

Kerensa McCallie, QPWS, Homevale National Park (2011).

Under the right conditions, patches of unburnt grasses are retained and burnt grass clumps remain as stubble.

Kerensa McCallie,QPWS, Homevale National Park (2011).

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.

Suggested monitoring issues include:

- Monitor the abundance of saplings and/or seedlings in the ground or mid stratum to ensure overabundance is managed.
- Monitoring the recruitment and establishment of young canopy trees to ensure future canopy tree replacement.

The Byfield fern *Bowenia serrulata*, like many other cycads, takes a long time to mature and set-seed. Monitoring the health of these species can be used as an indicator of appropriate fire regimes.

Frank Mills, QPWS, Byfield National Park (2007).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **high**. The majority **low**.

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.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate < 20 metre height canopy, mid stratum burnt completely (or nearly so).

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 intervals to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between three to seven years. At least seven years should be allowed between burns in some areas to retain obligate seeder shrubs, habitat features such as black she-oak (for the glossy black cockatoo), areas of denser vegetation, areas of senescing grasses and grass skirts (good insect habitat), bark etc.
- Other areas, particularly near the coast, require longer fire frequencies of around seven to twelve years because they are drier, are on poor soils or are more exposed. These areas are more limited in extent (see 'eucalypt forest – poorer soils', on map).

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 30–50 per cent burnt within the target communities. Where possible, aim to create a fine-scaled patchy burn (spatial mosaic) with multiple burn patches < 20 ha.

Landscape mosaic

- Do not burn more than 20 per cent of Central Queensland Coast eucalypt communities within the same year.

Other considerations

- **Variability:** Ensure successive fires are somewhat variable in intensity, season, frequency (do not burn to a prescription of every 'x' years but vary the fire frequency), and spatially (each fire creating a slightly different mosaic of burnt and unburnt areas).
- Be aware that some years will be wetter or drier than normal and fuel accumulation will vary. Fire frequency is only a guide.
- Do not burn during or immediately following drought.

Showing the results of a patchy low-severity fire.

Frank Mills, QPWS, Five Rocks area, Byfield Conservation Park (2007).

In areas with a strong shrub influence, allow a longer fire frequency for the retention of obligate seeders.

Joy Brushe, QPWS, Shoalwater Bay (1997).

What weather conditions should I consider?

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

Season:

- Burn during late wet to early dry season with occasional storm burns (around November to December). Winter burns are also acceptable in areas that remain uncured for longer and can not carry fire until winter.
- Be aware that winds may be unpredictable around September to October. Care should be taken anytime between August to December, as this is a period of increasing fire danger. If fire is required, use with caution and consideration of containment issues.

FFDI: < 11

DI (KBDI): 30–100 or up to 140 for storm burns

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

Soil moisture: The presence of good soil moisture is essential as it will assist in the rapid regeneration of native grasses post fire. Some indicators of good soil moisture include moist soil to a depth of greater than five centimetres, or at least 75 millimetres (mm) of combined rainfall over a two week period (ideally single falls should be of at least 15 mm) or seasonal creeks that are flowing in the area or water is pooled in creek beds and creeks are trickling.

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). 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.

- **Afternoon ignition**. Generally, ignition should occur after 2.00 pm when weather conditions have become more stable and are not prone to sudden weather changes (e.g. wind changes) often experienced during the day. This is particularly important late in the dry season where fire can be more prone to escape. Often this tactic will assist with creating a varied internal mosaic of burnt and unburnt patches. Under mild evening conditions the resulting fire may self-extinguish overnight. This tactic is useful when burning near cane areas as it helps ensure conditions of declining hazard. Carefully consider containment issues prior to ignition near cane areas.
- **Progressive burning** is an approach to planned burning where ignition is carried out throughout the year whenever conditions allow. Ignition can begin soon after the wet season (as soon as fuel has cured sufficiently to carry fire) with numerous small ignitions creating a fine-scale mosaic. Ideally, at least three periods of ignition should occur in each park, each year, but this depends on resource constraints. These burnt areas can provide opportunistic barriers to fire to support burning later in the year. Progressive burning helps create burnt and unburnt areas, a mosaic of severities and seasonal variability.
- Specific conditions are required for **storm burning**. Burn during the early wet season and ensure good soil moisture exists by burning after the second or third storm of the season Monitoring the weather for an impending cold front which may bring follow-up rain to assist in controlling the fire and prevent wildfire. A good indicator of an impending storm is rapidly increasing relative humidity.
- **Aerial ignition**. Used in tandem with good soil moisture and other landscape features such as drainage lines, moist gullies and vegetation communities including rainforests to reduce fire spread, this technique can assist in achieving a landscape mosaic.
- A **low intensity backing fire**. A slow-moving, low-intensity backing fire will generally result in a more complete coverage of an area and a better consumption of fuel. This tactic creates high residence time, useful for reducing overabundant saplings, while ensuring fire intensity and rate of spread are kept to a minimum.

- **Smoke issues**. Be aware of potential smoke impacts on urban settlements, mines and airports etc. Planned burns in adjoining areas should be undertaken when the prevailing weather conditions (in particular wind direction) will direct the resulting smoke away from settled areas. Standard neighbour notification protocols should be followed to ensure good neighbour relations.
- **Spot ignition** can be used to alter the desired intensity of a fire and create the desired mosaic of burnt and unburnt areas. This can be achieved using a range of methods including drip torches, matches and incendiaries (sling shots and power launchers). Spots closer together will result in a line of a greater intensity (as spots merge they create hot junction zones). Spots further apart or a single spot ignition in similar conditions will result in a lower-intensity fire and greatly varied mosaic of unburnt and burnt patches. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **Use of natural barriers**. Where natural barriers such as rock outcrops, creeks, rainforests and gullies are present they can be used to prevent large scale fires (except in very dry conditions). Natural barriers are useful in creating containment areas and landscape mosaics.

Issue 2: Reduce overabundant saplings

Overabundance of rainforest pioneers may reduce the health of the ground layer through competition and shading, and may result in the system transitioning to a more closed forest in which planned burning can be difficult to reintroduce and in some cases is beyond recovery.

Awareness of the environment

Key indicators

- The mid stratum is becoming dominated by young rainforest pioneers or other overabundant seedlings/saplings such as casuarinas.
- The understorey is difficult to see through or walk through.
- Grasses are scattered, poorly-formed and/or are collapsing. Other ground layer plants are reduced in abundance and health.
- Shrubs (where present) are declining in diversity and abundance.
- Mid stratum overabundance has reduced tree and shrub recruitment.

Rainforest pioneers in the mid stratum are becoming more abundant and grasses have become sparser in the ground layer. Fire is required to restore the health of grasses.
Dave Kington, QPWS, Lamington National Park (2007).

Shading impacts will eventually greatly reduce lower-layer diversity and reduce recruitment of canopy species.
Bill McDonald, Queensland Herbarium, Mid Molle Island (2010).

Discussion

- An overabundance of saplings or seedlings in the understorey may be triggered in response to:
    - a lack of, or a long absence of fire
    - a high-severity fire event triggering a flush of new seedlings
    - heavy grazing
    - a high rainfall event which has exacerbated thickening (due to one of the above causes).
- Overabundant **saplings** are unlikely to be killed outright by fire—rather they will be reduced to below the grassy layer, enabling other species to compete. **Seedlings** are more vulnerable to fire and may be killed by fire. If **seedlings** are observed and appear to be thickening, a fire should be applied as soon as fuel and appropriate conditions allow (as within a very short time frame, sometimes only a single year, it may not be possible to kill them).
- Certain eucalypts, acacias and casuarinas can germinate en masse. In the absence of fire, seed stock can build up and lead to a mass germination event after a fire. Where this has occurred, it is likely that more than one fire will be required to address the issue. Post-fire observations are essential to monitor the kill rate and germination of these species—this will ascertain the need for subsequent fires.
- Woody thickening becomes much more severe where heavy stock grazing is combined with repeated early season burns or a lack of fire. Stock grazing reduces fuel loads, preventing fires of sufficient severity to manage overabundant seedlings/saplings. This is further compounded when cattle concentrate feeding efforts on regrowth grasses in the recently burnt areas (and avoid the 'toxic' plants such as some quinine trees) allowing woody species the competitive advantage. Spelling an area for a period of time before and after fire may assist in this issue.
- It is important to recognise that in some areas, an abundance of some shrubs and trees are a natural part of the ecosystem and do not necessarily require an altered fire management approach. Seek advice if you are unsure.

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)
> 75 % of mid stratum saplings are scorched to the tip.	After fire select three or more sites (taking into account the variability of landform and likely fire intensity) count the number of saplings scorched to the tip.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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

Monitoring the issue over time

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

Often, this issue is not addressed by a single fire. It may be important to continue monitoring the abundance of saplings and/or seedlings in the ground or mid stratum to ensure overabundance is managed.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Moderate** to **High**. Aim for scorch height sufficient to scorch to the tip of overabundant saplings (see scorch heights in the table below).

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)
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.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate < 20 m height canopy, mid stratum burnt completely (or nearly so).

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

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

- In most cases, overabundant saplings and seedlings can be managed within an initial moderate to high-severity fire. An assessment should be made and consideration given to applying a second fire as soon as fuel build-up is sufficient to carry it.

Mosaic (area burnt within an individual planned burn)

- Greater than 75 per cent of the area dominated by understorey trees should be burnt.

Repeated fires

- Although **moderate** to **high**-severity fires may be necessary to control mid-stratum sapling overabundance, it may also have an impact on canopy species recruitment. Therefore once mid-stratum overabundance is controlled, it is important to return to mostly a **low** to **moderate**-severity fire regime (refer to Issue 1).

What weather conditions should I consider?

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

Season: July to November (drier conditions).

FFDI: 8–18

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

Other considerations: Be aware of containment issues, and the potential for re-ignitions when using fire at drier times of the year.

An example of a successful fire to control overabundant saplings. The saplings are consistently scorched to the tip yet grass stubble and unburnt fuels remain to promote a quick recovery of grasses.

Mark Parsons, QPWS, Wallaman Falls (2011).

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). 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.

- **Progressive burning** is an approach to planned burning where ignition is carried out throughout the year whenever conditions allow. Ignition can begin soon after the wet season and as soon as fuel has cured sufficiently to carry fire (with numerous small ignitions creating a fine-scale mosaic). These burnt areas can provide opportunistic barriers to fire to support burning later in the year to assist in managing overabundant saplings/seedlings.
- **Commence lighting on the leeward (smoky) edge.** This can be a useful way to create a containment edge for a higher-severity fire ignited inside the burn area.
- **A backing fire with good residence time.** A slow-moving backing fire (lit against the wind on the smoky edge or lit from upslope) may result in a more complete coverage of an area. This tactic ensures the fire has a greater amount of residence time while fire intensity and rate of spread are kept to a minimum. Greater residence time is useful in reducing understorey density.
- While a moderate-severity fire is often sufficient to address this issue, it is dependent upon the height of the saplings. A **running fire** of a higher-intensity may be required initially where there is a lack of surface and near surface fuels (e.g. due to shading if the thicket is well developed). In this instance, a follow-up planned burn will likely be required in the two to three years after the initial fire to kill the surviving saplings and any new seedlings.
- **Line or strip ignition** is used to create a fire of higher-intensity or to help fire carry through moist or inconsistent fuels. This is also useful to reduce overabundant trees (through scorching).

Issue 3: Manage high-biomass grasses

It is important to be aware of the presence of high biomass exotic grasses during planned burn operations as they can dramatically increase fire severity and are often promoted by fire. High-biomass grasses of concern in this fire vegetation group include guinea grass *Megathyrsus maximus*, molasses grass *Melinis minutiflora*, grader grass *Themeda quadrivalvis* and thatch grass *Hyparrhenia rufa*. In moister areas para grass *Urochloa mutica* may also be an issue.

Refer to Chapter 9 (Issue 3), for fire management guidelines.

Issue 4: Reduce *Lantana camara*

Where *Lantana camara* occurs as a scattered understorey plant and grass fuels are still continuous the recommended fire regime for healthy eucalypt forest and woodland should be applied.

Refer to Chapter 9 (Issue 4), for fire management guidelines where *Lantana camara* has become an infestation.

Lantana occurring as a scattered understorey plant. Notice that grass fuels are still relatively continuous and therefore the standard fire regime for eucalypt forest could be applied to help control lantana.

Kerensa McCallie, QPWS, St. Bees Island (2009).

Issue 5: Reduce rubber vine

The presence of rubber vine may require an altered approach to fire management.

Refer to Chapter 9 (Issue 6), for fire management guidelines.

Chapter 2: Tall open forest

This fire vegetation group includes tall open eucalypt forests (generally up to 40 metres) dominated by rose gum *Eucalyptus grandis*, a combination of red mahogany *Eucalyptus resinifera*, yellow stringybark *Eucalyptus acmenoides* and/or *Eucalyptus portuensis*; or *Eucalyptus montivaga*. A secondary tree layer is sometimes present with she-oaks, grevilleas, brush box *Lophostemon confertus*, acacia and pink bloodwood *Corymbia intermedia*. The ground layer is usually dominated by grasses, sedges, ferns and herbs in various combinations. A shrub layer is occasionally present. Within the Central Queensland Coast bioregion, tall open forest is only found in the Clarke and Connors Ranges at higher altitudes.

Fire management issues

The main fire management issue for tall open forests is the overabundance of rainforest saplings/seedlings due to a long fire absence. *Lantana camara* is also present in some areas and may contribute to an increase in fire severity and loss of ground layer diversity.

In forests dominated by *Eucalyptus montivaga*, low fuel accumulation in the ground stratum means that planned burns are generally not possible and fires will be infrequent. These communities will usually only burn with severe wildfire.

Issues:

1. Maintain healthy tall open forests.
2. Reduce overabundant saplings.
3. Reduce *Lantana camara*.

Extent within bioregion: 32 024 ha, 2 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Eungella National Park, 6 422 ha; Crediton Forest Reserve, 3 092 ha; Crediton State Forest, 2 626 ha; Ben Mohr Forest Reserve, 1 098 ha; Macartney State Forest, 888 ha; Collaroy State Forest, 444 ha; Homevale National Park, 435 ha; Epsom State Forest 3, 277 ha; Spencer Gap Forest Reserve, 259 ha; Pioneer Peaks National Park, 171 ha; Porphyry Hill State Forest, 133 ha; Kelvin Forest Reserve, 125 ha; Byfield State Forest, 111 ha; Connors Forest Reserve, 107 ha; West Hill State Forest, 76 ha; Pelion Forest Reserve, 57 ha; Kelvin State Forest 10 ha; Cathu State Forest, 8 ha; Pelion State Forest, 7 ha; Ben Mohr State Forest, 2 ha.

Issue 1: Maintain healthy tall open forests

Awareness of the environment

Key indicators of health

- Diversity in the understorey (of rose gum and red mahogany forests) across the landscape ranging from grassy through to shrubby or with a low tree layer including scattered rainforest species and pockets of rainforest (particularly within gullies).
- A diverse range of grasses, sedges, ferns and legumes should be present in grassy sites.
- Shrubs (where present) have healthy foliage.
- Some young canopy trees are present in the mid and lower stratums (enough to eventually replace the canopy), but **are not** having noticeable shading effects on ground layer plants.
- Bracken fern and blady grass are **not** dominant in the ground layer.

Tall open forest with a healthy and diverse understorey of grasses, sedges, bracken, legumes and she-oaks.

Bruce Higham, QPWS, Gamma National Park.

Young red mahogany trees are recruiting in the midstratum.

Joy Brushe, QPWS, Shoalwater Bay (1999).

In rose gum forests, areas with a rainforest understory often occur.

Jeanette Kemp, Queensland Herbarium, west of Crediton State Forest (2006).

Rose gum forest with a shrubby understorey.
Tina Ball, QPWS, Gamma National Park (2009).

Rose gum forest with an open and mixed understorey.
QPWS.

The following may indicate that fire is required to maintain a tall open forest.

- Rainforest pioneers are beginning to emerge above the ground-layer across large areas of community.
- The community is difficult to see through and walk through.
- Grasses are thinning, collapsing or appearing matted with a build-up of dead material.
- Shrubs have sparse crowns and/or beginning to die. There is limited or no recruitment of new shrubs (lack of juvenile shrubs).
- Bracken and blady grass are dominant in the ground layer.

Discussion

- Fire plays a central role in the maintenance of grassy tall open forests. The absence of fire or the application of fire frequencies that are longer than recommended can lead to a transition from an open to a closed structure (Williams and Tran 2009). Transitioning is often irreversible. In areas where transitioning has begun, it can be compounded by the application of repeated low to moderate severity fires, as this exhaust fuel for higher severity fires severe enough to scorch rainforest pioneers (Russel-Smith and Stanton 2002).
- In managing these forests, it is important to understand the mechanism of transitioning. Most rainforest species re-sprout after fire, however unlike eucalypts they must re-sprout from the ground level and fire keeps them at this level allowing other species to compete.
- There are limited windows of opportunity to conduct planned burns in tall open forests (as they are generally moister). It is critical to respond to opportunities to burn these communities when suitable weather conditions allow.
- A number of fauna species rely on tree hollows in tall open forest. These include yellow-bellied gliders *Petaurus australis australis*, the powerful owl *Ninox strenua* (listed as vulnerable in Queensland) and the masked owl *Tyto novaehollandiae* found on the Clarke-Connors range. Tree hollows take many years to form and care should be taken when planning burns to protect the hollow-bearing trees.
- The glossy black cockatoo *Calyptorhynchus lathami* is considered vulnerable in Queensland and is found within tall open forest. This species has a very restricted diet—feeding only on the seeds of she-oaks. Care should be taken to maintain food trees (where they exist) by ensuring some patches remain unburnt at the maximum end of the fire frequency, allowing these species to mature and set-seed.
- Tall open forest is habitat for a number of plant species restricted to the narrow, high-altitude zone on the Clarke Range, which otherwise only occur in southeast Queensland and high altitudes of the wet tropics (Queensland Herbarium 2011).

Yellow-bellied gliders depend on tall open forest habitat as they feed on the sap of red stringybarks (Strahan 1983), lemon-scented gum *Corymbia citriodora*, rose gum, red mahogany and pink bloodwood.
QPWS.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 50 % of rainforest saplings < 0.5 m reduced to the ground layer.	Before and after fire, select three or more sites (taking into account the variability of landform and likely fire intensity), and count the number of overabundant saplings (above ground components) reduced by fire.	**Achieved:** > 50 % reduced. **Partially Achieved:** 25–50 % reduced. **Not Achieved:** < 25 % reduced.
> 95 % of standing dead trees and standing live hollow-bearing trees (habitat trees) retained.	Before and after fire*, select three or more sites (taking into account the variability of landform and likely fire intensity) and count the number of habitat trees. Determine the percentage retained after fire.	**Achieved:** > 95 % retained. **Partially Achieved:** 85–95 % retained. **Not Achieved:** < 85 % retained.

> 95 % fallen logs (with a diameter ≥ 10 cm) retained.	Before and after fire*, select three or more sites (taking into account the variability of landform and likely fire intensity) and count number of fallen logs retained after fire. Determine the percentage retained after fire.	**Achieved:** > 95 % retained. **Partially Achieved:** 90–95 % retained. **Not Achieved:** < 90 % retained.
> 90 % of the clumping grass bases remain as stubble.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity) and estimate grass bases remaining after fire.	**Achieved:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 75 % bases remain.

*It is important to return to the same location before and after the fire. If using a line transect, a peg and a compass bearing can assist in relocating the original count location.

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

Monitoring the issue over time

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

Refer to Chapter 1 (Issue 1), for monitoring suggestions.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **Moderate**. An occasional high-severity fire helps manage emerging overabundant trees while low-severity fires help ensure enough canopy trees establish to eventually replace the canopy. It is important to strike a balance between sapling 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)	< 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.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate < 20 metre height canopy, mid stratum burnt completely (or nearly so).

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 five to seven years for rose gum open forest.
- Consider a broad fire interval range of between five to twelve years for red mahogany, yellow stringybark and/or *Eucalyptus portuensis* closed-forest to low open-forest.
- Do not apply fire directly to *Eucalyptus montivaga* open forest.

Mosaic (area burnt within an individual planned burn)

- Within rose gum open forest leave approximately 20 per cent unburnt.
- Within red mahogany, yellow stringybark and/or Eucalyptus portuensis closed-forest to low open-forest a mosaic within an individual burn will be less likely as these forests burn with a higher severity. Rather, mosaics can be planned at a landscape level (see below).

Landscape mosaic

- Different localities containing these communities should be targeted in different years ensure a continuum of habitat availability across the broader landscape (Queensland Herbarium 2011).

Other considerations

- **Variability:** Ensure successive fires are somewhat variable in intensity, season, frequency (do not burn to a prescription of every 'x' years but vary the fire frequency) and size (each fire creating a slightly different mosaic of burnt and unburnt areas).

What weather conditions should I consider?

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

Season

- Conduct burns when conditions are dry enough to carry a burn, but at the same time soil moisture is sufficient to encourage regeneration of grasses and a mixed ground stratum.
- Opportunities to burn these communities under suitable conditions can be rare. A high priority should be placed on conducting planned burns when conditions become available.

FFDI: 8–20 (moderate-high)

DI (KBDI): Ground ignition: 80–100 or up to 140 if the relative humidity, soil and fuel moisture conditions are appropriate.

Wind speed: < 23 km/hr

Soil moisture: The presence of good soil moisture is essential as it will assist in the rapid regeneration of native grasses post fire. Some indicators of good soil moisture include moist soil to a depth of greater than five centimetres, or at least 75 millimetres (mm) of combined rainfall over a two week period (ideally single falls should be of at least 15 mm) or seasonal creeks that are flowing in the area or water is pooled in creek beds and creeks are trickling.

Other considerations: Some years can be wetter or drier than normal and fuel accumulation will vary. Fire frequency is only a guide.

What burn tactics should I consider?

Refer to Chapter 1 (Issue 1), for tactics to address this issue.

Issue 2: Reduce overabundant saplings

Overabundance of rainforest pioneers, wattles or she-oaks may reduce the health of the ground layer through competition and shading.

Refer to Chapter 1 (Issue 2), for fire management guidelines.

Issue 3: Reduce *Lantana camara*

Lantana camara is present in some tall open forest communities. Where conditions are very dry the presence of lantana can increase the severity of fire and alter the structure and composition of native plant communities.

Refer to Chapter 9 (Issue 4), for fire management guidelines.

Chapter 3: Grasslands and sedgelands

This fire vegetation group includes grasslands and sedgelands in which trees and shrubs are absent or rare. Grasslands are generally dominated by one or a mix of grasses including kangaroo grass *Themeda triandra*, blady grass *Imperata cylindrica*, black and giant spear grass *Heteropogon* spp., and *Aristida* or *Eriachne* spp. with occasional sedges in the moister areas.

Freshwater sedgelands are rare within this bioregion and occupy very wet sites. They consist of sedges, forbs or (more rarely) grasses interspersed with rushes, ferns and herbs, but can also include areas of open water. Grasslands and sedgelands are found predominantly within lowland areas, on headlands and islands in patches no more than a few kilometres wide. However an extensive area also occurs at Goorganga plains, south of Proserpine. All of these communities are either of concern or endangered.

Fire management issues

The main fire management issue for grasslands which have been previously grazed (or otherwise disturbed) is the presence of weeds, in particular *Lantana camara*. Some sedgelands and grasslands are also heavily impacted by high-biomass grasses. Grasslands on islands are sometimes threatened by the encroachment of native woody species from adjacent communities.

A number of grassland and sedgeland communities do not require fire or only require infrequent fire. These include grasslands on drainage depressions in the uplands, grasslands/dwarf shrublands on headlands, grasslands on dunes where erosion issues may be a concern and most sedgelands.

Issues:

1. Maintain healthy fire-adapted grassland communities.
2. Limit fire encroachment into fire-sensitive grasslands and sedgelands.
3. Reduce *Lantana camara*.
4. Manage high-biomass grasses.
5. Reduce encroachment of woody species.

Extent within bioregion: 8 138 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: South Cumberland Islands National Park, 718 ha; Northumberland Islands National Park, 679 ha; Percy Isles National Park, 422 ha; Molle Islands National Park, 357 ha; Whitsunday Islands National Park, 278 ha; Smith Islands National Park, 182 ha; Gloucester Island National Park, 172 ha; Keppel Bay Islands National Park, 162 ha; Lindeman Islands National Park, 153 ha; Brampton Islands National Park, 137 ha; Broad Sound Islands National Park, 78 ha; Cape Palmerston National Park, 68 ha; Repulse Islands National Park, 49 ha; Slade Point Reserve, 42 ha; Dryander National Park, 35 ha; Byfield National Park, 31 ha; Byfield Conservation Park, 26 ha.

Issue 1: Maintain healthy fire-adapted grassland communities

Use fire to maintain fire-adapted grasslands.

Awareness of the environment

Key indicators of healthy fire-adapted grassland:

- There is a continuous or near-continuous layer of native grasses with a diversity of sedges, forbs, lilies and other ground-layer plants also present.
- Grasses appear upright and vigorous.
- Trees and shrubs are absent or only scattered.
- Grasslands are open and easy to walk through.
- Lantana (where present) is very scattered.

In healthy grasslands grasses are upright and vigorous and (more or less) continuous.
Jeanette Kemp, Queensland Herbarium, Slade Point (2006).

Grasslands are generally treeless or contain only very scattered trees and shrubs.
Jeanette Kemp, Queensland Herbarium, south of Quinns Gap (2003).

Healthy grasslands on coastal headlands require fire less frequently than inland grassland communities due to the harsh growing conditions.
Rosemary Lovatt, DSITIA, Shoalwater Bay (2007).

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

- There is an accumulation of thatch (dead material), collapsing grass and poorly formed grass clumps.
- The grass layer is not continuous or is becoming sparse.
- Swizzle bush *Timonius timon*, *Acacia* spp., *Pittosporum ferrugineum* and macaranga *Macaranga involucrata* var. *mallotoides*. are beginning to emerge above the grasses.
- Lantana (where present) is scattered but increasing.

Grasses sometimes collapse as they cure.

Jeanette Kemp, Queensland Herbarium, Goorganga Plains (1999).

Discussion

- It is thought that native woody species such as swizzle bush and macaranga (and perhaps *Pittosporum ferrugineum*) can become overabundant in island grasslands, and may cause them to transition to shrubland. Although in other areas, these species do not seem to be causing transitioning. More monitoring is required. Although this process is poorly understood, fire is likely to play a role in maintaining grasslands and controlling overabundance where it seems to be a problem (refer to Chapter 1 [Issue 2], for fire management guidelines).
- Endangered grasslands on dunes are vulnerable to erosion. Avoid burning (refer to Issue 2). If burning is occurring in nearby communities where there is a risk of fire encroachment, they should be conducted after rain when rapid regeneration of the grassy layer is expected. In addition, consideration should be given to the level of visitor impact these communities may be subjected to both before and after the fire.
- The frequency and season of a burn can affect the species composition of grasslands. Regular late dry-season fires may disadvantage kangaroo grass and favour black spear grass (the reverse may be true with regular early dry-season burns).
- Some areas of sedgelands are man-made (e.g. Goorganga Plains where bund walls have been built to prevent saltwater encroachment). Despite the man-made nature of these sedgelands, fire management guidelines remain the same.
- The vulnerable Byfield matchstick *Comesperma oblongatum* and the endangered headland commersonia *Commersonia perkinsiana* both have very limited distributions occurring in the Byfield area on headlands. Their fire requirements are poorly understood, but monitoring indicates both species regenerate after fire. When using fire in headland grasslands in this area, ensure it has a limited coverage, not burning all areas at once. Be guided by local monitoring programs.
- While the core habitat of the endangered Proserpine rock-wallaby is dry vineforest, they feed in adjacent grasslands during the dry season (Nolan and Johnson 2001). When burning grasslands adjacent to dry vineforest ensure good soil moisture is present and if possible burn away from the ecotone.

Fire ecology of the Byfield matchstick and headland commersonia *Commersonia perkinsiana* is poorly known. However, planned burns with good soil moisture and appropriate weather conditions are most likely to favour post-fire regeneration.
Kerensa McCallie, QPWS, Byfield National Park (2011).

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 from below as most appropriate for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 90 % of the grass clumps remain as stubble.	**Before the burn:** select three sites (taking into account the variability of landform and likely fire intensity) and mark a central point. **Before and after the burn** (immediately-very soon): count the grass clumps in a radius of at least five metres around the central point. Determine the percentage retained after fire.	**Achieved:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 75 % bases remain.
> 75 % of saplings < 2 metres are scorched to the tip.	After fire select three or more sites (taking into account the variability of landform and likely fire intensity) count the number of saplings scorched to the tip.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **moderate**. Use a **moderate**-severity fire if woody species are encroaching.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	50–100	0.3–0.5	≤ 2.5	Some patchiness. Most of the surface and near surface fuels have burnt. Stubble still evident.
Moderate (M)	100–1500	0.5–1.5	Complete standing biomass removed.	All surface and near surface fuels burnt. Stubble burnt to blackened remnants.

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

Mosaic (area burnt within an individual planned burn)

- Due to the mostly continuous nature of grass fuels, a high level of mosaic can be difficult to achieve. As such, it may be more realistic to manage grasslands at a park or landscape level (ensuring not all areas of grasslands are targeted at once).
- However, patchiness within an individual fire may be achievable using early season, late afternoon burns (that extinguish in the cool of the evening).

Landscape mosaic

- Do not burn more than 30 per cent of grasslands in the Central Queensland Coast bioregion within the same year.

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 intervals 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 four years for alluvial areas.
- When burning grasslands on poorer/shallower soils (such as those on islands and headlands) consider a broad fire interval of between four to six years. It is usually sufficient to allow fire to trickle in from nearby areas. However, monitor these grasslands for woody species invasion and if necessary target more directly with fire.

What weather conditions should I consider?

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

Season: Conduct burns at any time (but avoid late winter to spring) providing good soil moisture is present (to promote rapid regeneration). Use storm-burns in areas of woody thickening (storm burns will also improve regenerative conditions for grassland on headlands, in what are otherwise dry environments).

GFDI: 2–7

DI (KBDI): 40–80

Wind speed: Beaufort scale 1–3, or < 20 km/hr

Soil moisture:

- Good soil moisture is essential for the rapid regeneration of native grasses after fire. Some indicators include moist soil to a depth of greater than five centimetres, or at least approximately 75 mm of combined rainfall over a two week period (ideally, single falls should be of at least 15 mm) or seasonal creeks are flowing in the area or water is pooled in creek beds and the creeks are trickling.
- Grasslands on coastal headlands are heavily influenced by local weather conditions, exposure to strong winds and rapid drying after rain.

Other considerations: Some years will be wetter or drier than normal and fuel accumulation will vary. Fire frequency is only a guide.

Grasslands can be invaded by woody species if fires are too infrequent.
Dave Judd, QPWS, Prudhoe Island (2008).

Good soil moisture will favour the recovery of native grasses. Three months after fire this blady grass grassland is rapidly recovering.
Bill McDonald, Queensland Herbarium, North Molle Island (2011).

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). During the burn, tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **Spot ignition.** Can be used to effectively alter the desired intensity of a fire. Spots close together will result in a line of a greater intensity (as spots merge they create hot junction zones). Spots further apart will result in a lower-intensity fire. This may include aerial ignition.
- **Line or strip ignition** is used to create a fire of higher intensity or to help the fire carry through moist or inconsistent fuels. This is also useful to reduce overabundant trees (through scorching).
- Creating a **running** fire (through closely-spaced spot ignition or line ignition with the wind) may help carry the fire into areas that have been invaded by trees. Alternatively, widely-spaced spots in areas of low fuel (such as some headland grasslands) can assist in carrying the fire through these areas. Topography and wind can further assist in creating a running fire.
- **Limit fire encroachment into fire-sensitive communities.** Use appropriate lighting patterns along the margin of the non-target communities to promote a low-intensity backing fire that burns away from the non-target community.

Issue 2: Limit fire encroachment into fire-sensitive grasslands and sedgelands

A number of grassland communities do not require fire. These include grasslands on drainage depressions in the uplands, grasslands/ dwarf shrublands on headlands and grasslands on coastal dunes. Active protection is generally not required, however good soil moisture should be present if planned burns in adjacent communities are allowed to trickle into these grasslands.

Refer to Chapter 9 (Issue 5), for fire management guidelines.

Grasslands on coastal dunes are prone to erosion. These areas are not usually directly targeted. Allow fire to trickle into these areas when suitable moisture conditions are available.

Jeanette Kemp, Queensland Herbarium (2002).

Sedgelands do not require fire; avoid burning these areas.
Rhonda Melzer, QPWS, Shoalwater Bay (1993).

Planned burns should be conducted in fire-adapted communities adjacent to sedgelands when sedgelands have standing water or are very moist.
Rhonda Melzer, QPWS Shoalwater Bay (1993).

Issue 3: Reduce *Lantana camara*

The presence of lantana may require an altered approach to fire management or for well-established infestations the integrated use of both fire and other control methods.

Refer to Chapter 9 (Issue 4), for fire management guidelines.

Issue 4: Manage high-biomass grasses

It is important to be aware of the presence of high-biomass exotic grasses during planned burn operations as they can dramatically increase fire severity and are often promoted by fire. High-biomass grasses of concern in grasslands include molasses grass *Melinis minutiflora*, thatch grass *Hyparrhenia rufa*, guinea grass *Megathyrsus maximus* and grader grass *Themeda quadrivalvis*. High-biomass grasses in sedgelands include para grass *Urochloa mutica*, hymenachne *Hymenachne amplexicaulis* and Aleman grass *Echinochloa polystachya*. Some species of high-biomass grasses can be reduced or eliminated using fire.

Refer to Chapter 9 (Issue 4), for fire management guidelines.

Issue 5: Reduce encroachment of woody species

Grasslands on islands are sometimes threatened by the encroachment of woody species such as swizzle bush, acacia, *Pittosporum ferrugineum* and macaranga.

Refer to Chapter 1 (Issue 2), for fire management guidelines.

Chapter 4: Heath and shrublands

This fire vegetation group includes open to closed heaths that are treeless or contain only scattered trees and dwarf to tall shrublands that vary in some areas to low woodland. They are often found on exposed hills, mountains and headlands, including islands throughout the bioregion; and at lower elevations on dunes, including the wet heaths found in swampy low-lying areas of Byfield National Park. The dominant species are often mixed and include tea-tree, *Leptospermum* spp., brush box, *Lophostemon confertus*, swamp mahogany, *Lophostemon suaveolens*, *Acacia* spp., *Banksia* spp. and black she-oak, *Allocasuarina littoralis*. Occasionally mixed *Corymbia* or *Eucalyptus* species may be emergent. A very sparse ground stratum may contain grasses and sedges.

Fire management issues

It is important to apply fire in and around the heath, to break up fuel, so that too-frequent unplanned extensive fire (particularly in the late dry season) is avoided.

Some heaths and shrublands, particularly montane heaths, are essentially self-protecting as they are surrounded by rainforests or interspersed with bare rock. Fires should not be actively applied to these areas but allowed to trickle in infrequently, or will occur naturally (e.g. as a result of lightning strike).

Avoid burning peat in wet heaths and sedgelands. Peat is susceptible to fire when dry and may take many years to re-form.

Issues:

1. Maintain healthy heath and shrublands.
2. Avoid peat fires.

Extent within bioregion: 16 799 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Byfield National Park, 2 818 ha; Whitsunday Islands National Park, 1 831 ha; Gloucester Island National Park, 911 ha; Percy Isles National Park, 371 ha; Lindeman Islands National Park, 362 ha; Keppel Bay Islands National Park, 271 ha; Cape Hillsborough National Park, 210 ha; South Cumberland Islands National Park, 208 ha; Broad Sound Islands National Park, 175 ha; Byfield State Forest, 114 ha; Brampton Islands National Park, 88 ha; Homevale National Park, 84 ha; Pioneer Peaks National Park, 83 ha; Northumberland Islands National Park, 28 ha; Byfield Conservation Park, 19 ha; Newry Islands National Park, 15 ha; Repulse Islands National Park, 11 ha.

Issue 1: Maintain healthy heath and shrublands

Awareness of the environment

Key indicators of health:

- There is a diversity of shrub species that appear green and vigorous (these may include tea-trees, wattles and/or banksias).
- Obligate seed regenerating species (such as black she-oak) are present.
- There is generally a continuous cover of shrubs.
- On headlands and other exposed areas, shrubs are wind-sheared, sparse and interspersed by grasses.
- In swampy heath, shrubs are sparse and interspersed or dominated by sedges.
- Heaths are treeless or have only scattered trees.
- In montane heath, orchids and ferns are present.
- There is a variation in time-since-fire across the landscape.

Healthy heaths are naturally diverse communities.

Kerensa McCallie, QPWS, Byfield National Park (2011).

A landscape mosaic of heath showing varying time-since-fire. The canopy of more recently burnt areas is lower and appears even in height.

Kerensa McCallie, QPWS, Byfield National Park (2011).

Healthy heaths have vigorous green growth and no or only a few emergent trees.

Kerensa McCallie, QPWS, Byfield National Park (2011).

Swamp sand plains are often dominated by sedges with low woody species interspersed.

Joy Brushe, QPWS Dismal Swamp (1997).

Indicators that fire management may be required in heaths and shrublands:

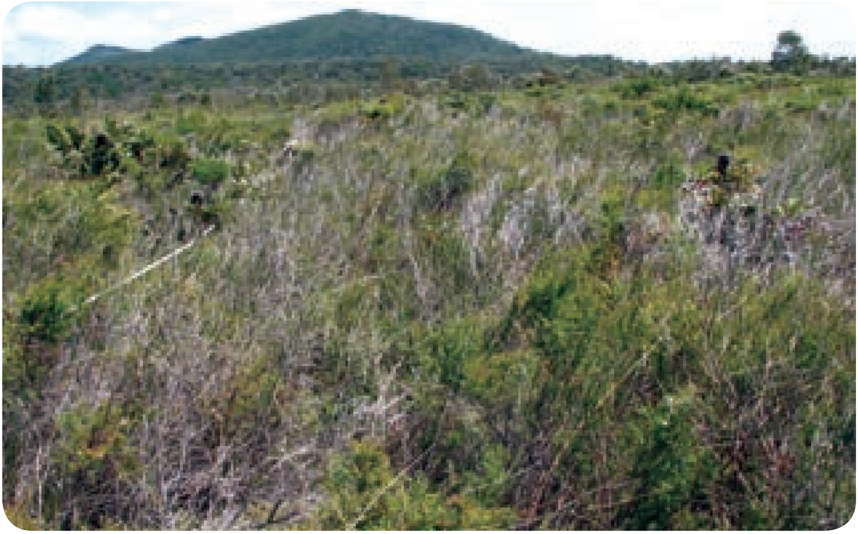
- There is a lack of variation in ages of heath across the landscape.
- The crowns or branches of shrubs are beginning to die or there is a significant loss of lower-level leaves.
- There is an abundance of dodder laurel *Cassytha pubescens* entangled in shrubs.
- Heath has returned to its pre-fire height.

Ensure the regeneration of obligate seed species:

- A build-up of seed capsules on tea-trees, *Lophostemon* spp. or black she-oaks, *Allocasuarina litoralis* (evidence of several years of seed production) can indicate that sufficient seed exists for post-fire regeneration.

Black she-oaks are fire-killed. Care should be taken to avoid too-frequent fire to allow she-oak communities to develop in some areas.

Joy Brushe, QPWS, Shoalwater Bay (1999).



The crowns of some plants in long-unburnt heath are beginning to die.
Rosemary Lovatt, QPWS, Shoalwater Bay (2007).

A build-up of dead and dying material may indicate the need for fire management.
Joy Brushe, QPWS, Shoalwater Bay (1997).

Dodder laurel, a parasitic vine, can entangle long-unburnt heath plants.

Kerensa McCallie, QPWS, Byfield National Park (2011).

Plants have lost their lower-level leaves. It is thought that this heath has not been burnt in over 30 years.

Rosemary Lovatt, QPWS, Shoalwater Bay (2007).

Discussion

- Before being exposed to fires, it is important to allow the seedlings of obligate-seeders enough time to mature and set-seed more than once. Fires at intervals of more than seven years allow seed reserves of most obligate seeders to be replenished. Shorter fire intervals may lead to the gradual decline in extent and/or loss of local populations of these species, as they are killed by fire and only recover from seedlings (Williams et al. 2006).
- Mosaic planned burns conducted in fire-adapted communities on slopes below montane heath will help prevent frequent fire. They also assist in mitigating impacts on orchids and ferns growing on rock faces.
- Implementing fire during drought conditions is not recommended. In most instances plants will be drought-stressed which impacts post-fire plant recovery (and the community in general). The resulting fire can also be more damaging and extensive and may encourage the germination of undesirable species.
- Be aware that small pockets of heathland/shrubland can occur on islands, particularly as stunted rainforest or acacia communities. These small areas are often unmapped and should be assessed before exposure to planned burns within surrounding fire-adapted communities.

Some heath communities are essentially self-protecting, as they are broken up by bare, rocky areas.

Jeanette Kemp, Queensland Herbarium, Homevale National Park (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.

Measurable objectives	How to be assessed	How to be reported (in fire report)
A mosaic pattern of burnt and unburnt areas is achieved, within the aerial ignition footprint or burn area reflecting topographical features that break up the burn.	Heath 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.	**Achieved:** Mosaic achieved within planned burn area. **Not Achieved:** Heath is all of a single age/ height or no mosaic was achieved.

A diversity of healthy seedlings is present approximately one month following fire.	Immediately or very soon after the burn, walk in to three burnt sites (taking into account the variability of landform and likely fire intensity) and note the presence/absence of healthy seedlings within a 10 x 10 metre area.	**Achieved:** > 50 healthy seedlings are present within most of the burn area. **Partially Achieved:** 10–50 healthy seedlings are present within some of the burn area. **Not Achieved:** < 10 healthy seedlings are present.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- Heaths usually burn with **moderate** to **extreme** severity. However moisture and topography influence the severity and unburnt patches may occur within the burn area.

Fire severity class	Fire intensity (during the fire)	Fire severity (post-fire)
	Average flame height (m)	Description (loss of biomass)
Moderate (M) to Extreme (E)	> 1.0	Greater than 60 % vegetation burnt. Extensive to total foliage burnt. Minimal evidence of green vegetation remaining. Skeletal frames of shrubs.

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). For coastal heath, consider a broad fire interval range of between seven to fifteen years.
- While fire should not be actively applied to montane heath and shrubland (and some shrubby headland areas), it should be prevented from occurring more frequently than every fifteen years. These areas are often self-protecting, but management of fire in surrounding fire-adapted areas will help to break-up fuel and create barriers to fire movement.

Landscape mosaic

- A landscape mosaic is achieved by targeting different sites in different years, usually with aerial ignition.

Other considerations

- An established mosaic of burnt and unburnt patches in coastal heath will protect the surrounding fire-adapted vegetation from too-severe fire entering from the heath community.
- Some years will be wetter or drier than normal and fuel accumulation will vary. Fire frequency is only a guide.

What weather conditions should I consider?

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

Season: Late wet to early dry season with occasional storm burns

FFDI: 5–12

DI (KBDI): 80–120 or up to 140 for storm burns

Relative humidity: Less than 50 per cent (ideally 40 to 45 per cent). At higher relative humidity heath will probably not burn, however be aware that in relative humidity that is less than 40 per cent, heath is extremely volatile and spotting distance increases.

Wind speed: < 23 km/hr. 15–23 km/hr may be required to push fire through heath.

Soil moisture:

- These areas are heavily influenced by local weather conditions (e.g. mountain and coastal), drying and exposure.
- Be aware that although coastal heaths and shrublands on rocky outcrops can receive regular moisture or rain, they are also exposed to strong winds and can dry out very quickly, particularly where they occur on granitic soils.
- Banks of orchids and basket ferns are often common on rock faces and in rocky shelters within the montane heath communities. Ensure good soil moisture is present to avoid burning these plants.
- Peat fires can occur in wet heaths and sedgelands. Ensure the peat is saturated or standing water is present to avoid peat fires.

Do not be alarmed if heath burns with high severity, it will recover.
Frank Mills, QPWS, Byfield National Park (2008).

Variations in moisture and topography in health will vary the fire severity. Some areas may not burn at all.
Frank Mills, QPWS, Byfield National Park (2008).

Occasional fires (no more frequent than every 15 years) should be allowed to trickle into dwarf shrubland on mountain tops.

Joy Brushe, QPWS, Mt Westall (1997).

Fires may occur naturally in montane heaths (e.g. as a result of lightning strike).

Rhonda Melzer, QPWS, Shoalwater Bay (1993).

What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). 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.

- **Burn in association with the surrounding** landscape. Woodlands on dune crests that are upslope of heathlands should be burnt prior to lighting dune-swale heaths. Concurrent dune-swales should generally not be burnt in the same year. Burn these areas by ignition in every three or four adjacent swales. A number of ignition points may be required in each swale.
- **Multi-point aerial strip ignition using heli-torch:** After the first ignition, additional ignition points on (or very close to) the head of the fire may be required to increase the fire severity and allow the front to increase rate of spread. Without these additional ignition points, the fire will often self-extinguish within close proximity to the original incendiary.
- **Storm burning:** Conduct burning at the start of the wet season, after the second or third storm (to ensure sufficient soil moisture exists). Wind and low relative humidity will be required to carry the fire through the heath. Ensure adjacent ridge communities are burnt in the year (or two years) prior to igniting the heath communities to assist in minimising fire spread.

Refer to Chapter 1 (Issue 1), for additional tactics to address this issue.

A fire lit on the windward edge of this swamp provided a secured fire break. A running fire was then used to assist in carrying the fire across the standing water.
Frank Mills, QPWS, Byfield National Park (2008).

Issue 2: Avoid peat fires

Wet heaths and swamps gradually accumulate partially decayed, densely-packed vegetation known as peat. In the absence of good soil moisture the peat is easily ignited and can result in a peat fire. Peat fires can burn for months and can have very negative impacts on the vegetation community. Peat takes many years to re-form.

Refer to Chapter 5 (Issue 2), for fire management guidelines.

Wet heaths may have peat soils and should only be burnt when standing water is present or the peat is waterlogged.

Rosemary Lovatt, QPWS, Shoalwater Bay (2007).

Chapter 5: Melaleuca communities

This fire vegetation group consists of three broad melaleuca communities; woodlands, gallery forests and melaleuca swamps. Different melaleuca species are associated with each community and there are considerable differences in their understoreys and therefore fire management. Drier sites support a grassy understorey sometimes with sparse shrubs such as grass trees and banksias. Wetter sites, found in lower-lying areas across the bioregion, can support understorey sedges, ferns, palms and pandanus.

Fire management issues

Because there are considerable differences in the understorey of melaleuca communities, different fire regimes are recommended. The main issue for drier woodlands is maintaining a landscape mosaic through broad-scale fire management which will limit the impacts of late-season wildfires. Gallery forests contain fire-sensitive species which require protection from fire. Some swamp communities are also generally fire-sensitive; however others can tolerate the occasional fire (e.g. some communities of swamp tea-tree and swamp paperbark/weeping paperbark open forest to woodland). The presence of high-biomass grasses, lantana, and rubber vine, can increase the fire severity and/or shade-out ground-layer plants making fire more difficult to apply.

Issues:

1. Maintain healthy melaleuca forest and woodland communities.
2. Avoid peat fires.
3. Limit fire encroachment into melaleuca gallery forests and swamps.
4. Manage high-biomass grasses.
5. Reduce *Lantana camara*.
6. Reduce rubber vine.

Extent within bioregion: 40 268 ha, 3 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Byfield State Forest, 2 713 ha; Byfield National Park, 1 662 ha; Cape Palmerston National Park, 1 561ha; Mia Mia State Forest, 244 ha; Sandringham Bay Conservation Park, 51 ha; West Hill State Forest, 25 ha; Percy Isles National Park, 21 ha; Ben Mohr State Forest 20 ha, Newry Islands National Park 18 ha, Whitsunday Islands National Park 18 ha, Bluff Hill National Park, 18 ha; Epsom State Forest 2, 17ha; Mount Buffalo State Forest, 16ha; Slade Point Reserve 14ha, West Hill Forest Reserve 12ha, Ben Mohr Forest Reserve 12ha, Conway National Park, 10ha; Collaroy State Forest, 8ha; West Hill National Park, 8ha; Additions to Byfield National Park, 6 ha; Skull Knob Conservation Park, 4 ha; Proserpine State Forest, 3 ha; Clairview Reserve, 2 ha; Eungella National Park, 2 ha; Byfield Conservation Park, 2 ha; Bakers Creek Conservation Park, 1 ha; Dryander National Park, 1 ha; Lindeman Islands National Park, 1 ha.

Issue 1: Maintain healthy melaleuca forest and woodland communities

Awareness of the environment

Key indicators of health:

- Healthy melaleuca forest and woodland has grasses, sedges, herbs, ferns (or any mix of these) in the understorey with a few canopy trees of variable sizes, enough to eventually replace the canopy; and a healthy canopy.
- Sparse shrubs (e.g. grass trees, banksias and grevilleas) may be present.
- Tea-tree orchids *Dendrobium canaliculatum* (where present) are found at varying heights (from low on tree trunks to the upper canopy).
- Swamp orchids Phaius australis (where present) are found with a build-up of pseudo bulbs.
- Weeds such as rubber vine, lantana and high-biomass grasses (if present) are only scattered.

Healthy melaleuca woodland with a mix of understorey plants including grasses and sedges.

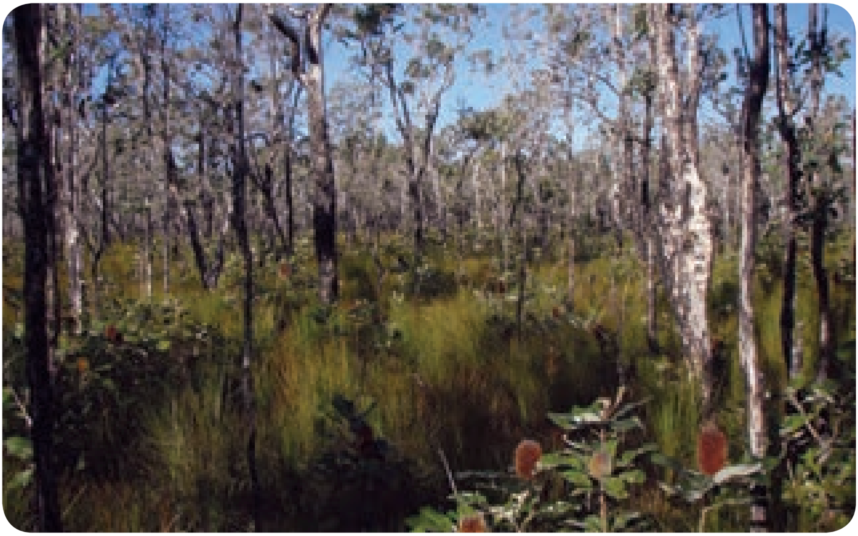
Jeanette Kemp, Queensland Herbarium (2002).

Some melaleuca communities have a naturally sparse ground stratum.
Rosemary Lovatt, QPWS (2007).

This melaleuca community has a healthy dense ground stratum with scattered shrubs.
Joy Brushe, QPWS, Shoalwater Bay (1997).

A range of trees of varying ages is present, and the ground stratum appears vigorous and healthy.

Kerensa McCallie, QPWS, Byfield National Park (2011).



In moister areas ferns may dominate the understorey.

Rosemary Lovatt, QPWS, Slade Point (1999).

The following may indicate that fire is required to maintain melaleuca forests and woodlands:

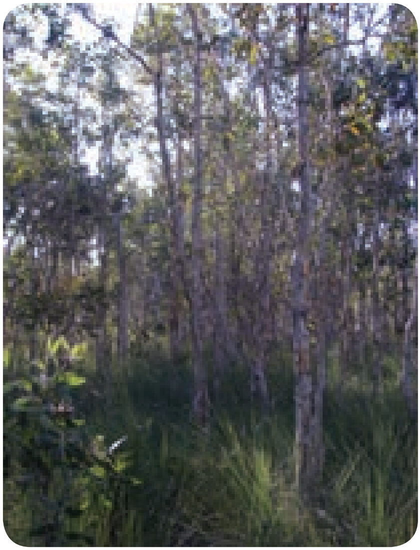
- Grasses, where they were once abundant, are becoming sparse or are poorly-formed. There is an accumulation of dead material and the grasses are beginning to collapse.
- Pandanus (where present) have a skirt of dead fronds.
- Ground-layer plants are declining in health and abundance and are becoming sparse due to shading.
- Where shrubs are present, there is a build-up of dead leaves and/or some dead or dying branches.
- Alyxia vine *Alyxia spicata* has become common as an understorey plant, or dodder laurel is entangled amongst the plants.
- An invasion of pine wildlings has begun to shade-out the ground layer.
- Blackened bark is absent from trees that are greater than 20 centimetres in diameter.
- An abundance of melaleuca seedlings are beginning to emerge above the grasses.

Melaleuca saplings and seedlings can become overabundant. They may eventually have shading impacts on the ground layer leading to a loss of diversity and fine fuels, and making fires difficult to apply.

Rosemary Lovatt, QPWS, Shoalwater Bay (2007).

Dodder laurel vine can entangle plants in areas which are long-unburnt.

Kerensa McCallie, QPWS, Byfield National Park (2011).

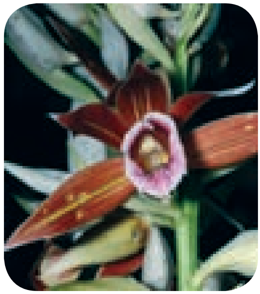


Lower layer plant diversity decreases as time-since-fire increases.

Kerensa McCallie, QPWS, Byfield National Park (2011).

Discussion

- Melaleuca communities that have a peat layer are vulnerable to peat fires in the drier months. Always burn when standing water is present or when the peat layer is waterlogged (refers to Issue 2, for fire management guidelines).
- The presence and condition of tea-tree orchids and endangered swamp orchids can be used as an indicator of appropriate fire. Tea-tree orchids are epiphytes that are capable of re-sprouting after fire (Bartareau and Skull 1994) but can be killed by repeated severe fires. They require four to five years of growth before flowering.
- These communities are habitat for numerous rare, threatened, endemic and poorly-known flora and fauna species (e.g. grey goshawk). However the general principles of mosaic burning should provide habitat for these species.



A build-up of pseudo-bulbs on swamp orchids indicate age. This tea-tree orchid is around six years old and has probably flowered twice. This indicates that fires have not been too frequent.

Michael Mathieson, Queensland Herbarium.

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)
Burn 40–60 % spatial mosaic of burnt patches.	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 GIS and thereby determine the percentage of area burnt; c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating the percentage of ground burnt within visual field.	**Achieved:** 40–60 % burnt. **Partially Achieved:** between 25–40 % or 60–75 % burnt. **Not Achieved:** < 25 % or > 75 % burnt.
> 90 % of grass clumps remain as stubble.	**Before the burn:** select three sites (taking into account the variability of landform and likely fire intensity) and mark a central point. **Before and after the burn** (immediately-very soon after): count the grass clumps in a radius of at least five metres around the central point. Determine the percentage retained after fire.	**Achieved:** > 90 % bases remain. **Partially Achieved:** 75–90 % bases remain. **Not Achieved:** < 75 % bases remain.

***It is important to return to the same location before and after the fire.** If using a line transect, a peg and a compass bearing can assist in relocating the original count location.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **Moderate** with most burns **Moderate**.

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

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

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

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.

- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between six to ten years.

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 40 to 60 per cent burnt within the target communities.

Landscape mosaic

- No more than 20 per cent of melaleuca communities within the bioregion should be burnt in any one year.

What weather conditions should I consider?

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

Season:

- Conduct burns during late wet to early dry season. Conduct occasional storm burns.
- Winter burns are also acceptable in areas that tend to remain uncured for longer periods (providing good soil moisture is present).

FFDI: 9–11

DI (KBDI): 80–140 or up to 180 for storm burns

Wind speed: Beaufort scale 1–3, or < 23 km/hr

Soil moisture: The presence of good soil moisture is essential for the rapid regeneration of native grasses after fire. Some indicators of good soil moisture can include moist soil to a depth of greater than five centimetres, or at least approximately 75 mm of combined rainfall over a two week period (ideally single falls should be of at least 15 mm), or seasonal creeks are flowing in the area, or water is pooled in creek beds and creeks are trickling.

Other considerations:

- Care should be taken in spring and early summer (around August to December) as most wildfires occur during this period.
- Some years are wetter or drier than normal and fuel accumulation will vary. Fire frequency is only a guide.

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). 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.

- **Areas with standing water** can be used to create fires with a greater patchiness. These burns also protect fire-sensitive species including pandanus.
- Be aware that the **papery bark** of melaleuca is highly flammable. Often described as a 'ladder fuel' paperbark can cause fire to rapidly ascend from the base to the top of the tree. Be aware of wind conditions and ember spot.

Refer to Chapter 1 (Issue 1), for additional tactics to address this issue.

Issue 2: Avoid peat fires

Moist low-lying melaleuca and wet heath communities contain a peat layer (an accumulation of partially decayed, densely-packed dead vegetation). In the absence of good soil moisture the peat is easily ignited and can result in a peat fire. Peat fires can burn for months, and can have very negative impacts on the vegetation community. If burnt, peat takes many years to re-form.

Awareness of the environment

Key indicators of suitable conditions to avoid peat fires:

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

A melaleuca community with peat. These communities are sensitive to fire when dry.
Neil Kershaw, QPWS, Shoalwater Bay (1993).

Melaleuca community with an understorey of ferns and sedges.
Sylvia Millington, QPWS, Mt Coom (2010).

Post fire in a melaleuca community with standing water.
Mark Parsons, QPWS, Sunday Creek, Girringun National Park (2010).

If standing water is not present or peat is not waterlogged, it can burn even if moist—this fire carried through damp peat.

Frank Mills, QPWS, Byfield National Park (2009).

The results of peat fire can be disastrous and peat can take many years to re form.

Frank Mills, QPWS, Byfield National Park (2009).

Discussion

- Due to its porous nature and high carbon content peat is easily ignited when dry and can burn / smoulder for an extended period of time, causing re-ignitions and long-term damage to ecosystems.
- Be aware of peat issues when burning in areas adjacent to melaleuca or wet heath communities. The condition of the peat should be checked prior to burning to ensure that if the fire encroaches, a peat fire will not result. If it is necessary to burn adjacent areas in less than ideal conditions, manage the fire carefully to minimise the risk of fire entering the peat areas (use suitable tactics such as burning away from wetland edges).
- When peat burns underground it can be smokeless, often remaining undetected for many months until above-ground plants are ignited (causing visible smoke). Peat fires can cause wildfires some distance away from the ignition point well after the initial peat fire commenced.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations, walk through and record the observations.

Measurable objectives	How to be assessed	How to be reported (in fire report)
The planned burn does not result in a peat fire.	Ongoing visual assessment during and post burn to ensure the fire has not carried into peat layer and developed into a peat fire.	**Achieved:** Fire did not carry into peat layer and develop into a peat fire. **Not Achieved:** Fire carried into peat layer and developed into a peat fire.

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** to **moderate**.

A low-severity fire adjacent to a Melaleuca viridiflora community where ground saturation has been used to control fire encroachment.

Mark Parsons, QPWS, Sunday Creek, Girringun National Park (2010).

What weather conditions should I consider?

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

Season: Avoid late dry season fires in the vicinity of peat

FFDI: < 7 low–moderate

DI (KBDI): < 120

Wind speed: < 23 km/hr

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

Other considerations:

- Avoid burning areas adjacent to peat in years that are drier than normal.
- Continuous low relative humidity (e.g. less than 50 per cent for more than one week) may dry the peat surface more quickly making it more susceptible to ignition—avoid burning during these conditions.

What burn tactics should I consider?

When burning adjacent fire-adapted areas where standing water or water logged peat is not present use tactics that limit fire encroachment.

- **Spot ignition** can be used to effectively alter the desired severity of a fire. Spots closer together will result in a line of a greater intensity (as spots merge they create hot junction zones). Spots further apart will result in a lower-severity fire.
- **A low intensity backing fire** ensures fire intensity and rate of spread are kept to a minimum. **Do not create a running fire**.

Limit fire encroachment into non-target communities (refer to tactics, Chapter 9, Issue 5).

Peat fires are an issue in some swamp paperbark communities. The key is to burn with standing water present or ensure the peat is water logged.

Rosemary Lovatt, QPWS, Shoalwater Bay (2007).

Issue 3: Limit fire encroachment into melaleuca gallery forests and swamps

Gallery forests contain fire-sensitive species which can be damaged by fire and require protection.

Some melaleuca swamp systems are fire-tolerant; and seasonal flooding is likely to be a major component of the ecosystems function. The ground stratum of these communities is generally moist with high decomposition rates and consequently low fuel accumulation. If allowing fire to penetrate swamp communities from surrounding areas, ensure standing water is present or the peat is waterlogged. Fire should not be allowed to trickle in any more frequently than every five years.

In general, planned burns in surrounding fire-adapted communities should use tactics and weather conditions that limit fire encroachment into adjacent gallery forests and swamps. Mosaic burning of adjacent communities will also assist in mitigating the impacts of wildfire.

Refer to Chapter 9 (Issue 5), for fire management guidelines.

Melaleuca gallery forests can contain river she-oaks *Casuarina cunninghamiana*, and other fire-sensitive species.

Jeanette Kemp, Queensland Herbarium, 30 km south-west of Sarina (2010).

Swamp paperbark communities do not require fire. However occasional fires may be allowed to trickle in (providing standing water or water-logged peat is present).
Jeanette Kemp Queensland Herbarium (2002).

When burning fire-adapted communities adjacent to melaleuca swamps, use tactics and weather to prevent encroachment of fire. These areas may dry seasonally.
Joy Brushe, QPWS, Shoalwater Bay (1997).

Issue 4: Manage high-biomass grasses

High-biomass grasses of concern in the Central Queensland Coast bioregion include para grass, Indian couch, hymenachne, molasses grass and guinea grass. Some of these species can be reduced or eliminated using fire.

Refer to Chapter 9 (Issue 3), for fire management guidelines.

Issue 5: Reduce *Lantana camara*

The presence of *Lantana camara* may require an altered approach to fire management. For well-established infestations, the integrated use of fire and other control methods can be used.

Refer to Chapter 9 (Issue 4), for fire management guidelines.

Issue 6: Reduce rubber vine

The presence of rubber vine may require an altered approach to fire management.

Refer to Chapter 9 (Issue 6), for fire management guidelines.

Chapter 6: Dune communities

This fire vegetation group includes foredune communities such as beach she-oak forests, sand blows with either bare sand or sparse herbs/shrubs and a diverse range of open to closed forests and woodlands on dunes and beach ridges. Common canopy species include a mixture of *Corymbia* spp., *Melaleuca* spp., *Eucalyptus* spp., she-oak (*Casuarina* spp., or *Allocasuarina* spp.), brush box, tea-tree *Leptospermum* spp., *Acacia* spp. or coastal banksia *Banksia integrifolia*. A dense shrub layer (e.g. of *Leptospermum* spp.) may be present and a sparse to dense ground stratum is often dominated by sedges or grasses. Rainforest species are also found in some communities. Dune communities can be located on islands and up to around four kilometres inland from the coast.

Fire management issues

Dune communities contain both fire-adapted and fire-sensitive ecosystems. The main issue for **fire-adapted** dune communities is maintaining longer fire intervals in areas adjacent to more frequently burnt fire vegetation groups (e.g. grassy eucalypt forest).

Communities dominated by Moreton Bay ash and coastal banksia or hickory wattle *Acacia disparrima* subsp. *Disparrima* that occur in association with rainforest species, do not require fire. However an occasional low-severity fire may be allowed to trickle in from surrounding areas, providing there is no potential for subsequent weed invasion. Foredune communities contain many **fire-sensitive** species including beach she-oak *Casuarina equisetifolia* which are killed by fire. Areas of bare sand with sparse herbaceous plants can become vulnerable to erosion if burnt.

Issues:

1. Maintain healthy fire-adapted dune communities.
2. Limit fire encroachment into fire-sensitive communities.
3. Reduce *Lantana camara*.
4. Manage high-biomass grasses.

Dune and foredune communities closest to the coastline are exposed to very harsh growing conditions and are generally fire-sensitive.

Andrew McDougall, QPWS, Byfield National Park (2007).

Extent within bioregion: 25 556 ha, 2 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Byfield National Park, 5 472 ha; Whitsunday Islands National Park, 854 ha; Percy Isles National Park, 563 ha; Cape Palmerston National Park, 526 ha; West Hill National Park, 334 ha; Bakers Creek Conservation Park, 96 ha; Keppel Bay Islands National Park, 52 ha; Byfield Conservation Park, 44 ha; Broad Sound Islands National Park, 32 ha; Additions to Byfield National Park, 22 ha; Skull Knob Conservation Park, 21 ha; Cape Hillsborough National Park, 20 ha; Newry Islands National Park, 19 ha; Ext to Reliance Creek National Park, 17 ha; Clairview Reserve, 15 ha; Slade Point Reserve, 13 ha; Dryander National Park, 12 ha; Bloomsbury Conservation Park, 3 ha; South Cumberland Islands National Park, 2 ha; Byfield Base Reserve, 1 ha; Seaforth Base (Port Newry Road) 1 ha.

Issue 1: Maintain healthy fire-adapted dune communities

Maintain healthy fire-adapted dune communities by conducting mosaic burns in association with the surrounding fire-adapted communities.

Awareness of the environment

Key indicators of health

- Canopy trees (e.g. eucalypts, *Corymbia* spp., acacias, melaleuca) are of varying ages (and there are enough to eventually replace the canopy). There is a healthy canopy.
- There is a healthy low tree or shrub layer (e.g. tea-trees, acacias, banksias, grass trees or fan palms).
- The presence of occasional stags and live trees with hollows.
- A diverse and healthy ground layer exists and may include grasses, vines, sedges, lilies and ferns.
- Lantana where present, appears as scattered individuals or in small, isolated clumps.
- Herbaceous weeds (including grasses) are absent or rare.

This bloodwood and eucalypt open forest shows a healthy, diverse shrubby understorey.
Leanne Simpson, QPWS, Three Rivers Road, Byfield National Park (2011).

Fire-adapted forests on dunes will often adjoin fire-sensitive communities. Use of appropriate weather conditions combined with tactics to limit fire encroachment will minimise impacts on fire-sensitive areas.
QPWS, Keppel Bay Islands National Park (2008).

Dune woodlands with a dense shrubby understorey can burn with high severity. Ensure good soil moisture exists to limit the fire severity and improve post-fire regeneration.
Joy Brushe, QPWS, Shoalwater Bay Military Training Area (1999).

This dune forest has a dense mixed understorey of grasses, sedges and ferns.
Joy Brushe, QPWS, Shoalwater Bay Military Training Area (1997).

A healthy dense shrub layer in open woodland
Joy Brushe, QPWS, Shoalwater Bay Military Training Area (1999).

The following may indicate that fire is required to maintain dune communities

- Young trees and seedlings of canopy trees are absent or uncommon.
- The shrub and low tree layer is beginning to senesce (die off).
- Grasses are thinning, collapsing or appear matted with a build-up of dead material.
- Grass trees, where present, have dense brown skirts.

Be aware that the indicators above (e.g. grasses thinning), may be influenced by other factors including season, drought, slope, aspect and soil type.

Joy Brushe, QPWS, Shoalwater Bay Military Training Area (1997).

Discussion

- Dune communities are naturally restricted in extent and are often vulnerable to erosion and weed invasion when disturbed. Any planned burns should consider the combined impacts of the fire with the potential impacts from vehicles, weeds and visitor use.
- Swampy areas between dune ridges provide habitat for the only known occurrence of the vulnerable Halifax fan palm *Livistona drudei*, in the Central Queensland Coast bioregion. Too-frequent fires in its habitat can inhibit the recruitment of seedlings.
- Dune communities are also habitat for a number of species at the northern limit of their range. The general principles of mosaic burning and diversity of fire types should provide habitat for these species.
- The Brush-tailed phascogale *Phascogale tapoatafa*, nest between June and September. Their nests are particularly vulnerable as they are often made of dry vegetation in hollows, under logs and in other sheltered locations. Planned burns with good soil moisture and patchy-low severity fires will assist in protecting their nests.
- Birds of prey such as white-bellied sea eagles *Haliaeetus leucogaster*, brahminy kites *Haliastur indus* and eastern ospreys *Pandion cristatus*, require tall trees for nesting. Within Byfield National Park, these suitable nest sites are limited—the maintenance of tall habitat trees is a key objective of fire management. Refer to the burn tactics for the appropriate guidelines.

Some dune communities, such as this Moreton Bay ash/coastal banksia forest (with rainforest species), are tolerant of occasional low-severity fires trickled in when good soil moisture is present. Ensure there is no potential for subsequent weed invasion prior to any burning in surrounding areas.

Jeanette Kemp, Queensland Herbarium (2002).

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 from below as most appropriate for the site:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Burn 25–60 % spatial mosaic of burnt patches.	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 GIS and thereby determine the percentage of area burnt. c. In three locations (that take account of the variability of landform and ecosystems within burn area), walk 300 or more metres through planned burn area estimating the percentage of ground burnt within visual field. d. Using fire scar remote sensing data, estimate burnt and unburnt country by month, on an annual basis.	**Achieved:** 25–60 % burnt. **Partially Achieved:** 15–25 % or 60–80 % burnt. **Not Achieved:** < 15 % or > 80 % burnt.

> 95 % of standing dead trees and standing live hollow-bearing trees (habitat trees) retained.	Before and after fire*, select three or more sites (taking into account the variability of landform and likely fire intensity) and count the number of habitat trees. Determine the percentage retained after fire.	**Achieved:** > 95 % retained. **Partially Achieved:** 85–95 % retained. **Not Achieved:** < 85 % retained.
> 95 % fallen logs (with a diameter ≥ 10 cm) retained.	Before and after fire*, select three or more sites (taking into account the variability of landform and likely fire intensity) and count number of fallen logs retained after fire. Determine the percentage retained after fire.	**Achieved:** > 95 % retained. **Partially Achieved:** 90–95 % retained. **Not Achieved:** < 90 % retained.

***It is important to return to the same location before and after the fire.** If using a line transect, a peg and a compass bearing can assist in relocating the original count location.

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

Monitoring the issue over time

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

Refer to Chapter 1 (Issue 1), for further monitoring options.

Within a year after fire, acacias often produce a flush of seedlings which tend to dominate in areas where fire was hottest. In dune communities it is not necessary to apply another fire to thin the acacia as this will occur naturally over time.

Frank Mills, QPWS, Byfield National Park (2011).

Low-severity fires in dune communities may assist in mitigating the impacts of wildfires later in the dry season.

Frank Mills, QPWS, Five Rocks Campground, Byfield Conservation Park (2007).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **Moderate** severity and occasionally **High** severity in dense shrubby communities.

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.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate less than 20 metre height canopy, mid stratum burnt completely (or nearly so).

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 seven to ten years.
- Some dune communities dominated by acacia and/or with a shrub understorey can be left up to fifteen years.

Mosaic (area burnt within an individual planned burn)

- A mosaic is achieved with generally 25 to 60 per cent burnt within the target communities.

Landscape mosaic

- Do not burn more than 30 per cent of the fire-adapted dune communities in the CQC bioregion within the same year.

Other considerations

- Some years will be wetter or drier than normal and fuel accumulation (amongst other factors) will vary. Fire frequency is only a guide.

What weather conditions should I consider?

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

Season: Burn during late wet to early dry season. Use occasional storm burns.

FFDI: 5–12

DI (KBDI): 40–100 or up to 120 for storm burns

Wind speed: Beaufort scale 1–3, or < 23 km/hr

Soil moisture: The presence of good soil moisture is essential for the rapid regeneration of vegetation after fire. Some indicators of good soil moisture may include moist soil to a depth of greater than five centimetres, or at least approximately 75 mm of combined rainfall over a two week period (ideally, single falls should be of at least 15 mm) or seasonal creeks are flowing in the area or water is pooled in creek beds and creeks are trickling.

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). 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.

- **Protection of habitat trees**. Rake dense fuels away from the base of habitat trees. Whenever this is impractical, avoid using a running fire to ensure fires only trickle around the base of habitat trees.
- **Use of natural barriers**. Natural barriers such as creeks, rainforests, previously burnt areas, dune swales and gullies can be used to create fires of limited size (except in very dry conditions). Natural barriers are useful in creating containment areas and landscape mosaics.

Refer to Chapter 1 (Issue 1), for additional tactics to address this issue.

Lighting different dune ridges each year under appropriate conditions limits fire spread and assists in producing a landscape-level mosaic. In Byfield National Park, aerial ignition of every third dune has been used successfully with the pattern varied each year.
Frank Mills, QPWS, Byfield National Park (2008).

Issue 2: Limit fire encroachment into fire-sensitive communities

Exclude fire in foredune communities such as beach she-oak and sand dunes with sparse shrubs/grasses. Active protection may be required as these communities are highly sensitive to fire.

Refer to Chapter 9 (Issue 5), for fire management guidelines.

Fire-sensitive dune communities are highly erodible following fire.
Rosemary Lovatt, QPWS, Shoalwater Bay Military Training Area (2007).

Fire-sensitive foredune communities do not require fire for regeneration.

Andrew McDougall, QPWS, Cape Palmerston National Park (2006).

Beach she-oaks are fire-killed and active protection will be required.

T. Kitchener, Queensland Herbarium (2002).

Issue 3: Reduce *Lantana camara*

Herbicide is the preferred control method in dune communities where *Lantana camara* is relatively sparse or found in small dense pockets.

If lantana is widespread, refer to Chapter 9 (Issue 4), for fire management guidelines.

Issue 4: Manage high-biomass grasses

Although presently uncommon in dune communities guinea grass and molasses grass are found and if new infestations be identified immediate action should be taken as they are easier to control when newly established.

Refer to Chapter 9 (Issue 3), for fire management guidelines.

Chapter 7: Rainforest

In the CQC bioregion, rainforest is the second most extensive vegetation group and occurs in predominately high altitude areas including the Conway, Clarke and Connors ranges and Mount Dryander. It is also found in small patches in lowland coastal areas and on islands. This vegetation group includes deciduous, microphyll, notophyll and mesophyll vine forests, cloud forest and beach scrubs.

Fire management issues

Typically rainforests will not burn due to moisture, microclimatic conditions and a lack of flammable grasses (Bowman 2000). Heavily disturbed rainforest (e.g. as a result of logging, drought, cyclones or weed invasion) can become potentially flammable in severe fire weather.

The main strategy to protect rainforests is to maintain the surrounding fire-adapted communities with mosaic burning to minimise the spread and severity of fire (particularly during severe fire weather). Particular types of rainforests such as beach scrub, deciduous or semi-deciduous forests are more vulnerable to fire during dry conditions and in some situations (e.g. where dry or damaged rainforest communities are upslope from a planned burn area) it may be necessary to employ specific tactics such as burning away from rainforest edges.

Occasionally, fire is used in rainforest areas for specific weed control and rehabilitation purposes. Rainforest can also make an effective natural fire break in suitable weather and climatic conditions.

Issue:

1. Limit fire encroachment into rainforests.

Rainforests are generally self-protecting under appropriate planned burning conditions.
Bill McDonald, Queensland Herbarium, Conway State Forest (2008).

Extent within bioregion: 191 540 ha, 13 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Eungella National Park, 34 011 ha; Conway National Park, 26 725 ha; Dryander National Park, 6 979 ha; Crediton State Forest, 6 324 ha; Proserpine State Forest, 6 159 ha; Whitsunday Islands National Park, 5 582 ha; Cathu State Forest, 5 467 ha; Crediton Forest Reserve, 5 292 ha; Macartney State Forest, 4 360 ha; Pelion Forest Reserve, 2 055 ha; Kelvin Forest Reserve, 2 033 ha; Ben Mohr Forest Reserve, 1 721 ha; Dryander Forest Reserve, 1 262 ha; West Hill State Forest, 1203 ha; Bluff Hill National Park, 1160 ha; Pelion State Forest, 968 ha; Pioneer Peaks National Park, 924 ha; Dryander State Forest, 886 ha; Molle Islands National Park, 676 ha; Mount Martin National Park, 673 ha; Collaroy State Forest, 661 ha; South Cumberland Islands National Park, 587 ha; Northumberland Islands National Park, 586 ha; Connors Forest Reserve, 539 ha; Rosedale State Forest, 454 ha; Ben Mohr State Forest, 351 ha; Mount Ossa National Park, 349 ha; Glencoe State Forest, 349 ha; Andromache State Forest, 345 ha; Cape Hillsborough National Park, 335 ha; Byfield National Park, 311 ha; Gloucester Island National Park, 301 ha.

Issue 1: Limit fire encroachment into rainforests

Healthy rainforests are generally self-protecting during planned burns under appropriate conditions however, it may be necessary to burn back from rainforest edges in some cases.

Refer to Chapter 9 (Issue 5), for fire management guidelines.

Sometimes it may be necessary to burn back from rainforest edges to protect them.
Joy Brushe, QPWS, Shoalwater Bay (1997).

Chapter 8: Mangroves and saltmarsh

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

Fire management issues

Mangroves do not require fire and generally do not burn. Sometimes mangroves can be scorched in nearby planned burning operations or wildfire, but it is rare that any lasting damage is done.

Care needs to be taken when burning around saltmarsh, as it is potentially flammable. The main strategy is to burn with king tides, recent rain or with groundwater seepage as this protects the saltmarsh vegetation. Saltmarsh may occasionally burn, but plan to avoid it.

Rubber vine is found within some saltmarsh communities. In some cases it can be controlled with fire providing fire-sensitive species are not present.

Issues:

1. Limit fire encroachment into saltmarsh.
2. Manage rubber vine in saltmarsh.

Extent within bioregion: 57 618 ha, 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Cape Palmerston National Park, 2 796 ha; Conway National Park, 1 561 ha; Ext to Reliance Creek National Park, 999 ha; Sandringham Bay Conservation Park, 520 ha; Whitsunday Islands National Park, 458 ha; Byfield National Park, 364 ha; Bakers Creek Conservation Park, 337 ha; West Hill National Park, 329 ha; Additions to Byfield National Park, 308 ha; Dryander National Park, 247 ha; Clairview Reserve, 81 ha; Skull Knob Conservation Park, 73 ha; Percy Isles National Park, 38 ha; Newry Islands National Park, 13 ha.

Issue 1: Limit fire encroachment into saltmarsh

Refer to Chapter 9 (Issue 5), for fire management guidelines.

The main strategy is to burn with a king tide, after recent rain or with groundwater seepage as these conditions protect the saltmarsh vegetation. Saltmarsh is vulnerable to scorching if fire-promoting plants (especially flammable grasses) occur within or adjacent to them.

Mangroves will generally not burn but their edges may be scorched by severe fire, however it is unlikely that any lasting damage will be done.
Jeanette Kemp, Queensland Herbarium (2002).

Burns adjacent to saltmarsh should be undertaken on a king tide or following recent rain.
Jeanette Kemp, Queensland Herbarium, Mackay (2002).

Fire can degrade habitat values such as removing food items for wader birds and other species.
Peter Alden, DAFF, Goorganga Plains (2004).

Issue 2: Manage rubber vine in saltmarsh

Rubber vine can be managed in some grassy saltmarsh communities as saltmarsh can tolerate occasional fire.

Refer to Chapter 9 (Issue 6), for fire management guidelines.

Occasional fire within a grassy saltmarsh community can help manage weeds, however fire generally is not necessary to maintain this community.

Frank Mills, QPWS, Byfield National Park (2007).

Chapter 9: Common issues

In the CQC 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 heritage sites.
3. Manage high biomass exotic grasses.
4. Reduce *Lantana camara* infestations.
5. Limit fire encroachment into non-target fire vegetation groups.
6. Reduce rubber vine.
7. Post cyclone planned burning.
8. Manage exotic pine wildings.

Issue 1: Hazard reduction (fuel management) burns

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

Awareness of the environment

Main indicators of where fire management is required:

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

Or

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

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

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

Dead material builds up around the base of grasses.
Kerensa McCallie, QPWS (2010).

In long-unburnt areas, there is a build-up of bark, sticks and leaf litter that smothers ground layer plants. There is also a build-up of elevated fuel. Elevated fuels contribute significantly to fire severity.
Mark Parsons, QPWS, Mount Windsor (2010).

A recent fire created a **low** overall fuel hazard and fuel load of less than five tonnes per hectare. Maintaining a simplified vertical fuel structure is an important aspect of fuel management.

Robert Miller, QPWS, Davies Creek (2008).

Discussion

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

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

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

- It is important to maintain a simplified vegetation fuel structure in protection zones and wildfire mitigation zones, which means addressing issues such as suspended and elevated fuel and overabundant saplings and seedlings.

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

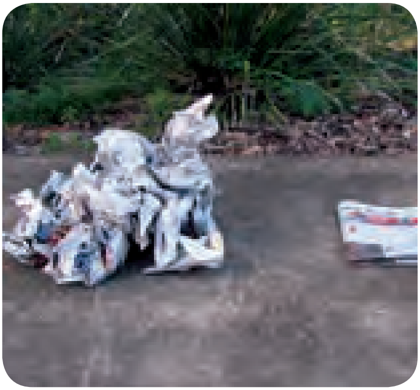


Photo 1a: The two samples above have the same **fuel load** (eighteen pages of newspaper) but a different fuel arrangement.

Troy Spinks, QPWS (2010).

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

Troy Spinks, QPWS (2010).

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

- **Protection zones:** 90 per cent burnt
- **Wildfire mitigation zones:** 70–80 per cent burnt.

What weather conditions should I consider?

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

Season: January–August

- Later burning can occur in protection zones if they are well established and have no containment hazards. For Wildfire Mitigation Zones, avoid periods of increasing fire danger when relights are more likely.

FFDI: < 12

DI (KBDI): < 120

Wind speed: < 15 km/hr

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

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

What burn tactics should I consider?

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

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

Care should be taken to ensure to protect properties upslope of dense vegetation.
Kerensa McCallie, QPWS, Keswick Island (2008).

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

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

Scars on trees may indicate where bark was removed to make canoes, containers or temporary shelters. These trees are potentially vulnerable to fire if fuel builds up around their bases.

David Cameron, DNRM (2004).

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

David Cameron, DNRM, Atherton (2002).

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

David Cameron, DNRM, Bribie Island (2005).

Key indicators of European cultural heritage sites:

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

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. These include (from the top left): shield trees (this one marks an apiary site), road signs (and other signs) and timber processing equipment such as the sawmill engine above. Because of their location in forested areas these items are often vulnerable to wildfire and may need to be protected through appropriate planned burning or mechanical fuel reduction. Consider if particularly mild weather conditions, tactics, chipped lines or mechanical fuel reduction (e.g. raking) is required prior to implementing any planned burns.

David Cameron, DNRM, Eungella National Park (2000).

Discussion

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

- A landscape proactively managed with mosaic burning will help reduce the 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 weather predictions 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: Closely monitor the wind direction to avoid smoke, flame and/ or radiant heat coming into contact with sensitive cultural heritage sites.

Soil moisture: Ensure good soil moisture.

What burn tactics should I consider?

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

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

Issue 3: Manage high biomass exotic grasses

High-biomass exotic grasses are capable of outcompeting native species to form dominant stands. High-biomass grasses of concern in the Central Queensland Coast are guinea, hamil, molasses, grader, para, elephant, thatch, hymenachne, aleman, and Indian couch. These grasses are generally much taller and produce significantly more dry matter than native species. This increases fuel loads, fire severity and frequency, spotting and flame height and can lead to increased fire spread— resulting in greater tree death and loss of habitat features with flow-on effects to other species. High-biomass grasses both promote fire and may be promoted by fire. Fire can be used as part of the control for some high-biomass exotic grasses. High biomass exotic grasses 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 high-biomass grasses during planned burn operations.

Awareness of the environment

Key indicators:

- Note: be on the look-out for **newly forming stands** of invasive high-biomass grasses as their **control is much easier** if their presence is **detected early**.
- The presence of high-biomass grasses that usually occur as a dense infestation.
- High biomass grasses often form single species dominated stands.
- The grasses are generally taller than native species.
- The grasses have a lot of mass and/or dead material.

Guinea grass infestation. The height, mass and structure of high biomass grass infestations increases flame height and severity, contributing to tree death.

Kerensa McCallie, QPWS, Jubilee Pocket (2012).

Close up of guinea grass including seed heads.
Paul Williams, Vegetation Management Science Pty Ltd, near Patterson's Gorge (2005).

Thatch grass infestation.
John Clarkson, QPWS, Mareeba (2007).

Grader grass infestation.
John Clarkson, QPWS, Mareeba (2007).

Grader grass seed head.
Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Molasses grass flowering.
Paul Williams, Vegetation Management Science Pty Ltd, Near Patterson's Gorge.

Para grass infestation.
Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Elephant grass seed head.

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Fruiting para grass.

Paul Williams, Vegetation Management Science Pty Ltd (2007).

Elephant grass can grow to three metres and easily carry fire into the canopy.

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Discussion

- During planned burn operations where these grasses are present, the potential to either promote them or control them and their effect on fire severity must be considered. Be aware that fire will usually promote these grasses unless used in very specific ways (outlined below).
- Exotic grasses are highly invasive and thrive on disturbance. They can establish where the cover of native grasses has been reduced, however some species such as molasses grass can outcompete even a dense cover of native grasses.
- There is a relationship between fire timing, frequency and severity and the ability of these grasses to invade, which is still poorly understood. It is important to record observations regarding these species' response to fire.
- Be aware of weed hygiene issues when planned burning in areas with high-biomass grasses. Fire vehicles and machinery can aid seed spread along firelines and should be washed down after exposure.
- In many cases burning high biomass invasive grasses should be avoided due to the likely increase in fire severity and the potential to promote them. However, the risk of wildfire later producing an even higher-severity fire must be considered. In some situations burning high-biomass grasses under mild conditions with planned fire is more desirable than allowing them to burn with wildfire.
- For some species the application or exclusion of fire is known to be an important aspect of control. Specific information is offered below:

Control of guinea grass *Megathyrsus maximus* var. *maximus*, hamil grass *Megathyrsus maximus* cv. *hamil* and thatch grass *Hyparrhenia rufa*

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

Molasses grass *Melinis minutiflora*

- Molasses grass is prominent on roadsides and hill slopes and can easily out-compete native grasslands and woodlands, even with a dense ground stratum in undisturbed areas. It can spread by runners and smother native grasses even if the native grass cover is reasonably healthy. Molasses grass is easily killed by fire, however follow-up burning or chemical control is essential to manage post-fire recruitment. Fire is most effective if applied prior to seed production (during mid-May), particularly for follow-up burns.
- Two fires within three years have proven to be an effective control method at Bowling Green Bay National Park. An initial fire killed the adult plants and produced a flush of seedling germination. These young plants did not begin producing seed until their second year and a burn prior to seed drop significantly reduced the molasses grass cover (Williams and Bulley 2003).

Para grass *Urochloa mutica*

- Fire has been used with partial success for the management of para grass where it occurs in swamps and drainage lines in heavily disturbed sites (e.g. Townsville Town Common). Fire is more effective where the para grass is within ephemeral swales which have dried out. Burning has been found to be more effective if used in the mid–late dry season (with higher-fire severity) or in combination with chemical control.

Grader grass *Themeda quadrivalvis*

- Fire is not considered to be an effective tool to manage grader grass as it can encourage seed germination. If fire can not be avoided in areas where grader grass exists, the fire frequency should be greater than five years.

Elephant grass *Pennisetum purpureum*

- Little information is available regarding elephant grass and fire; however there is some evidence that fire increases its biomass causing subsequent fires to be of higher-severity. Fire is not recommended as a management tool for this species.

Other high biomass grasses

- Successful fire management techniques for other species of high-biomass grasses are not yet established and will require experimentation. The examples above might be useful as a starting point.

What is the priority for this issue?

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

Fire has been found to be effective control for para grass where it exists in ephemeral wetland depressions. This can open channels of water flow previously clogged by grass invasion.

Paul Williams, Vegetation Management Science Pty Ltd, Townsville Town Common (2007).

Evaluating 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. Record counts before and after fire to support estimations and return to the same locations before and after fire.

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Protect high biomass grass infestation from unplanned fire, by burning adjacent areas.	Inspection of infestation at the end of the fire year.	**Achieved:** At the end of the fire year, infestation remains unburnt. **Partially Achieved:** At the end of the fire year, infestation partially burnt. **Not Achieved:** At the end of the fire year, infestation burnt.
Distribution of weed species (e.g. buffel grass, guinea grass) is not increased as the result of the burn.	**Before and after the burn** (after suitable germination/ establishment conditions): GPS the boundary of the weed species in the area or take standard photographs at a minimum of three photo-monitoring sites. Compare the pre and post burn distribution of the weed species.	**Achieved:** no increase in the distribution of the weed - based on results of formal assessment and general observations. **Partially Achieved:** minor expansion of weed species distribution; will not result in increase in fuel loads (e.g. scattered individuals spread into burn area; easily controlled). **Not Achieved:** Significant advance in the spread of the weed; will result in increase in fuel loads in the newly invaded areas.

Significant reductions in grass weed species. *Be aware that more than one fire may be required before assessment.	The species of grass and abundance will determine whether the assessment should focus on frequency of occurrence, cover or density, and the most appropriate technique. Seek advice from resource staff and/or publications such as the Parks Victoria Pest Plant Mapping and Monitoring Protocol (Anon 2005). 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 [Anon 2005]): • Rare (Up to four per cent 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 before the fire to rare after the fire). **Partially Achieved:** Weed infestation 'drops' one 'density category' (e.g. goes from dense before the fire to medium-dense after the fire). **Not Achieved:** No change in density category or weed density gets worse.

*__Note that some of these species quickly bounce back even after they have been reduced__. A second fire or follow up chemical control will likely be necessary following planned burning. Ongoing monitoring is recommended.

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

Monitoring the issue over time

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

When using fire to reduce the density of high-biomass grasses it is important to monitor the potential for these grasses to re-establish.

Fire parameters

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

As highly invasive weeds, high-biomass grasses such as this single guinea grass plant can quickly establish and spread. The maintenance of a healthy native grass cover is vital to exclude high-biomass exotic grasses. Fire has an important role in maintaining a healthy grass cover.

Mark Parsons, QPWS, Princess Hill, Girringun National Park (2007).

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). During the burn, tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **As part of a control program.** The initial spraying of high-biomass grasses (e.g. guinea grass) with herbicide followed in a month or so later by a low to moderate-severity planned burn has been proven to be an effective control method for some species. The successful treatment of these grasses will require continued monitoring and follow-up (either by fire or herbicide) of any remaining plants and new seedlings.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire (particularly where there is a high-biomass grass infestation). Increased spacing between spots will result in a fire of lower-intensity. The spacing of the spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- **A low intensity backing fire.** A slow-moving, low-intensity backing fire (lit against the wind or down slope) will generally result in a more complete coverage of an area and a better consumption of available fuels. This tactic ensures the fire has a greater amount of residence time and reduces available fuels (particularly fine fuels) while ensuring fire severity and rate of spread is kept to a minimum.
- **Running fire**. Burning early in the season is recommended for many high-biomass grasses. Conditions which favour a running fire will help carry the fire though the infestation if the weather conditions are too mild or the grasses are not sufficiently cured. This can be achieved by shortening the spacing of lit spots or alternatively using line or strip ignition.
- **Use fire to improve access for chemical control:** Fire may be used to improve access into areas of dense weed cover. This allows greater efficiency (to target larger areas) for follow-up chemical control.

Issue 4: Reduce *Lantana camara* infestations

Lantana occurs throughout most fire vegetation groups. It favours disturbed areas, rich soils, clearings, drainage lines, gullies, road verges and wet riparian pockets. Lantana can increase shading of the ground layer, preventing or limiting the regeneration of native species or reducing fine fuel loads (possibly even preventing low-severity planned burns). At the same time lantana can readily carry high-severity fires in dry periods (Tran et al. 2008). Where lantana abuts fire-sensitive communities, it may increase the severity of fire and potentially impact ecosystems.

Awareness of the environment

Key indicators of *Lantana camara* where it has a scattered distribution:

- *Lantana camara* occurs as a scattered understorey plant.
- Grass fuels are still continuous despite the occurrence of lantana.

Key indicators of *Lantana camara* where it is a dense infestation:

- *Lantana camara* occurs as a dense infestation.
- There is an absence of fine fuels.

Lantana occurring as a scattered understorey plant. Notice that native grass fuels are still continuous and therefore the standard fire regime for the fire vegetation group could be applied to help control the lantana.
Mark Parsons, QPWS (2010).

Discussion

- **A series of fires (with increased fire frequency)** can be used to reduce the size and height of individual plants. This gives native ground cover the ability to compete. Fire will not normally result in the death of lantana however it can be used to suppress it. Where lantana is widespread fire may be the only practical method of control and may allow access into internal areas of the infestation to further control efforts. Implementing the recommended regime for the fire vegetation group may be effective in the management of the density and occurrence of lantana where it is scattered as an understorey plant. In areas where lantana is not widespread, herbicide application becomes more practical and may be the preferred approach. A balance must be struck in terms of resourcing.
- In areas where lantana density is high but where some native grasses remain beneath it, the introduction of a low to moderate-severity fire 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 (sometimes herbicide on its own may prove sufficient).
- Low-severity fire with a high residence time, repeated fires or fire with follow-up herbicide application may be applied to reduce lantana. **Generally, a single fire will not address the issue.**
- High-severity fire in lantana that exists adjacent to fire-sensitive vegetation (e.g. rainforest) can cause scorching. Repeated high-severity fires may result in the contraction of these communities. 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 kill lantana.

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Significant reduction in cover lantana.	**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 [Anon 2005]): • 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.

Majority of lantana clumps burnt back to the extent that regrowth is by basal resprouting (and hence follow-up spraying more efficient and effective).	**After the burn** (preferably after rain): visual estimation (by traversing the burn area on foot) of the percentage of clumps that are reduced to basal resprouting.	**Achieved:** ≥ 60 % of clumps reduced to basal resprouting. **Partially Achieved:** 25 to 59 % of clumps reduced to basal resprouting. **Not Achieved:** < 25 % of clumps reduced to basal resprouting.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Key factors

- The principal factor in successful control is repetitive fire or a combination of fire and follow-up chemical control.

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

- Apply successive fires frequently (within three years of each other) where fuels are sufficient, until observations indicate that the issue is under control. Then 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 enough to apply the standard recommended fire frequency for the fire vegetation group in which it occurs. In any case, increasing fire frequency for a while may assist in its control however, this should be considered in light of the ecological needs of the community and the impacts that more frequent fires may have. Monitor the situation.
- Some areas of dense lantana may need to be designated as a rehabilitation zone until the issue is under control. Once lantana is removed OR reduced to scattered individuals, the area can be rezoned as a conservation zone and the fire frequency recommended for that fire vegetation group reinstated.

Mosaic (area burnt within an individual planned burn)

- Burn as much of the area containing the lantana as possible.

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.
- For a dense infestation, **moderate** to **high**-severity fire may initially be required. A sequence of fires later in the year (ensuring good soil moisture exists) may be used to reduce the biomass of high-density infestations. This may assist in creating better access for herbicide control. Be aware of potential damage to ecosystems and be cautious when using this method adjacent to fire-sensitive vegetation.

What weather conditions should I consider?

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

Season: Different approaches are possible including burning early in the year with good moisture or alternatively progressive burning to secure a late season burn under dry conditions. The reduction of lantana by fire has been very successful when implemented in the wet season with high relative humidity, high temperatures, impending rain and good soil moisture.

FFDI: < 12 and sometimes 18 for higher severity fires

DI (KBDI): < 120

Wind speed: Less than 23 km/hr. Variable and will depend on the objectives and the density of the lantana infestation (denser infestations may require some fanning by wind so that the fire will carry).

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). During the burn, tactics should be reviewed and adjusted as required to achieve the burn objectives. What is offered below is not prescriptive, rather a toolkit of suggested tactics.

- **A low to moderate-severity backing fire.** Where lantana is scattered in the understorey, a slow-moving, low to moderate-severity backing fire with good soil moisture (and the presence of sufficient surface fuels) ensures a greater residence time at ground level and has proven to be successful in killing both seedlings and mature lantana plants.
- **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 lantana infestation is of such a density that spot ignition will not be sufficient or there are minimal surface fuels available (e.g. grasses).
- **Subdividing lantana infestations**. Dividing an infestation into sections by hand or with heavy equipment can improve access, aeration and allow the infestation to be burnt in sections. This can help to manage fire behaviour and fire severity.
- **As part of a control program**. The initial treatment of lantana with herbicide (e.g. by a splatter gun), knocking down the lantana frames a month or so post herbicide treatment and then implementing a low to moderate-severity burn into the remaining material has been used as an effective control method (particularly useful along rainforest margins). Alternatively, it is possible to knock down the lantana prior to herbicide control. The successful treatment of lantana will require monitoring and follow-up treatment by either fire or herbicide treatment of any remaining plants and new seedlings.

- **Creating areas of low fuel around the infestation to limit the impacts of higher-severity fire later in the season.** Where lantana is present as a dense infestation the implementation of low-severity, early dry season burns (to create a safe perimeter around the lantana infestation), followed by a storm burn of a moderate to high-severity targeting the lantana infestation.
- **Aerial incendiary using a heli-torch**. Applying fire using a heli-torch may allow planned burns to be conducted in milder conditions or earlier in the season than incendiaries (heli-torch gels can enhance ignition and increase residence time). Under mild/wet conditions where the fire will not spread, this method can also be used in some fire sensitive vegetation communities. The use of a heli-torch may also assist where lantana is located within fire sensitive communities such as rainforests or gullies however care should be taken to ensure surrounding vegetation is moist or other conditions (such as high relative humidity and low wind speed) will prevent the fire from spreading.
- **Use fire to increase access for chemical control**. Fire may be used to improve access into areas of dense weed cover. This allows follow-up chemical control to be applied to a larger area of infestation. Chemical control may also be used to gain access and increase ground stratum fuel loads for future planned burns.

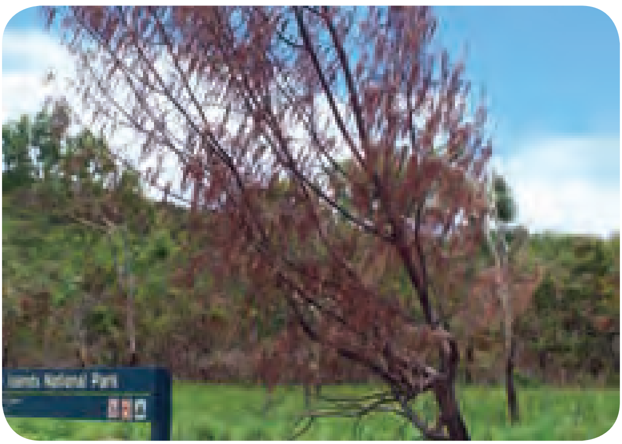
Issue 5: Limit fire encroachment into non-target fire vegetation groups

Non-target fire vegetation groups include rainforests, beach scrub, gallery forest, beach she-oak *Casuarina equisetifolia* and some dune communities. These communities are often self-protecting if fire is used under appropriately mild conditions. If suitable conditions are not available, tactics such as burning away from these communities should be used to protect them. Other areas to consider limiting fire encroachment include melaleuca and wet heath communities when the peat is dry (refer to Chapter 5 [Issue 2], for fire management guidelines) or other fire vegetation groups as relevant.

Awareness of the environment

Indicators of fire encroachment risk:

- The conditions are not sufficiently mild and the vegetation is too dry to ensure fire extinguishes on the edge of fire vegetation group.
- There are invasive grasses or lantana are adjacent to or invading fire-sensitive communities.
- The non-target community is upslope of a planned burn area.
- A beach she-oak or other fire-sensitive community is adjacent to a planned burn area.
- There is cyclone damage with dry fuel lying upon the ground inside of fire sensitive communities.



Beach she-oaks are killed by fire. Wildfire carried through the dense blady grass in the hind dunes fanned by strong south-easterly winds.

Kerensa McCallie, QPWS, South Repulse Island (2010).

Limit fire penetrating into most riparian communities. River she-oak is fire-sensitive.

Jeanette Kemp, Queensland Herbarium, west of Dryander National Park (2002).

Hoop pines and golden orchids often grow in rocky areas and are self-protecting under appropriately mild conditions.

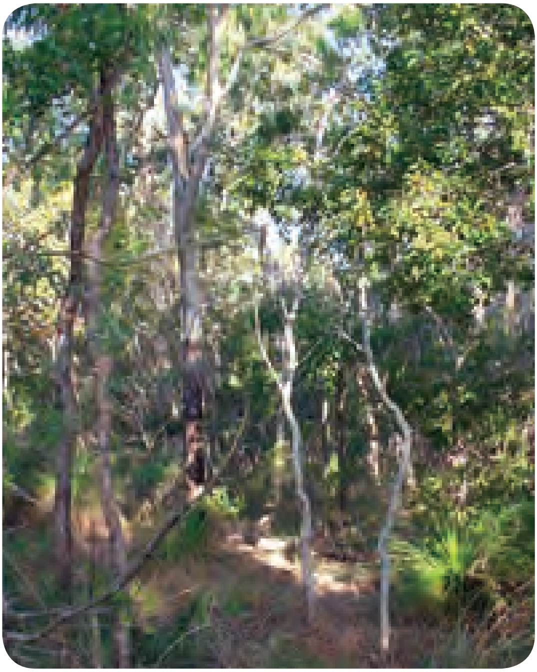
Bill McDonald, Queensland Herbarium, North Molle Island (2010).

Certain rainforests can be vulnerable in dry conditions (beach scrubs and semi-evergreen forests) and/or if they have invasive species or damage at their edges. In such cases tactics such as burning away from rainforest edges can assist if suitable weather conditions are not available.

Bill McDonald, Queensland Herbarium, Cow Island (2010).

Beach scrub is fire-sensitive, particularly where high-biomass grasses grow along the edges.

Jeanette Kemp, Queensland Herbarium, Slade Point (2004).



Some dune communities (such as this Moreton Bay ash open forest) do not require active fire management; however high-severity fire should be prevented.

Rosemary Lovatt, QPWS, Cape Palmerston National Park (2003).

While this melaleuca community is fire tolerant, high-severity fire when the soil is dry can be detrimental. If sufficient soil moisture cannot be assured, burn back from the edges.

Jeanette Kemp, Queensland Herbarium, Cape Palmerston National Park (2010).

Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (e.g. there is no guarantee that peat swamps or rainforest litter will be moist) it has the potential to damage non-target and fire-sensitive fire vegetation groups. Proactive broad-scale management of surrounding fire-adapted areas with mosaic burning is one of the best ways to reduce the impacts of unplanned fire on non-target and fire-sensitive communities.
- Under appropriate planned burn conditions with good soil moisture, fire-sensitive communities tend to self-protect and additional protective tactics may not be required. Where a fire-sensitive community occurs at the top of a slope, it is sometimes necessary to avoid running fires upslope, even in ideal conditions.
- Sometimes lantana forms a thicket that can draw fire into fire-sensitive communities. Reducing lantana prior to burning (to reduce biomass and avoid scorching) may be advisable (refer to Issue 4: Reduce *Lantana camara* in this chapter).
- The presence of high-biomass grasses increases the severity of fire and may contribute to rainforest contraction (Bowman 2000). If high-biomass grasses are present, use fire with caution (refer to Issue 3: Manage high-biomass grasses).
- Many riparian communities contain a high proportion of fire-sensitive species and/or habitat trees. Too-frequent and/or severe fire removes or inhibits the development of structurally complex ground and mid-strata 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). This increases the fire hazard. It is highly desirable to exclude fire (or at least minimise the frequency and intensity of fire) in riparian communities to promote structurally-complex ground and mid-strata vegetation and retain mature habitat trees.
- She-oaks are an important food tree for the red-tailed, *Calyptorhynchus banksii* and glossy black-cockatoo, *Calyptorhynchus lathami* and other cockatoos and parrots. When burning adjacent fire-adapted communities, care should be taken to avoid any fire penetrating into fire-sensitive she-oak communities including beach she-oak, *Casuarina equisetifolia* or river oak, *C. cunninghamiana*. A bare-earth buffer can easily be scratched with a rake-hoe through she-oak needles on sand to prevent fire trickling into these communities. Care should be taken to avoid too frequent fire in other communities containing she-oak (for example back she-oak, *Allocasuarina littoralis* in forests and woodland).
- The main strategy for saltmarsh is to burn with king tide, recent rain or groundwater seepage as it will protect the saltmarsh vegetation. Saltmarsh is most vulnerable to scorching if fire-promoting plants (especially flammable grasses) occur within or adjacent to them.

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 penetrates no further than one metre into the edge (if there is a well defined edge).	**After the burn** (immediately or very soon after): visual assessment from one or more vantage points, or from the air. **Or** **After the burn** (immediately or very soon after): walk the margin of the non-target community, or representative sections (e.g. a 100 metre long section of the margin in three locations) and determine whether the fire has penetrated further than 1m into the edge.	**Achieved:** In 90 % of area surveyed fire penetrates no further than one metre into the edge. **Not Achieved:** Fire penetrates further than one metre into the edge in > 10 % of area surveyed.

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

Fire parameters

What fire characteristics will help address this issue?

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

Fire severity

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

FFDI: Refer to relevant fire vegetation group

DI (KBDI): Refer to relevant fire vegetation group

Wind speed: < 15 km/hr

Soil moisture: Refer to relevant fire vegetation group.

Fires lit downhill or against the wind burn slowly and with lower intensity. This can assist in protecting fire-sensitive communities such as these rainforest patches.
Kerensa McCallie, QPWS, Lindeman Island (2007).

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). 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.

- **Test burn** the site to ensure non-target communities will not be affected.
- **Do not create a running-fire**. When burning in adjacent sclerophyll forest during dry conditions use a low-severity perimeter burn from the edge of low-lying communities to protect its margins.
- **Commence lighting on the leeward (smoky) edge** to establish the fire and promote a low-severity backing fire. Depending on available fuels and the prevailing wind on the day, this may require either spot or strip lighting or a combination of both.
- **Afternoon ignition**—planned burning in areas adjacent to non-target communities can be undertaken late in the afternoon. The milder conditions during this period will assist in promoting low-severity fires that trickle along the edge and generally self-extinguish, particularly during winter.
- **Limit fire encroachment into non-target communities**. Where the non-target community is present in low-lying areas (e.g. sedgelands), utilise the surrounding topography to create a low-intensity backing fire that travels down the slope towards the non-target community. If conditions are unsuitable (e.g. the non-target community is too dry to ensure the fire will self-extinguish on its boundary or it is upslope of a potential run of fire) use appropriate lighting patterns along the margin of the non-target community. This will promote a low-intensity backing fire that burns away from the non-target community.
- **Use strip ignition to draw** fire away from the non-target community's edge. When more than one line of ignition is used it can create micro wind conditions that can draw fire away from non-target areas. It is important to have safe refuges when undertaking this type of burning.
- Low-severity fire trickling into **beach she-oak communities** will kill these species. Ensure fire is not lit on the windward side of the community. Sea breezes can be used to help avoid fire encroachment. When suitable conditions are not available, scratch a bare earth break between the fire-adapted community and the fire sensitive she-oak community (where practical). Often it is sufficient to walk the break, dragging the flat edge of a rake-hoe (she-oak needles are easily removed from sand). Storm burning may be useful to minimise impacts on mature she-oak. Be aware, dense grasses such as Mossman river grass Cenchrus echinatus or guinea grass *Megathyrsus maximus* var. *maximus* infestations can draw fire into these communities.

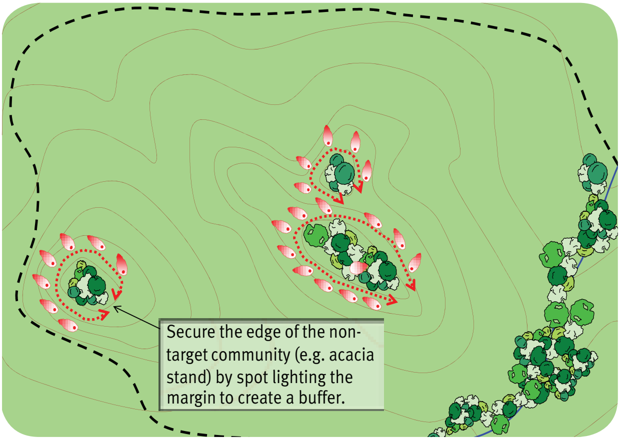
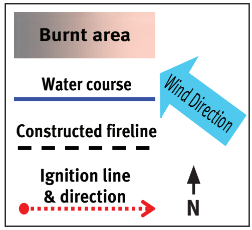


Figure 1: Example of initial lighting pattern to limit fire encroachment into non-target fire vegetation group.



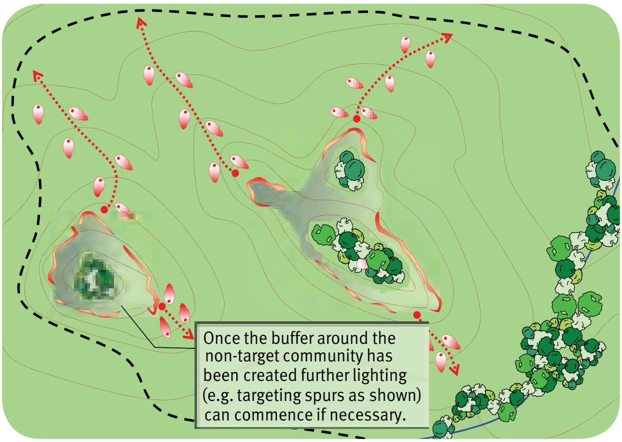


Figure 2: Example of strategic ignition adjacent to non-target community and along spurs.

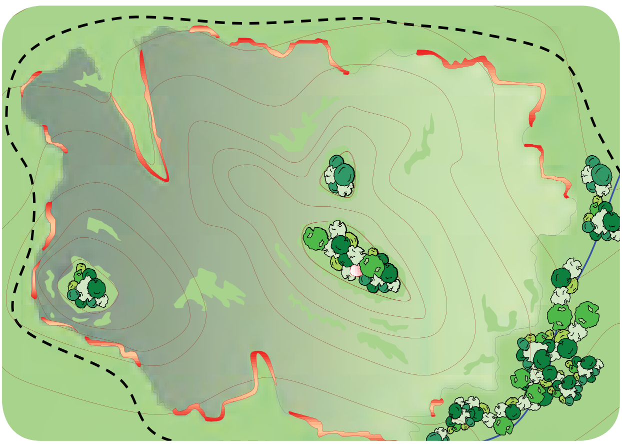


Figure 3: It was not necessary to burn back from the non-target community at the bottom of the slope, as the backing fire naturally extinguished against its edge due to greater moisture in the low lying area.

Issue 6: Reduce rubber vine

Rubber vine *Cryptostegia grandiflora* is found predominantly in the far north west of the bioregion on coastal creeks and headlands in the north and on islands. It is not restricted to disturbed vegetation and prefers a good layer of organic material in the soil. It is also restricted to areas where fires are absent or infrequent (Mackey et al. 1996). The 2008 Rubber vine containment line bisects the bioregion from east to west, just north of Airlie Beach. South-west of this line a priority management area has been declared due to the low to moderate-density infestations that occur just south of the containment lines. Rubber vine has the potential to spread throughout the bioregion.

Rubber vine has the ability to smother trees and shrubs and shade-out grasses, making fire difficult to apply. The vine is usually found in riverine areas, floodplain woodland, saltmarshes and creeks including dry creek beds. It spreads from these areas onto alluvial flats, plains and beach scrubs. It is also found in higher areas and in isolated pockets where seeds have been dispersed by wind, water or birds.

Awareness of the environment

Key indicators of where rubber vine can be managed with fire:

- Rubber vine occurs in fire-adapted vegetation or where it occurs in fire-sensitive vegetation fire severity and extent can be minimised.
- Grass or other fine fuels are still sufficiently continuous to carry fire despite the occurrence of rubber vine.
- Grass fuel crumbles in the hand meaning it is sufficiently cured.

Rubber vine occurring in marine samphire forbland. These forblands are adapted to the occasional fire. Fire may assist in reducing rubber vine.
Barry Nolan, QPWS, Cape Upstart (2007).

This sequence of images shows the successful use of fire to control young rubber vine plants. This first image was taken in October 2005. A moderate-severity fire was used to scorch smaller plants to their tips and brown the leaves of the taller plants.
Eleanor Collins, QPWS, Bowling Green Bay.

This second image, taken in March 2006 shows the results.
Eleanor Collins, QPWS, Bowling Green Bay.

Fire might be a useful tool near watercourses in which herbicide use poses an environmental risk.

John Clarkson, QPWS, Undara (2009).

Fire-killed rubber vine. Fire can be a useful technique to kill rubber vine in inaccessible or remote locations.

Barry Nolan, QPWS, Cape Upstart (2009).

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

- Rubber vine occurs in areas of insufficient fuel to sustain fire.
- Rubber vine occurs in fire-sensitive vegetation.

Rubber vine smothering native trees. Fire has been applied to kill rubber vine in the foreground but due to low fuel, has not reached some plants.

Above: Rubber vine flower.

Col Dollery.

Barry Nolan, QPWS, Cape Upstart National Park (2008).

Rubber vine seedlings. If fire were to trickle between the boulders, the low fuel load may provide insufficient residence time to kill the plants. Care should be taken in post -burn inspection.

Kerensa McCallie, QPWS, Gloucester Island (2005).

Rubber vine on beach dunes. Fire should not be applied where rubber vine occurs in fire-sensitive vegetation such as beach scrubs unless the impact of fire is limited and other control options are not available.

Kerensa McCallie, QPWS, Gloucester Island (2005).

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

Barry Nolan, QPWS, Cape Upstart (2008).

Using fire in areas where dense rubber vine has almost completely dominated the canopy may not be possible due to low fuel loads at the base of plants.

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

Discussion

- Where sufficient fuel is available, a single fire can be used to reduce or eliminate rubber vine seeds, seedlings and young plants. Follow-up fires may be required if some seeds survive in the seed bank or plants resprout.
- Rubber vine should always be burnt when the soil is moist to allow native grasses the best chance of re-establishing.
- Using fire to control rubber vine is more successful in areas where rubber vine rust occurs. Leaf-drop caused by the rust means fuel depth is greater below infected plants. If this fuel occurs adjacent to the stems it can increase residence time or (if spread more widely) it can help carry the fire through areas where it may have previously extinguished. Leaf-drop can also open-up the rubber vine canopy allowing grasses to grow.
- More mature plants require increased residence time to kill the plant. Simply scorching mature rubber vine is not sufficient to kill them.
- In areas where rubber vine has shaded-out native grasses, mechanical or chemical control may be necessary. A combination of fire and chemical control could also be useful where grasses abut an infestation. A backing fire into the 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, inaccessible areas or where chemical use is not viable. The flammable petroleum-based gel is applied directly to the plant. Fuel below the plant will sustain the fire once the gel has combusted which will improve the kill rate. In some areas this method has been very successful however mixed results in other areas have been reported. (See tactics below).
- Care should be taken when using fire in fire-adapted communities that abut fire-sensitive communities such as rainforest. Dead plant material or high-severity fire could draw fire in to the fire-sensitive areas.
- Be aware of weed hygiene issues when planned burning in areas with rubber vine. Fire vehicles and machinery can aid seed spread along firelines, roads and tracks and should be washed down after exposure.

What is the priority for this issue?

Priority	Priority assessment
High	Conservation burn in areas where structure and diversity are good but rubber vine plants are beginning to intrude. Ground layer plants are beginning to become sparse.
Medium	Sites much degraded but potentially recoverable with a series of fires. Plants representing the ecosystem are no longer the dominant structural element in the lower layer. It becomes difficult to find windows of opportunity to apply fire to this area.

Assessing outcomes

Formulating objectives for burn proposals

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

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 90 % reduction in number of rubber vine seedlings, saplings and young or mature plants.	**Before and after the burn** (after suitable germination/ establishment conditions, or a growing season): In three locations (that take account of the variability of landform and weed density within burn area), 1 year after fire count the number of saplings have been killed and those which survived. **Or** If using the 'heli-torch' method, retrace the flight path in three locations and count the number 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 rubber vine.	**Before and after the burn** (after suitable germination/ establishment conditions and growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Anon 2005]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–50 % cover) = 1/4 weed cover to equal proportions of weed to native species. • Medium-dense (51–75 %) = equal proportions of native to ¾ weed cover. • Dense (>75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation ‘drops’ two ‘density categories’ (e.g. goes from medium-dense before the fire to light after the fire). **Partially Achieved:** Weed infestation ‘drops’ one ‘density category’. **Not Achieved:** No change in density category or weed density gets worse.

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

Monitoring the issue over time

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

A single treatment should not be considered sufficient to have controlled the issue. Follow-up is always required.

Fire parameters

What fire characteristics will help address this issue?

Key factors

- The principal factor in successful control is residence time. Slow-moving fires kill mature rubber vine although intensity is also critical.

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

- In some cases applying the standard recommended fire frequency for the fire vegetation group in which rubber vine occurs may be sufficient to control the issue. Increasing fire frequency for a while may further assist in its control.
- Apply a follow-up burn during the following year if the observations indicate that the issue is not under control (e.g. mature plants have re-sprouted or seedlings have emerged from the seed bank). In some cases a third fire may be required to completely remove the infestation. Once resolved, re-instate the recommended fire regime for the fire vegetation group. Continue Monitoring the issue over time.

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 rubber vine occurs.

What weather conditions should I consider?

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

Season: Different approaches are possible including burning early in the year with good soil moisture or alternatively, progressive burning to secure a late season burn under dry conditions or storm burning.

GFDI: < 11

DI (KBDI): 80–160

Wind speed: < 23 km/hr. Variable depending on the objectives and the density of the rubber vine infestation (denser infestations may require wind for the fire to carry).

Other considerations: In some western areas, greater rubber vine control has been achieved using low humidity and high temperatures (e.g. 20 per cent humidity and 30ºC).

What burn tactics should I consider?

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

- **Storm burning**. Burn during the storm season after the first rains. A minimum of 50 mm of cumulative rainfall is recommended (with consideration to its spread). Individual falls should be around 15 millimetres. The containment of storm burns relies on the earlier season burns that established defendable boundaries (and have lower fuel levels).
- A **running fire** of a higher severity may be required to carry the fire through areas of low fuel.
- **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. Greater residence time at ground level and has proven to be successful in killing seeds, seedlings, young and some mature rubber vine plants.
- **As part of a control program.** In areas where dense rubber vine shades-out grasses (and limits the fuel available for a fire), initial herbicide treatment could be used. Care should be taken when applying fire to the dead rubber vine plants that remain hanging in the canopy as they may act as elevated fuels.

  Rubber vine rust as a biological control rarely kills mature plants however it may increase the effectiveness of burning operations.
- **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 that are fire-sensitive) applying fire using a heli-torch may help control the issue. A heli-torch involves applying gelled gasoline to the rubber vine, directly igniting the immediate area. The surrounding vegetation needs to be moist or conditions sufficiently mild to ensure the fire does not carry outside the area of the infestation or plant. A balance needs to be met between ensuring the surrounding vegetation is moist enough that it will not ignite and ensuring the rubber vine is dry enough that it will burn (refer to Figures 1 and 2).

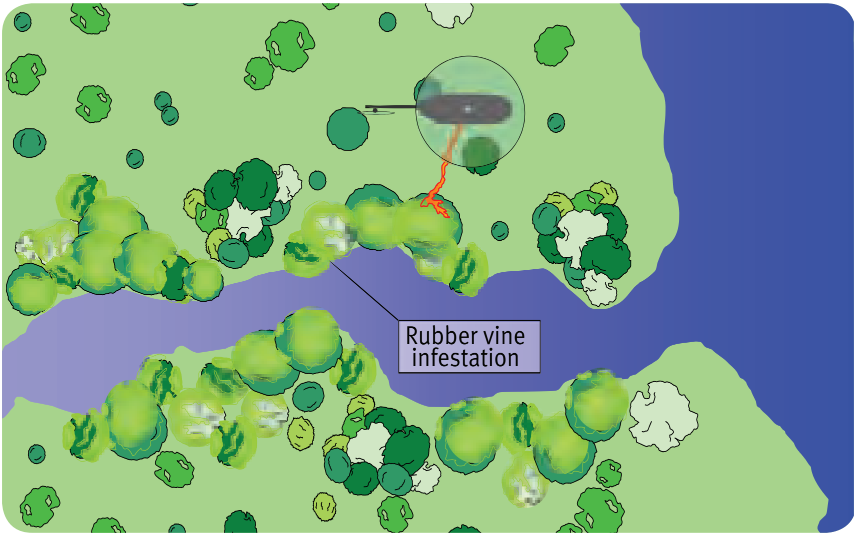


Figure 1: Fire should be applied to the plants allowing sufficient time to ignite the rubber vine and the surrounding infested areas.

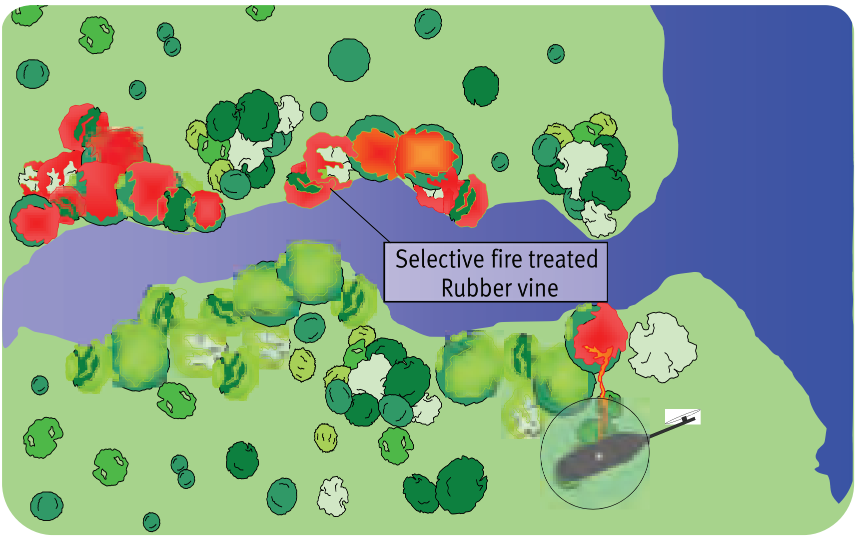


Figure 2: Individual rubber vine plants can be targeted meaning little to no damage occurs to fire sensitive communities in the right conditions.

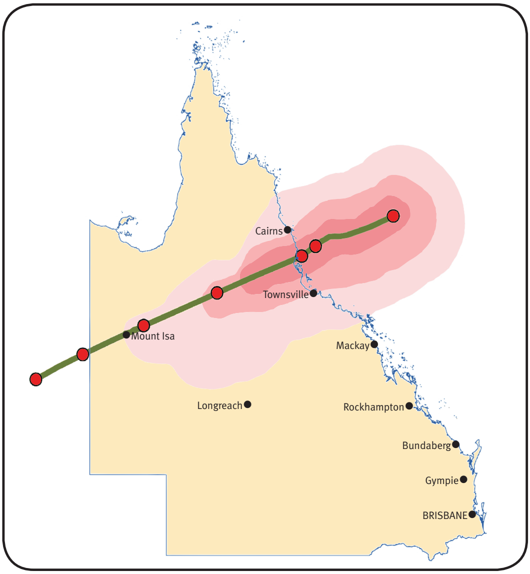
Issue 7: Post cyclone planned burning

In the event of a severe tropical cyclone (Category three or higher), 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. In the event of a Category four or higher cyclone, understorey vegetation is also damaged increasing elevated fuels. A high level of fallen tree damage can also be expected, increasing heavy fuel loads and impeding fire line access.

Once dry, the changed fuel conditions may lead to:

- the potential for extensive or high severity wildfires
- an increased fuel hazard near to assets and infrastructure
- altered fire behaviour during planned burning operations in the two years following a cyclone
- fire-sensitive communities becoming vulnerable to fire encroachment during certain dry periods
- an opportunity to re-introduce fire into areas that have been transitioning to closed forest.

Strategic planned burning with high soil moisture and avoiding dry conditions; encouraging landholders to mechanically reduce fuel; avoiding ignition sources during risk periods; and reviewing scheduled planned burns to make use of moister seasonal conditions are strategies to compensate for changed fuel conditions.



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.

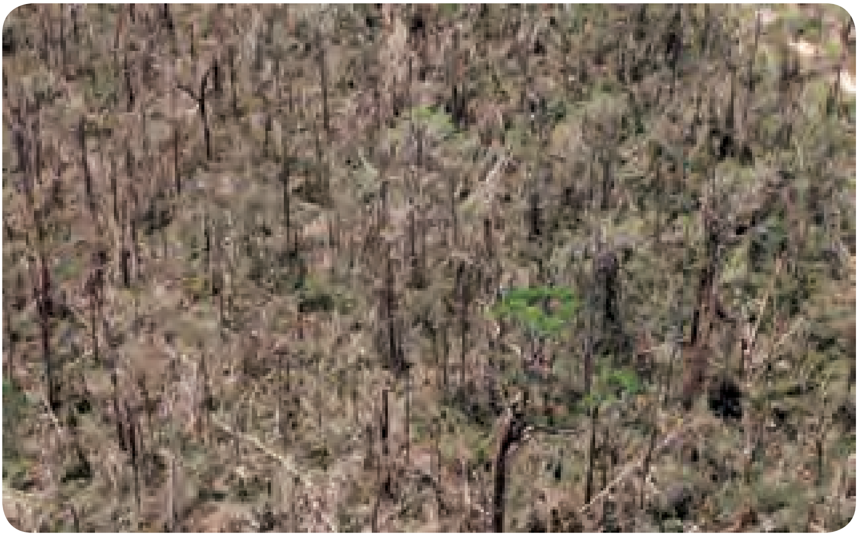
David Clark, QPWS (2011).

Awareness of the environment

Indicators of increased fuel hazard due to a severe tropical cyclone:

- there has been at least a **Category three severe tropical cyclone** (165 - 224 km/hr, very destructive winds)
- vegetation and branches stripped from open forest trees
- leaf, leaf shred, branches and limbs accumulate on the ground as significant fuel loads
- branches and fine fuel elevated above ground where they can easily aerate and become an elevated fuel hazard
- the reduction in native vegetation cover has allowed the establishment of high biomass invasive grasses (refer to Issue 3 of this chapter)
- rainforest or other fire-sensitive community extensively stripped of canopy foliage creating an open structure, with fuel accumulation on the ground or suspended; the open structure creating conditions where forest floor fuels become flammable under dry conditions.
- there has been at least a **Category four severe tropical cyclone** (225 - 279 km/hr, very destructive winds)
- in this case, understorey vegetation may also be severely damaged creating excessive vertical and ladder fuels leading to an increased fuel hazard.

Although cyclone categories have been used to indicate wind damage, be aware that the pattern of damage can be quite variable. For example, a forest might be stripped of canopy vegetation, however have no accumulated fuel, as the fuel was blown elsewhere. Similarly a forest that did not sustain wind damage (for example, the protected side of a ridge) may have received the blown fuel. Therefore post cyclone assessments on the ground and/or by air are essential. Monitoring fuel conditions in the years following a cyclone is important as fuel matures and breaks down at different rates in different locations.



Strewn fuel and fallen branches will create a high fuel hazard when dry. Dead or fallen trees will allow fires to smoulder for some time, creating re-ignition risk.

Audrey Reilly, QPWS, Cyclone Yasi, Murray Falls (2011).

Category 5 cyclonic winds can cause build-up of fine and elevated fuels over substantial areas. Suspended fuel is aerated which decreases drying time and increases combustibility.

Richard Lindeman, QPWS, Cyclone Yasi, Stephens Island, Barnard Island Group National Park (2011).

These fallen fuels have dried to a point of ignition within 2 weeks of a cyclone.
Mark Parsons, QPWS, Cyclone Yasi, Lily Creek (2011).

Be aware of changed fuel conditions next to assets and infrastructure after cyclonic wind impact.
Audrey Reilly, QPWS, Cyclone Yasi, Bingal Bay (2011).

Usually not fire prone, coastal littoral communities can accumulate sufficient fuels to carry fire following a cyclone; if there are aerated fine fuels and fire is pushed by a sea-breeze.

Mark Parsons, QPWS, Cyclone Yasi, Foreshore, Girramay National Park (2011).

A melaleuca wetland severely impacted by cyclonic winds. Be aware that fuel lying upon wetlands may carry fire where it would not usually travel. Also, this wetland now has an enormous amount of ladder fuel which will increase fire severity leading to tree death if burnt inappropriately.

Audrey Reilly, QPWS, Cyclone Yasi, Hull River (2011).

Strewn fuel and trees fallen across fire lines is one of the many issues to consider when planning fires after cyclones.

Audrey Reilly, QPWS, Cyclone Yasi, Murray Falls (2011).

Melaleuca wetland damage by Category 5 cyclonic winds. Notice that most trees have been stripped and many lie on the ground.

Audrey Reilly, QPWS, Cyclone Yasi, Hull River (2011).

Category 5 cyclonic winds impacted these ridges and peaks, causing a build up of dead and flammable material next to vine forest. Avoid fires in the late dry season as vine forest/ rainforest edges are potentially vulnerable to fire in the two years after a cyclone, if they are upslope of a run of fire.

Audrey Reilly, QPWS, Cyclone Yasi, Cardwell Range (2011).

Discussion

- After a severe tropical cyclone, people will 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 already stressed canopy.
- The canopy of trees damaged by severe cyclones is particularly susceptible to further impacts (such as canopy scorch) and may lead to tree death. Until the health of the canopy is restored, fires which may impact them should be avoided.
- 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, a low severity, are easy to control and allow disorientated and distressed fauna to find refuge areas. Also, they are less likely to further stress the canopy. The next best time to utilise moist conditions is the following storm season.
- Where ignition sources can be reliably controlled, consider avoiding fires altogether for a period. Especially where fires are likely to scorch stressed canopy.
- Despite best efforts, after a cyclone that causes extensive damage, it will not be possible to reduce fuel hazard in all the areas where it would be desirable to do so. A prioritised approach is required.
- The best way to protect property and infrastructure is emphasising the landholder's responsibility to mechanically clean up fuel. However, planned burning in moist conditions may form part fuel reduction strategies.
- Expectations of how fire behaves in a normal year must be reconsidered post cyclone (or even after a severe storm). It is likely programmed fire management can continue, but only after re-assessment of planned burn areas. Be aware that increased finer fuels and increased native or high biomass 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 fire lines, and over wetlands). Site preparation, careful consideration of tactics and a different burning window may be required, using more moist and humid seasonal conditions than normal years in order to compensate for increased fuel.

- If it is not possible to use moister seasonal conditions and yet it is still important to reduce fuel, careful consideration of ignition tactics will be required. Backing fires away from risk areas, down slope and/or against the wind can be considered. Afternoon and evening conditions can also be considered.
- 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 seedling/sapling and rainforest 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.
- After a severe cyclone, there will be a substantial number of fallen trees that may smoulder long after fire (especially after the second year), creating a re-ignition risk if burning in increasing fire hazard periods (mid to late dry season). Planned burning will not normally consume fallen trees, and the problem is likely to persist for years after a cyclone. Burning with moisture and in periods of stable moist conditions, or in declining fire hazard, will minimise the risk.
- During the late dry season in the two years after a cyclone, rainforest edges are vulnerable to upslope runs of fire. Lantana, high biomass grass invasion and severe cyclone events (causing a more open canopy) increases the risk of encroachment.

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

Choose objectives as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
No canopy scorch.	There are two options: 1. From one or more vantage points, estimate extent of canopy scorched. 2. In three locations (that take account of the variability of landform within burn area), walk 300 or more metres through planned burn area estimating percentage of canopy scorched within visual field.	**Achieved:** No canopy scorch. **Partially Achieved:** 1–20 % of canopy scorched. **Not Achieved:** > 20 % of canopy scorched.
Reduce overall fuel hazard to low. **Or** Reduce fuel load to less than five tonnes/ha.	Post fire; use the Overall Fuel Hazard Guide (Hines et al. 2010b), or Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations.	**Achieved:** Fuel hazard has been reduced to low; Or fuel load has been reduced to less than five tonnes/ha. **Not Achieved:** Fuel hazard has not been reduced to low Or fuel load is greater than five tonnes/ha.

Fire patchiness of 70–100 % burnt.	There are three options: 1. From one or more vantage points, estimate aerial extent of ground burnt. 2. In three locations (that take account of the variability of landform within burn area), walk 300 or more metres through planned burn area estimating percentage of ground burnt within visual field. 3. Walk into one or more gully heads, and down one or more ridges and estimate percentage of ground burnt within visual field.	**Achieved:** Mosaic or patchiness of > 70 %. **Partially Achieved:** Mosaic or patchiness of 50–70 %, the extent and rate of spread of any subsequent wildfire would still be limited. **Not Achieved:** Mosaic or patchiness of < 50 %. High proportion of patchiness, unburnt corridors extend across the area (the extent and rate of spread of any subsequent wildfire would not be 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.

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** and occasionally **moderate**. Slow moving trickling fires preferred. Be aware that in the two years after a cyclone, burning in dryer months might create higher than anticipated fire severity.

Fire frequency / interval

- After a cyclone, it may be imperative to reduce fine fuels to reduce risk.

Patchiness (mosaic of individual burns)

- Mosaic or patchiness of > 70 per cent to reduce litter fuels.

Other consideration

- Planned burning in moist conditions is only one of the ways to reduce risk after a cyclone. Mechanical fuel reduction and avoiding ignition sources during risk periods are also important strategies.
- Fires should not scorch the canopy of trees which have been cyclone damaged. Be aware that this may be more difficult following cyclones due to higher fuel loads and considerable care should be taken.

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.

Recent rain: Burn soon after rain events as this increases the controllability of fire where excessive fuels have accumulated. Use the drying tables available in the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to estimate how soon the site will be ready to carry fire after rain (but take account of the fact there are suspended aerated fuels that might dry sooner). Moist conditions will recur in the following storm burning season (November to January).

Humidity: > 50 per cent humidity will create conditions where fire will trickle. This helps to create a low-severity fire with sufficient residence time to consume fuel.

Wind speed: < 15 km/hr (higher for storm burning)

FFDI: ‹ 11

Season: Aim for **summer** til **autumn**. Also, storm burns during **December** til **January**.

What burn tactics should I consider?

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

- **Progressive burning** is very useful after a cyclone when combined with careful observations of fire behaviour, as this will indicate when conditions are becoming too dry for easy control of fires.
- **Commence lighting on the leeward (smoky) edge** to contain the fire and promote a low intensity backing fire.
- **A low intensity backing fire.** A slow moving, low intensity backing fire will generally result in a better consumption of surface 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.
- **Spot ignition**. Can be used to alter the desired intensity of a fire particularly where there is a high accumulation of available and volatile fuels. Increased spacing between spots will result in a lower severity fire. The spacing of the spots should be varied throughout the burn to take into consideration changes in weather conditions, topography, fuel loads etc.
- **Afternoon ignition**. This is particularly useful where suitable conditions are not available during the day. This will assist in promoting a low-severity fire that may trickle along the edge of non-target communities and generally self-extinguish due to milder conditions overnight.
- **Limit fire encroachment into non-target communities.** Where the non-target community is present in low lying areas (e.g. riparian systems), utilise the surrounding topography to create a low-severity backing fire that travels down slope towards the non-target community. If conditions are unsuitable (the non-target community has been damaged by cyclone and is upslope) use appropriate lighting patterns combined with active suppression along the margin of the non-target community to promote a low severity backing fire that burns away from the non-target community (refer to Chapter 9, Issue 5).

- **Strip ignition to draw** fire away from non-target community edge. Using more than one line of ignition can create convective updrafts which draw fires together and away from non-target areas. It is important to have safe refuges when undertaking this type of burning. For example for lighting along a track the person furthest from the track should walk parallel to the track and at least 20 m ahead of the person lighting nearer the track. This reduces the chance of the 'outer' person becoming cut off from the refuge area (the track).
- **Wet lines, blower lines (to clear strewn material) and/or rake-hoe lines** may have to be established along the edge of non-target areas. It is time consuming to establish wet lines, blower lines or rake-hoe lines especially where the boundary is extensive and where there has been considerable fallen timber, so use this tactic only where the prevailing weather conditions or the above tactics are not suitable to limit fire encroachment into non-target areas.

Issue 8: Manage exotic pine wildings

Pine wildings *Pinus* spp., invade areas of protected estate adjacent to forestry pine plantations. If they are not managed, pine wildings can displace native species and pine needles can smother lower-layer plants. When pine wildings become overabundant they provide conditions that are conducive to the promotion of weeds such as molasses grass and lantana.

Awareness of the environment

Key indicators of invasion or potential invasion:

- The vegetation community is adjacent to a pine plantation.
- Young pine wildings are beginning to emerge above the ground-layer plants.
- Pine wildlings are present and ground-layer plants are reduced in abundance and health. Grasses where present are scattered, poorly-formed and are collapsing.
- There is an accumulation of pine needles.

Pine wildings are beginning to emerge above the grassy layer.
Kerensa McCallie, QPWS, Byfield State Forest (2011).

Discussion

- Pine wildings less than one metre in height are relatively easy to manage and most fires will kill the saplings providing there is sufficient fuel around the stem base. Wildings that are one to three metres high are more difficult to manage and specific tactics may be required such as a high-severity fire or a running fire—these scorch the tip of the wilding.
- Repeated low-severity fires will promote pine wildings—the initial fire promotes a flush of seedlings and following fires are not hot enough to kill the growing seedlings (as the fire does not scorch to the tip of the plant).
- High-severity fires can reduce the quality of pine trees and make them unsuitable for products which require good quality timber. Care should be taken when burning areas adjacent to pine plantations to avoid fires impacting them.
- Pine trees grow approximately one metre per year for the first 10 years. Once they reach approximately 10 metres in height they tend to decrease their vertical growth rate but the trunk continues to increase its girth.
- Pine seeds are primarily wind dispersed (species dependant) and can be found up to five kilometres from the parent plant. These are often isolated individuals. However the majority of seedlings will fall within 500 metres of the plantation and regular reinfestation means ongoing management is crucial.
- While responsibility for wildling management lies with QPWS on protected estate, Forestry Plantations Queensland (FPQ) policy and guidelines 'Management of exotic pine wildings originating from Forestry Plantations Queensland plantations' may provide additional guidance in managing the issue.

Why are wildings overabundant?

Pine wildings in the understorey may occur:

- in areas adjacent to pine plantations
- in response to a fire event with no subsequent fire to thin the resulting flush of tree seedlings. If a fire triggers a flush of wildings, it will be necessary to plan a subsequent burn

Pine wildings may be promoted by:

- repeated low-severity, early season fires
- the prolonged absence of fire

Potential impacts of overabundant wildings:

- Overabundant wildings may result in a lower diversity of plants within the understorey. This occurs due to suppression from pine needles and the displacement of native species.

As pine trees grown, they can be difficult to manage as applying fire that is severe enough to kill them may have undesirable consequences. In these circumstances mechanical or chemical control (or a combination of these techniques) and fire may be necessary.

Kerensa McCallie, QPWS, Byfield State Forest (2011).

Few native species are able to establish where pine trees have shaded-out the ground layer. The light provided by felled trees in combination with fire will allow native species a competitive advantage.

Graeme Bulley, QPWS, Bribie Island (2008).

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)
> 75 % of pine wildings less than two metres are scorched to the tip.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire intensity), count the number of overabundant saplings (above ground components) scorched, and those that weren't.	**Achieved:** > 75 %. **Partially Achieved:** 50-75 %. **Not Achieved:** < 50 %.

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Moderate** to **high**. Aim for scorch height that is sufficient to scorch to the tip of the pine wildings.

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)
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.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate less than 20 metre height canopy, mid stratum burnt completely (or nearly so).

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

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

- See the interval recommended for the fire vegetation group.
- Avoid repeated low-intensity fires as this can promote the germination and persistence of pine wildings.

Mosaic (area burnt within an individual planned burn)

- > 80 per cent of area dominated by understorey trees burnt.

Repeated fires

- It is likely that more than one planned burn will be required to manage this issue. If the initial fire does not occur before mature pines seed, a flush of wildings may occur. In this case a follow-up planned burn within two years with **Moderate** to **High** severity fire may help address the issue.

What weather conditions should I consider?

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

Season: The season should be appropriate for the fire vegetation group. If fires can not be planned to co-inside with the cycle, burning before seed drop in spring.

FFDI: As per fire vegetation group.

Wind speed: As per fire vegetation group.

The flame height in this fire was sufficiently high to scorch the tips of the smaller pines in the foreground (and has killed them). Unfortunately the larger trees behind have not been killed and mechanical control may be required.

Graeme Bulley, QPWS, Centre Swamp, Bribie Island (2005).

Pine invasions can occur well away from the source plantation. This large tree (centre) was probably the parent plant and over successive years of seeding has formed its own monoculture of pines—displacing native vegetation.

Graeme Bulley, QPWS, North of Poverty Creek, Bribie Island (2005).

This area was clear felled of pines in 2000. Eleven years later trees are having shading impacts on the ground layer and native species diversity has reduced below the regrowth. Without management intervention this area will continue to redevelop into a pine forest.

Graeme Bulley, QPWS, Westaways Creek, Bribie Island (2011).

This fire is of sufficient severity to scorch the smaller pines (centre) but not those to the right of the image.

Frank Mills, QPWS, Mount Atherton (2010).

Regeneration of pine invaded areas may be a two step process; after mechanical removal of mature pines, fire is applied to remove ground fuel, pine saplings and promote regeneration of native species.

Graeme Bully, QPWS, Near Centre Swamp, Bribie Island (2010).

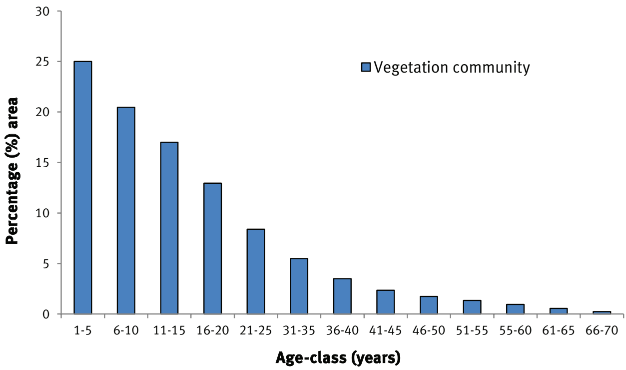
What burn tactics should I consider?

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

- While a moderate-severity fire is often sufficient to address this issue, it is dependant upon the height of the wildings. A **running fire** of a higher-severity may be required to increase the scorch height (to ensure the tips of the wildings are scorched).
- **Line or strip ignition** is used to create a fire of higher-severity or to help fire carry through moist or inconsistent fuels. A second line of fire parallel to the initial strip can increase fire severity between the two lines, as the fires draw together.
- **A backing fire with good residence time.** A slow-moving backing fire (lit against the wind on the smoky edge or lit from upslope) will generally result in a more complete coverage of an area and ensures the fire has a greater amount of residence time. This tactic will also ensure fire intensity and rate of spread are kept to a minimum. Greater residence time is also useful for killing wildings one to two metres high.
- **Combining mechanical control with planned burning** can be a useful tactic where fuel loads are insufficient for fires to carry or to cause scorch to the tip of the pines. Three to six months prior to burning, fell as many trees as possible, making the cut below the lowest branch (this ensures the pines will not regrow). Using a bobcat-mounted slasher can assist in felling dense infestations or infestations over a large area.

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.

References

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

Bartareau T and Skull S (1994), 'The effects of past fire regimes on the structural characteristics of coastal plain *Melaleuca viridiflora* Sol. ex Gaert. woodland and the distribution patterns of epiphytes (*Dendrobium canaliculatum* R. Br., *Dischidia nummularia* R. Br.) in northeastern Queensland', *Biotropica*, vol. 26, pp. 118-123.

Bowman DM 2000, *Australian rainforests. Islands of green in a land of fire*, Cambridge University Press, Cambridge.

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

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

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

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

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

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

Lynn J 2009, *Cape Upstart National Park fire strategy*, unpublished internal report. Queensland Parks and Wildlife Service, Airlie Beach.

Mackey AP, Carsten K, James P, March N, Noble K, Palmer B, Vitelli J and Vitelli M 1996, 'Rubber vine *Cryptostegia grandiflora* in Queensland', Queensland Department of Natural Resources, Brisbane.

Nolan B and Johnson P 2001, *Recovery plan for the Proserpine rock-wallaby Petrogale persephone 2000–2004*. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.

Parks Victoria 1995, *Parks Victoria pest plant mapping and monitoring protocol*, Parks Victoria.

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

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

Queensland Herbarium 2012 (16 April), *Survey and mapping of 2009 remnant vegetation communities and regional ecosystems of Queensland* (pre-release of version 7.0) spatial layer, Queensland Government, Brisbane.

Russell-Smith J and Stanton PJ 2002, 'Fire regimes and fire management of rainforest communities across northern Australia', p. 329, in RA Bradstock, JE Williams and AM Gill (eds.), *Flammable Australia: the fire regimes and biodiversity of a continent*, Cambridge University Press, Cambridge.

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

Tran C, Gilroy J and Williams P 2008, 'Quantifying fuel loads and fire hazard in a wet sclerophyll community of south-eastern Queensland', *The International Bushfire Research Conference 2008*, Adelaide.

Williams P and Bulley G 2003, 'Short fire intervals can reduce molasses grass cover', Queensland Parks and Wildlife Service, *Ecological Management and Restoration*, vol. 4, part 1.

Williams P, Collins E, Mason D, Prince J, and Anchen G (2006), 'Variation in the age at first flowering for seedlings of 15 fire-killed shrubs and trees on sandstone outcrops and sand plains in central and north-western Queensland', *Ecological Management and Restoration*, vol. 7, part 1, pp. 61–63.

Williams P and Tran C 2009, *Evaluating fire management in sandstone landscapes on Queensland parks*, internal report, Queensland Parks and Wildlife Service, Brisbane.

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

Appendix 1: List of regional ecosystems

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

Fire vegetation group	Hectares within the Central Queensland Coast bioregion	Percentage
Eucalypt forest and woodland	645 472	44
Tall open forest	32 025	2
Grasslands and sedgelands	8 138	1
Heath and shrubland	16 799	1
Melaleuca communities	40 269	3
Dune communities	25 556	2
Rainforest	191 540	13
Mangroves and saltmarsh	57 618	4
Plantations	7 904	1
Sand	75	0
Water	5 059	0
Non-remnant	427 027	29
Other bioregions	2 872	0
TOTAL	**1 460 354**	**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 forest and woodland	Eucalypt forest and woodland	E	8.12.5c, 8.12.12d, 8.12.27a, 8.12.27b, 8.3.8, 8.5.5, 8.11.5b, 8.11.5a, 8.11.6, 8.11.8b, 8.12.5a, 8.12.14c, 8.12.14d, 8.12.25, 8.12.31b, 8.12.32, 8.3.5, 8.3.6c, 8.3.6a, 8.3.13d, 8.5.1b, 8.5.1a, 8.5.3b, 8.5.3a, 8.9.1, 8.10.1b, 8.10.1a, 8.11.1, 8.11.3c, 8.11.3b, 8.11.3a, 8.11.4, 8.12.5b, 8.12.6b, 8.12.6a, 8.12.7c, 8.12.7a, 8.12.7b, 8.12.9, 8.12.12a, 8.12.12b, 8.12.20a, 8.12.20c, 8.12.22, 8.12.23, 8.12.26, 8.3.13c.
			Eucalypt forest – poorer soils	Ec	8.11.8a, 8.11.12b, 8.11.12a, 8.12.14a, 8.12.14b.
2	1	Tall open forest	Rose gum open forest	R	8.12.31a.
			Red mahogany, yellow stringybark and/or *E. portuensis* closed-forest to low open-forest	A	8.12.4.
			E. montivaga open forest	M	8.12.8.

Central Queensland Coast Bioregion of Queensland: Appendix 1—List of regional ecosystems

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
3	1	Grasslands and sedgelands	Grasslands	G	8.3.12, 8.12.13, 8.12.13a, 8.12.13b.
	2		Grasslands (poorer soils)	Gp	8.10.1d, 8.11.9.
	2		Sedgelands	S	8.3.4, 8.3.14, 8.2.9.
4	1	Heath and shrubland	Coastal heath	Hc	8.11.10, 8.12.29, 8.12.29a, 8.12.29b, 8.2.3a, 8.2.3d, 8.2.4a, 8.2.4b, 8.2.7b.
			Montane heath	Hm	8.11.7, 8.12.10a, 8.12.10b, 8.12.29c.
5	1	Melaleuca communities	Melaleuca forest and woodland	Mw	8.2.13b, 8.3.2, 8.3.11, 8.5.2a, 8.5.2c, 8.5.6, 8.5.7.
	3		Melaleuca gallery forests	Mg	8.3.3a, 8.3.3b, 8.3.15.
	3		Melaleuca swamps	Ms	8.2.11, 8.2.4c, 8.2.7a, 8.2.7e, 8.3.13a, 8.3.13b.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
6	1	Dune Communities	Fire-adapted	Fa	8.2.13a, 8.2.12b, 8.2.12a, 8.2.7c, 8.2.8b, 8.2.8a, 8.2.8e, 8.2.8d.
	2		Fire-sensitive	Fs	8.2.1, 8.2.10, 8.2.14a, 8.2.14b, 8.2.6a, 8.2.6b, 8.2.14c.
7	1	Rainforest	Rainforest	R	8.3.1b, 8.3.1a, 8.3.9, 8.3.10, 8.8.1b, 8.8.1a, 8.11.2, 8.11.11, 8.12.1a, 8.12.1b, 8.12.2, 8.12.3b, 8.12.3a, 8.12.3c, 8.12.11, 8.12.11a, 8.12.11c, 8.12.16, 8.12.17a, 8.12.17b, 8.12.17c, 8.12.18, 8.12.19, 8.12.28, 8.12.30.
	1		Beach scrubs	Bs	8.2.2, 8.2.5
8	1	Mangroves and saltmarsh	Mangroves		8.1.1
	1		Saltmarsh	Sa	8.1.2, 8.1.3, 8.1.4, 8.1.5, 8.10.1c

Spatial data is derived from a pre-release of version 7.0 of the "Survey and Mapping of 2009 Remnant Vegetation Communities and Regional Ecosystems of Queensland" layer (16 April 2012 - pre-release of version 7.0) (refer to Figure 1).

Includes all Regional Ecosystem (RE) spatial records with a dominant RE classification associated with the Central Queensland Coast bioregion. As such some spatial records extend beyond the Central Queensland Coast bioregion boundary.

Some of the REs listed in the planned burn guideline will not be matched in the spatial data. This may be because the Regional Ecosystem is "not of a mappable size", the Regional Ecosystem "has been moved" (i.e. it has been reclassified into a new RE code), the Regional Ecosystem exists only as a sub-dominant RE within the spatial data or the Regional Ecosystem has not yet been mapped. In the REDD system, the comments section indicates if the Regional Ecosystem is not of a mappable size or if it has been moved.

No REs were unmatched with the GIS spatial layer.

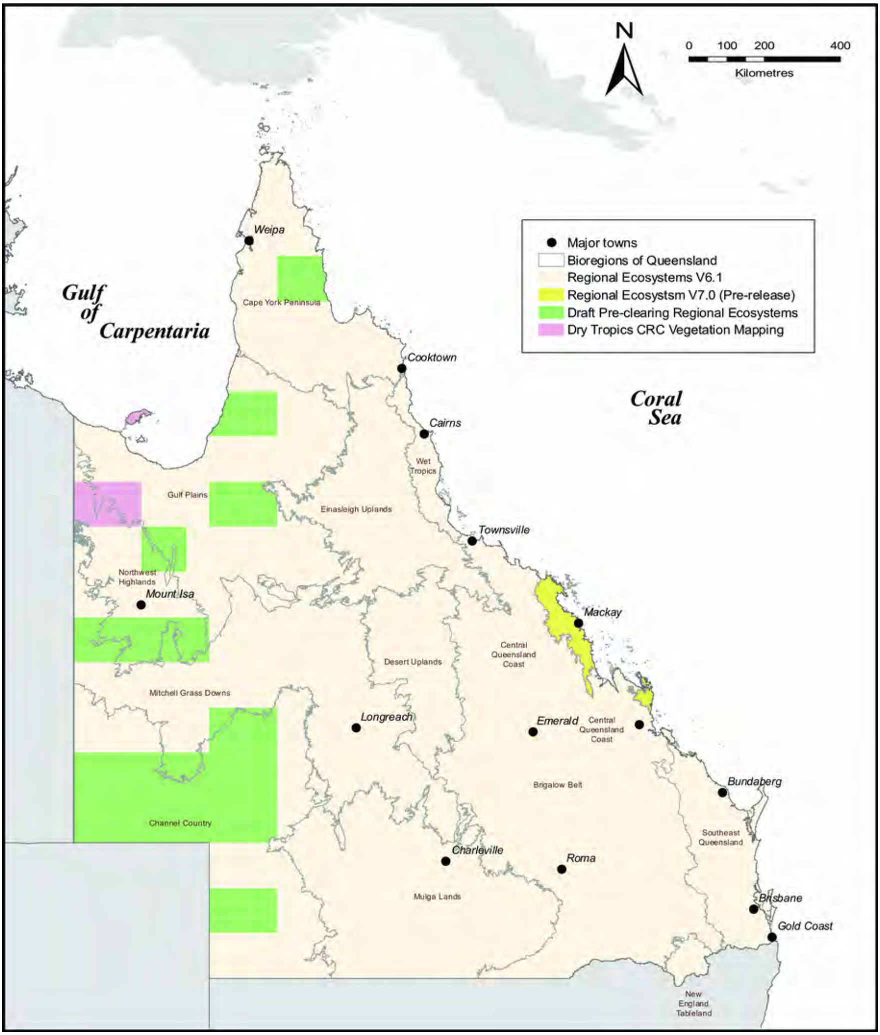


Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

Appendix 2: Mosaic burning

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

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

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

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

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

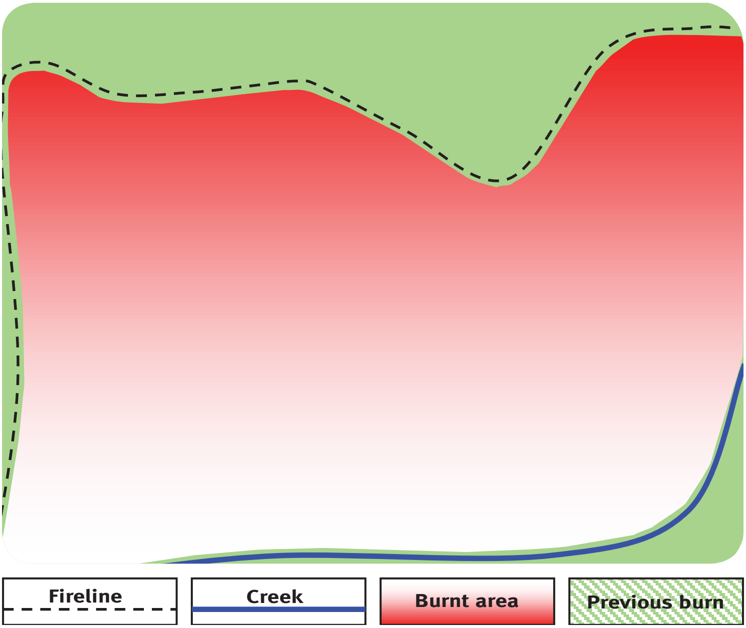


Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

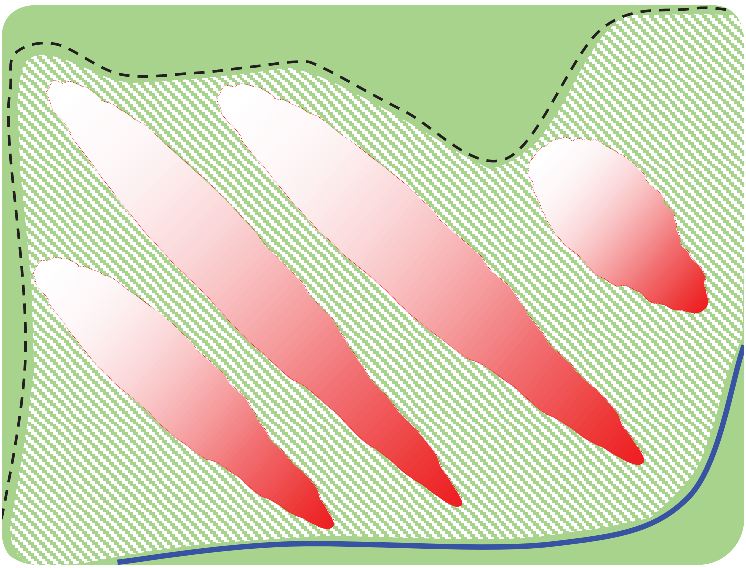


Figure 2: Planned mosaic burn—year 8.

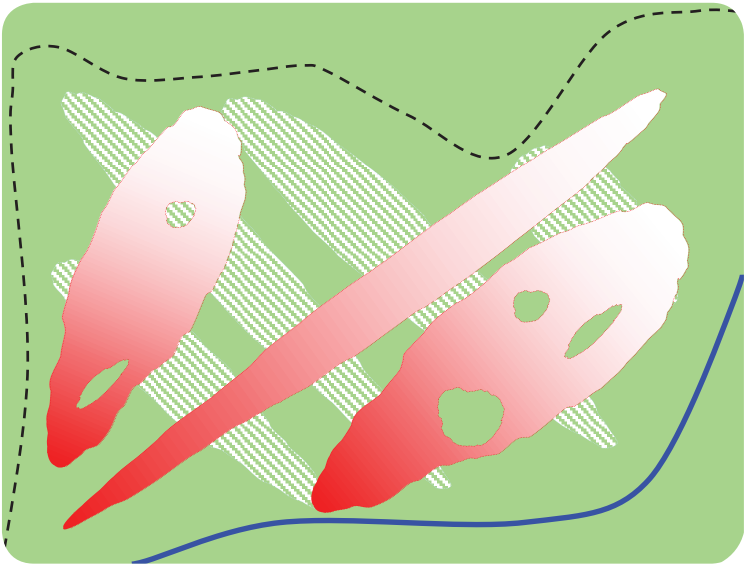


Figure 3: Planned mosaic burn—year 20.

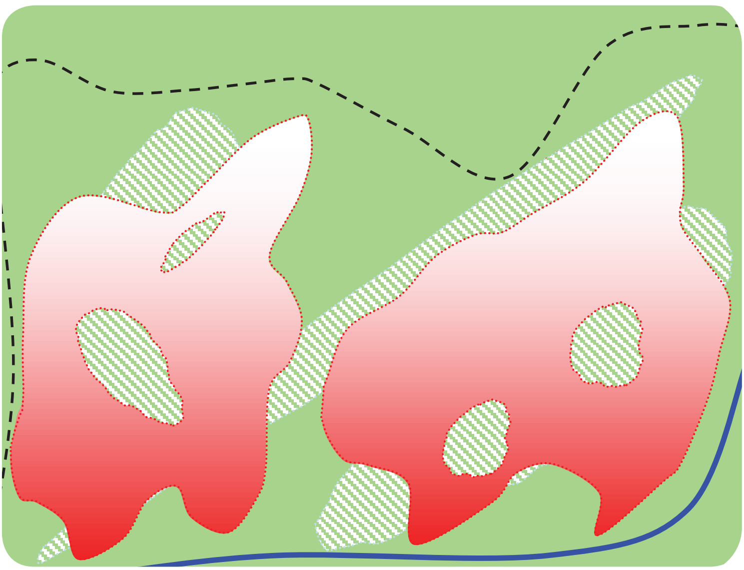


Figure 4: Planned mosaic burn—year 28.

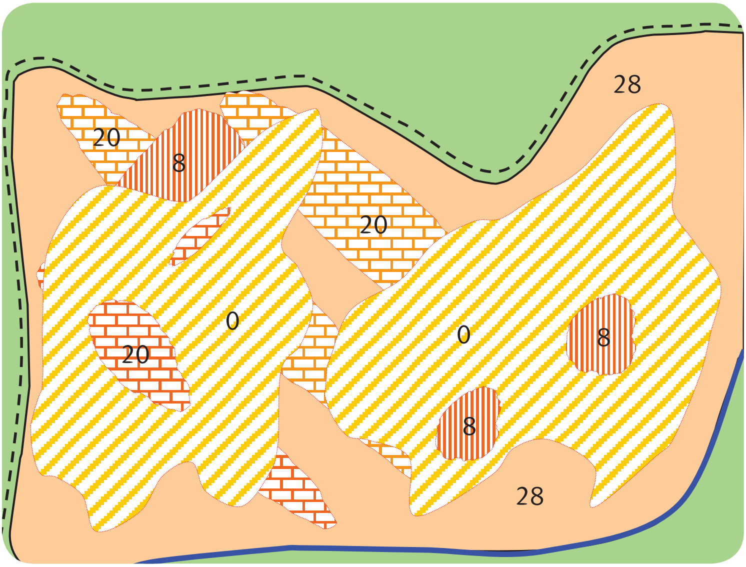


Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

Mosaic burn on Conway National Park showing approximately 40 per cent coverage across the landscape.

Kerensa McCallie, QPWS, Mt Rooper, Conway National Park (2012).

13 QGOV (13 74 68)

www.nprsr.qld.gov.au