Department of National Parks,
Recreation, Sport and Racing

Planned Burn Guidelines

Cape York Peninsula Bioregion of Queensland

Queensland Government

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Front cover photograph: 55 km north of Strathmay Station, Mark Newton, DSITIA (2008).

Bp2009

Foreword

The protected area network throughout Cape York Peninsula (the peninsula) provides the cornerstone of biodiversity conservation for this unique part of our state. Fire, I believe, provides us with the single-most valuable tool to assist in managing these natural assets. A well-planned and implemented fire program will afford managers the ability at the landscape level, to influence diversity in ecosystem age, class and structure.

As the increased resourcing of fire management has enabled the ongoing funding of successive peninsula-wide aerial ignition programs, we have successfully commenced a return to more pre-European regimes which promoted greater “patchiness” across the landscape. Throughout the peninsula, this return has effectively resulted in a shift away from the more recent patterns of destructive and large-scale late dry season wildfires. The benefit is threefold. Firstly we fulfil our obligations as custodians of nature, secondly we fulfil our commitment to be good neighbours and we reduce the greenhouse gas emissions from the protected area estate by shifting toward a generally lower-intensity fire regime.

This planned burn guideline provides comprehensive guidance that supports fire strategies and planned burning at a bioregional level. For those with little or no familiarity with the peninsula, the ability to use this guideline in the development of fire strategies and burn proposals will provide a certain confidence not available previously. The completion of the guideline represents a huge step forward and will prove a valuable addition to the fire management tool-kit for all staff, our joint management partners and other like-minded land managers.

It will be important to remember that this guideline seeks to assist in objective decision making only. It should be expected that fire behaviour and objectives will change across time and space and that skilled fire practitioners will keenly observe the natural environment to enable them to best meet the objectives of a burn. The window in which we have to meet the objectives of a burn can at times be very narrow and our ability to judge this is the key.

Adapt burn programs over time as confidence is gained and openly discuss and debate the observations. Suggested changes to these guidelines as time progresses are welcome, but similarly be prepared with good arguments to support them.

James Newman
Regional Director
Northern Region
Queensland Parks and Wildlife Service.

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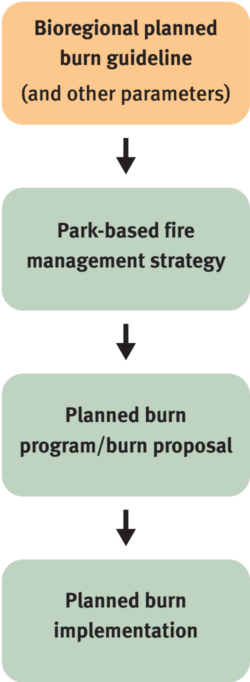
Purpose of this guideline

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

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

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



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

Scope

- This guideline applies to the Cape York Peninsula bioregion (refer to Figure 1) and covers the following fire vegetation groups: eucalypt communities, grassland communities, sedgelands, heath communities, melaleuca communities, acacia communities, dunes and coral cays, rainforests and 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 Cape York Peninsula bioregion. In some cases, there will be a need to include issues in fire strategies or burn proposals that are 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.

Peter Stanton, Environmental Consultant Pty Ltd, Heathlands (1993).

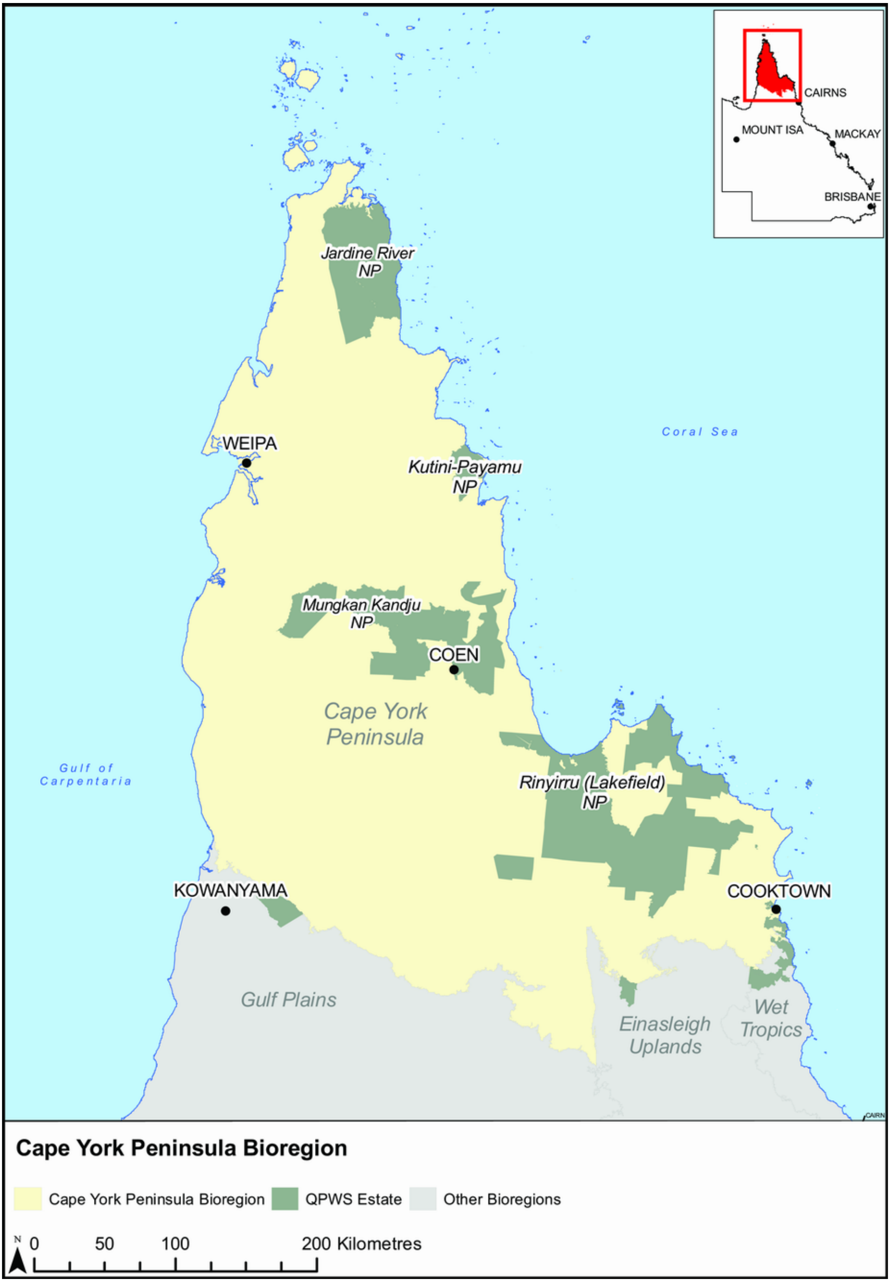


Figure 1: Map of Cape York Peninsula bioregion of Queensland.

Fire in the monsoonal tropics of the Cape York Peninsula bioregion, Queensland

On Cape York Peninsula it is important to be aware of curing rates. Curing commences in the late wet season (after the last incursion of the monsoon trough from the northern hemisphere and the peninsula has begun to dry from the south). As a broad generalisation, the south central area of the peninsula dries northwards through central Cape York Peninsula with an unequal drying toward the north. This is followed by the west and finally the eastern regions (refer to Figure 2).

While occurring at different times in different locations, the seasons follow a regular pattern which varies curing rates. The wet season is a time of regular rains, high temperatures and high humidity. It begins (usually) very late in the year and is the time in which most of the grass growth and rainfall (80 per cent) occurs. This is followed by the early dry when the country commences curing and fires will usually be of a low-severity. During the mid-dry season, little rainfall occurs in the east and often no rainfall in central and western areas. Curing continues until the late dry season when fuels are completely dry and in some areas high-severity, widespread wildfires become an issue. In some north-eastern areas, fires may not carry until this time. During the storm season, irregular though increasing rains indicate a lead-up to the next wet season. Other factors such as soil type and topographic variation also affect curing at the local level (curing at this scale should be considered in planning burns and fire strategies).

Fire risk is closely linked to the occurrence of fire weather days or sequences of days (FDR very high+ / FDI 25+). In Weipa, these days have an average temperature of approximately 35˚C, a low humidity of approximately 25 per cent and sustained winds of more than 22 km/hr. Palmerville (further south and inland), these days have a slightly higher average temperature of approximately 36˚C, a lower humidity of approximately 18 per cent and sustained winds of approximately 12 km/hr (refer to Figure 3).

Planned burning on Cape York Peninsula must remain flexible to allow for the variation in the timing and length of wet seasons. Limited windows of opportunity to burn occur due to consistently strong moist winds along most of the east coast of the peninsula.

Staff must be vigilant in recognising opportunities to burn and capitalising on these opportunities. It is also important to be aware of conditions prior to and following burns.

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>.

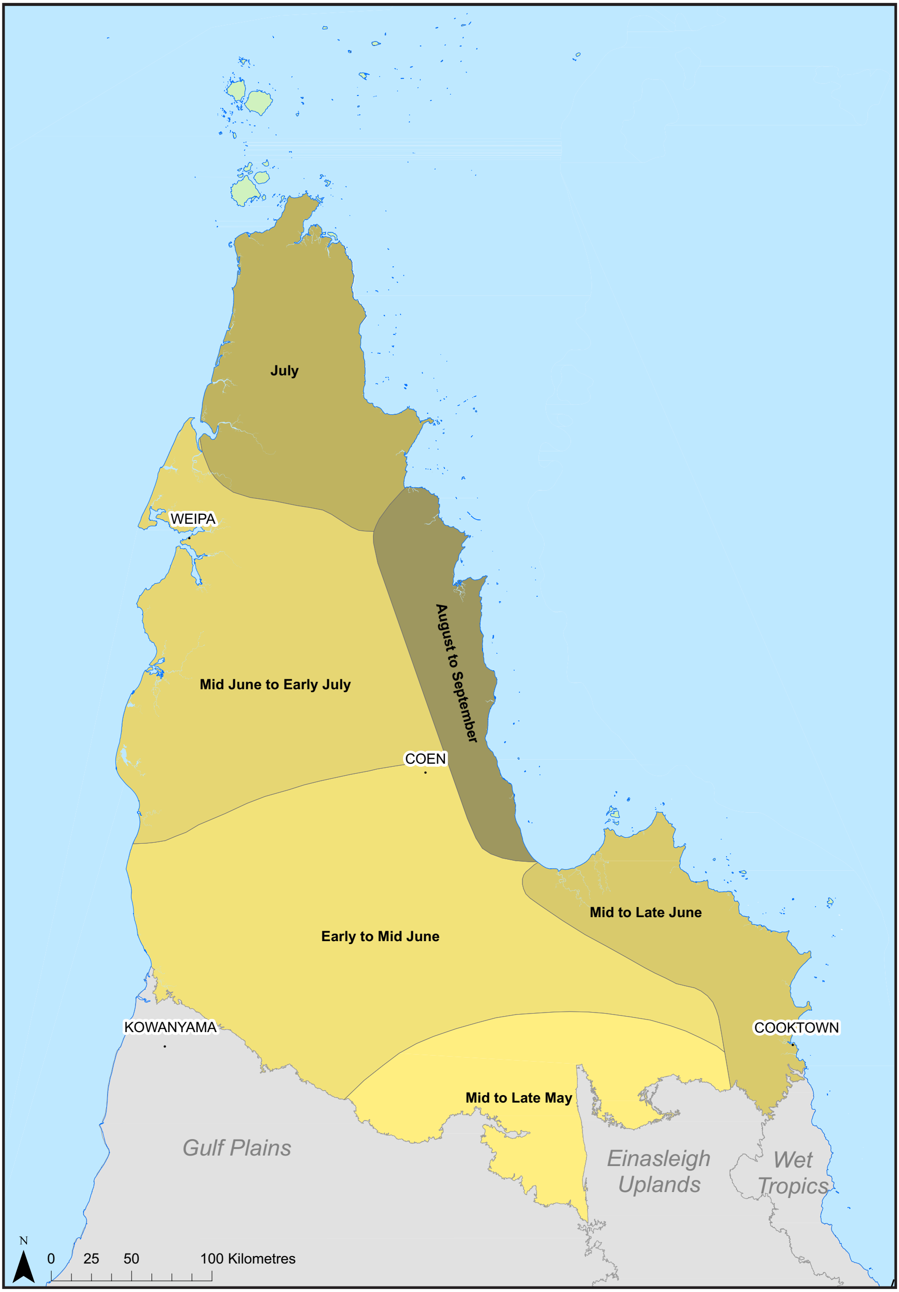
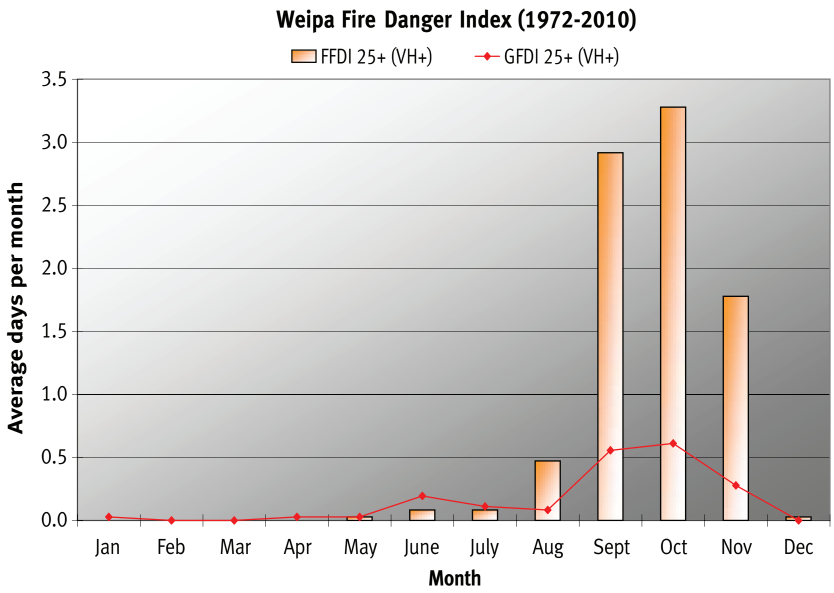
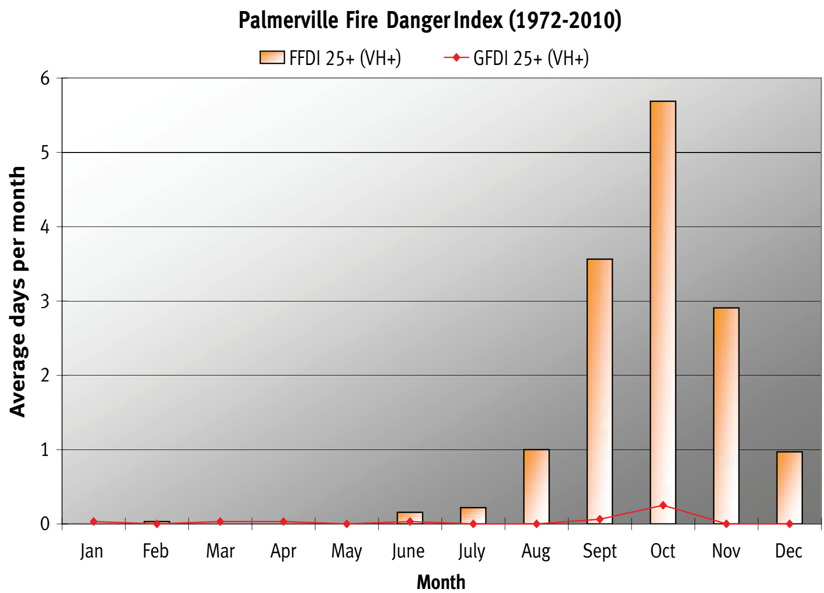


Figure 2: Map of Curing on Cape York Peninsula.

Figure 3: Fire weather risk in the Cape York Peninsula bioregion.





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

How to use this guideline

Step 1: Know your local fire strategy. This planned burn guideline works with and supports your local fire strategy. While the guideline should address the majority of issues in your area, it is essential you also review your fire strategy before completing your planned burn proposal to ensure all ecological issues are considered (e.g. zoning plan, threatened species, fire histories, *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* and other legislative requirements).

Step 2: Observe the country. It is essential to regularly observe the country that you manage (and the surrounding landscape). Familiarise yourself with this guideline so it becomes part of your observation of the environment as you go about your work. To assist you in observing the environment, undertake this simple exercise:

1. If a **canopy** is present (e.g. for open forests and woodlands) observe the following:
   a) Is tree branch foliage dying? Is there epicormic regrowth on branches? Are there any dead trees?
   b) Are there habitat trees (e.g. trees with hollows)?
   c) Are there rainforest, scrub or riparian ecosystems nearby?
2. For fire vegetation groups with a **mid-layer** (trees above the height of shrubs and grasses but not yet in the canopy) observe the following:
   a) What are the mid-layer trees (young canopy trees, wattles, casuarinas or rainforest species)? How open or dense is the mid-layer?
   b) Is there evidence of fire? What is the prevalence and height of blackened bark?
3. For fire vegetation groups with a **ground-layer** of grasses, sedges or shrubs, observe where relevant:
   a) The presence of grasses and grass clumps. Do the grasses look healthy and vigorous? Are there well-formed grass clumps?
   b) Is there a build-up of dead and decaying matter associated with grasses, shrubs, ferns or sedges?
   c) Are shrubs looking healthy and vigorous? Are there dying crowns on the shrubs?
   d) Does the ground-layer have a diversity of species or is it dominated by one or a few juvenile tree species? Are weeds dominating the understorey?

Step 3: Read the relevant chapters of this guideline and decide which issues apply to the area you are observing. It is common for burn proposals to address more than one issue—do not necessarily limit yourself to one issue per burn proposal.

Step 4: Consider your fire management priorities. Each chapter offers guidance for determining fire management priorities. The statements about priorities are based on a standard QPWS planned burn proposal prioritisation framework intended to guide both land managers and approval bodies.

Step 5: Choose measurable objectives. Each chapter of this guideline provides measurable objectives to include in your burn proposals (be guided also by the objectives in your fire strategy). Choose one or more objectives whilst observing the land. Do you need to adjust the objectives so they apply to your situation? Do you need to develop objectives not already included in these guidelines? If you find it difficult to identify your objectives, contact your natural resource management ranger or equivalent.

Step 6: Write a burn proposal. The **measurable objectives, fire behaviour, tactics** and **weather conditions** sections of each chapter can be copied directly into your burn proposals. Copy (ctrl+c) statements from a PDF version of this guideline and paste them (ctrl+v) into the burn proposal. Note that you may have to adjust the wording.

Step 7: Is your burn ready to go? Refer to the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go. Becoming familiar with the tools in this guideline will enable you to predict fire behaviour and achieve your burn proposal objectives.

Step 8: Review the measurable objectives in your burn proposal. After a fire, undertake the post-fire assessment recommended by this guideline (as defined in your burn proposal). This will indicate if you have achieved your planned burn objectives. This guideline provides information on how to report the results in your fire report.

Step 9: Review your fire management issue (re-apply this guideline to the burn area starting from Step 1). Return to the burn area after one year and then a few years after the original burn—once again applying this guideline. Many issues (such as weed control) are not resolved with a single burn and it is important to keep observing the land. If the results of fire management are unexpected or difficult to understand please seek further advice. If this process identifies shortfalls in your fire strategy, consider reviewing it. Step 9 can be implemented as part of a structured photo-monitoring process at various locations within the estate. Instructions can be obtained from the QPWS Fire Management System.

Chapter 1: Eucalypt communities

This fire vegetation group contains a range of eucalypt open forest and floodplain woodland communities located across the Cape York Peninsula bioregion. The canopy ranges in height from eight to twenty-seven metres and is typically dominated by a mix of eucalypt and corymbia species. The understorey is predominantly grassy but may include shrubs, small trees and a recruiting canopy. Grass species vary with location and include kangaroo, blady, black, giant and white spear grass. On poorer soils a shrub layer tends to dominate and grasses can be sparse.

Fire management issues

This fire vegetation group occurs over extensive inaccessible areas. This necessitates a broad-scale approach to fire management, most efficiently achieved through aerial ignition. The key strategy is to commence planned burning early in the dry season to break up the continuity of fuels across the landscape. This will mitigate the extent and impact of late season wildfires. In the absence of proactive planned burning, late season wildfires are extensive, frequent and intense, resulting in ecological impacts (such as loss of age-class diversity) and producing an enormous amount of greenhouse gas emissions.

Another major issue is loss of open structure through overabundant seedlings/saplings leading to woody thickening, particularly in areas of higher rainfall. This process is attributed to a lack of planned burning and/or fires repeatedly applied too early in the season (when they are not intense enough to control emerging overabundant seedlings/saplings). Woody thickening becomes much more severe where stock grazing is combined with repeated early season burns. Stock grazing reduces fuel loads preventing fires of a sufficient severity to manage overabundant seedlings/saplings. This is further compounded by concentrated feeding on regrowth grasses in the recently burnt areas which allows woody species the competitive advantage.

Issues:

1. Maintain healthy eucalypt communities.
2. Reduce overabundant seedlings / saplings.
3. Manage high-biomass invasive grasses.

Eucalypt communities are typically dominated by a mix of eucalypt and corymbia species.
Mark Newton, DSITIA, Merluna Station (2003).

Extent within bioregion: 8 525 969 hectares (ha), 69 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Mungkan Kandju National Park, 333 151 ha; Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 254 428 ha; Jack River National Park, 127 457 ha; Cape Melville National Park, 110 785 ha; Strathmay Station, 90 693 ha; Olive River Reserve, 83 069 ha; Crosbie Creek Station, 67 305 ha; Orchid Creek (Under Negotiation With Aboriginal Land And NP), 58 760 ha; KULLA (McIlwraith Range) National Park (Cape York Peninsula Aboriginal Land), 58 150 ha; Upper Bridge Creek (Under Negotiation With Aboriginal Land and NP), 39 850 ha; Jardine River National Park, 37152 ha; Heathlands Resources Reserve, 35 970 ha; Alwal National Park (Cape York Peninsula Aboriginal Land), 34 729 ha; Mary Valley Station, 26 510 ha; Shelburne Bay Environmental Purposes Reserve, 26 005 ha; Lama Lama National Park (Cape York Peninsula Aboriginal Land), 21 309 ha; Mount Jack Station Acquisition, 15 787 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 10 742 ha; Melsonby (Gaarraay) National Park, 8269 ha; Battle Camp Station, 6198 ha; Annan River (Yuku Baja-Muliku) National Park, 5766 ha; Starcke National Park, 4850 ha; Jardine River Resources Reserve, 3566 ha; Flinders Group National Park, 2473 ha; Ngalba Bulal National Park, 1643 ha.

Issue 1: Maintain healthy eucalypt communities

Maintain healthy open eucalypt and floodplain woodland communities using broad-scale planned burning.

Indicators of healthy eucalypt communities

- Grassy eucalypt communities have a ground layer of mixed grasses with occasional legumes, lilies, *Lomandra* spp., or shrubs. Grasses are upright and vigorous, with well-formed bases. Perennial grasses are more common than annuals.
- Eucalypt communities have a canopy of eucalypt or corymbia trees. Some young canopy species are recruiting in the understorey (enough to eventually replace the canopy), but are not extensive enough to produce shading impacts.
- The community appears open and easy to walk through.
- Lower and mid-stratum small tree species are present but are not having a noticeable shading effect on ground-layerplants.
- In some areas with poorer soils, the shrub layer dominates and grasses are sparse.
- Blackened bark is present on trees indicating a history of fire.

A healthy bloodwood community. Notice that canopy recruitment is extensive, but not enough to produce shading impacts.

Mark Newton, DSITIA, near Coen (2003).

Healthy grassy eucalypt communities are open and easy to walk through.

Mark Newton, DSITIA, 11km south-east of Ebagoola (2008).

Blackened bark indicates a history of fire in Eucalypt communities.

Mark Newton, DSITIA, Port Stewart (2008).

The following may indicate that fire is required to maintain eucalypt communities with a grassy, shrubby or mixed grassy/shrubby understorey:

- Grasses are collapsing or appear matted with a build-up of dead material.
- There is an abundance of eucalypt, melaleuca or rainforest seedlings/saplings becoming apparent above the grasses.
- Pandanus (where present), have well-developed skirts.
- *Xanthorrhoea* spp. (where present), have brown skirts.
- Cycads (where present), have an accumulation of dead fronds (e.g. Cape Melville and Mungkan Kandju).
- Chain fruit *Alyxia spicata* (where present) or *Dodonaea* spp. are becoming abundant and/or are beginning to smother the ground layer.

A build-up of dead grass indicates the need for fire.
Mike Ahmet, QPWS, Mungkan Kandju National Park (2009).

When grasses begin to collapse, it is a good indication of the need for fire.

Peter Stanton, Environmental Consultant Pty Ltd, Cape Melville (1993).

Rainforest pioneers are beginning to become abundant due to infrequent fire.

Mike Ahmet, QPWS, Yuku Baja-Muliku Resource Reserve (2008).

Above: An accumulation of dead fronds on cycads indicates the need for fire.
Mark Newton, DSITIA (2003).

Left: In the absence of fire brown skirts accumulate on *Xanthorrhoea* spp.
Daryn Storch, QPWS, Cape York Peninsula (2011).

Chain fruit becomes abundant when sites are long-unburnt.
Mick Ahmet, QPWS, Cape Melville (2008).

Discussion

- A key strategy to manage the vast expanse of inaccessible eucalypt communities in Cape York Peninsula is broad-scale management through aerial ignition. Ideally this would include at least three different ignition periods on each property per year. However, the ability to achieve this will depend on resourcing. Aim to achieve as many ignition periods as feasible.
- Eucalypt communities on floodplains require particular management attention due to an accumulation of issues including grazing, weed invasion, rapid fuel accumulation, poor access and woody thickening. Fuel accumulation can reach its maximum within two years with increased wildfire risk. Rubber vine is found in floodplain woodlands on southern areas of Cape York Peninsula (refer to Chapter 10, Issue 4 for management guidelines). These communities also have episodic mass germination that occurs after floods, baring the soil (providing a good seed bed) and are often followed by persistent rains. Fire should be applied to reduce the overabundant seedlings/saplings (refer to Chapter 10, Issue 5, regarding fire management guidelines).
- Variation in burn seasons and short fire frequencies promote a healthier habitat for many species of birds in eucalypt communities. Valentine et al. (2007) found that bird abundance dramatically increased in burnt sites soon after fire (12 months), but declined in the longer term (four years), with greatest reduction in the number of nectivores and granivores.
- In healthy eucalypt communities with a history of regular fire management, overabundant seedlings/saplings leading to woody thickening is not usually a problem. Where it is becoming a problem, the application of repeated low-severity fires exacerbates it (as the fires produced are not of sufficient severity). Grazing further complicates the issue by altering fuel loads and potentially reducing the fire-severity and extent.
- In the moister areas of the east coast and along the floodplains of the Archer River, woody thickening occurs through the development of rainforest understorey in eucalypt communities. To the west of the dividing range woody thickening occurs due to melaleuca and eucalypt overabundance (refer to Chapter 10 [Issue 5], regarding fire management guidelines).
- Rainforest expansion at Iron Range occurs rapidly—within 30 years (Stanton 1992; Russel-Smith et al. 2004). Russel-Smith et al. (2004) also found that rainforest expansion can occur large distances away from rainforest edges.
- Cypress pine overabundance in eucalypt communities occurs in the Jardine River catchment and adjacent coastal areas. In many places it is so far advanced that it is no longer recoverable. Aim to use fire wherever possible in newly emerging transition areas.
- Grasses are generally considered ready to burn when they reach 50–60 per cent cured. The North Australian Grassland Fuel Guide (Johnson 2001) may assist in determining when they are ready to burn. However, caution should be used and local knowledge sought, as some grass species which still appear too green to burn will burn severely (and vice versa).

Weeds can be a problem in some floodplain woodlands; however if they are fire-killed such as this rubber vine, maintaining fire management controls the problem.
Peter Stanton, Environmental Consultant Pty Ltd, Lakefield National Park (1992).

Heavy grazing reduces grassy fuel biomass. Maintaining fuel loads is important in managing woody thickening.
Mike Ahmet, QPWS, Cape Melville (2008).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Progressive burning demonstrated.	Using fire scar remote sensing data, estimate burnt and unburnt country by month, on an annual basis.	**Achieved:** Remote sensing shows a series of progressive burns through the season. **Partially Achieved:** One to two burns achieved. **Not Achieved:** No burning has occurred.
30–60 % of eucalypt communities within the property planned burnt.	Using fire scar remote sensing data, estimate burnt and unburnt country on an annual basis.	**Achieved:** 30–60 %. **Partially Achieved:** 20–30 % or 60–80 %. **Not Achieved:** < 20 % or > 80 %.
Within a property, the annual area burnt by planned burns is greater than that burnt by wildfires.	Using fire scar remote sensing data, estimate area of planned burns against wildfire on an annual basis.	**Achieved:** Annual area planned burnt > wildfire. **Not Achieved:** Annual area planned burnt < wildfire.
> 75 % of overabundant saplings < 2 m are reduced.	Select several sites or walk several transects, estimate the percentage of overabundant saplings (above ground components) reduced.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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

Monitoring the issue over time

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

Fire history mapping is an important tool in monitoring these ecosystems. Tools such as the North Australian Fire Information (NAFI) can provide good fire history maps and can be used in planned burns.

Fallen logs provide fauna habitat. Burning in conditions which result in low-severity fire will assist in maintaining these important features.

Daryn Storch, QPWS (2011).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **moderate**; with occasional **high**-severity fire during storm burns.

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	< 100	< 0.5	< 2.0	Some patchiness, most of the surface and near surface fuels have burnt. Some scorching of elevated fuels. Little or no canopy scorch.
Moderate (M)	100–500	0.5–1.5	2.0–5.0	All surface and near surface fuels burnt. All or most of mid-storey canopy leaves scorched. Upper canopy leaves may be partly scorched.
High (H)	500–10000	1.5–4.0	Complete canopy scorch	All ground material affected by fire. All mid storey canopy leaves scorched or charred. All upper storey canopy leaves scorched.

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

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

- Apply mosaic planned burns across the landscape at a range of 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 one and five years (or between one and three years for eucalypt communities on flood plains).

Mosaic (area burnt within an individual planned burn)

- Under mild burning conditions fires will be patchy. Patches within individual burns can be useful as they contribute to mosaics and help retain habitat features.

Landscape mosaic

- 30–60 per cent of eucalypt communities burnt within the property.

Low-severity fire will generally produce a patchy burn and assist in retaining stags and fallen logs.

Daryn Storch, QPWS, Cape York Peninsula (2011).

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

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

Fire frequency is only a guide. Fuel accumulation tends to be the determining factor.

Peter Stanton Environmental Consultant Pty Ltd, Archer Bend (1993).

Fires applied too early in the season will not be of sufficient severity to reduce overabundant seedlings/saplings.

Mike Ahmet, QPWS, Yuku Baja Muliku Lands (2008).

What weather conditions should I consider?

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

Season:

- Burn at any time of the year **after the wet season** when it is dry enough to burn **but ahead of late dry-season wildfires**.
- Use occasional **storm burns**.
- Avoid burning during **extremely dry conditions** (with humidity less than 30 per cent and high temperatures, which tend to occur just before the start of the storm season).
- Ensure successive fires are somewhat **variable in intensity, season and frequency** (e.g. **alternating** early season burns with dry season or storm burns, rather than burning to a prescription of every ‘x’ years at the same time of year). Each fire should create a slightly different mosaic of burnt and unburnt areas.
- Repeated early season burns are **not recommended** where overabundant seedlings/saplings are an issue (refer to Chapter 10 [Issue 5], for fire management guidelines).

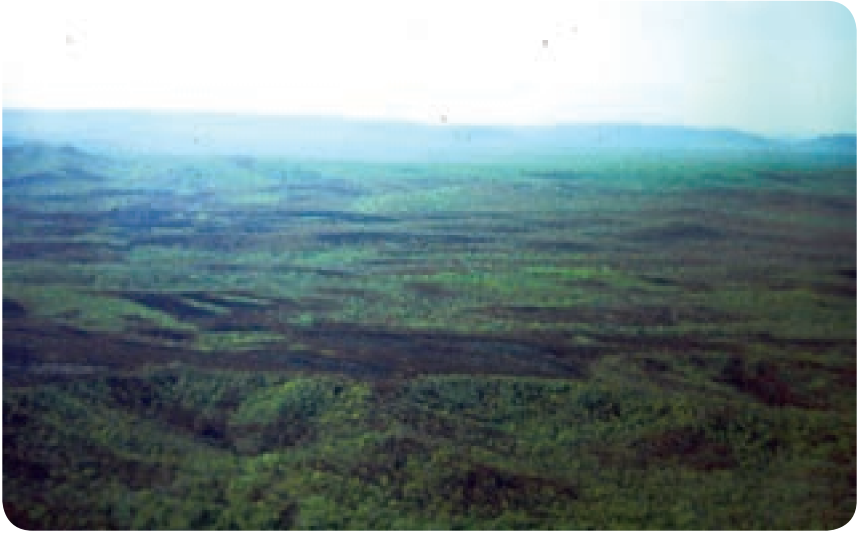
Post wet season until extremely dry	Storm burns
GFDI: < 11	**GFDI:** 8–16
DI (KBDI): 80–180	**DI (KBDI):** < 80
Wind speed: < 23 km/hr	**Wind speed:** < 23 km/hr

What burn tactics should I consider?

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

- **Aerial ignition.** Broad-scale fire management is necessary due to the size and inaccessibility of eucalypt communities. This is mostly achieved through **aerial ignition**. Early dry-season fires can be lit in either the morning or afternoon depending on the desired outcome. Ignition timing would be determined by how far the fire is required to travel before self-extinguishing in evening conditions. A useful tool to determine the rate of spread is the CSIRO Grassland Fire Spread Meter for Northern Australia. Utilise natural features to contain fires. These can include rivers and streams (even if there is no water, there may be sufficient moisture), areas of sparse or uncured fuel, rainforest or previously burnt areas. But realise that these features may also prevent fire from carrying as far as intended. It is good practice to plot an aerial incendiary path using maps, satellite images or aerial photographs and program the path into a GPS for use in flight.
- **Spot ignition** is used to alter the desired intensity of a fire and create the desired mosaic of burnt and unburnt areas. A number of patterns of lighting can be used. The spacing of the spots affects the resulting intensity and mosaic.
- **Single point ignition** is used to create a fire of limited extent with a limited fire front. Often, this may mean lighting in a single location for an entire burn (a number of ignition points at the same location may be required) or very widely-spaced ignition points that create separate fires. If creating a patchy fire is the objective then it is better to use successive single-point ignitions to create separate fires.
- **Progressive burning** is an approach to planned burning where ignition is carried out throughout as much of the year as conditions allow. On Cape York Peninsula, 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 in each year, but this will depend on resource constraints. These burnt areas can provide opportunistic barriers to fire to support burning later in the year. They also provide fauna refuge areas. Progressive burning helps create a rich mosaic of severities, burnt/unburnt areas, and seasonal variability.

- **Boundary ignition (see diagram over page)** is an aerial ignition strategy, often undertaken in the early dry season. It is used to reduce the risk of late-season fires entering a property or contain fires within the boundary.
- **Storm burns** are fires lit in the storm season after the first rains. A minimum of 50 mm of rainfall is recommended with consideration to the spread of rainfall. Containment of storm burns relies on earlier-season burns having already established a network of burnt areas sufficient to contain the storm burn within the planned burn area.
- Use **periods of declining fire hazard**, so that fires are more controllable. Daily patterns can be utilised. For example, after 2 pm the relative humidity tends to increase and temperature and winds decrease resulting in fires that are less severe and often self-extinguishing early in the season, but may carry through the night later in the year. Be aware that re-ignition may occur at the heel of the fire where there is increased residence time.
- **A running fire** of a higher-intensity may be required initially where the objective is to reduce weeds or overabundant rainforest seedlings/saplings or carry fire through areas of low fuel.
- **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 can be created using slope or wind direction. This tactic creates high residence time which is useful in reducing overabundant melaleuca or eucalypt saplings, while ensures the fire intensity and rate of spread are kept to a minimum.



Broad-scale fire management should attempt to establish a landscape mosaic to break-up the country and mitigate late dry-season wildfires.

Peter Stanton, Environmental Consultant Pty Ltd, Heathlands (1989).

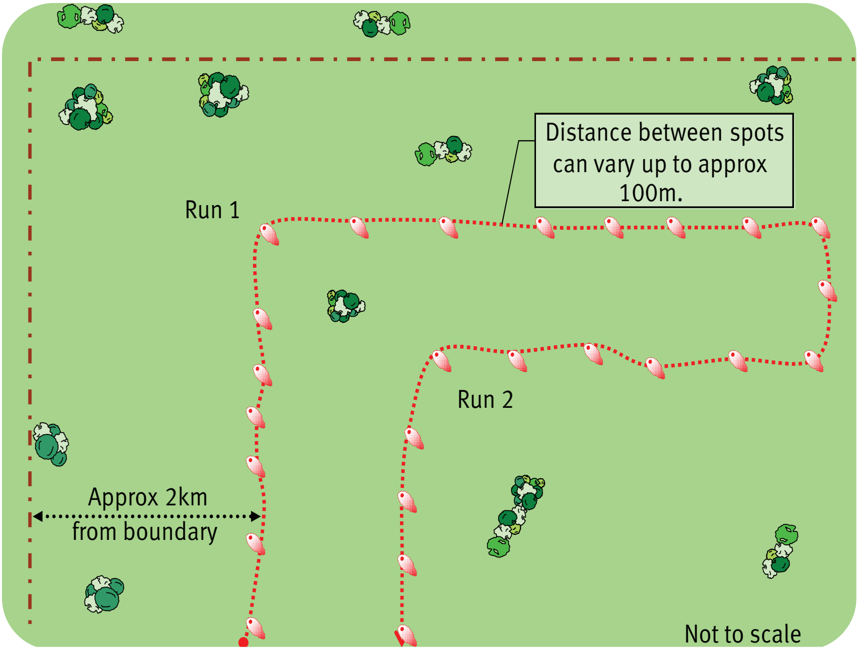


Figure 1: Boundary ignition example

Two parallel lines (within 20 m of each other), are created approximately 2 km inside the boundary edge, usually using aerial ignition. Incendiaries should be spaced relatively closely (approximately 100 m apart), but should vary somewhat in spacing. The two lines tend to draw together. This technique helps manage the spread of fire and creates an area of no or relatively low fuel. This approach can be used to control the movement of fire across property boundaries, fence lines or the edges of fire-sensitive vegetation.

Issue 2: Reduce overabundant seedlings / saplings

Refer to Chapter 10 (Issue 5), regarding fire management guidelines.

Reduce overabundant seedlings/ saplings using fire. In the moister areas of the east coast and along the floodplains of the Archer River, woody thickening can occur through the development of rainforest in eucalypt communities. To the west of the dividing range woody thickening occurs due to melaleuca and eucalypt overabundance. Other trees such as cypress pine can also become overabundant.

Issue 3: Manage high-biomass invasive grasses

Refer to Chapter 10 (Issue 3), regarding fire management guidelines.

It is important to be aware of the presence of high biomass grasses as they can dramatically increase fire severity and can be promoted by fire. Sometimes fire can be used to help in their control.

Grader grass can significantly increase the severity of fire.

Mike Ahmet, QPWS, Yuku Baja-Muliku Lands (2008).

Chapter 2: Grassland communities

Grasslands are open and treeless or contain scattered trees or shrubs. They usually contain a mix of perennial grass species including *Heteropogon, Themeda, Aristida, Chrysopogon, Cymbopogon* spp., blady *Imperata cylindrica* and cane grass *Mnesithea rottboellioides*. Significant diversity is added by forbs, sedges and annual grasses.

Fire management issues

The main fire management issue is retaining open areas of grasslands by preventing their invasion by trees and shrubs. Overabundant seedlings/saplings (leading to woody thickening) occur where fire has been long-absent, infrequent or repeatedly applied too early in the season (creating fires of insufficient severity to scorch seedlings/saplings). In moister areas (predominantly to the east of the dividing range) rainforest overabundance is the primary issue, and to the west, melaleucas and eucalypts. However other shrubs and small trees may be an issue in specific areas.

Broad-scale fire management is the key to preventing late season wildfires which can be extensive, frequent and intense. They can also result in ecological impacts and produce an enormous amount of greenhouse gas. The key strategy is to commence planned burning early in the dry season as this will break-up the continuity of fuels across the landscape. Be aware of the presence of invasive and high-biomass grasses as they can be promoted by fire and have the potential to increase fire severity.

Issues:

1. Maintain grasslands.
2. Reduce overabundant seedlings/saplings.
3. Manage high-biomass grasses.

Extent within bioregion: 439 270 ha, 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 70 483 ha; Olive River Reserve, 6895 ha; Strathmay Station, 6257 ha; Bathurst Bay land adjoins Lakefield NP, 3048 ha; Mount Jack Station Acquisition, 2619 ha; Mungkan Kandju National Park, 2315 ha; Cape Melville National Park, 1405 ha; Lama Lama National Park (Cape York Peninsula Aboriginal Land), 1169 ha; Crosbie Creek Station, 919 ha; KULLA (McIlwraith Range) National Park (Cape York Peninsula Aboriginal Land), 704 ha; Lizard Island National Park, 585 ha; Alwal National Park (Cape York Peninsula Aboriginal Land), 148 ha; Shelburne Bay Environmental Purposes Reserve, 144 ha; Sir Charles Hardy Group National Park, 123 ha; Jardine River Resources Reserve, 121 ha.

Issue 1: Maintain grasslands

Maintain grasslands with broad-scale fire management.

Awareness of the environment

Key indicators of health:

- Grasslands are treeless and shrubless or contain only scattered trees or shrubs.
- There is more or less a continuous layer of grasses with a diversity of forbs, sedges and other ground-layer plants scattered.
- Grasses should appear upright and vigorous.

Grasslands should be treeless or contain only very scattered trees and shrubs such as this grassland on a marine plain.

Peter Stanton, Environmental Consultant Pty Ltd, Nifold Plain (1993).

Grasses should appear upright and vigorous.

Mick Blackman, Friendly Fire Ecological Contractor Pty Ltd, Silver Plains (2010).

Late in the dry season, as grasses cure, they may begin to collapse, however they are still healthy.

Mike Ahmet, QPWS, Lakefield National Park (2008).

A more-or-less continuous layer of grasses characterise grasslands.

Mike Ahmet, QPWS, Lizard Island (2005).

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

- There is an accumulation of thatch (dead material), collapsing grass and/or the grass clumps are poorly-formed.
- Overabundant seedlings/saplings are beginning to emerge above the grasses.
- Shrubs are becoming more than scattered.

Melaleuca saplings are emerging above the grassy understorey.

Mike Ahmet, QPWS, Lakefield National Park (2008).

Grasslands on coastal headlands are under threat from shrub invasion. However, this one still appears quite open.

Peter Stanton, Environmental Consultant Pty Ltd, Bolt Head (1994).

Discussion

- Rare grasslands are quickly being lost and so their retention and maintenance using fire is a conservation priority (e.g. at Iron Range National Park grasslands surrounded by rainforests are being lost due to tree invasion and grasslands on coastal headlands are being lost to shrub invasion). Be aware that irruptions of rainforest plants can appear in grasslands even if they are well away from rainforest edges.
- Grasslands found on deep soil are susceptible to rainforest invasion, grasslands on poorly-drained soils are susceptible to melaleuca thickening and grasslands on cracking clay soils of central Cape York Peninsula are susceptible to thickening by *Piliostigma malabaricum*.
- Melaleuca thickening, subsequent broad-scale loss of grassland and the need for a concerted fire management effort has been identified for many years (Crowley and Garnett 1998) and is an ongoing issue. The crimson finch, star finch and golden-shouldered parrot utilise grasslands and may be threatened by overabundant saplings/seedlings that shade-out the grasses.
- Woody thickening becomes much more severe where stock grazing is combined with repeated early season burns. Stock grazing reduces fuel loads preventing fires of a sufficient severity to manage overabundant seedlings/saplings. This is further compounded by concentrated feeding on regrowth grasses in the recently burnt areas which allows woody species the competitive advantage.
- Grasses are generally considered ready to burn when they reach 50–60 per cent cured. The North Australian Grassland Fuel Guide (Johnson 2001) may assist in determining when grasses are ready to burn. However, caution should be used and local knowledge sought as some grass species which still appear too green to burn, will burn severely (and vice versa).
- Grazing reduces grass cover and thus the fire severity (through reduced fuel loads). Continuous grazing can lead to an increase in saplings/seedlings which can dominate where the grassy ground-cover has been reduced.
- Variation in burn season and short fire frequency promotes better habitat for many species of birds in grassland communities. Valentine et al. (2007) found that bird abundance dramatically increased in burnt sites soon after fire (12 months) but declined in the longer term (4 years) with the greatest reduction in the number of nectarivores and granivores. The season is important with dry season burns being beneficial to some species and the wet season beneficial for others—variability is the key.
- The endangered crimson finch utilises cane grass and pandanus habitat for shelter. Fires late in the dry season can destroy the cane grass and pandanus skirts that are animal refuges (Dorricot and Garnett 2007). Also, melaleuca invasion into grasslands is thought to threaten their habitat. Refer to Chapter 10 (Issue 5), regarding fire management guidelines for overabundant trees.

Piliostigma malabaricum overabundance occurs on the cracking clay soils of central Cape York Peninsula.

Peter Stanton, Environmental Consultant Pty Ltd, Archer Bend (1993).

The open nature of this community has been impacted by overabundant trees.

Mike Ahmet, QPWS, Lakefield National Park (2008).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Progressive burning demonstrated.	Using fire scar remote sensing data, estimate burnt and unburnt country by month, on an annual basis.	**Achieved:** Remote sensing shows a series of progressive burns through the season. **Partially Achieved:** One to two burns achieved. **Not Achieved:** No burning has occurred.
30–60 % of grassland communities within the property planned burnt.	Using fire scar remote sensing data, estimate burnt and unburnt country on an annual basis.	**Achieved:** 30–60 %. **Partially Achieved:** 20–30 %. **Not Achieved:** < 20 % or > 60 %.

Within a property, the annual area burnt by planned burns is greater than that burnt by wildfires.	Using fire scar remote sensing data, estimate planned burns as against wildfire on an annual basis.	**Achieved:** Annual area planned burnt > wildfire. **Not Achieved:** Annual area planned burnt < wildfire.
> 75 % of overabundant saplings < 2 m are reduced.	Select several sites or walk several transects (taking into account the variability of landform and likely fire intensity), estimate the percentage of overabundant saplings (above ground components) reduced.	**Achieved:** > 75 %. **Partially Achieved:** 25–75 %. **Not Achieved:** < 25 %.

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

Monitoring the issue over time

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

Very late in the dry season fuels are fully cured and grasses have collapsed. The potential for intense and extensive fires is high. Avoid burning at this time.

Mike Ahmet, QPWS, Iron Range National Park (2008).

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Low** to **moderate** with the occasional **high**-severity fire, particularly where overabundant seedlings/saplings are an issue.

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	< 2.0	Some patchiness, most of the surface and near surface fuels have burnt. Some scorching of elevated fuels. Little or no canopy scorch.
Moderate (M)	100–1500	0.5–1.5	Complete standing biomass removed	All surface and near surface fuels burnt. Stubble burnt to blackened remnants.
High (H)	1500–5300	> 4.0	Complete biomass removed	Ground burnt completely stubble burnt to ash.

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

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

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

Landscape mosaic

- 30–60 per cent of grasslands burnt within Cape York Peninsula annually.

Mosaic (area burnt within an individual planned burn)

- Under mild burning conditions, fires will be patchy. Patches within individual burns can be useful as they contribute to mosaics and help to retain habitat features.

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.

Post wet season until extreme dry season	Storm burns
GFDI: < 11 **DI (KBDI):** 80–180 **Wind speed:** < 23 km/hr	**GFDI:** 8–16 **DI (KBDI):** < 80 **Wind speed:** < 23 km/hr

Season:

- Any time of the year **after the wet season** when it is sufficiently dry to burn. Occasional storm burns (normally between October and January), or late dry season burns. Avoid burning during **extremely dry conditions** with humidity less than 30 per cent and high temperatures, which tend to occur just before the start of the storm season.
- Early season burns are **not recommended** where overabundant seedlings/saplings are an issue, nor should they be applied regularly in the same location.
- **Variability:** Ensure successive fires are somewhat variable in intensity, season and frequency (e.g. **alternating** early season burns with storm burns or late dry burns, rather than burning to a prescription of every ‘x’ years at the same time of year). Each fire should create a slightly different mosaic of burnt and unburnt areas.

Vary the severity of fire in grasslands with most burns low to moderate, with occasionally high-severity fires.

Melissa Spry, DNRM, south-west of the Dixie Homestead (2007).

What burn tactics should I consider?

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

- **Aerial ignition.** Broad-scale fire management is necessary due to the size and inaccessibility of most grassland communities. This is mostly achieved through **aerial ignition**. Early dry season fires can be lit in either morning or afternoon, depending on the desired outcome. Ignition timing will be determined by how far the fire is required to travel before self-extinguishing in evening conditions. A useful tool to determine the rate of spread is the CSIRO Grassland Fire Spread Meter for Northern Australia. Utilise natural features to contain fires. These can be rivers and streams (even if there is no water, there may be sufficient moisture), areas of sparse or uncured fuel, rainforest or previously burnt areas. Note that these may also prevent fire from carrying as far as intended. It is good practice to plot an aerial incendiary path using maps, satellite images, or aerial photographs and program these into a GPS for use in flight (refer to Chapter 1, for further tactics).

Issue 2: Reduce overabundant seedlings/saplings

Refer to Chapter 10 (Issue 5), regarding fire management guidelines.

Overabundant seedlings and saplings of rainforests or melaleuca species can reduce the health and abundance of grasses and eventually lead to a transition from grassland to forest.

Issue 3: Manage high-biomass grasses

Refer to Chapter 10 (Issue 3), regarding fire management guidelines.

It is important to be aware of the presence of high-biomass grasses as they can dramatically increase fire severity and can be promoted by fire. Sometimes fire can be used to help in their control.

Chapter 3: Sedgelands

Sedgelands are treeless (or contain only scattered trees) with a ground-layer dominated by one or two sedges, rushes, or similar species with other ground-layer plants scattered. They may be permanently or seasonally inundated and are generally found in low areas of the landscape throughout Cape York Peninsula. They are dominated by saw sedge *Gahnia sieberiana*, bulkaru *Eleocharis* spp. and other species of sedges or ferns. Wetter sites may have water lilies *Nymphaea* spp., wild rice *Oryza rufipogon*, marshworts and occasionally *Nymphoides* spp. Often these wetter sites are fringed by woodlands of broad-leaved tea tree *Melaleuca viridiflora*, weeping paperbark *Melaleuca leucadendra* or sedgelands.

Fire management issues

Sedgelands on Cape York Peninsula are not actively targeted with fire. They are allowed to burn in association with the surrounding landscape but tend to burn far less often due to the presence of water. Saw sedge communities that are very extensive, may require active fire management. Saw sedge communities mostly occur with *Melaleuca quinquenervia* swamp forest (refer to Chapter 5 for fire management guidelines). Permanent lakes and lagoons with fringing woodland/sedgelands rarely burn and active fire management is not required.

Sometimes there is a risk of a peat fire occurring in some sedgeland communities. These can include saw sedge communities and permanent lakes and lagoons. Be aware of this issue when planning fires.

Extent within bioregion: 100 674 ha, 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Jardine River National Park, 16 910 ha; Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 4517 ha; Olive River Reserve, 2150 ha; Shelburne Bay Environmental Purposes Reserve, 2003 ha; Mungkan Kandju National Park, 1877 ha; Jardine River Resources Reserve, 1692 ha; Mount Jack Station Acquisition, 550 ha; Cape Melville National Park, 470 ha; Jack River National Park, 417 ha; Endeavour River National Park, 265 ha; Heathlands Resources Reserve, 203 ha; Annan River (Yuku Baja-Muliku) National Park, 174 ha; Lama Lama National Park (Cape York Peninsula Aboriginal Land), 168 ha; Strathmay Station, 157 ha; Mary Valley Station, 63 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 45 ha.

Bulkaru sedgelands in the dry season.
Mike Ahmet, QPWS, Red Lily Lagoon Lakefield National Park (2009).

Permanent lakes and lagoons. These communities will generally not burn. However, be aware of peat existing in adjacent communities.
Daryn Storch, QPWS, Mary Valley Station (2011).

Discussion

- Peat fires should be avoided. Perennial sedges in ecosystems with a significant peat layer are vulnerable to severe fires. When peat catches fire it tends to burn slowly, with high severity and is very difficult to put out. Sedge roots burn when peat burns, often resulting in the death of all or part of the sedge colony. A peat fire or high-severity fire which removes most of the dominant sedge layer can cause a significant species change with colonies of perennial sedges taking many years to re-appear. The sedge roots, along with the peat layer can take decades or more to reform and affect other plant species which are adapted to the peat substrate. This process of species change may have flow-on effects to fauna species that have specific requirements.
- Refer to Chapter 5 (Issue 2), regarding fire management guidelines for avoiding peat fires.

Chapter 4: Heath communities

Heaths are shrubby communities that are treeless or contain only scattered trees (Keith et al. 2002). The main centres of distribution are within the Jardine and Olive river catchments and at Iron Range National Park. On Cape York Peninsula the heathlands are less diverse than the other heathlands of Australia. In many areas one or two species dominate, others are more diverse. Usually this community consists of extensive areas of closed shrublands in undulating terrain, on hills, mountains and on sand dunes. This fire vegetation group also includes open-heaths and dwarf open-heaths on dune fields, sand plains and headlands. On the Jardine River extensive areas of seasonally-inundated heath swamps occur. These are characterised by sedges and occasional shrubs. For melaleuca dominated heaths see Chapter 5.

Fire management issues

This fire vegetation group occurs over extensive inaccessible areas necessitating a broad-scale approach, most efficiently achieved through aerial ignition. Because heaths have a longer fire interval than the surrounding fire-adapted vegetation, it is important to apply fire in and around the heath so that too-frequent unplanned fire is avoided. A lack of fire will allow an accumulation of fuel. After many years this accumulation can create the risk of a large-scale single-event fire that reduces ecosystem diversity and promotes a cycle of repeated large-scale fire events.

The key approach is to maintain a Landscape Mosaic using broad-scale fire management. Aerial ignition is the most efficient way to achieve this and will assist in breaking up the continuity of fuels across the landscape. This will mitigate the extent and impact of late-season wildfires. In the absence of proactive planned burning, late season wildfires are extensive, frequent and intense, resulting in negative ecological impacts and producing an enormous amount of greenhouse gas emissions. In some areas a loss of diversity has occurred due to a lack of fire and has allowed longer-lived species to dominate.

Issue:

1. Maintaining healthy heath communities.

Extent within bioregion: 587 299 ha, 5 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Jardine River National Park, 140 838 ha; Shelburne Bay Environmental Purposes Reserve, 74 839 ha; Heathlands Resources Reserve, 73 110 ha; Olive River Reserve, 42 997 ha; Jardine River Resources Reserve, 10 541 ha; Jack River National Park, 9301 ha; Cape Melville National Park, 5612 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 3850 ha; Orchid Creek (Under Negotiation With Aboriginal Land And NP), 2633 ha; Mount Jack Station Acquisition, 2078 ha; Starcke National Park, 1884 ha; Battle Camp Station, 1743 ha; Upper Bridge Creek (Under Negotiation With Aboriginal Land and NP), 1048 ha; KULLA (McIlwraith Range) National Park (Cape York Peninsula Aboriginal Land), 385 ha; Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 242 ha; Melsonby (Gaarraay) National Park, 130 ha; Annan River (Yuku Baja-Muliku) Resources Reserve, 115 ha; Flinders Group National Park, 90 ha; Possession Island National Park, 30 ha; Lizard Island National Park, 17 ha; Iron Range/Portland Roads, 13 ha; Archer Point Conservation Park, 5 ha; Hann State Forest, 2 ha.

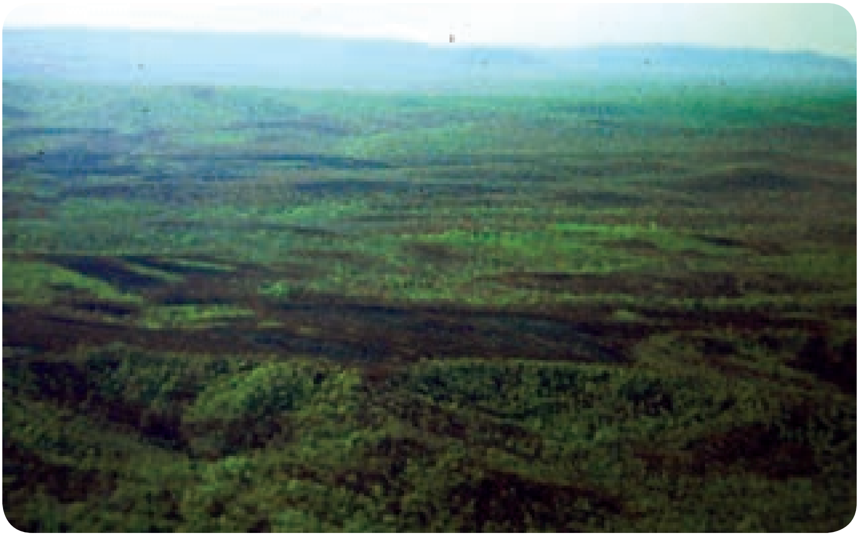
Issue 1: Maintaining healthy heath communities

Implementation of mosaic burning in and around heath (usually with aerial ignition) helps achieve longer fire intervals by creating a Landscape Mosaic that mitigates against too much heath burning at once.

Awareness of the environment

Indicators of health:

- There is a variation in time-since-fire for heath across the landscape.
- A continuous cover of shrubs exists (except in areas that are naturally sparse). On headlands, shrubs are wind-sheared, sparse and interspersed by grasses. In heath swamps shrubs are sparse and are interspersed by sedges.
- There are few or no trees.



Heaths should vary in time-since-fire across the landscape. A mosaic of burnt and unburnt areas will mitigate the impacts of too-frequent and widespread wildfire.
Peter Stanton, Environmental Consultant Pty Ltd, Heathlands Resource Reserve (1989).

Healthy closed heath. A continuous cover of shrubs appears green and dense.
Mike Ahmet, QPWS, Tozers Gap, Iron Range National Park (2008).

In healthy heath Swamps, shrubs are naturally sparse and interspersed by sedges.
Peter Stanton, Environmental Consultant Pty Ltd, Jacky Jacky Creek (1988).

Shrubs within headland communities are often wind-sheared and do not emerge far above the grasses.

Peter Stanton, Environmental Consultant Pty Ltd, Captain Billy Landing (1985).

Indicators of where fire is required:

- Heath plants are beginning to lose their lower-level leaves and some crowns or lower branches of the heath plants are dying.
- There is a build-up of dead and dying material.
- Heath community is becoming dominated by Allocasuarina trees (e.g. black she-oak *Allocasuarina littoralis*).
- Mature toothbrush grevillea *Grevillea pteridifolia* (where present) are more than two metres high.
- Heaths which are long unburnt have become entangled with dodder vine (a leafless, parasitic vine).
- Cypress pine *Callitris intratropica* (where present) are beginning to become abundant.

Notice the crowns of many shrubs have begun to die. This is an indicator of the need to apply fire to maintain a healthy heath. Occasional she-oak trees are not a problem. Where they are beginning to dominate, planned burning should be considered.

Mark Newton, DSITIA, Iron Range National Park (2009).

Plants are beginning to lose lower-level leaves.

Mike Ahmet, QPWS, Olive River Resource Reserve (2009).

Lower branches of heaths begin to die when they remain long-unburnt.

Peter Stanton, Environmental Consultant Pty Ltd, Iron Range National Park (1996).

Some species are no longer present in this community—it has begun to simplify due to a long absence of fire. However, be aware that many heaths on Cape York Peninsula are naturally less-diverse.

Mike Ahmet, QPWS, Olive River Resource Reserve (2009).

Long fire intervals tend to lead to a domination of some species such as this toothbrush grevillea.

Peter Stanton, Environmental Consultant Pty Ltd, Heathlands Resource Reserve (1991).

Discussion

- The key approach is to maintain a Landscape Mosaic using broad-scale fire management. Aerial ignition is the most efficient way to achieve this.
- Long fire intervals tend to lead to a domination of tree species. In heaths these often include black she-oak, cypress pine and grevillea. As a result, diversity in heath gradually decreases. Black she-oak has the ability to establish in dense litter allowing them a competitive advantage over other heath species in the absence of fire (Stanton 1999).
- A lack of fire will allow an accumulation of fuel. After many years this accumulation can create the risk of a large-scale, single-event fire that reduces ecosystem diversity and promotes a cycle of repeated large-scale fire.
- Planned burns in adjacent fire-adapted communities have two roles: The first is to help maintain longer fire intervals in heaths by mitigating too frequent unplanned fires. The second is to mitigate the impact of severe heath fires impacting the surrounding areas.
- Some heaths contain many endemic, rare and endangered species such as the rare *Xanthostemon arenarius*, the rare *Xanthostemon xerophilus* and the endangered *Eremochloa muricata*. While these species' fire response is poorly understood, fire maintains healthy heathlands which increases their chance of persistence.
- Stanton (1992) observed that even high-severity fires in heath can create a varied mosaic of burnt and unburnt patches, and attributed this to wind speed variation.
- A long absence of fire leads to a loss of some species from the community. Cool fires can be detrimental as they do not promote the regeneration of heath species. A hot fire is required to germinate the seed bank (Stanton 1992).
- On Cape York Peninsula the structure of heaths can vary considerably from dense, closed heath on sand dunes to dwarf heath on plains.
- Fires in heaths tend to burn in a linear (long narrow fire) pattern when under the influence of a strong wind. In the evening the flank fires will tend to self-extinguish, while the head fire will continue to burn. This can assist in breaking up areas of long-unburnt heath and establishing a mosaic pattern.

Fires lit with the wind (running fires) tend to burn heath in a linear pattern.

Peter Stanton, Environmental Consultant Pty Ltd, Jardine River catchment (1989).

Heaths occur on a variety of landforms including sand dunes.
Peter Stanton, Environmental Consultant Pty Ltd, Iron Range National Park (1996).

This dwarf heath is long unburnt.
Peter Stanton, Environmental Consultant Pty Ltd, Heathlands (1993).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
10–20 % of heath communities within the property planned burnt annually.	Using fire scar remote sensing data (e.g. NAFI), estimate burnt and unburnt country on an annual basis.	**Achieved:** 10–20 %. **Partially Achieved:** 5–10 % or 20–30 %. **Not Achieved:** Less than 5 % more than 30 %.
Within a property, the annual area burnt by planned burns is greater than that burnt by wildfires.	Using fire scar remote sensing data (e.g. NAFI), estimate planned burns as against wildfire on an annual basis.	**Achieved:** Annual area planned burnt > wildfire. **Not Achieved:** Annual area planned burnt < wildfire.

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.

Consider monitoring the height of toothbrush grevillea to indicate the need for fire. Planned burns should be implemented when they reach about two metres and a well-developed shrub layer has formed.

Consider monitoring the presence of black she-oak. Fire has been absent for too long where black she-oak trees begin to dominate above the shrub layer.

Fire parameters

What fire characteristics will help address this issue?

Fire severity

- **Patchy**/**low** or **moderate**/**extreme**. Fires will either burn severely or at very low-severity.

Fire severity class	Fire intensity (during the fire)	Fire severity (post-fire)
	Average flame height (m)	**Description (loss of biomass)**
Patchy (P) to Low (L)	< 1	40–60 % vegetation burnt. Unburnt vegetation (green patches) in the ground and shrub layer. Does not remove all the surface fuels (litter) and near surface fuels. Can create distinct 'holes' in closed heath. Overall little canopy scorch. Some scorching of shrubs and small trees.
Moderate (M) to Extreme (E)	> 1	Greater than 60 % vegetation burnt. Understorey burnt to mineral earth. 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 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 five and ten years.

Mosaic (area burnt within an individual planned burn)

- Patchiness will occur in some areas due to the presence of creeks, drainage lines and other landscape features such as rocky outcrops. Overnight conditions will lead to decreased fire severity and add to patchiness.

Landscape Mosaic

- 10–20 per cent.

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: August–September or even November depending on the season. Heath will not burn prior to this period as it is too wet. Be aware of containment issues in the very late dry season.

FFDI: < 24

DI (KBDI): 160–190

Don't be concerned if heath burns completely. Heaths recover well from stored seed banks or resprouts from the base.

Peter Stanton, Environmental Consultant Pty Ltd, Jardine River (1991).

Four years after fire these *Melaleuca arcana* are recovering by resprouting. They will eventually regain their original height.

Peter Stanton, Environmental Consultant Pty Ltd, Lakefield National Park (1998).

What burn tactics should I consider?

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

- **Aerial ignition.** Broad-scale fire management is necessary due to the size and inaccessibility of heath communities. This is mostly achieved through **aerial ignition**. Incendiaries should be placed so that fire spread will be limited. This can be achieved by placing incendiaries so that fires will only burn to the edge of areas previously burnt. Refer to Chapter 1 for further information.
- **Single point ignition.** It may be necessary to light only a single location for the entire burn (a number of ignition points at the same location is sometimes required). If creating a mosaic is the objective of the burn then use successive single-point ignitions, allowing one fire to extinguish before lighting another (this provides a better chance of breaking the area into a mosaic). When combined with a strong wind, a single-point ignition will create a long narrow fire.

Chapter 5: Melaleuca communities

This fire vegetation group includes all communities dominated by melaleuca. In the Cape York Peninsula bioregion most of these communities are periodically inundated. Drier sites have a grassy understory with occasional sparse shrubs such as xanthorrhoea and grevillea. Wetter sites support sedges, ferns, palms and pandanus in the understory. They are found across the bioregion.

There are four broad sub-groupings of melaleuca communities on Cape York Peninsula with different fire requirements:

1. Melaleuca woodlands (woodlands)

Woodlands can be dominated by one or a mix of melaleuca species with other canopy species also present. The understoreys may be dominated by grasses, shrubs, sedges, ferns or a mixture of plants. The ground-layer is often sparse. Woodlands can be found in wetter areas such as drainage depressions, marine plains and swamps. These can remain boggy for weeks or months. Low hills and rises dry more quickly but accumulate fuel very slowly.

2. Melaleuca heath (heath)

Heaths have a low, dense structure dominated by a mix of species including: *Melaleuca stenostachya, Melaleuca citrolens, Thryptomene oligandra*, Cape York paperbark *Melaleuca arcana* and sometimes co-dominant broad-leaved paperbark *Melaleuca viridiflora*. There is usually no understorey or very sparse grasses. These heaths are found adjacent to wet areas such as on marine plains, stream edges or fringing fresh water lakes. They also occur on knolls and hills. Like other heaths, when melaleuca heath burns it often scorches completely with plants reshooting from the base.

3. Melaleuca gallery forest and lagoon margins (gallery forests)

Gallery forests are tall to very tall (up to 50m) and are located on the margins of swamps and lagoons on deep peat soils, on the levee banks of major streams or as part of a complex of flood channels and levee banks. Gallery forests are fire-sensitive. They sometimes have rainforest species present.

4. Melaleuca swamps (swamps)

Swamps are low areas where water usually remains near or above the surface of the peat or gley soils. They are often dominated by swamp paperbark *Melaleuca quinquenervia* or weeping paperbark *Melaleuca leucadendra*. Other species may also dominate in some areas. Swamps may have shrubs or rainforest pockets present and sedges dominate the ground layer. Swamps can cover vast areas, in some cases up to a few hundred hectares.

Fire management issues

The main issue for the drier woodlands and heaths is maintaining a Landscape Mosaic through broad-scale fire management (this limits the impacts of late season wildfires). In addition, heaths prefer a longer fire interval which is difficult to maintain if the surrounding landscape is not proactively burnt to limit extensive and regular late-season fire.

Maintaining a Landscape Mosaic within fire-adapted vegetation adjacent to gallery forests and swamps will assist in mitigating impacts of fire. Avoid peat fires by burning when standing water is present or the peat is water logged.

Issues:

1. Maintain healthy melaleuca communities.
2. Avoid peat fires.
3. Limit fire encroachment into non-target communities.

Extent within bioregion: 1 701 670 ha, 14 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 180 812 ha; Crosbie Creek Station, 42 859 ha; Cape Melville National Park, 39 843 ha; Mungkan Kandju National Park, 28 081 ha; Jack River National Park, 26 989 ha; Strathmay Station, 24 647 ha; KULLA (McIlwraith Range) National Park (Cape York Peninsula Aboriginal Land), 20 579 ha; Lama Lama National Park (Cape York Peninsula Aboriginal Land), 11 283 ha; Mary Valley Station, 11 039 ha; Olive River Reserve, 8018 ha; Alwal National Park (Cape York Peninsula Aboriginal Land), 7474 ha; Battle Camp Station, 3767 ha; Jardine River National Park, 3572 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 3119 ha; Mount Jack Station Acquisition, 2420 ha; Heathlands Resources Reserve, 2254 ha; Orchid Creek (Under Negotiation With Aboriginal Land And NP), 2077 ha; Errk Oykangand National Park (Cape York Peninsula Aboriginal Land), 830 ha; Annan River (Yuku Baja-Muliku) National Park, 204 ha.

Issue 1: Maintain healthy melaleuca communities

Indicators of healthy melaleuca communities:

Woodlands

- Healthy melaleuca woodlands have grasses, sedges, or shrubs (or any mix of these) in the understorey. A few canopy trees of varying size should be present—enough to eventually replace the canopy.
- Grasses are upright and vigorous, with well-formed bases. Perennial grasses are more common than annuals.
- Some melaleuca woodlands on low rises and hill slopes have a naturally-dense shrub layer. These can include species such as grevillea and *Jacksonia* spp. Grasses will be sparse here.

Heath

- There is a variation in age-class of heath stands across the landscape.

Gallery forests

- Plants such as the cluster fig *Ficus racemosa* var. *racemosa*, Leichhardt tree *Nauclea orientalis*, ebony *Diospyros* sp., wild plum *Terminalia platyphylla*, strychnine bush *Strychnos lucida* or wattles are present in the canopy or shrub layer.
- There is an absence of blackened trunks.

Swamps

- Sedges are upright and vigorous. Ferns are vigorous without a significant build-up of dead material.

Grasses in melaleuca woodlands should be upright and vigorous with well-formed bases.

Mark Newton, DSITIA, Main Edward River Road (2008).

Gallery forests do not require fire. Maintaining a landscape mosaic in surrounding fire-adapted communities will assist in protection from wildfire.

Daryn Storch, QPWS, Lakefield National Park (2011).

The canopy is quite sparse in scrub teatree *Melaleuca citrolens* woodlands.
Mark Newton, DSITIA, Musgrave (2008).

The following may indicate that fire is required:

Woodland

- Grasses or sedges collapsing or appearing matted with a build-up of dead material.
- *Xanthorrhoea* spp. (where present) have brown skirts.
- Shrubs (where present) are starting to decline, the crowns or branches are dying and/or lower leaves are browning.

Swamps

- Continuous fuel exists above the water level.
- Sedges are collapsing or appear matted. They have a build-up of dead material. This can form above the water level.
- Ferns are accumulating dead fronds.
- Pandanus (where present) have a build-up of dead fronds.

Heaths

- Plants are beginning to lose their lower level leaves or some crowns are dying.
- Plants have some dead or dying branches.

Melaleuca woodland on rises.

Skirts of dead material on grass trees can indicate the need to apply fire.

Mark Newton, DSITIA, Upper Archer/Wenlock River (2003).

Collapsing, matted sedges.

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

Discussion

- A key strategy to manage the vast expanse of inaccessible melaleuca communities in Cape York Peninsula is broad-scale management through aerial ignition. Ideally this would include at least three different ignition periods on each property, each year. However, the ability to achieve this will depend on resourcing. Aim to achieve as many ignition periods as feasible.
- Melaleuca communities with a peat layer are vulnerable to peat fires in the drier months. These areas should always be burnt with standing water present or when the peat layer is water logged (refer to Issue 2, for guidelines to avoid peat fire).
- Melaleuca woodlands are quite resilient and do not change quickly. In addition, fires can be frequent and long-unburnt areas rare. In some wetter areas casuarinas and acacias may become frequent.
- The number of melaleuca species and of communities containing melaleuca on Cape York Peninsula is greater than anywhere else in Australia (Stanton 1976) and their fire management requirements are variable.
- Be aware that the **papery bark** of melaleuca is volatile, highly flammable and is often described as a 'ladder fuel' as it causes fire to rapidly ascend from the base to the top of the tree. Be aware of wind conditions and ember spotting.
- Be aware that very tall (up to 50 m) gallery forests along levee banks of major streams occur (e.g. within Lakefield national Park), but are not described in the Regional Ecosystems database (Queensland Herbarium 2011a). Tall (> 30 m), melaleuca woodlands on the margins of swamps and lagoons on deep peat soils are also not described in the Regional Ecosystems database (Queensland Herbarium 2011a).
- Rubber vine occurs in gallery forest and can be managed with fire. Fire should only be applied after at least 30 mm of rain when the melaleuca bark is wet (refer to Chapter 10 [Issue 4], regarding fire management guidelines).
- Grasses are generally considered ready to burn when they reach 50–60 per cent cured. The North Australian Grassland Fuel Guide (Johnson 2001) may assist in determining when grasses are ready to burn. However, caution should be used and local knowledge sought as some grass species which still appear too green to burn, will burn severely (and vice versa).

The fire tolerance of ant plants *Myrmecodia beccarii* is unknown. Where this species is present, use a low flame height.

Paul Forster, Queensland Herbarium (2000).

What is the priority for this issue?

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

Assessing outcomes

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

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
Woodland: 30–60 % of melaleuca woodland burnt within management area.	Using fire scar remote sensing data, estimate burnt and unburnt country on an annual basis.	**Achieved:** 30–60 %. **Partially Achieved:** 20–30 % or 60–80 %. **Not Achieved:** < 20 % or > 80 %.
Woodland: > 50 % of Pandanus skirts retained.	Select one or more sites or walk one or more transects (taking into account the variability of landform and likely fire severity) and estimate number of Pandanus skirts remaining after fire.	**Achieved:** > 50 % retained. **Partially Achieved:** 25–50 % retained. **Not Achieved:** < 25 % retained.

Melaleuca swamps or gallery forests: The planned burn does not result in a peat fire.	Ongoing visual assessment during and post burn to determine if the fire has carried into peat layer and developed into a peat fire.	**Achieved:** Fire did not carry into peat layer and develop into a peat fire. **Not Achieved:** Fire carried into peat layer and developed into a peat fire.
Gallery forest: No scorch of the margin of gallery forest.	**After the burn** (immediately-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-very soon after): walk the margin of the pocket or representative sections (e.g. a 100m long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** No scorch of the margin. **Partially Achieved:** < 10 % of margins scorched. **Not Achieved:** > 10 % or margins scorched.
Heath: 10–20 % of heath communities burnt within the Park in any one year.	Using fire scar remote sensing data, estimate burnt and unburnt country on an annual basis.	**Achieved:** 10–20 %. **Partially Achieved:** < 10 % or 20–30 %. **Not Achieved:** > 30 %.

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.

Woodland of *Melaleuca saligna* on floodplains. The naturally-sparse ground layer of this community means that fires are infrequent.
Mark Newton, DSITIA, 12 Mile Yards (2004).

Low-severity fire in melaleuca woodland.
Mark Newton, DSITIA, Stewart River Crossing (2008).

Fire parameters

What fire characteristics will help address this issue?

Melaleuca woodland

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

- 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 **one** and **three years**.

Fire severity

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

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	< 150	< 0.5	≤ 2.5 (up to 8m 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 20m 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.

- Refer to Chapter 1 (Issue 1), regarding other fire management guidelines.

Melaleuca swamps

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

- Use a frequency that is greater than **four years** to allow sufficient fuel to accumulate enabling fire to carry. These communities can be left for much longer unless they are at risk of wildfire encroachment.
- Keep fire out when peat is dry (refer to Issue 2, for guidelines to avoid peat fire).

Fire severity

- **Moderate** with occasionally **high**.

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 metre height canopy, mid stratum burnt completely (or nearly so).

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

Melaleuca gallery forests

- Refer to Chapter 10 (Issue 6), for fire management guidelines.
- Burn the surrounding areas under conditions that limit fire encroachment. Fire has a role in defining the ecotone— allow fire to carry into the edge of these communities so that the ecotone can be maintained. Occasional fire within the community will play a role in maintaining the melaleuca component.

Melaleuca heaths

- Refer to Chapter 4 (Issue 1), regarding fire management guidelines.

Melaleuca gallery forest.

Mark Newton, DSITIA, Peach Creek (2003).

What weather conditions should I consider?

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

Season:

- Burn any time of the year **after the wet season** when it is sufficiently dry to carry a fire. Use occasional storm burns (normally between October and January) or late dry-season burns.
- **Avoid extremely dry conditions**, high temperatures and when the humidity is less than 30 per cent. These conditions tend to occur just before the start of the storm season. Care should be exercised when undertaking planned burning in very high to extreme fire conditions.
- Ensure successive fires are somewhat variable in intensity, season and frequency (e.g. **alternating** early season burns with storm burns or late dry burns) rather than burning to a prescription of every ‘x’ years at the same time of year. Each fire should create a slightly different mosaic of burnt and unburnt areas.

Melaleuca woodland

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

Melaleuca heaths

- Refer to Chapter 4 (Issue 1), regarding fire management guidelines.

Melaleuca swamps

Season: Burn any time of the year **after the wet season** when it is sufficiently dry to carry a fire. Avoid the very late dry season when the peat may be dry.

GFDI: < 11 and occasionally up to 18 for high-severity

DI (KBDI): 80–180

Wind speed: 15–20 km/hr

Soil moisture: Prior to the planned burn ensure standing water is present or the peat is waterlogged (water can be squeezed from the peat).

Melaleuca gallery forests

- When allowing fire to penetrate from surrounding areas, ensure moist conditions exist. Avoid peat fires by ensuring standing water is present or the peat is waterlogged (water can be squeezed from the peat).

What burn tactics should I consider?

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

Melaleuca woodland

- **Burn in association with the surrounding landscape:** Melaleuca woodlands are burnt in association with the surrounding fire-adapted communities such as grasslands and eucalypt woodlands. Refer to Chapter 1 (Issue 1) for tactics. Note that melaleuca woodlands will tend to burn less frequently than eucalypt communities due to lower fuel accumulation rates and/or the presence of moisture.

Melaleuca heaths

- Refer to Chapter 4 (Issue 1), regarding fire management guidelines.

Melaleuca swamps

- **Secure containment:** Melaleuca swamps tend to burn with moderate to high severity. When burning swamps, it may be necessary to protect the surrounding areas from high-severity swamp fires. This can be achieved by burning the surrounding areas early in the season or at the end of the previous year.
- **Ongoing fire management in surrounding areas** will assist in preventing late-season wildfire impacts and peat fires. The best way to mitigate wildfire is to maintain mosaic burning in the surrounding landscape.

Melaleuca gallery forests

- **Limit fire encroachment.** Refer to Chapter 10 (Issue 6), regarding fire management guidelines.
- **Ongoing fire management in surrounding areas** will assist in preventing late-season wildfire impacts and peat fires. The best way to mitigate wildfire is to maintain mosaic burning in the surrounding landscape.

Issue 2: Avoid peat fires

On Cape York Peninsula most areas dry out seasonally, therefore creating an annual peat fire risk.

Low-lying communities (including wetlands and melaleuca communities) will often accumulate partially decayed, densely packed vegetation known as peat. In the absence of good soil moisture the peat is easily ignited resulting in a peat fire. Peat fires can burn for months, and can have very negative impacts on the vegetation community. Peat takes many years to re-form.

Awareness of the environment

Key indicators of suitable conditions to avoid peat fires:

- Standing water: visible water on 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).
- Regular fires in surrounding fire-adapted communities that provides adequate protection of peat communities from wildfire.

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

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

Peat is extremely vulnerable when dry.
Mike Ahmet, QPWS, Cape Melville (2004).

Discussion

- Peat is highly flammable when dry due to its porous nature and high-carbon content. The resulting fire is generally of a high to very high-severity, is difficult to put out, may burn slowly and for an extended period of time and can severely damage or destroy ecosystems. Re-ignitions can occur many weeks after the main fire has passed.
- Be aware of peat issues when burning in areas adjacent to melaleuca communities or wetlands. The condition of the peat should be checked to ensure that if fire encroaches the peat will not be accidentally ignited. 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 area (use suitable tactics such as burning away from wetland edges).

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.

Peat fires can burn for many weeks and have a significant impact on melaleuca. Avoid very late dry season fires.
Peter Stanton, Environmental Consultant Pty Ltd, Low Lakes, Lakefield National Park (1991).

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

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

- Refer to relevant fire vegetation group.

Low-severity fire adjacent to a *Melaleuca viridiflora* community. Ground saturation has been used to control fire encroachment.

Mark Parsons, QPWS, Sunday Creek (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.

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

GFDI: < 11
DI (KBDI): < 80–100

Wind speed: < 20 km/hr

Soil moisture: The presence of standing water or waterlogged peat is the critical factor that will avoid peat fire.

What burn tactics should I consider?

When burning adjacent fire-adapted areas, where the conditions of standing water or waterlogged peat can not be achieved, use tactics that will limit encroachment of fire into the community (see below).

- **Aerial ignition.** Broad-scale fire management is the most common technique for fire management on Cape York Peninsula. Refer to Chapter 1 'Eucalypt communities' for techniques. Timing planned burns to avoid peat fires is particularly important as it may be the only measure by which to gauge the condition of the peat prior to the day of ignition. Targeting surrounding communities early in the dry season, or when water is visible on the surface will assist in avoiding peat fire.
- **Limit fire encroachment into non-target communities.** Where the non-target community is present in low lying areas utilise the surrounding topography to create a low-intensity backing fire that travels down slope towards the non-target community. If conditions are unsuitable (e.g. the non-target community is too dry to ensure 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 (refer to Chapter 10 [Issue 6], regarding tactics).
- **A low-intensity backing fire.** A slow-moving, low-intensity backing fire will generally result in the more complete coverage of an area and a better consumption of fuel. This can be created using slope, wind direction or topography and ensures fire intensity and rate of spread are kept to a minimum.
- **Spot ignition** is used to alter the desired intensity of a fire and create the desired mosaic of burnt and unburnt areas. A number of patterns of lighting can be used. The spacing of the spots affects the resulting intensity and mosaic. Refer to Chapter 1 'Eucalypt communities' for techniques.

Issue 3: Limit fire encroachment into non-target communities

Refer to Chapter 10 (Issue 6), regarding fire management guidelines.

Chapter 6: Acacia communities

This fire vegetation group includes all communities where acacia dominates the canopy. Canopy species include lancewood *Acacia shirleyi*, *Acacia polystachya* or *Acacia homaloclada*, *Acacia brassii* or north coast wattle *Acacia leptostachya*. These communities exist in small pockets particularly on poorer soils. In most cases acacia communities are of such limited extent that they have not been mapped.

Fire management issues

On Cape York Peninsula, these communities are self-protecting due to a combination of low fuel loads and their position in the landscape. They are not actively managed with fire.

Discussion

- This Fire Vegetation Group is essentially self-protecting due to a combination of low fuel loads and the position of acacia communities in the landscape. Fires may trickle through at low intensity occasionally when sufficient fuel is available. Sometimes acacia communities occur in rocky areas in which fire will not carry at all.
- Lancewood communities occur on ironstone jump-ups. These appear as small isolated pockets on raised duricrusts that are surrounded by eucalypt communities. Frequent severe fire in lancewood communities can have an impact on community structure (as lancewoods only reproduce via seed). However the occasional moderate to high-severity fire may benefit the community by allowing the species' hard seeds to germinate. Russel-Smith et al. (2010) suggest that more than 10 years is required to allow lancewood to mature and set-seed prior to the next fire.

Cape York has five endemic acacia species including:

1. *Acacia* sp. (Iron Range D.G. Fell DF2327)
2. *Acacia solenota*
3. *Acacia* sp. (Harmer Creek, J.R. Clarkson, 9133)
4. *Acacia ommatosperma* (Mekunga Creek, J.R. Clarkson, 4373)
5. *Acacia* sp. (Mekunga Creek, J.R. Clarkson, 4373).

Extent within bioregion: 2496 ha, ‹ 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Crosbie Creek Station, 161 ha; Strathmay Station, 157 ha.

Acacia communities are usually dominated by a single species. This community has been impacted by a severe fire and will slowly recover providing further fires do not impact it for many more years.

Peter Stanton, Environmental Consultant Pty Ltd, Cape Melville (1993).

Chapter 7: Dunes and coral cays

Dune and coral cay communities are found in interrupted strips along the coastline and on the continental islands and cays of the northern Great Barrier Reef and Torres Strait. This fire vegetation group is very diverse and includes coastal she-oak woodland, microphyll and notophyll vine forest on fore dunes (beach scrub) and pisonia forest.

Fire management issues

All dune and coral cay communities are fire-sensitive and do not require fire.

In some cases dune and coral cay communities are vulnerable to wildfire during the dry season and their protection relies on proactive fire management in adjacent, fire-adapted communities. Sometimes these communities may become more susceptible to wildfire in severe fire weather, particularly as a result of disturbances such as drought, logging, cyclones or weed invasion (refer to Chapter 10 [Issue 7], regarding post-cyclone fire management guidelines).

Issue:

1. Limit fire encroachment into dunes and coral cays.

Extent within bioregion: 57 179 ha, < 1 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Shelburne Bay Environmental Purposes Reserve, 3659 ha; Jardine River Resources Reserve, 2184 ha; KULLA (McIlwraith Range) National Park (Cape York Peninsula Aboriginal Land), 2172 ha; Jardine River National Park, 2113 ha; Cape Melville National Park, 1748 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 1516 ha; Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 1460 ha; Lama Lama National Park (Cape York Peninsula Aboriginal Land), 979 ha; Bathurst Bay land adjoins Lakefield NP, 620 ha; Olive River Reserve, 416 ha; Endeavour River National Park, 263 ha; Iron Range/Portland Roads, 151 ha; Annan River (Yuku Baja-Muliku) Resources Reserve, 99 ha; Heathlands Resources Reserve, 78 ha; Possession Island National Park, 59 ha; Three Islands Group National Park, 48 ha; Lizard Island National Park, 43 ha; Denham Group National Park, 40 ha; Flinders Group National Park, 25 ha; Annan River (Yuku Baja-Muliku) National Park, 21 ha; Howick Group National Park, 14 ha; Turtle Group National Park, 13 ha; Kalpowar land adjoins Lakefield National Park, 8 ha; Saunders Islands National Park, 3 ha.

Issue 1: Limit fire encroachment into dunes and coral cays

Refer to Chapter 10 (Issue 6), regarding fire management guidelines.

Aim to conduct mosaic burns in surrounding fire-adapted communities to protect these communities from wildfire. Beach scrub edges are generally self-protecting during planned burning in appropriate conditions. Sometimes however, it may be necessary to burn back from the edges of this vegetation type.

Chapter 8: Rainforest

Rainforests occur predominantly in intermittent strips along the east coast (predominantly between Coen and Lockhart River) and as gallery forests in thin strips along rivers. On Cape York Peninsula this fire vegetation group includes mesophyll, notophyll and microphyll vine forest, gallery forests, boulder fields with vine thickets and rock pavements with very sparse herbland or shrubland. It also includes gallery forests of the Archer and Coen river systems and parts of other river systems.

Fire management issues

Typically under low to moderate-severity fire, rainforests will not burn due to moisture, microclimatic conditions and a lack of flammable grasses (Bowman 2000). Rainforest that has been repeatedly impacted by severe, late dry season fire are retracting in dryer central and western areas of the bioregion. However, in the higher rainfall areas of Cape York Peninsula (approximately greater than 1500 mm), rainforest expansion has (and continues) to occur on a large scale (Stanton 1992). A lack of fire or the practice of applying repeated, early dry-season fire (in fire-adapted communities) is the most likely cause of rainforest expansion. Refer to Chapter 10 (Issue 5), regarding fire management guidelines for reducing overabundant seedlings/saplings.

The main strategy in the protection of rainforests is to maintain surrounding fire-adapted communities with mosaic burning. This will minimise the spread and severity of wildfire during the late dry season. In certain situations, rainforests are more vulnerable to fire (e.g. dry scrubs or gallery forest adjacent to eucalypt communities or where damaged rainforest is upslope from a planned burn area). In these instances it may be necessary to employ specific tactics such as burning away from rainforest edges.

Issue:

1. Limit fire encroachment into rainforests.

Extent within bioregion: 480 819 ha, 4 per cent; **Regional ecosystems:** Refer to Appendix 1 for complete list.

Examples of this FVG: Kulla (McIlwraith Range) National Park (Cape York Peninsula Aboriginal Land), 76 779 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 33 385 ha; Jardine River National Park, 32 209 ha; Olive River Reserve, 15 581 ha; Mungkan Kandju National Park, 15 018 ha; Heathlands Resources Reserve, 14 504 ha; Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 5735 ha; Cape Melville National Park, 5669 ha; Shelburne Bay Environmental Purposes Reserve, 3266 ha.

Discussion

- The rainforests of Cape York Peninsula are unique in Australia due to the influences of nearby Papua New Guinea (PNG). The continent of Australia had been periodically joined to PNG many times over the last few million years for significant periods of time due to sea level fluctuations. The land bridge created at times when they merged allowed flora and fauna the ability to travel or disperse more readily. Cape York Peninsula, being the point at which the land masses joined, was at the forefront of these migrations and the rainforests were particularly influenced by these periodic merges.
- Be aware that some rainforest margins are stable in the absence of fire even if climatic conditions are suitable for rainforest expansion. Stanton and Fell (2005) attribute this to unsuitable soil conditions.

In the drier areas, severe late dry-season fires are causing rainforests to contract.
Mark Newton, DSITIA (2003).

Issue 1: Limit fire encroachment into rainforests.

Refer to Chapter 10 (Issue 6), regarding fire management guidelines.

To protect rainforest edges from wildfire it is essential to conduct mosaic burns in surrounding fire-adapted communities. Rainforests edges are generally self-protecting during planned burning under appropriate conditions. Sometimes however, it may be necessary to burn back from rainforest edges.

Chapter 9: Mangroves and saltmarshes

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

Fire management issues

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

Saltmarsh is potentially flammable however it is not actively protected from fire on Cape York Peninsula. Saltmarsh can burn in association with fires in the surrounding landscape. Occasional fire here may also play a role in reducing or eliminating rubber vine infestations.

Extent within bioregion: 272 990 ha, 2 per cent; Regional ecosystems: Refer to Appendix 1 for complete list.

Examples of this FVG: Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land), 22 925 ha; Bathurst Bay land adjoins Lakefield National Park, 10 213 ha; Shelburne Bay Environmental Purposes Reserve, 7760 ha; Cape Melville National Park, 5466 ha; Olive River Reserve, 4318 ha; Jardine River National Park, 1486 ha; Endeavour River National Park, 1072 ha; Kutini-Payamu (Iron Range) National Park (Cape York Peninsula Aboriginal Land), 724 ha; Howick Group National Park, 660 ha; Lama Lama National Park (Cape York Peninsula Aboriginal Land), 625 ha; Flinders Group National Park, 440 ha; Jardine River Resources Reserve, 356 ha; Annan River (Yuku Baja-Muliku) National Park, 354 ha; Kalpowar land adjoins Lakefield National Park, 103 ha; Iron Range/Portland Roads, 102 ha; Turtle Group National Park, 84 ha; Lizard Island National Park, 55 ha; Heathlands Resources Reserve, 32 ha; Possession Island National Park, 30 ha; Saunders Islands National Park, 20 ha; Three Islands Group National Park, 17 ha; Denham Group National Park, 9 ha; Piper Islands National Park (Cape York Peninsula Aboriginal Land), 6 ha; Endeavour River Resources Reserve, 4 ha; Round Island Conservation Park, 1 ha.

Chapter 10: Common issues

In the Cape York Peninsula 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 are 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 invasive grasses.
4. Reduce rubber vine.
5. Reduce overabundant seedlings / saplings.
6. Limit fire encroachment into non-target fire vegetation group.
7. Post-cyclone planned burning.

Issue 1: Hazard reduction (fuel management) burns

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

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

Awareness of the environment

Main indicators of where fire management is required

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

Or

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

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

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

Discussion

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

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

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

- It is important to maintain a simplified vegetation fuel structure in protection zones and wildfire mitigation zones, which means addressing issues such as suspended and elevated fuel and overabundant saplings and seedlings.
- Fire management that favours grasses will assist in achieving an open structure suitable for wildfire management and mitigation. Moist conditions and low-severity burns that retain the bases of grasses will give them a competitive advantage over woody species.

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

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

Troy Spinks, QPWS (2010).

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

Troy Spinks, QPWS (2010).

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

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

What weather conditions should I consider?

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

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

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

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

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

What burn tactics should I consider?

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

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

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

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

Scars in trees may indicate past use by indigenous people. More recent tenants may include opportunistic micro bats. Low to moderate-severity fire presents little threat to these trees.

Daryn Storch, QPWS, Mary Valley Station (2011).

This rock art site is potentially vulnerable to radiant heat and smoke impacts.

QPWS, Carnarvon Gorge.

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

David Cameron, DNRM, Unspecified location.

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

David Cameron, DNRM, Atherton (2002).

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

David Cameron, DNRM, Bribie Island (2005).

Key indicators of European cultural heritage sites:

- Ruined buildings, corrugated iron shacks, wooden house stumps, old fence posts, old stockyards, tombstones, 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 (often seen as deep holes covered with corrugated iron or wood).
- The existence of plane wreckage.

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

David Cameron, DNRM, Dogwood Creek (2005).

Discussion

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

What is the priority for this issue?

Priority	Priority assessment
Highest	Planned burn required to **protect** life and/or **property**, usually within protection zones.
Very high	Planned burn required to maintain areas of **special conservation significance**.

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

Season: Favour early season burning and moist conditions

GFDI: < 11

DI (KBDI): 80–180

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 is present.

Smoke is directed away from a rock art site during a planned burn.
Mark Parsons, QPWS, Fishers Creek (2010).

What burn tactics should I consider?

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

- **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 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 to effectively 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. This tactic will promote a slow-moving and manageable low-severity fire and limit the chance of a high-severity junction zones developing.
- **A low-severity backing fire.** A slow-moving, low-severity backing fire can help ensure fire severity and rate of spread are kept to a minimum.
- Depending on the conditions, **spot light the windward (clear) edge** to direct the active fireline and smoke away from the cultural heritage site. Use a chipped or wet line around the site so the resulting backing fire can be extinguished or will self-extinguish at the chipped or wet line.

Manual removal and burning of flood debris from around the posts of a historical railroad bridge.

Mark Cant, QPWS (2002).

Issue 3: Manage high-biomass invasive grasses

High-biomass exotic grasses are capable of outcompeting native species to form dominant stands. High-biomass grasses of concern on Cape York Peninsula include (but are not limited to) grader, gamba, Parramatta, Guinea, aleman, olive hymenachne, para, thatch and annual and perennial mission grasses. These grasses are generally much taller and produce significantly more dry matter than native species. These traits increase fuel load, fire intensity, spotting ability and flame height all of which lead to an increased fire severity and spread. This then results in greater tree death and loss of habitat features with flow-on effects to flora and fauna species and the community as a whole. Fire can be used as part of control for some high-biomass exotic grasses. At the same time, high-biomass grasses both promote fire and many are promoted by fire. These grasses tend to occur as a result of disturbance and spread along roadsides, 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 of high-biomass grass species:

Note: be on the lookout for newly-forming stands as **control is much easier if their presence is detected early**.

- Dense stands of grasses (often single-species dominated) are present.
- High-biomass grasses are generally taller than the native species.
- There is a lot of mass and/or dead material present.

Guinea grass infestation.

John Clarkson, QPWS, Mereeba (2007).

Close up of Guinea grass.

Paul Williams, Vegetation Management Science Pty Ltd, near Patterson's Gorge (2005).

The height, mass and structure of guinea grass infestations increases flame height and severity, contributing to tree death.

Mark Parsons, QPWS, Mullers Creek (2010).

In this photo, increased fire severity caused by gamba grass has resulted in tree death.
Paul Williams, Vegetation Management Science Pty Ltd, Bachelor Northern Territory (2007).

A Gamba grass infestation.
John Clarkson, QPWS, Batchelor, Northern Territory (2004).

Grader grass infestation.

John Clarkson, QPWS, Mareeba (2007).

Thatch grass infestation.

John Clarkson, QPWS, Mareeba (2007).

Para grass infestation.
John Clarkson, QPWS, Julatten (2007).

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 mentioned below.
- Exotic grasses are highly-invasive and thrive on disturbance. They can establish where the cover of native grasses has been reduced, however some species such as gamba 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. You are encouraged to record observations regarding these species' response to fire.
- Be aware of weed hygiene issues when conducting planned burns in areas with high-biomass grasses. Fire vehicles and machinery can aid seed spread along firelines and should be washed down after exposure.
- In many cases it is desirable to avoid burning high-biomass invasive grasses, due to the likely increase in fire severity and the potential to promote them. However, the risk of wildfire later producing an even higher-severity fire must be considered. In some situations, burning high-biomass grasses under mild conditions with planned fire is more desirable then allowing them to burn with wildfire.

- For some species, application or exclusion of fire is known to be an important aspect of control. Specific information is offered below:

Gamba grass and mission grass

- These grasses dramatically increase fuel loads. In gamba grass this can be as high as 11–15 tonnes/ha and possibly as high as 30 tonnes/ha. This can carry fire into the canopy, killing mature trees. As such, **fire is generally not recommended as a control method for these species.**
- If fires are applied they should be conducted prior to seeding. Updrafts during burning can carry the light seeds great distances away and create new infestations.
- Fire removes the bulk of the grass biomass and encourages active growth making herbicide application (following fire) more effective.
- Gamba grass has a short lived seed bank with only one per cent of seeds viable within a year. Thus control is possible over a couple of years.
- An effective method of control for mission grass is to burn before it flowers in the early dry season. A follow-up application of herbicide is required in the next wet season.

Grader grass

- Grader grass is an annual (its life cycle occurs within a year) and the viability of seed in the soil has been observed to drop off after four or five years. Fire should be excluded for four or five years (if fire is applied while the seed is still viable the grader grass will be promoted).
- If using fire, attempt to time it prior to setting-seed (typically in March-May). Timing of fires to control grader grass may be difficult on Cape York Peninsula due to the length of the wet season (fuels may not be sufficiently cured to carry fire before they set seed).
- When fire is reapplied in these infestations ensure good soil moisture exists to aid the re-establishment of native grasses.
- Too-frequent or severe fire promotes the spread of grader grass.
- New infestations of grader grass can be controlled by hand removal, before they set seed (March-May).

Olive hymenachne

- Fire has been shown to be an effective tool in the control of this grass when used in combination with other methods such as grazing or herbicide.
- Fire should be applied just prior to the wet season when plants have dried out enough to provide suitable fuel. Fire should be followed by grazing or herbicide control.
- Fire will destroy seeds on the surface of the soil, but not seed that is buried — a follow-up fire will be required.

Guinea and thatch grass

- Fire is not known to be an effective tool in the control of Guinea grass. However, frequent fire (every one to two years) can promote it's spread through disturbance mechanisms and possibly also through the reduction of canopy cover.
- Post-fire herbicide control is 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 to avoid creating a high-severity fire and encroachment into riparian zones.

Para grass

- Fire can be used with partial success for the management of para grass where it occurs in swamps and drainage lines. Fire is more effective where the para grass is within ephemeral swales which have dried out. Burning has been found to be more effective if used later in the year or in combination with chemical control.

Other high-biomass grasses

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

Fruiting para grass.

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

Fire has been found to be effective in burning 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).

What is the priority for this issue?

Priority	Priority assessment
High	It is important to be **aware of the presence** of high biomass grasses so that their negative effects can be managed and the potential of control can be considered.

Assessing outcomes

Formulating objectives for burn proposals

Every proposed burn area contains natural variations in topography, understorey or vegetation type. It is recommended that you select at least three locations that will be good indicators for the whole burn area. At these locations walk around 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)
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.

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

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 healthy grass cover.

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

Fire parameters

The fire parameters vary depending on the species (see discussion above).

What burn tactics should I consider?

Tactics will be site-specific and different burn tactics may need to be employed at the same location (e.g. due to topographical variation). 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 as part of a control program.** The initial spraying of high-biomass grasses (e.g. Guinea grass) with herbicide, followed a month later by a low to moderate-severity planned burn is an effective control method. 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 up slope), will generally result in the 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, reduces available fuels (particularly fine fuels) and ensures the fire intensity and rate of spread are kept to a minimum.

Issue 4: Reduce rubber vine

Rubber vine *Cryptostegia grandiflora* is found in scattered infestations in southern Cape York Peninsula. 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). While known rubber vine infestations are primarily south of the Rubber Vine Strategic Control Line (which bisects Cape York Peninsula at approximately 15° South) it has the potential to continue it's spread north throughout the peninsula.

Rubber vine has the ability to smother trees and shrubs and shade-out grasses and marine forbs, making fire difficult to apply. It 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:

- Use fire where rubber vine occurs in fire-adapted vegetation, or the fire extent can be limited where it occurs in fire-sensitive vegetation.
- Fire can be used where grass or forbland fuels are still continuous enough to carry a fire despite the occurrence of rubber vine.
- When grass fuel crumbles in the hand, meaning it is sufficiently cured.

Rubber vine occurring in marine samphire forbland. These forblands are adapted to occasional fires. A series of fires 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.

The image on the left 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.

The image below, taken in March 2006, shows the results.

Eleanor Collins, QPWS, Bowling Green Bay (2006).

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 when using fire or fire alone would be insufficient:

- Where rubber vine occurs in areas that have insufficient fuel to sustain a fire.
- Where 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).

Emergent seedlings. If fire were to trickle between the boulders the low fuel load may provide insufficient residence time to cause the sap to boil and kill the plants.
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 or 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).

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 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 the fuel density is greater below infected plants and if this fuel occurs adjacent to the stems, it can increase residence time. Rubber vine rust tends to reduce the density of the plants latex (possibly lowering the boiling point) leading to a more effective burn.
- More mature rubber vine plants require increased residence time to allow the latex to boil, which will 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 infestation 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 then ignited. The success of this method is generally reliant upon the moisture content of the rubber vine which needs to be high to effectively cause the sap to boil and kill the plant. In some areas this method has been very successful but mixed results in other areas have been reported. See tactics below.
- Take care using fire where fire-adapted communities abut fire-sensitive communities (e.g. rainforest). Dead plant material or high-severity fire can draw fire in to these communities.
- 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. Infestations of rubber vine north of the Rubber Vine Strategic Control Line presently occur in the Holroyd Basin and Lama Lama National Park (Cape York Peninsular Aboriginal Land [CYPAL]).

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.

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

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

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
> 90 % reduction in number of 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), one year after fire estimate what percentage saplings have been killed. **Or** If using the 'heli-torch' method, retrace the flight path in three locations and estimate the percentage of mature rubber vine plants killed.	**Achieved:** > 90 % plants killed* **Partially Achieved:** 75–90 % plants killed* **Not Achieved:** < 75 % plants killed* *It is not necessarily a good outcome if you have killed most of the rubber vine plants and yet the fire was too severe.

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

Monitoring the issue over time

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

Fire Parameters

What fire characteristics will help address this issue?

Key factors

- The principal factor in successful control is residence time. Slow-moving fire is required to kill mature rubber vine.
- A second fire may be required where mature plants have re-sprouted or seedlings are emerging from the seed bank.

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

- Apply a follow-up burn the following year if the observations indicate that the issue is not under control. 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.
- 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 period of time may further assist in its control.

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 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 objective and density of rubber vine infestation (denser infestation may require some fanning by wind so that the fire will carry).

Other considerations: In some western areas, greater rubber vine control has been achieved using low humidity and high temperatures for example 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** is undertaken in the storm season after the first rains. A minimum of 50 mm is recommended with consideration to the spread of the rainfall. The containment of storm burns relies on earlier-season burning having established defendable boundaries with lower fuel.
- A **running fire** of a higher severity may be required to carry 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 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 to the fire, an initial herbicide treatment could be used. Care should be taken when applying fire to dead rubber vine plants which remain hanging in the canopy as they may act as elevated fuels.
- **Aerial incendiary using a heli-torch.** In areas where rubber vine has invaded communities where fire is either not required or desired (e.g. fire-sensitive communities), apply fire using a heli-torch (an aerial incendiary that uses gelled gasoline to ignite the rubber vine directly). The surrounding vegetation needs to be moist to wet to ensure the fire doesn’t spread.

Issue 5: Reduce overabundant seedlings / saplings

In the Cape York Peninsula bioregion overabundance of rainforest, melaleuca or eucalypt seedlings/saplings (and occasionally other species) may reduce the health and diversity of the ground-layer through competition and shading. If left unmanaged, the structure of woodlands and forests can become more closed and grasslands can become woodlands, a process known as woody thickening. As woody thickening progresses fires become more difficult to reintroduce.

Melaleuca and eucalypt overabundance occurs predominantly on the drier western and southern areas of the bioregion, west of the dividing range. Rainforest pioneers are more common in the moister eastern area where rainfall is generally > 1500mm (Stanton 1992). Cypress pine, *Callitris intratropica* overabundance in eucalypt communities occurs in the Jardine River catchment and adjacent coastal areas. Rose butternut, *Blepharocarya involucrigera* is invading eucalypt communities in the Iron and McIlwraith Range and to a lesser extent in the Jardine River area. On the cracking clay soils of central Cape York Peninsula the transition is to *Piliostigma malabaricum*.

Awareness of the environment

Key indicators:

- Young trees including rainforest species, melaleuca, eucalypt or cypress pines are beginning to rise above the ground layer plants.
- The understorey or mid-stratum is becoming difficult to see through or walk through.
- Ground-layer plants are declining in health, diversity and abundance due to shading.
- Grasses are thinning.
- Vines are making walking difficult.
- *Alyxia spicata* is climbing into the mid stratum.

Young melaleuca trees are beginning to rise above the grassy ground layer.
Mark Newton, DSITIA, near Silver Planes house (2003).

Young eucalypt trees are abundant in the mid-stratum. It is becoming difficult to see through.
Mike Ahmet, QPWS, Mungkan Kandju (2009).

Grasses are beginning to thin-out due to overabundant trees.
Mike Ahmet, QPWS, Annan River (2008).

Rainforest trees are invading this grassland.
Mike Ahmet, QPWS, Iron Range National Park (2008).

Discussion

- East of The Great Dividing Range in the moister areas of Cape York Peninsula (where rainfall is above 1500 mm per year), the speed of rainforest encroachment into surrounding ecosystems is rapid. This is mainly due to more regular, continual rainfall, warmer temperatures and less frequent fires. In the drier western area of the bioregion, the area impacted by the expansion of melaleuca and eucalypts is less due to frequent, late dry season fires which impact a large proportion of the bioregion. However where it does occur it can have a significant impact on species and communities and emphasis should be placed on minimising further losses of open woodland and grasslands.
- Rainforest expansion at Iron Range National Park occurs rapidly, within 30 years (Stanton 1992; Russel-Smith et al. 2004). Russel-Smith et al. (2004) also found that rainforest expansion can occur even at large distances away from rainforest edges. In grassy pockets within rainforest, fire frequency is likely a more important factor than fire severity in overabundant rainforest seedlings/sapling control.
- Soil type varies the species that are likely to become overabundant. For example, in some areas grasslands are found on deep soil which is suitable for the development of rainforest. Melaleuca overabundance usually occurs on shallow, poorly drained soils. On cracking clay soils of central Cape York Peninsula the transition is to *Piliostigma malabaricum*.
- Cypress pine overabundance is extensive and very far advanced in eucalypt communities that occur in the Jardine River catchment and adjacent coastal areas. Cypress is limited to deeper soil types on broad ridges in an undulating landscape. This overabundance (which has occurred over a long period of time) is now far beyond recovery through planned burn operations. However, nearby emerging problems should be considered a priority.
- In eucalypt communities that exist on floodplains, be aware of episodic mass germination that can occur after flooding. The bare soil provides an ideal seed bed for eucalypt germination, and is usually followed by persistent rains that nurture the regrowth.
- Application of fire in rare grassland communities is a very high priority. These areas include grasslands surrounded by rainforests at Iron Range National Park and coastal headland grasslands invaded by shrubs. Remaining examples of these communities should be retained.

- The endangered golden-shouldered parrots *Psephotus chrysopterygius* nest in termite mounds in grasslands. Their habitat is declining due to melaleuca woodland invading grassland and reducing nesting habitat, food sources and potentially increasing the threat of predation. Melaleuca seedlings and saplings shade-out and eventually replace open grassland communities when high-severity fires are restricted or absent. These parrots are now confined to two populations in central Cape York Peninsula which continue to retreat and become isolated. They are found on protected estate at Staaten River National Park (Garnett and Crowley 2002), Alwal National Park (CYPAL) and Mary Valley Station.
- Palm cockatoos *Probosciger aterrimus* are threatened by overabundant rainforest seedling/saplings in their preferred nesting habitat—open woodlands adjacent to rainforest (Murphy et al. 2003). Palm cockatoos have a lower nesting success rate in rainforest possibly due to higher humidity, greater rates of predation and higher tree turn over. As such, their preference is for nest sites in open woodland areas. However, distance from the rainforest margin is also important as they utilise food sources in both ecosystems— their habitat range is limited to the ecotone. Rainforest expansion threatens suitable nest sites in areas of open woodlands which are burned too infrequently or with low-severity— fire plays a key role in the survival of this species.
- Seed-eating species such as the crimson finch (white bellied) *Neochmia phaeton evangelinae*, and the star finch (northern) *Neochmia ruficauda clarescens* have declined significantly across the tropical north of Australia to such an extent that their survival is threatened. While not completely understood, it is thought that this (in part) is attributed to grasslands being invaded by melaleuca woodland (altering habitat and reducing food sources). Cattle grazing, introduced flora and fauna, illegal trapping and trampling most likely also play a role (Dorricott and Garnet 2007). The finches are found on protected estate at Lakefield National Park and Battle Camp Station in the Laura Basin.
- Woody thickening becomes much more severe where stock grazing is combined with repeated early season burns. Stock grazing reduces fuel loads preventing fires of a sufficient severity to manage overabundant seedlings/saplings. This is further compounded by concentrated feeding on regrowth grasses in the recently burnt areas which allows woody species the competitive advantage.

The grassland habitat of the golden-shouldered parrot continues to decline due to inappropriate fire.

Above: nest in a termite mound.

Daryn Storch, Cape York Peninsular.

Appropriate fire management is vital to the survival of palm cockatoos.

Daryn Storch, QPWS, Wenlock River, Batavia Downs (2010).

A female crimson finch. Inappropriate or altered fire regimes may play a role in their decline.

Daryn Storch, QPWS, Kennedy Bend Lakefield National Park (2010).

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.

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

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

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Residence time or scorching

- **For overabundant cypress, melaleuca and eucalypts** use a slow-moving backing fire that creates high residence time around the base of the saplings/seedlings. For **rainforest saplings/seedlings**, scorching to the tip of the plant is more important, therefore ensure fire is of sufficient severity —see below).

Mosaic (area burnt within an individual planned burn)

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

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

- It is likely that more than one planned burn will be required to manage this issue. Monitor the outcomes until the overabundant saplings/seedlings are controlled.

Fire severity

- **Use moderate** for most situations where young trees are less than one metre tall. Where young trees are taller than one metre, a **high**-severity fire might be necessary. Use high-severity fire with caution, as there will be an impact on habitat trees and fallen logs and the fire will be much harder to contain. Avoid lower-severity burns as this will exhaust fuel and reduce opportunities for subsequent higher-severity burns.

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.

Other considerations

- It is important to observe post-fire germination, regeneration and kill rates to ascertain the need for subsequent fires. If the initial fire triggers a flush of new seedlings, a follow-up planned burn within two years, using a **moderate**-severity fire may be required.
- If a fire has triggered a flush of eucalypt seedlings do not burn the following year but allow the fuels to accumulate so that fire in the second year kills the seedlings.
- Once the area has recovered, the recommended regime for the fire vegetation group can be resumed (see relevant chapter).

To manage rainforest sapling and seedlings, fire of sufficient severity should be applied to scorch the tip of the plant (see scorch heights in the table on page 136).
Mike Ahmet, QPWS, Iron Range National Park (2008).

When grasses have thinned as significantly as this, it can be difficult to burn.
Peter Stanton, Environmental Consultant Pty Ltd (1996).

What weather conditions should I consider?

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

Late season burns	Storm burns
GFDI: 2–18	**GFDI:** 12–24
DI (KBDI): 80–180	**DI (KBDI):** < 80
Wind speed: 15–20 km/hr	**Wind speed:** < 23 km/hr

Fires applied too early in the season will result in fire severity that is too low to kill saplings/ seedlings. Note the eucalypts resprouting.

Mike Ahmet, QPWS, Mungkan Kandju (2009).

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 recommended to address overabundant rainforest seedlings/saplings, this issue is largely 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 (due to shading-out or if the thicket is well developed). **Line or strip ignition** is used to create a fire of higher-intensity or to help carry fire through moist or inconsistent fuels. In this instance a follow-up planned burn will be required in the one to three years post-fire to kill the surviving and new seedlings/saplings. Poorer soils will take a longer time to accumulate fuel.
- **A backing fire with good residence time.** For melaleuca, cypress and eucalypt overabundance, a slow moving backing fire (lit against the wind on the smoky edge), will allow a greater residence time, while ensuring fire intensity and rate of spread are kept to a minimum. Greater residence time is useful in reducing these overabundant seedlings/saplings.
- **Storm burning** is undertaken in the storm season after the first rains. A minimum of 50 mm is recommended with consideration to the spread of the rainfall.
- **Aerial ignition** is a tactic used when access is difficult and limited. Grid ignition can be used to increase the fire severity (see below). The established route of any flight should take into consideration the property boundaries and any fire-sensitive vegetation. Flight routes should be programmed into a GPS.
- **Grid ignition:** Incendiaries are dropped well-within the park boundary (as illustrated below) in sweeping 180^{o} turns with considerable variation in spacing between ignition points and runs. In areas of overabundant seedlings/saplings, the spacing between incendiaries is reduced to increase the severity and lessen patchiness.

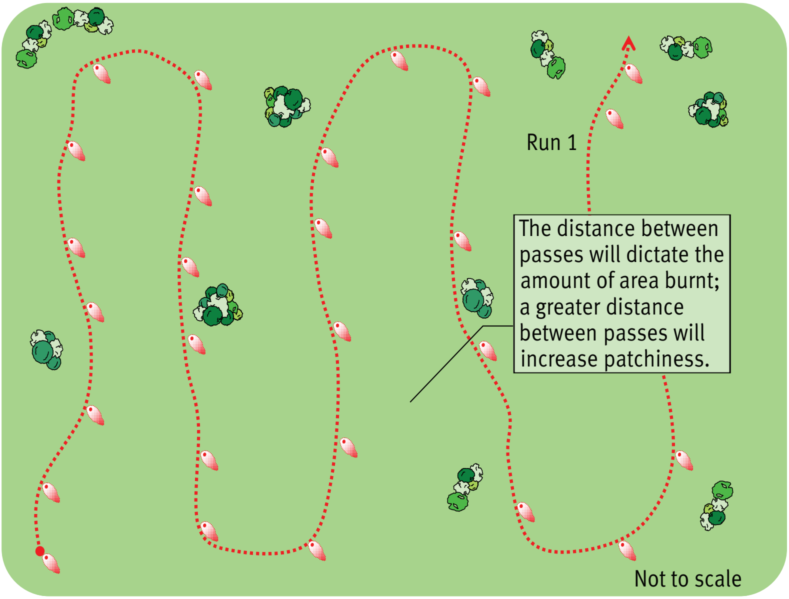


Figure 1: Aerial ignition tactics

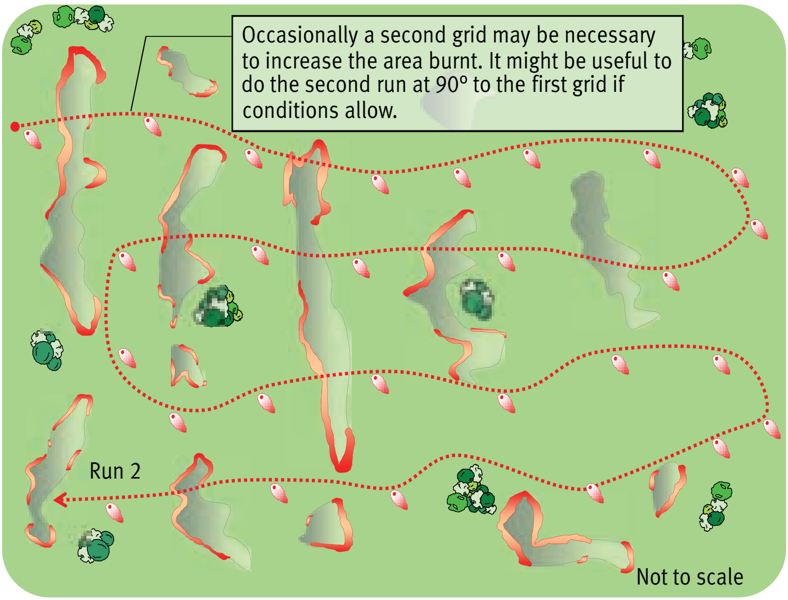


Figure 2: The second run of aerial ignition at 90° will further increase the area burnt and the severity of the fire.

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

Non-target fire vegetation groups include rainforests, riparian, saltmarsh, coral cays, casuarina and foredune 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 the community may be required to protect them. Other areas to limit fire encroachment may include melaleuca and wetland communities when the peat is dry (refer to Chapter 5 [Issue 2]) or other fire vegetation groups which are not ready to burn.

Awareness of the environment

Indicators of fire encroachment risk:

- The fire-sensitive community is located within or adjacent to areas where frequent wildfires occur.
- Cyclone or logging damage where dry fuel is upon the ground or suspended in trees inside rainforests or other fire-sensitive vegetation.
- High-biomass grasses are invading riparian communities.
- The non-target community is upslope of the planned burn area.
- Melaleuca communities where the peat is dry.

A low-severity fire in *Melaleuca viridiflora* community. Ground saturation has been used to control fire entering the community.

Mark Parsons, QPWS, Sunday Creek (2010).

A low-severity backing fire under the right conditions will not scorch the riparian community. Fire will trickle downhill and self-extinguish before reaching the riparian zone.
Kerensa McCallie, QPWS, Davies Creek, Dinden National Park (2010).

Surface water is used to control fire encroaching into saltmarsh.
Mark Parsons, QPWS, Waterfall Creek (2010).

Discussion

- Under appropriate planned burn conditions with good soil moisture, or if a landscape-level mosaic is well-established it may not be necessary to employ specific tactics to protect fire-sensitive vegetation (as they tend to self-protect). If suitable conditions cannot be achieved specific tactics may be required to protect the non-target fire vegetation group. See the tactics at the end of this chapter.
- In some melaleuca and sedgeland communities, ensure suitable conditions to avoid peat fires prior to burning the surrounding area. Refer to Chapter 5 (Issue 2), regarding fire management guidelines.
- 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 these communities.

What is the priority for this issue?

Priority	Priority assessment
Very high	Planned burn required to maintain areas of **special conservation significance.**

Assessing outcomes

Formulating objectives for burn proposals

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)
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 one metre into the edge.	**Achieved:** Fire penetrates no further than one metre into the edge. **Not Achieved:** Fire penetrates further than one metre into the edge.

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

Fire parameters

What fire characteristics will help address this issue?

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

Fire severity

- A **low**-severity fire in 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 patchiness for the fire vegetation group being burnt. Aim for the higher end of the recommended patchiness, as this will help mitigate the movement of wildfire into fire-sensitive communities.

Landscape Mosaic (a planned landscape level mosaic)

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

What weather conditions should I consider?

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

FFDI/GFDI: Refer to relevant fire vegetation group.

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

Wind speed: < 15km/hr

Soil moisture: If fuel moisture within a fire-sensitive community is insufficient or the fire-sensitive community is upslope from the planned burn, consider using the tactics outlined below.

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-intensity 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-intensity backing fire. Depending on available fuels and the prevailing wind on the day, this may require either spot or strip lighting or a combination of both.
- **Afternoon ignition.** Planned burning in areas adjacent to non-target communities can be undertaken late in the afternoon. The milder conditions during this period will assist in promoting low-severity fires that trickle along the edge 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 on the ground.
- **Broad-scale fire management.** Refer to the tactics in Chapter 1 for specific guidelines on establishing and maintaining a mosaic across large areas.

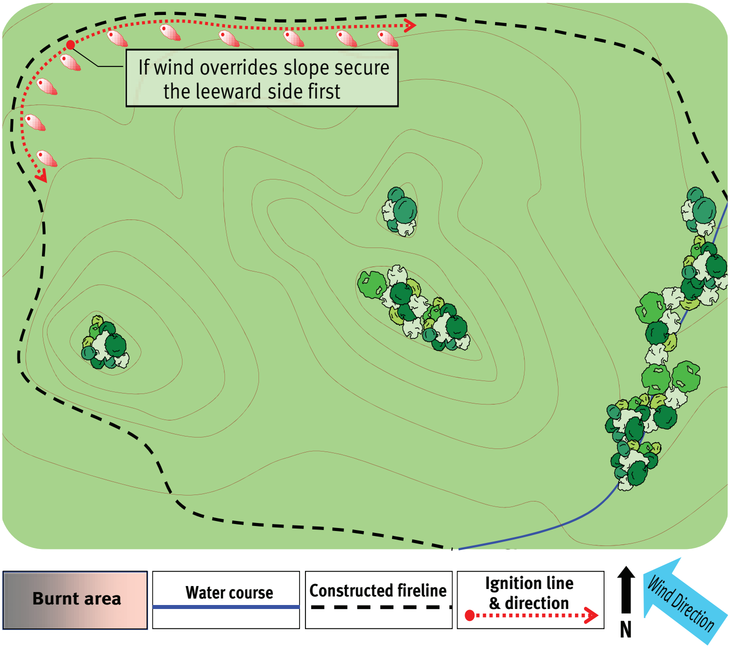


Figure 1: An example of an initial lighting pattern where wind is the dominating influence.

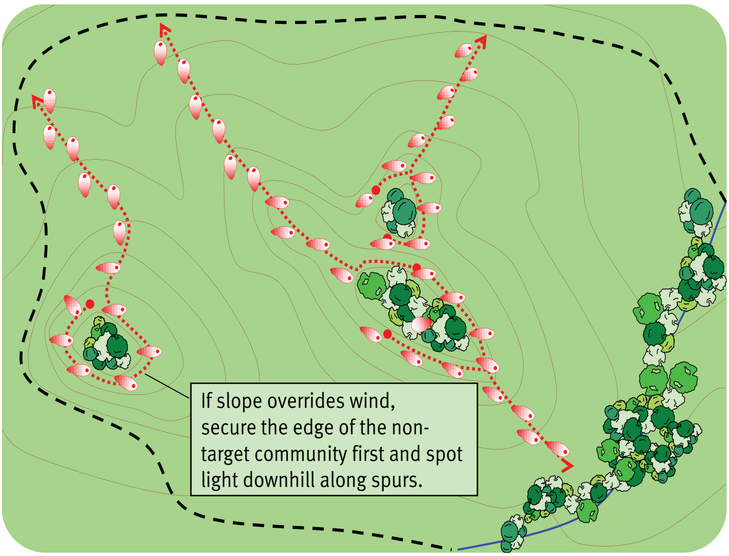


Figure 2: An example of strategic ignition adjacent to the non-target community and along spurs in an area where the slope is the dominant influence.

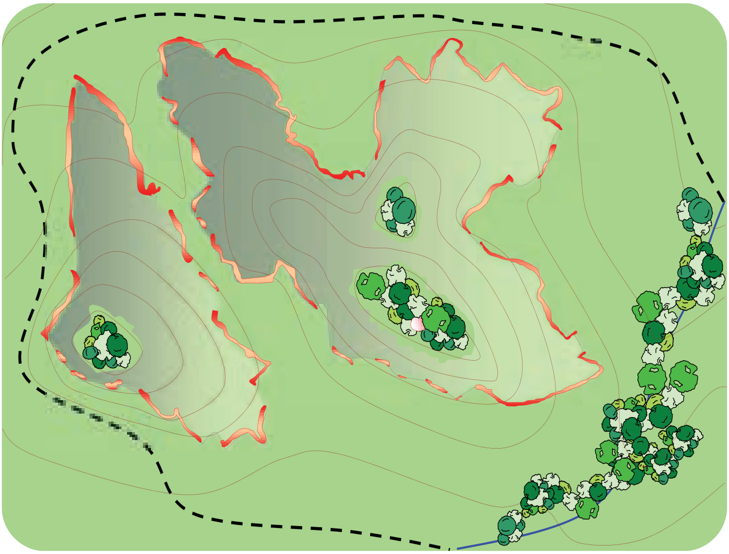


Figure 3: An example of the possible resulting burn pattern after burning from the edge of the non-target community.

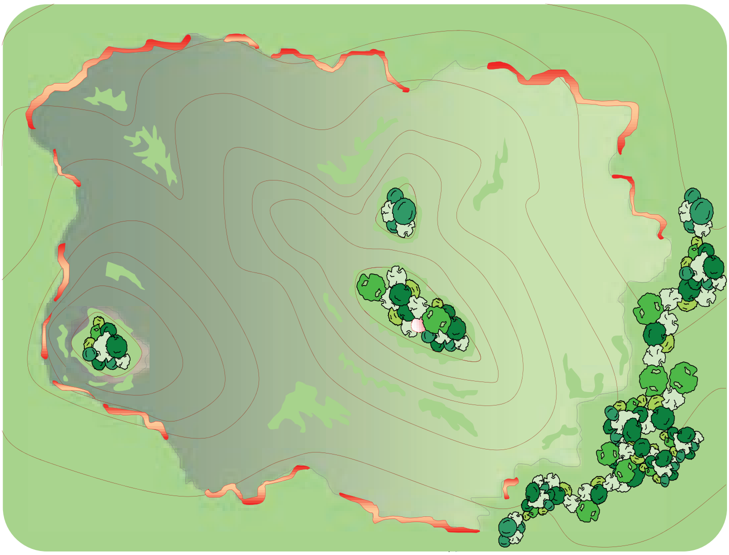


Figure 4: It was not necessary to burn back from the non-target community at the bottom of the slope, as the backing fire naturally extinguished against its edge due to greater moisture in the low-lying area.

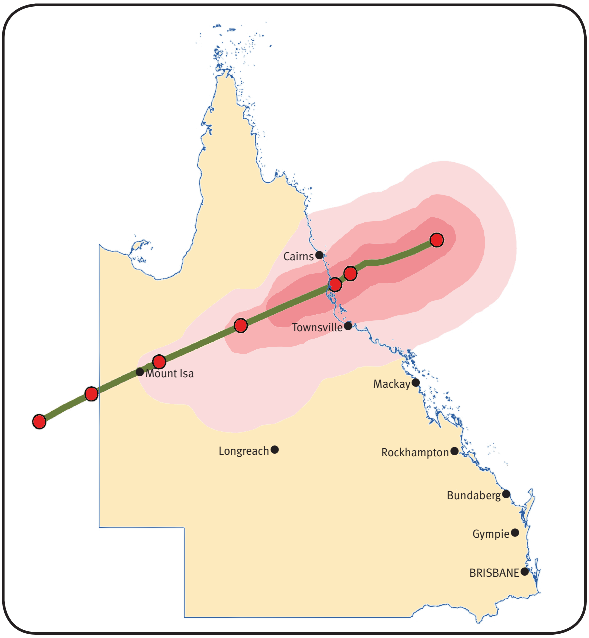
Issue 7: Post cyclone planned burning

In the event of a severe tropical cyclone (category three or higher) the canopy of trees and shrubs may be stripped, accumulating upon 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 further increasing elevated fuels. A high level of fallen tree damage can also be expected, increasing heavy-fuel loads and impeding fireline 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.



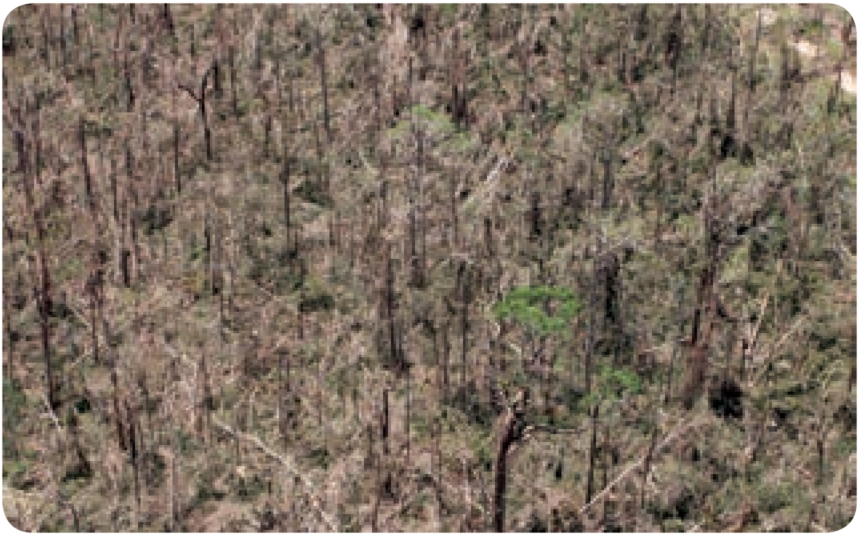
Illustrating the extensive region of wind damage caused by Cyclone Yasi which devastated the Cassowary Coast in February 2011.

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 are stripped from open forest trees.
- Leaf, leaf shred, branches and limbs are accumulated on the ground as significant fuel loads.
- Branches and fine fuels are 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 6 of this chapter).
- Rainforest or other fire-sensitive community has been 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 (e.g. 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).

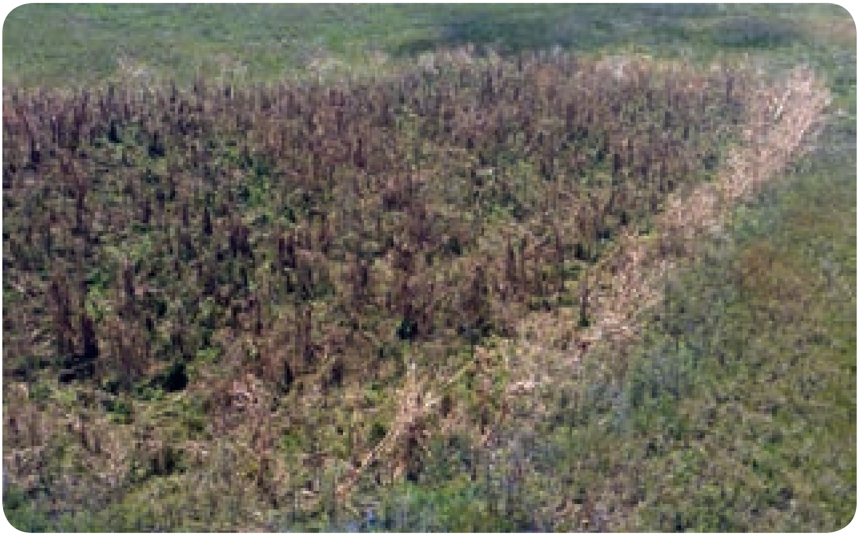
Category 5 cyclonic winds can cause build-up of fine and elevated fuels over substantial areas. Suspended fuel is aerated which decreases drying time and increases combustibility.
Richard Lindeman, QPWS, Cyclone Yasi, Stephens Island, Barnard Island Group National Park (2011).

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.

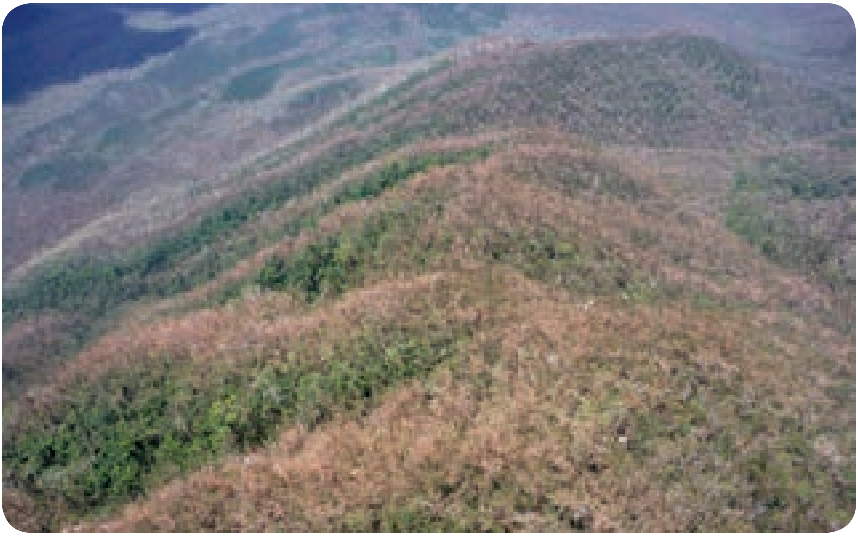
Audrey Reilly, QPWS, Cyclone Yasi, Hull River (2011).

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 five 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 % 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 % 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** until **autumn**. Also, storm burns during **December** until **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 10, Issue 6).
- **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).

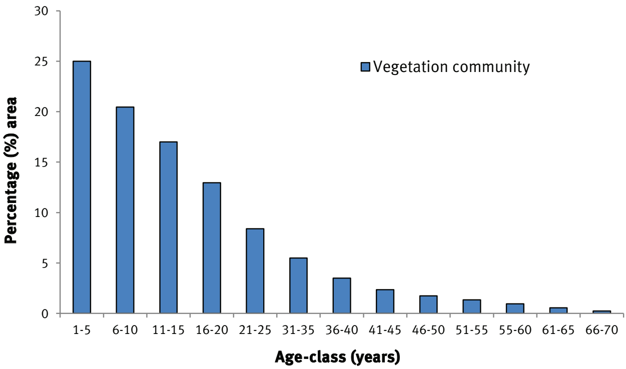
- **Wet lines, blower lines (to clear strewn material) and/or rake-hoe** lines may have to be established along the edge of non-target areas. It is time consuming to establish wet lines, blower lines or rake-hoe lines especially where the boundary is extensive and where there has been considerable fallen 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.

Severe Cyclone Monica (Category three) uprooted entire trees in the northern section of Mungkan Kandju National Park in April 2006.

Mike Ahmet, QPWS (2006).

Glossary of fire terminology

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

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

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

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

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

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

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

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

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

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

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

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Appendix 1: List of regional ecosystems

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

Fire vegetation group	Hectares within the Cape York Peninsula bioregion	Percentage
Eucalypt communities	8 525 969	69.11
Grasslands	439 270	3.56
Heath communities	587 299	4.76
Melaleuca communities	1 701 670	13.79
Sedgelands	100 674	0.82
Acacia communities	2 496	0.02
Dunes and coral cays	57 179	0.46
Rainforest	480 819	3.90
Mangrove and saltmarsh	272 990	2.21
TOTAL	**12 336 713**	**100**

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
1	1	**Eucalypt communities**	Eucalypt communities		3.12.37, 3.12.7, 3.12.8, 3.12.9, 3.10.15a, 3.10.15b, 3.11.12, 3.11.15, 3.11.15a, 3.11.15b, 3.11.17, 3.11.17a, 3.11.17b, 3.11.17x1, 3.11.5, 3.11.6a, 3.11.6b, 3.11.6c, 3.12.17, 3.12.17a, 3.12.17b, 3.12.17x1, 3.12.18, 3.12.19a, 3.12.19b, 3.2.7, 3.2.7a, 3.2.7b, 3.3.17a, 3.3.17b, 3.3.18, 3.3.19, 3.3.20a, 3.3.20b, 3.3.20c, 3.3.21, 3.3.22a, 3.3.22b, 3.3.23, 3.3.28, 3.3.29, 3.3.8, 3.5.21, 3.5.21x1, 3.5.22a, 3.5.22b, 3.5.22c, 3.5.22d, 3.5.22x1, 3.5.22x2, 3.5.25a, 3.5.25b, 3.5.25c, 3.5.26, 3.5.31, 3.5.5a, 3.5.5b, 3.8.3a, 3.8.3b, 3.11.8, 3.11.8x1, 3.11.8x2, 3.11.9, 3.12.10a, 3.12.10b, 3.12.10c, 3.12.10x2, 3.12.11, 3.12.12, 3.12.13, 3.12.14a, 3.12.14b, 3.12.14c, 3.12.23a, 3.12.23b, 3.12.24, 3.12.25, 3.12.38, 3.10.10, 3.10.10a, 3.10.10b, 3.10.11, 3.10.21a, 3.10.21b, 3.10.21c, 3.10.6a, 3.10.6b, 3.10.6c, 3.10.6d, 3.10.6x1a, 3.10.6x1b, 3.10.7a, 3.10.7b, 3.10.8, 3.10.9a, 3.10.9b, 3.10.9c, 3.10.9d, 3.10.9e, 3.11.10a, 3.11.10b, 3.11.11, 3.11.11x1a, 3.11.11x1b, 3.11.11x1c, 3.11.11x1d, 3.11.11x2, 3.11.11x3, 3.11.13, 3.11.14, 3.11.4, 3.11.7, 3.12.15a, 3.12.15b, 3.12.15x1a, 3.12.15x1b, 3.12.15x1c, 3.12.15x2a, 3.12.15x2b, 3.2.10a, 3.2.10b, 3.2.10c, 3.2.5a, 3.2.5b, 3.2.5c, 3.2.8a, 3.2.8b, 3.2.9, 3.3.26, 3.3.27a, 3.3.27b, 3.3.27c, 3.3.31a, 3.3.31b, 3.3.31c, 3.3.70, 3.5.1, 3.5.10, 3.5.10x1, 3.5.11, 3.5.12, 3.5.2, 3.5.23, 3.5.23x1, 3.5.24a, 3.5.24b, 3.5.6, 3.5.7a, 3.5.7b, 3.5.7c, 3.5.7d, 3.5.7e, 3.5.7x1, 3.5.7x2a, 3.5.7x2b, 3.5.7x2c, 3.5.8a, 3.5.8b, 3.5.8c, 3.5.9a, 3.5.9b, 3.5.9d, 3.7.3, 3.7.4, 3.7.5a, 3.7.5b, 3.9.2a, 3.9.2b, 3.9.2x2, 3.9.2x1, 3.9.2x3, 3.9.2x4, 3.9.2x5, 3.9.4, 3.9.4a, 3.9.4b, 3.9.6, 3.3.30.
	1		Floodplain woodlands		3.3.11, 3.3.15, 3.3.16, 3.3.24, 3.3.25a, 3.3.25b, 3.3.25c, 3.3.35, 3.3.36, 3.3.36a, 3.3.36b, 3.3.37a, 3.3.37b, 3.3.40a, 3.3.40b, 3.3.45, 3.3.46, 3.3.69, 3.3.9.
2	1	**Grasslands**	Grasslands		3.3.44, 3.12.29, 3.3.56, 3.3.56a, 3.3.56b, 3.3.56c, 3.12.30, 3.12.31, 3.12.31x1, 3.12.31x1a, 3.12.31x2a, 3.12.31x2b, 3.12.32, 3.3.34, 3.3.57, 3.3.58, 3.3.60a, 3.3.60b, 3.3.61a, 3.3.61b, 3.3.62, 3.5.29, 3.5.30, 3.5.30x1, 3.5.30x3, 3.8.4a, 3.8.4b, 3.9.5, 3.9.7, 3.9.8a, 3.9.8b.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
3	1	**Sedgelands**	Saw sedge or bulkaru sedgelands	Sb	3.10.20, 3.2.33, 3.3.63, 3.3.64, 3.3.64a, 3.3.64b, 3.3.64c, 3.3.65.
3	1	**Sedgelands**	Permanent lakes and lagoons	Sl	3.2.27, 3.2.27a, 3.2.27b, 3.3.66a, 3.3.66b, 3.3.66x1a, 3.3.66x1b.
4	1	**Heath communities**	Heath communities		3.12.26a,3.12.26b, 3.12.26c, 3.12.26x1, 3.12.26x2, 3.12.27, 3.12.28, 3.3.53a, 3.3.53b, 3.3.53x1, 3.3.53x2, 3.3.54, 3.3.55, 3.10.12, 3.10.13, 3.10.14, 3.10.17, 3.10.18, 3.10.19a,3.10.19b, 3.11.19, 3.11.19a, 3.11.19b, 3.2.18a,3.2.18b, 3.2.18c, 3.2.19a,3.2.19b, 3.2.20, 3.2.21, 3.2.22, 3.2.23, 3.5.19, 3.5.19x1, 3.5.19x2, 3.5.19x3, 3.5.19x4, 3.5.19x5, 3.5.19x6, 3.5.19x7, 3.5.19x8, 3.5.28.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
5	1	**Melaleuca communities**	Melaleuca swamps	Ms	3.2.4a, 3.2.4b, 3.2.4c, 3.2.4d, 3.2.4e, 3.3.12.
	1		Melaleuca heath	Mh	3.3.51, 3.3.52a, 3.3.52b, 3.3.52c, 3.2.14, 3.3.67, 3.7.6x2.
	1		Melaleuca gallery forest	Mg	3.3.10a, 3.3.10b, 3.3.10c, 3.3.10d. *see note below table
	1		Melaleuca woodland	Mw	3.3.42a, 3.3.42b, 3.3.43, 3.3.43x1, 3.3.47, 3.3.48a, 3.3.48b, 3.3.49x1, 3.3.49a, 3.3.49b, 3.3.50a,3.3.50b, 3.3.50c, 3.10.16a,3.10.16b, 3.10.16c, 3.10.16x1, 3.10.16x2, 3.11.18a,3.11.18b, 3.11.18c, 3.12.16a,3.12.16b, 3.12.16c, 3.2.3, 3.3.13, 3.3.14a, 3.3.14b, 3.3.32, 3.3.41, 3.3.42c, 3.5.13, 3.5.14a,3.5.14b, 3.5.14c, 3.5.15a,3.5.15b, 3.5.16, 3.5.17a,3.5.17b, 3.5.18, 3.5.18x2, 3.5.27, 3.7.6, 3.7.6a,3.7.6b, 3.7.6x1, 3.7.6x3, 3.3.33, 3.2.16. **see note below table

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
6	1	**Acacia communities**	Acacia communities		3.7.2. *** see note below table
7	1	**Dunes and coral cays**	Dunes and coral cays		3.2.1a,3.2.1b, 3.2.11, 3.2.12, 3.2.13, 3.2.15a,3.2.15b, 3.2.15x1, 3.2.17, 3.2.2a,3.2.2b, 3.2.25, 3.2.28, 3.2.29, 3.2.31, 3.2.6a, 3.2.6b.
8	1	**Rainforest**	Rainforest		3.12.1a,3.12.1b, 3.12.22, 3.12.4a,3.12.4b, 3.12.5, 3.12.6, 3.3.5a,3.3.5b, 3.3.5c, 3.10.1, 3.10.1a,3.10.1b, 3.10.1c, 3.10.1d, 3.10.2a,3.10.2b, 3.10.3, 3.10.5a,3.10.5b, 3.11.1x1a, 3.11.1x1b, 3.11.2a,3.11.2b, 3.11.3, 3.11.3x1, 3.12.2, 3.12.20, 3.12.21a,3.12.21b, 3.12.21c, 3.12.3a,3.12.3b, 3.12.3c, 3.12.33a,3.12.33b, 3.12.34a,3.12.34b, 3.12.34c, 3.12.35a,3.12.35b, 3.12.35c, 3.12.35d, 3.12.35e, 3.12.35f, 3.12.36a,3.12.36b, 3.12.36x3, 3.3.1a,3.3.1b, 3.3.1c, 3.3.2a,3.3.2b, 3.3.38, 3.3.38a,3.3.38b, 3.3.39, 3.3.4, 3.3.6, 3.3.68, 3.3.7, 3.5.20, 3.5.3, 3.5.3x1, 3.5.32, 3.5.4, 3.5.4x1, 3.5.4x2, 3.5.4x3, 3.5.4x4, 3.5.4x5, 3.7.1, 3.7.1x1a, 3.7.1x1b, 3.7.1x2, 3.8.1, 3.8.2a,3.8.2b, 3.8.2x1, 3.8.5a, 3.8.5b, 3.8.5c, 3.8.5d, 3.8.5e.
9	1	**Mangrove and saltmarsh**	Mangrove and saltmarsh		3.1.1a, 3.1.1b, 3.1.1c, 3.1.2a,3.1.2b, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.2.24, 3.2.26, 3.2.30, 3.2.32.

*Melaleuca gallery forests are not well described by the Regional Ecosystem Description Database (REDD), probably because of their remoteness. While only one regional ecosystem is included here there are other communities. Refer to Chapter 4 for further information.

**Melaleuca woodlands are generally well described by the REDD however very tall (+ 30m) woodlands on the margins of swamps and lagoons on deep peat soils have not been identified, probably because they only cover a very small area.

***Acacia dominated communities constitute only a very small proportion of the CYP bioregion. While only one regional ecosystem is included here, others are described in Chapter 6 that are likely not of sufficient size to be mapped for the REDD.

The spatial data is based on version 6.1 of the "Queensland Remnant Vegetation Cover 2006" layer (16 September 2011) and the "Draft Pre-clearing with Regional Ecosystems" layer (20 August 2010) (refer to Figure 1).

Some of the regional ecosystems (RE) listed above are not matched in the spatial data. This may be because the RE is 'not of a mappable size', the RE 'has been moved' (i.e. it has been reclassified into a new RE code), the RE exists only as a sub-dominant RE within the spatial data or the RE has not yet been mapped. In the REDD system, the comments section indicates if the RE is not of a mappable size or if it has been moved.

The RE's listed below do not have any matching records in the spatial data of version 6.1 of the Survey and Mapping of 2006 Remnant Vegetation Communities and Regional Ecosystems of Queensland spatial layer (16 September 2011) and the Draft Pre-clearing Vegetation Communities and Regional Ecosystems layer (20 August 2010).

Unmatched regional ecosystems	3.10.12, 3.10.13, 3.10.17, 3.10.18, 3.10.3, 3.10.8, 3.11.14, 3.3.54, 3.3.7, 3.1.1c, 3.10.20, 3.12.32, 3.3.14b, 3.10.14, 3.10.16x1, 3.10.1b, 3.10.1c, 3.10.1d, 3.11.17a, 3.12.17b, 3.12.19a, 3.12.1a, 3.12.1b, 3.12.26x2, 3.2.18b, 3.3.1c, 3.3.26, 3.3.38b, 3.3.53a, 3.3.53b, 3.5.7b, 3.5.7c, 3.5.7e, 3.7.6a, 3.8.1, 3.8.2x1, 3.11.11x2, 3.11.15b, 3.12.17x1, 3.12.21c, 3.12.22, 3.12.26b, 3.12.34b, 3.2.10b, 3.3.42b, 3.3.45, 3.3.52b, 3.3.60b, 3.3.64c, 3.3.67, 3.5.18x2, 3.5.30x3, 3.5.5b, 3.9.2b.

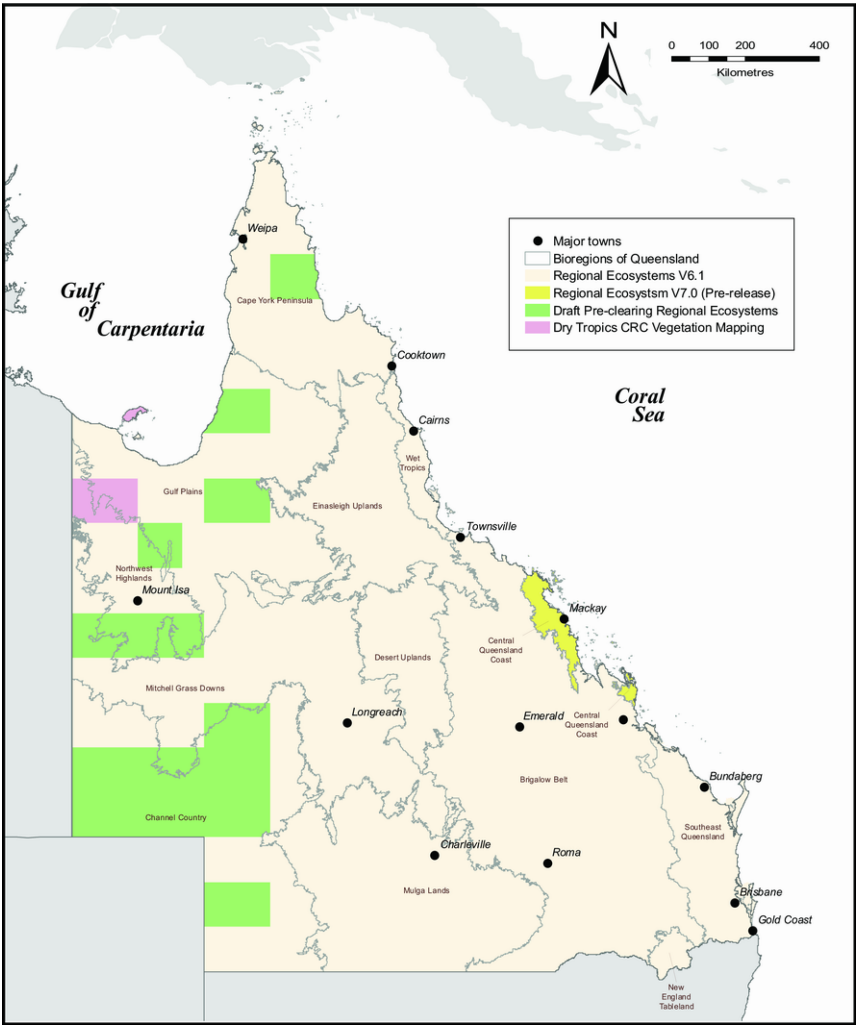

Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

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.

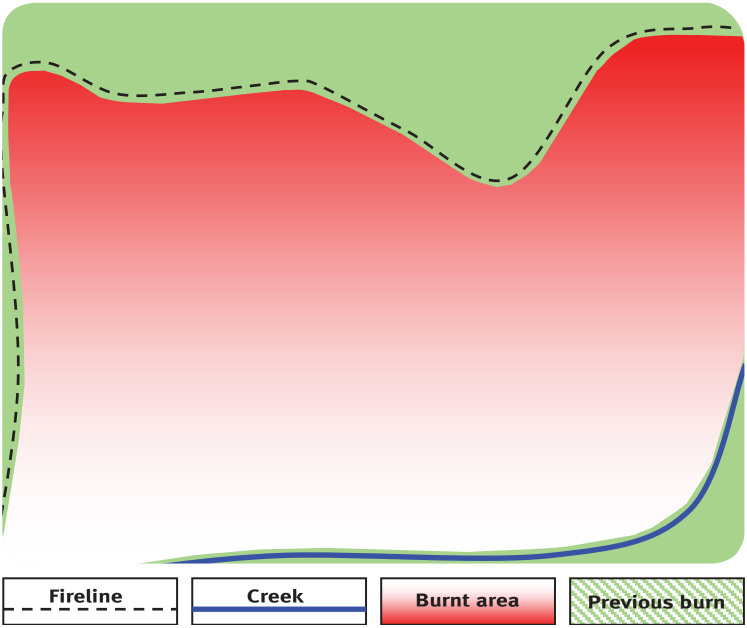

Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

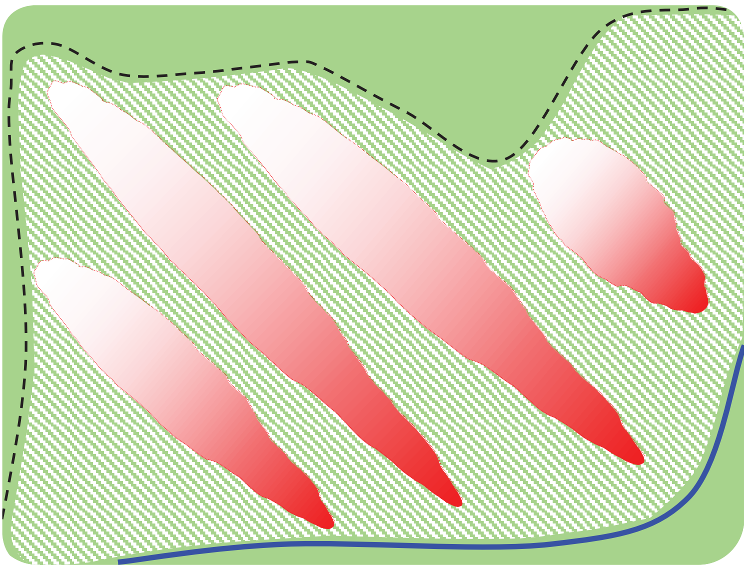

Figure 2: Planned mosaic burn—year 8.

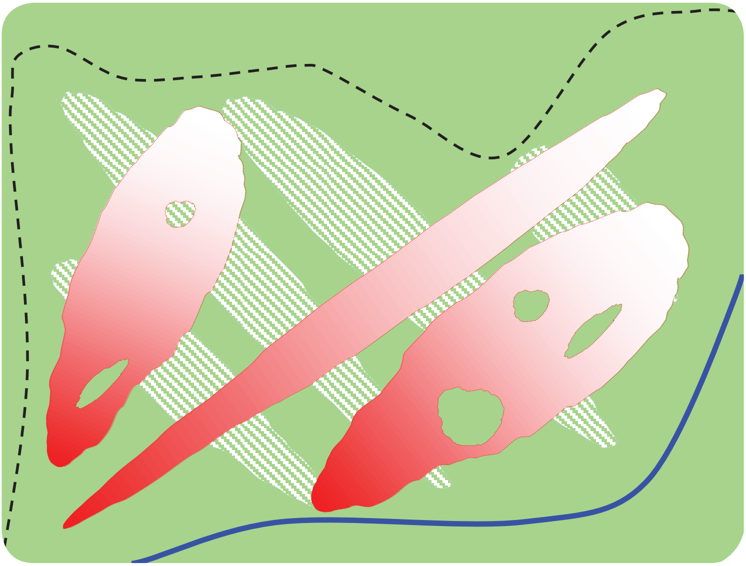

Figure 3: Planned mosaic burn—year 20.

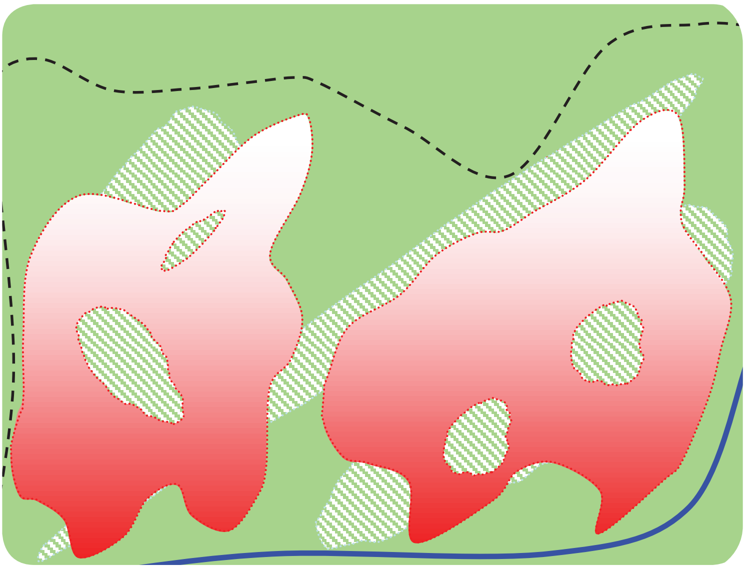

Figure 4: Planned mosaic burn—year 28.

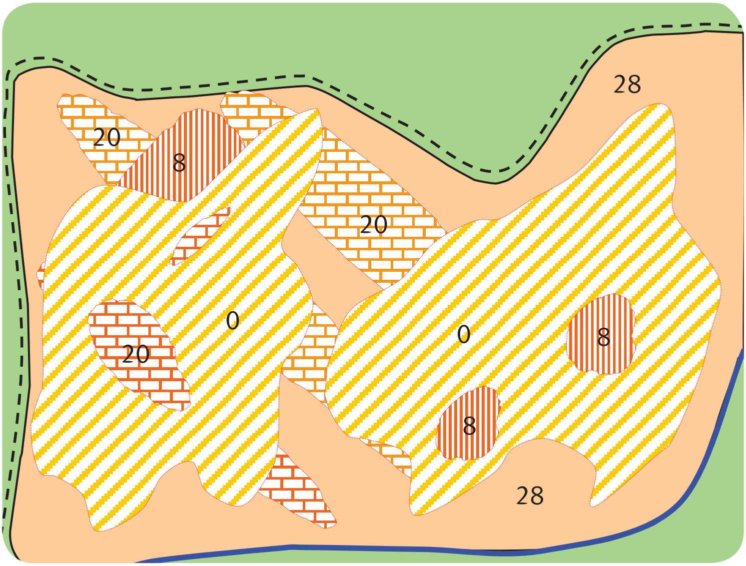

Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

Peter Stanton, Environmental Consultant Pty Ltd, Heathlands Resource Reserve (1989).

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