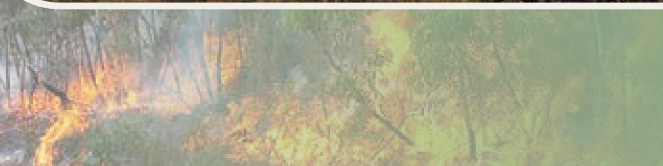
Department of Environment and Science

Queensland Parks and Wildlife Service

# Planned Burn Guidelines

## Southeast Queensland Bioregion of Queensland



Queensland Government

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*We recognise their connection to land, sea and community, and pay our respects to Elders past, present and emerging.*

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## Citation

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## Acknowledgements

Healthy Land and Water made important contributions to the intellectual content of these planned burn guidelines.

Bp2005.
Front cover photograph: Mount Greville: Moogerah Peaks National Park 2008.
*Photo: © Qld Govt.*

# Contents



# 1. Introduction

The Southeast Queensland bioregion has a subtropical climate that supports rainforests, wet and dry eucalypt forests, woodlands, heath and wetlands. The area is densely populated, with considerable habitat fragmentation across the landscape.

It is important that rangers and other land managers apply appropriate fire regimes to improve ecosystem condition, conserve biodiversity and mitigate bushfire hazards. The bioregion's various ecosystems and habitats require different fire regimes.

**Planned burn objective**

Planned burning maintains and enhances ecological and cultural values while minimising negative impacts and severity of bushfires.

Queensland Parks and Wildlife Service (QPWS) works with neighbours and stakeholders to ignite many separate parcels of land each year. This creates an evolving patchwork (mosaic) of areas burnt at different times across fire-adapted ecosystems and landscapes.

**Reading ecosystem conditions**

Achieving the desired outcomes for a planned burn requires skills in reading the landscape's condition and knowledge of appropriate ignition techniques.

An effective fire program implements many planned burns throughout the year based on ongoing assessments of landscape condition.

Reading ecosystem conditions is a fundamental skill. This guideline provides practical examples to help foster this ability.

## 1.1 Purpose of this guideline

This guideline is part of the ***QPWS Fire Management Framework for Queensland's parks and forests***. It covers the needs of broad vegetation groups found within the Southeast Queensland bioregion.

This guideline is designed to be read in conjunction with the ***Introductory Volume***.

Broad vegetation groups are a high-level grouping of vegetation communities and regional ecosystems (REs). Each chapter of this guideline addresses a single broad vegetation group, describing the ecological needs and considerations for fire management.

A vegetation classification matching resource is available on the QPWS fire management guides SharePoint page.

The ***Southeast Queensland Planned Burn Guideline*** supports the work of rangers, providing guidance to:

- develop fire strategies and burn proposals
- implement strategic planned burns
- conduct post-fire assessments and ongoing monitoring.

Using this guideline will help maintain ecosystems in good condition while also minimising impacts to life and property during fire management activities.

This guideline draws on learnings about the ecological requirements of each broad vegetation group. It also supports ongoing observations to help increase knowledge of landscapes at a local level.

This second edition of the guideline for the Southeast Queensland bioregion has been updated based on feedback from rangers and stakeholders and the results of recent research and monitoring.

Toby's Gap, Fraser Island. *Photo: Adam Creed © Qld Govt.*

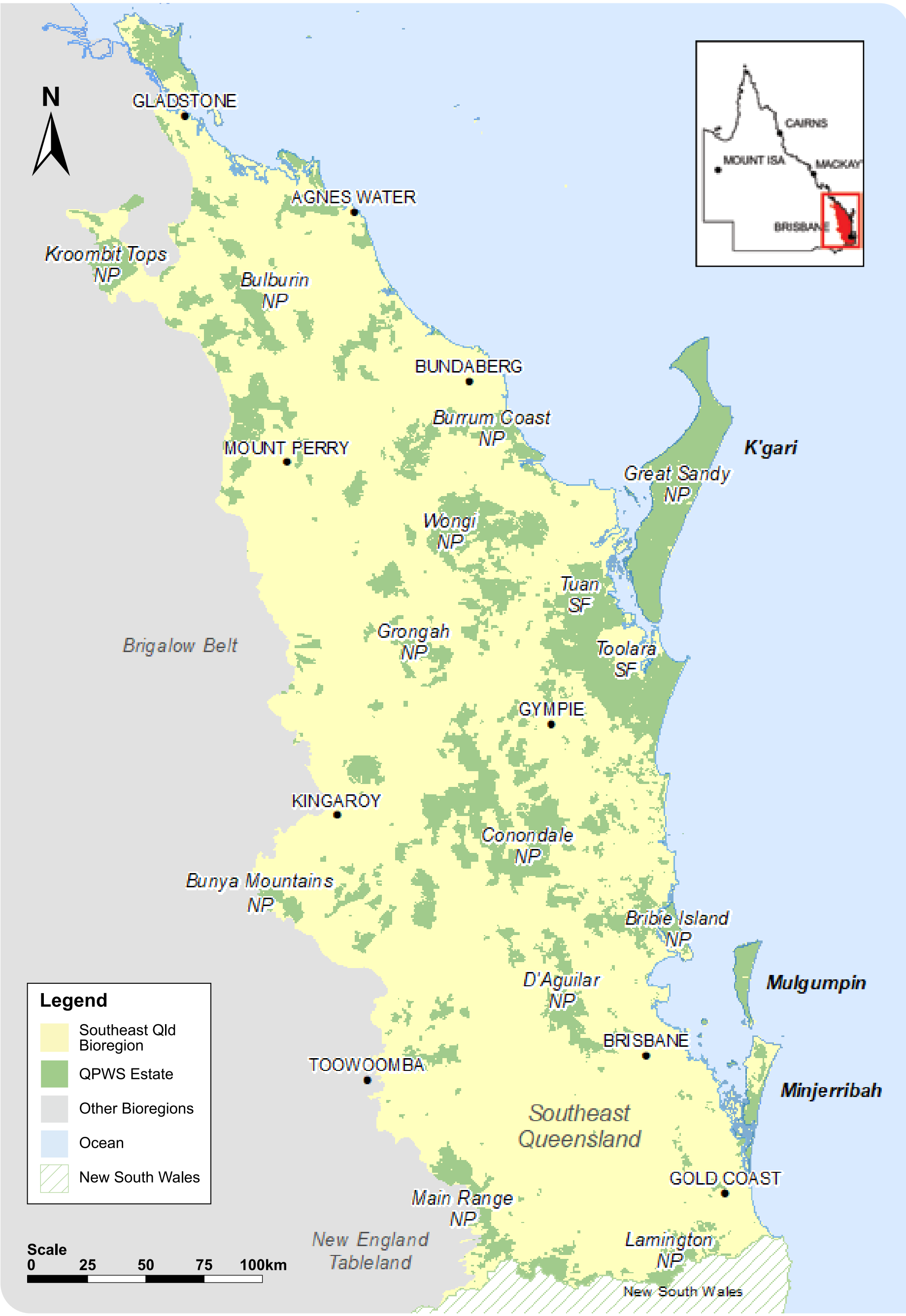


**Figure 1:** Map of the Southeast Queensland bioregion.

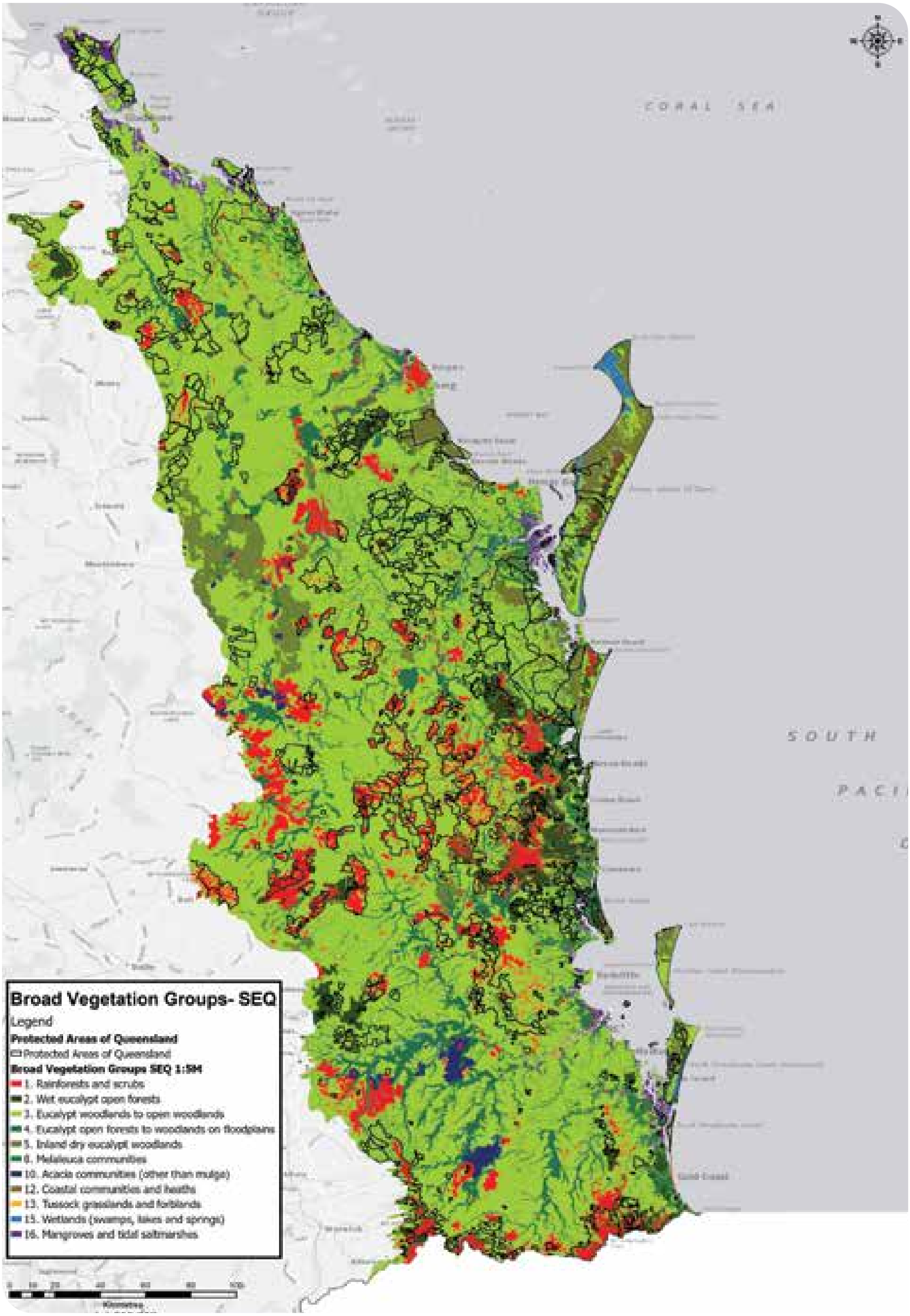


**Figure 2:** Map of the Broad Vegetation Groups in the SEQ bioregion.

## Broad vegetation groups

This guideline describes vegetation communities based on Queensland's broad vegetation groups (BVG) (1:5 million scale).

| BVG | BVG description | Related chapter in this guideline |
|---|---|---|
| 1 | Rainforests, scrubs | Chapter 2: Rainforests and scrubs |
| 2 | Wet eucalypt open forests | Chapter 3: Wet eucalypt open forests |
| 3 | Eastern eucalypt woodlands to open forests | Chapter 4: Eucalypt woodlands to open forests |
| 4 | Eucalypt open forests to woodlands on floodplains | Chapter 5: Eucalypt open forests to woodlands on floodplains |
| 5 | Eucalypt dry woodlands on inland depositional plains | Chapter 6: Inland dry eucalypt woodlands |
| 6 | Eucalypt open woodlands usually with spinifex understorey | Not in SEQ PBG |
| 7 | Callitris woodland – open forests | Not in SEQ PBG |
| 8 | Melaleuca open woodlands on depositional plains | Chapter 7: Melaleuca communities |
| 9 | Acacia aneura (mulga) dominated open forests, woodlands and shrublands | Not in SEQ PBG |
| 10 | Other Acacia dominated open forests, woodlands and shrublands | Chapter 8: Acacia communities (other than mulga) |
| 11 | Mixed species woodlands – open woodlands (inland bioregions) includes wooded downs | Not in SEQ PBG |
| 12 | Other coastal communities or heaths | Chapter 9: Coastal communities and heaths |
| 13 | Tussock grasslands, forblands | Chapter 10: Tussock grasslands and forblands |
| 14 | Hummock grasslands | Not in SEQ PBG |
| 15 | Wetlands (swamps and lakes) | Chapter 11: Wetlands (swamps, lakes and springs) |
| 16 | Mangroves and tidal saltmarshes | Chapter 12: Mangroves and tidal saltmarshes |

## 1.2 How to use this guideline

Read this guideline in conjunction with the ***QPWS Planned Burn Guidelines Introductory Volume*** (referred to as the ***Introductory volume***).

The ***Introductory Volume*** discusses issues relevant to all 13 Queensland bioregions.

Other helpful resources include:

- Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go
- Regional Ecosystem descriptions (available online at https://apps.des.qld.gov.au/regional-ecosystems/).

All fire management guidelines should be considered in the context of on-ground assessments of the landscape condition indicators presented in this document.

### Step 1: Become familiar with local park ecology and the park fire strategy

This planned burn guideline supports the local park fire strategy. Before completing a planned burn proposal, review the relevant fire strategy and learn about the fire issues unique to the local landscape.

This will ensure all ecological issues are considered (e.g. zoning plan, threatened species, fire histories) and the proposal is in line with the QPWS whole-of-landscape approach to planning and management (QPWS Good Neighbour Policy).

### Step 2: Frequently observe the landscape

Observe the environment to identify changes happening over time, including before and after a burn. Walking through the landscape allows for more detailed observation than travelling in a vehicle.

During inspections, consider the monitoring data available, including health check assessments. There may be opportunities to check established monitoring locations and indicators.

#### Indicators in the environment

1. Observe and note the following if a canopy is present:
    - Is the canopy full of healthy foliage?
    - Is tree branch foliage dying? Is there epicormic regrowth on branches? Are there any dead trees?
    - Is there an overabundance of mistletoe in the canopy?
    - Are there habitat trees (e.g. large trees with hollows)?
    - Do the bases of some trees contain fire scar damage?

2. Observe and note the following if there is a mid-layer of woody plants:
   - What are the mid-layer plants? Are they shrubs (e.g. Fabaceae or *Banksia* species) or young saplings (e.g. eucalypts, wattles, casuarinas or rainforest species)? How tall are they (e.g. within the grass layer, eye height or taller)? How open or dense is the mid-layer (i.e. how far can you see through it)?
   - Are shrubs looking healthy and vigorous? Do the shrubs have dying crowns?
   - Is there evidence of fire (e.g. charred trunks, dead shrub stems)? How prevalent and high is blackened bark? Has green, new growth returned to the same height as the burnt, dead stems?
   - Have most obligate-seed regenerators set at least one seed crop?
3. Observe and note the following in ecosystems with a ground layer of grasses or sedges:
   - Do grasses look healthy and vigorous? Are there well-formed grass clumps?
   - Is there a build-up of dead and decaying matter around grasses, shrubs, ferns or sedges?
   - Does the ground layer have species diversity, or do one or a few juvenile tree species dominate?
4. Observe other aspects:
   - Are there rainforest, scrub or riparian ecosystems nearby?
   - Are weeds dominating the understorey?

### Step 3: Identify the broad vegetation group found in the proposed burn area and read the relevant chapter of this planned burn guideline

Request a map of Biodiversity Status and Broad Vegetation Group at https://apps.des.qld.gov.au/map-request/re-broad-veg-group/

### Step 4: Identify any specific considerations relevant to the proposed burn area

The proposed burn area may have several considerations. Burn proposals should address all the considerations relevant to that location.

### Step 5: Consider the fire management priorities

Within management areas, fire management priorities must be determined.

These planned burn guidelines help rangers prioritise different areas based on ecological requirements. Refer to the broad vegetation group chapter, then find the relevant considerations for information about priorities.

Use these guidelines in conjunction with the ***QPWS Bushfire Risk Management Framework (BRMF)*** to set priorities. The BRMF helps to prioritise actions to address risks to environmental, non-environmental and cultural assets.

Using both documents ensures the fire program reduces bushfire risk while promoting ecological outcomes.

### Step 6: Choose measurable objectives

Setting burn objectives allows the results of the burn to be evaluated. This guideline includes measurable objectives relevant to each consideration in each chapter.

Choose one or more of the objectives listed or develop different objectives to suit the situation. The burn objectives should be documented in burn proposals and fire strategies. Health checks can also be incorporated into fire objectives and assessments.

Contact the natural resource management ranger (or equivalent) to help with defining the objectives.

### Step 7: Finish the burn proposal

Complete the burn proposal by adding details about fire behaviour, tactics and weather conditions. Relevant information can be copied from this guideline into the burn proposal.

### Step 8: Assess whether the burn is ready to go

Refer to the ***QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go.*** The tools in this guideline can be used to predict fire behaviour and help achieve the burn proposal objectives.

Once the appropriate criteria have been met, the burn can be conducted.

### Step 9: Assess the results of the fire

After a fire, complete the post-fire assessment to determine whether short-term objectives have been achieved (e.g. achieving the recommended fire severity and patchiness).

These initial results will indicate whether planned burn objectives have been met. This guideline provides information on how to report the results in a fire report.

The burn area may need to be visited several times after the fire. The frequency will depend on the burn and fire strategy objectives.

Assessments can be completed using health checks, rapid assessments or detailed monitoring.

Many issues (e.g. weed control) will not be resolved with a single burn. Ongoing observation is needed to monitor progress. If unexpected results are seen, contact your natural resource management ranger (or equivalent).

If this process identifies shortfalls in your fire strategy, consider reviewing it.

## 1.3 Fire and climate in Southeast Queensland

In the Southeast Queensland bioregion, substantial rain usually begins to fall from November or December. Afternoon easterly winds then set in until winter weather arrives, usually from around late May to June.

The hazardous fire season (when more severe bushfires usually occur) is between mid-August and December. This season is a period of low rainfall, low humidity, increasing temperatures and strong winds (particularly in August and September). Dry lightning during extended dry periods can also ignite bushfires.

Increased fire risk accompanies fire weather days or sequences of days when the fire danger rating is very high with a forest fire or grass fire danger index ≥25.

In Southeast Queensland, these conditions tend to occur when deep, low-pressure systems develop over southern Australia. This system brings strong, dry westerly winds from the continental interior to the coast, increasing the likelihood of bushfires.

By November, the fire risk typically starts to lower with the beginning of storm rains. However, in some years, rain can be delayed until late summer.

From December through to March, frequent southeast trade winds and afternoon sea breezes bring higher humidity, making fires easier to manage.

Customarily, most planned burns should be implemented in the wet and early dry seasons to avoid the dangerous bushfire conditions often prevalent in spring.

In drought years, the bushfire risk period can extend as late as March, as was the case in 2019. These extended dry periods reduce planned burn opportunities and highlight the importance of implementing many planned burns in wet years. Burning under good conditions will help reduce the impact of catastrophic bushfire events in extreme conditions.

While broad bushfire season patterns provide a good guide, it is important to consider local seasonal conditions, current rainfall and the geography of each management area.

Read more about fire and climate 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

Read more about climate change in the ***Introductory Volume***.

**Increasing weather severity**

Since 2000, fire weather has rapidly increased in severity compared with the previous five decades. In the southeast coastal region, the number of hazardous fire days is increasing. These days are also being seen both earlier and later in the year. The annual accumulated Forest Fire Danger Index (FFDI) has increased by 51%, with the annual incidence of FFDI ≥25 days increasing by 254% (i.e. more than double) or equal to an increase of 29 days.

For every 2°C increase in the average daily maximum temperature, the average daily FFDI value increases by 7%.

Since the turn of the 21st century, there have been eight years with over 120 days that had statewide-averaged totals of FFDI ≥25. Before 2000, only one year saw this same elevated number of days with FFDI ≥25.

## 1.4 Lessons from the 2019–2020 bushfires

In the 2019–2020 summer, large areas of the Southeast Queensland bioregion burnt during drought conditions. This event, known as the Black Summer bushfires, burnt approximately 7% of Lamington National Park, 56% of Main Range National Park and large sections of Bulburin, Great Sandy and Noosa national parks.

### Case study: 2019–2020 bushfires in Gondwana rainforests of Southeast Queensland—Scenic Rim and Main Range

Bushfires burnt large areas of national park across the Scenic Rim area in the bushfires of 2019–2020. Post-fire assessments found that regular burning of eucalypt forests had reduced fire severity during these bushfires. Forests with regimes of frequent planned burns were more resilient to the bushfires than forests where planned burns were infrequent.

Two years after the fire, frequently-burned forest at Mount Lindesay was in better condition than adjacent forests that experienced more-limited planned burns.

This pattern was also seen at Spicers Gap section of Main Range National Park, where regularly burnt eucalypt forest remained in better health than adjacent unburnt forest.

These responses demonstrate that regular planned burning is important to mitigating the impacts of bushfires.

On a landscape scale, frequent planned burning when there is good soil moisture can greatly mitigate the potential severity and widespread damage from bushfires in drought years. Frequent burning helps maintain an open, structured grassy forest with minimal saplings.

These findings correspond with international research concluding that planned burning lowers the intensity of bushfires.

Regularly-burnt eucalypt forest at Mount Lindesay remained in good condition after the 2019 bushfire.
*Photo: © Paul Williams, Vegetation Management Science Pty Ltd.*

Rarely-burnt eucalypt forest at Mount Lindesay suffered crown damage and excessive wattle and she-oak recruitment after the 2019 bushfire. These dense saplings will increase the potential intensity of subsequent fires.
*Photo: © Paul Williams, Vegetation Management Science Pty Ltd.*

**Case study: 2019–2020 bushfires in Gondwana rainforests of Southeast Queensland—Lamington National Park**

During the 2019–2020 bushfires, areas of rainforest and wet eucalypt forest within the Gondwana Rainforests of Australia World Heritage Area burnt.

The bushfires impacted nearly one-tenth of lowland subtropical and dry rainforest and nearly one-tenth of wet eucalypt forest in Lamington National Park. Leaf drop, large fallen trees, smouldering and continued dry conditions caused secondary fires to reignite in already-burnt areas.

In the impacted rainforest, 30.6% burnt at low severity, 49.5% at moderate severity, 18.2% at high severity and 1.6% at extreme severity.

In the impacted wet eucalypt forest, 23.6% burnt at low severity, 53.1% at moderate severity, 22.2% at high severity and 1.1% at extreme severity.

Some large rainforest trees were killed. In both ecosystems, the ecological impacts were classified as moderate to high/catastrophic due to the fire sensitivity of the ecosystems and history of deliberate fire exclusion.

These bushfires show that rainforests can burn under extended dry, hot conditions. However, the post-fire responses of both rainforest and wet sclerophyll species show that these species are resilient to bushfires.

Recovery actions will focus on weed and feral animal control and fire management in adjacent areas to buffer the effects of future fires and allow rainforest species to recover.

## 1.5 Planned burn timing

The time of day and season of burning significantly influence fire behaviour and vegetation response.

### 1.5.1 Time of day

Generally, temperature declines and humidity rises in the late afternoon. This makes the early to mid-afternoon an optimal time to commence ignition when temperature and humidity will become milder after the fire is started.

Starting fires in the late afternoon and at night can help keep fire intensity down in areas with high fuel loads or other hazards. However, wind can be variable in the late afternoon, increasing in speed or changing direction, especially on the coast. On islands and coastal landscapes, plan for conditions becoming increasingly hazardous later in the day.

### 1.5.2 Season

Season is a critical consideration for burning, influencing fuel and soil moisture and weather conditions.

When an area is in good condition, ecological burning should be done when there is adequate soil moisture. However, in some areas (e.g. poor-condition areas) burning when soil moisture is low is necessary to achieve the desired objective.

It is often too dry to implement burns from August through to November. Planned burning under dry conditions, even in winter when the air temperature is low, promotes excessive sapling recruitment, especially *Acacia* and *Allocasuarina* spp. and herbaceous weeds.

Winter fire leaves the grass layer bare for many months, prolonging the absence of habitat for wildlife that depends on a litter or ground-cover layer. These fires also promote a dense mid-layer fuel in the absence of grass competition, which will increase the intensity of subsequent fires. Strong, dry westerly winds are common in August, increasing the risk of fires reigniting.

The end of the wet season and very early dry season (usually around February) is a good time to begin a planned burn program because the fuel and soil remain moist. This keeps fire intensity low and creates a patchily-burnt landscape with numerous small fires. At this time of year, most QPWS estate in the Southeast Queensland bioregion should have some planned burn activity.

Planned burning at the end of or soon after the wet season promotes rapid regrowth and germination of grasses and herbs. Flowers and seeds from these grasses and herbs are valuable for wildlife, especially granivorous birds. Igniting multiple burns in the same area over a couple of months extends grass seed availability across the landscape, with seed heads maturing progressively in adjacent patches.

The germination of grasses and herbs is also influenced by the season of burning. Generally, soil seed reserves are higher following the end of the wet season, and some grasses (e.g. black speargrass) will not germinate until the start of the next wet season.

The wet season is too moist for burning in many circumstances. However, valuable habitat outcomes can be achieved using storm burning (i.e. igniting fires after significant rainfall at the start of the wet season). Storm burning produces fires of enough intensity to manage sapling growth, while there is also good soil moisture to promote rapid grass regrowth. However, as storms are patchy, there is a high risk of fires escaping and spreading into drier areas.

There can be opportunities to burn in the middle and end of the wet season and following good rain in spring, when there is high soil moisture. Mid-wet season burning can help manage some annual weeds when implemented before flowering and seed set (e.g. January).

Read more about planned burn timing in the ***Introductory Volume***.

## 1.6 Vegetation assessment and monitoring

Every planned burn should have a clear purpose and tangible objectives, such as promoting native grasses or managing excessive wattle saplings or lantana.

It is useful to identify two measurable objectives about fire behaviour that can be evaluated immediately after the fire.

For example, one measurable objective may relate to fire extent and patchiness, such as aiming for a 50–75% burnt ground layer and containing the fire to the planned boundary. A second objective could relate to fire intensity, such as limiting canopy scorch or achieving a low or moderate fire-severity class over ‹80% of the burn area.

The results of this assessment should be reported in FLAME soon after the burn, either at the time of final patrol or within a fortnight of the planned burn being extinguished.

A second visit to the burnt site is needed to evaluate the vegetation response to a fire. This visit should occur months after the fire, following good rain, to allow time for seed germination and resprouting.

Read more about assessment, monitoring and evaluation in the *Introductory Volume*.

## 1.7 Indigenous cultural landscapes

All landscapes contain the imprint of human use. The way perceptions, beliefs, stories, experiences and practices give shape, form and meaning to the landscape is termed a cultural landscape.

Evidence of long-term regular burning by First Nations people over thousands of years can be seen in the landscape. The continued presence of old trees that are sensitive to high-intensity fires, such as coastal cypress, is one example.

Areas with trees like these as well as a range of other cultural sites should be identified in park fire strategies. Planned burning should be managed to protect these sites.

Detailed knowledge and understanding of the cultural landscape in which QPWS works are critical. Working with First Nations partners will ensure appropriate management. Priorities and local arrangements for the protection and maintenance of cultural landscapes should be identified in the relevant documents (e.g. the park fire strategy, Indigenous Land Use Agreements and Native Title determinations).

> QPWS recognises and respects First Nations peoples' ecological knowledge and the importance of collaborative fire management and protecting cultural and heritage values.
>
> Sustained, respectful and inclusive engagement of local First Nations people when preparing and implementing planned burns and fire strategies should be undertaken where relevant.

Read more about partnering with First Nations people in the *Introductory Volume*.

# 2. Rainforests and scrubs

In the Southeast Queensland bioregion, rainforests and scrubs include:

- extensive areas of subtropical rainforest, warm and cool temperate rainforest and Antarctic beech forest in the south-east corner
- isolated remnants of rainforest in Kroombit Tops and Bulburin national parks
- semi-evergreen vine thickets (dry scrubs or softwood scrubs) in the drier west
- a variety of rainforest, feather palm and fan palm communities in the coastal lowlands, sand islands and gullies or swampy areas
- simple *Pisonia grandis* closed forests restricted to coral cay islands
- hoop and kauri pine communities
- littoral or beach scrub communities.

While rainforests have characteristics that help protect them from fire, they can be impacted by bushfires under drought conditions.

Dry rainforests and vine thickets are generally more vulnerable to fire than wetter rainforest types. These drier rainforest communities usually grow in small patches next to or upslope from fire-adapted vegetation communities. They are particularly susceptible to fire during drought periods.

Rainforests are more likely to be affected by fires where there has been disturbance (e.g. storm damage, historic logging) or where there are high-biomass exotic grasses or lantana.

Fire management of surrounding areas can help protect rainforests from the impacts of bushfires.

**Fire management considerations:**

- Prevent fire encroachment into rainforests and scrubs and limit scorching of their margins (see section 2.1).

Many rainforests in the Southeast Queensland bioregion grow in areas that tend not to burn due to topography, internal moist microclimate and a lack of available fuels (Williams et al. 2006; QPWS 2007), Main Range National Park 2011.
*Photo: Jenise Blaik © Qld Govt.*

## 2.1 Prevent fire encroachment into rainforests and scrubs and limit scorching of their margins

Mosaic burning of the surrounding fire-adapted vegetation communities will help limit the impacts of bushfires on rainforest communities. Planned burning near rainforest, especially drier types, should be undertaken when there is good soil moisture. Sometimes, burning back from rainforest edges may be necessary to avoid fire damage.

Invasive, high-biomass grasses (e.g. guinea grass and lantana) can grow on rainforest edges and increase fire intensity. Controlling these can help protect rainforests from fire.

Repeated wildfires in dry conditions in combination with the slow rate of regeneration in vine thicket vegetation have been attributed to the loss of vine thicket remnants in Queensland particularly on hill slopes and fragments adjacent to roadsides, Cressbrook Conservation Park (2006). *Photo: Mark Daly © Qld Govt.*

Open forest and rainforest interface. Burning back away from rainforest edges may be necessary in some situations to avoid fire encroachment, Lamington National Park. *Photo: Wayne Kington © Qld Govt.*

# 3. Wet eucalypt open forests

Wet eucalypt open forests are generally tall communities (30–50m high) that grow in wet locations with relatively fertile soils, including uplands, highlands, gullies, alluvial flats and parabolic dunes.

Typical canopy species of wet eucalypt open forests include flooded gum *Eucalyptus grandis*, Sydney blue gum *E. saligna*, red mahogany *E. resinifera*, turpentine *Syncarpia glomulifera*, Fraser Island satinay *Syncarpia hillii*, New England blackbutt *E. campanulata* or blackbutt *E. pilularis*. Blackbutt typically dominates the canopy on coastal sands, sub-coastal sandstones and basalt ranges. Other common canopy or subcanopy species include brush box *Lophostemon confertus*, tallowwood *E. microcorys* and forest she-oak *Allocasuarina torulosa*.

The understorey varies with geology, rainfall, altitude, aspect and fire frequency, ranging from grassy to shrubby. A shrubby understorey is more typical in forests with poorer soil.

Fire management is critical to retaining a grassy or shrubby understorey in wet eucalypt open forests.

Implementing frequent fire when there is good soil moisture will help maintain wet eucalypt open forests in good condition. This is particularly important for communities with a diverse, grass-dominated ground layer.

Wet eucalypt open forest communities are often susceptible to rainforest invasion in the absence of fire. Once the understorey is dominated by rainforest species, the community will only burn under extremely dry conditions. Many rainforest species also have the capacity to resprout from the base after a fire.

While fire frequency helps prevent the transition of wet eucalypt open forest to rainforest, the primary drivers are soil-related (edaphic) features.

Many wet eucalypt open forest canopy species do not have lignotubers to help protect seeds and saplings against fire. Fire intervals need to consider the capacity of regenerating canopy species to survive.

**Fire management considerations:**

- Maintain good-condition wet eucalypt open forest with a predominately herbaceous understorey (see section 3.1).
- Maintain wet eucalypt open forest with a shrub-dominated understorey (see section 3.2).
- Maintain wet eucalypt open forest with a sparse rainforest mid-layer (see section 3.3).

## 3.1 Maintain good-condition wet eucalypt open forest with a predominantly grassy understorey

### 3.1.1 Monitoring vegetation condition

A good-condition wet eucalypt open forest with a grassy understorey has an open structure. This makes it relatively easy to see through and walk through.

The ground layer is often dominated by kangaroo grass *Themeda triandra*, scaly poa *Poa labillardieri* and wild sorghum *Sarga leiocladum*. Blady grass *Imperata cylindrica* and bracken fern *Pteridium esculentum* can be common but this may be due to fires, particularly recurrent fires, under dry conditions.

Low densities of *Acacia maidenii, Acacia melanoxylon, Allocasuarina torulosa, Alphitonia excelsa* and *Exocarpos cupressiformis* are commonly present in grassy forests.

As fire intervals increase, or in particularly wet and shady areas, large tussock grasses like kangaroo grass and poa are replaced by small broad-leaved grasses like *Oplismenus aemulus* and *Ottochloa gracillima*, as well as sedges, such as *Gahnia* and *Scleria* species.

Regular planned burning when there is good soil moisture is critical to maintain areas of wet eucalypt open forest with a grassy understorey.

Grassy wet eucalypt open forest at Conondale National Park.
*Photo: © Paul Williams, Vegetation Management Science Pty Ltd.*

Chapter 3—Wet eucalypt open forests

**Key indicators of good-condition wet eucalypt open forests with a predominantly grassy understorey**

- A near-continuous grass layer.
- A mid-layer and understorey that is easy to walk through without dodging many saplings and shrubs.
- Well-formed, healthy-looking grass tussocks.
- Scattered, small rainforest saplings.
- Few to no aggressive weeds.

Sydney blue gum tall wet eucalypt open forest with a ground layer of native tussock grasses, kangaroo grass and blady grass in good condition, Conondale National Park 2007.
*Photo: Rowena Thomas © Qld Govt.*

Blackbutt wet eucalypt open forest with a mixed grass/fern/shrub understorey, Glasshouse Mountains National Park 2011.
*Photo: Rowena Thomas © Qld Govt.*

## 3.1.2 Considerations for burning

### Maintaining good condition

- Grassy wet eucalypt open forests are rare. Frequent burning when there is good soil moisture is critical to maintaining their health. This is one of the highest priorities for ecological burning in Southeast Queensland.
- Wet eucalypt open forests grow in conditions that promote rapid shrub and tree growth. Frequent fire is needed to maintain a grassy ground layer.
- Without frequent fire, *Lantana camara* can become dense.

- Where some clumps of tussock native grasses (e.g. kangaroo grass) remain, several regular fires may partially restore grass cover.

### Weather conditions

- High-intensity fires in dry conditions will promote excessive recruitment of some shrub species, especially *Acacia* spp. and *Dodonaea triquetra*.

### Rainforest transition

- Rainforest plants primarily germinate when grass cover is low. This can occur immediately following a fire if the soil is bare. It can also occur if rainforest plants grow into a mid-layer that shades out grasses. Maintaining a dense grass cover prevents rainforest recruitment and stops conversion to rainforest.
- See sections 3.2 and 3.3 for more information about rainforest transition.

### Fire management guide: Eastern bristlebird habitat

The eastern bristlebird *Dasyornis brachypterus* has an endangered status under both the Queensland *Nature Conservation Act (1992)* and Commonwealth *EPBC Act (1999)*.

This ground-dwelling bird occurs in several isolated populations located between the New South Wales–Victorian border and Southeast Queensland.

There are two subspecies of eastern bristlebird. The northern eastern bristlebird *D. b. monoides* is found in open woodlands and forests above 600m altitude in north-eastern New South Wales and Southeast Queensland. The southern eastern bristlebird *D. b. brachypterus* occurs in the coastal and sub-coastal heathland regions south of Sydney to the New South Wales–Victorian border.

Northern eastern bristlebirds are usually found in large areas (>40ha) where the ground cover is mostly large tussocks of wild sorghum *Sarga leiocladum* with basal areas measuring at least 30cm (Lamb et al. 1993). Other species of tussock grass can occur in these areas, including scaly poa *Poa labillardierei* and fine-leaved tussock grass *P. sieberiana* var. *sieberiana*.

Regular fire is essential to maintain the dense grass layer required for eastern bristlebird habitat and population growth.

Planned burns should be implemented when there is good soil moisture.
Fires during dry conditions are more likely to promote excessive sapling density (especially wattles) that can shade out grasses.

Fire frequency should be guided by site inspections of grass tussock health and sapling density. Planned burns should generally be implemented every two to five years, and no longer than eight years (Watson 2013; Z. Stone, M. Maron & L. Tasker unpublished data).

Where a fire promotes excessive wattle germination, a follow-up fire will be necessary within two years to thin saplings.

For the long-term maintenance of northern eastern bristlebird habitat, bristlebird habitat should be divided and burned at different times, creating a mosaic of open forests with different-aged understoreys. This mosaic provides areas for bristlebirds to escape during planned burns. It also reduces the likelihood of bushfire in bristlebird areas.

**Fire management guide: Hastings River mouse habitat**

The Hastings River mouse *Pseudomys oralis* is found in forests from southern New South Wales into Southeast Queensland, including Main Range and Lamington national parks.

In Queensland, Hastings River mouse habitat is primarily grassy, tall, wet eucalypt forest and associated eucalypt/rainforest ecotones. A dense cover of grasses, sedges and sometimes low shrubs provides important habitat.

Hastings River mice feed on leaves, stems, seeds, flowers, pollen, fern sporangia, mycorrhizal fungi and insects.

Planned burning should be conducted at a frequency that:

- promotes and maintains a dense grass and sedge cover
- prevents dense growth of wattle and eucalyptus saplings
- limits rainforest encroachment.

Burns should be implemented when there is good soil moisture. This will help maintain a low to moderate-intensity fire to:

- minimise the loss of habitat features for shelter (e.g. logs)
- leave unburnt patches for food resources and cover from predators
- facilitate rapid grass regrowth.

Fire frequency should be guided by site inspections of habitat conditions, such as grass, shrub and sapling cover and vigour, and the extent of rainforest development. A burn interval of three to five years is likely to be appropriate.

A long-term population monitoring program combined with information on planned burn conditions and fire history will help refine fire management for the Hastings River mouse over time.

### 3.1.3 Prioritising areas for burning

Good-condition wet eucalypt open forests with a predominantly grassy understorey are rare in Southeast Queensland. These forests should be given the highest priority for regular burning.

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

### 3.1.4 Assessing outcomes

#### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

Critical reasons for burning good-condition wet eucalypt open forests are to maintain a dense native grass layer and good-condition sclerophyll shrubs. Fires intensity should not damage the tree canopy or promote the dense growth of rainforest plants and wattle saplings.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Promote the growth of dominant eucalypt canopy species. | **Before the burn:** Select three sites that represent the variability of landform and likely fire intensity. Mark the start and finish of a transect line/s (e.g. 50m long).<br>**Before and after the burn** (preferably after rain but before seedlings will be obscured by grass growth): Assess a series of 1 x 1m quadrats, spaced evenly along the transect, for the presence of eucalypt seedlings. Calculate the frequency of occurrence (i.e. if you assess 50 quadrats and 10 of them contain eucalypt seedlings, the frequency is 10/50 x 100 = 20%).<br>Alternatively, count the actual number of seedlings in a series of quadrats before and after the burn. | **Achieved:** Frequency of eucalypt seedling occurrence is at least five times greater after the burn than before.<br>**Partially achieved:** Frequency of eucalypt seedling occurrence is at least three times greater after the burn than before.<br>**Not achieved:** Frequency of eucalypt seedlings occurrence is less than three times as great after the burn than before. |
| Maintain and promote native grass cover. | Photograph the representative areas soon after the fire and two years after the fire. Record an estimate of the living native grass cover. | **Soon after the fire**<br>**Achieved:** >90% of grass bases remain alive with some green shoots. Some leaf litter remains.<br>**Partially achieved:** 75–90% of grass bases remain alive.<br>**Not achieved:** <75% of grass bases remain alive.<br>**Two years after the fire**<br>**Achieved:** Grass cover remains very high or has increased where only moderate cover existed before the fire.<br>**Partially achieved:** Grass cover remains moderate to high.<br>**Not achieved:** Grass cover has declined, even after two years of average rainfall. |

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Maintain and promote sclerophyll shrubs. | Photograph the representative areas soon after the fire and two years after the fire. Record an estimate of native sclerophyll shrub cover and health. | **Soon after the fire (for known resprouting shrub species)**<br>**Achieved:** >90% of burnt shrubs have coppice shoots.<br>**Partially achieved:** 75–90% of burnt shrubs have coppice shoots.<br>**Not achieved:** <75% of burnt shrubs have coppice shoots.<br><br>**Two years after the fire**<br>**Achieved:** Most shrubs remain alive and coppice shoots have returned to at least ¾ of their pre-fire shrub height. Some shrub seedlings are present.<br>**Partially achieved:** Minor decline in shrub density. Coppice shoots are at least ¾ their pre-fire shrub height. Few shrub seedlings are present.<br>**Not achieved:** Shrub density and cover have declined. |
| Prevent growth of rainforest plants and excessive wattle saplings from fire. | Photograph the representative areas after significant post-fire rain. Observe and record the abundance of rainforest and wattle saplings.<br><br>If there is dense rainforest and wattle growth, implement a follow-up fire within a few years to thin saplings. | **Achieved:** Most pre-existing rainforest and wattle saplings have coppiced, but there are no new seedlings.<br>**Partially achieved:** All pre-existing rainforest and wattle saplings have coppiced and there are scattered new seedlings.<br>**Not achieved:** Rainforest and wattle saplings have coppiced and there is considerable germination. |

## Choosing locations for evaluation

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

### Monitoring over time

Examples of good-condition wet eucalypt open forests are rare and significant. Resources should be made available to monitor their condition using repeated, detailed surveys of permanently-marked transects. These transects should document the abundance of the grass layer and shrubs and the recruitment of canopy species over time. The post-fire regeneration and growth of rainforest plants and wattles should also be measured.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

## 3.1.5 Fire parameters

Planned burns should aim for specific fire characteristics to help maintain forests in good condition.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for low to moderate fire severity.

A moderate-severity fire may be required to scorch the top of overabundant rainforest and wattle saplings. Good soil moisture at the time of burning is vital to avoid promoting further regrowth of these saplings and favour grass regeneration.

| Fire severity class | **Fire intensity** (during the fire) | | **Fire severity** (post-fire) | |
|---|---|---|---|---|
| | **Fire intensity (kWm¹)** | **Average flame height (m)** | **Average scorch height (m)** | **Description** (loss of biomass) |
| **Low (L)** | ‹500 | ‹1.5 | ‹2.0 | Some patchiness. Most of the surface and near-surface fuels are burnt. Stubble is still evident. |
| **Moderate (M)** | 500–3000 | 1.5–3.0 | Complete grass biomass consumed. | All surface and near-surface fuels are burnt. Stubble is burnt to blackened remnants. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

In each planned burn, a mosaic of burnt and unburnt ground should result from the ignitions. Generally, wet eucalypt open forests do not burn completely.

As these forests are spatially separated, burning different forests in different years will create a landscape mosaic. This helps create a varied age-class structure that supports a diversity of habitats and species.

### Fire frequency

Wet eucalypt open forests need regular fire to maintain abundant grass cover and appropriate sclerophyll shrub density.

Native grasses begin thinning around three to five years after a fire. To maintain native grass abundance, fires should typically be implemented every three to five years. Where a shrubby understorey is sought, a fire interval of 8 to 20 years is more appropriate. Regular burning at this frequency will also repeatedly reduce small rainforest plants to ground-level coppice shoots. This prevents them from shading out grasses, herbs and sclerophyll shrubs.

## 3.1.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | • Concentrate efforts during years of good rainfall.<br>• Avoid burning following frosts.<br>• Wet open eucalypt forests may dry out later than surrounding eucalypt forests.<br>• Post-fire grass growth and recovery is slower in winter. This may result in longer periods of patchy bare ground and weed growth. |
| **GFDI** | <7 |
| **DI (KBDI)** | <100 |
| **Wind speed** | <15km/hr |
| **Soil moisture** | Good soil moisture is critical to help retain grass bases and encourage grass regeneration. Burning in the days following rain (and before adjoining forests will burn) will improve regeneration and limit weed growth. |

## 3.1.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Burn surrounding drier eucalypt forests earlier in the season to provide a fuel-reduced area around or adjacent to wet eucalypt open forests. Do not burn wet forests under hot and dry conditions to get better coverage and penetration of fire. Burning in dry conditions will cause canopy and grass damage. It will also increase the fuel hazard risk by promoting the dense growth of wattle saplings. Sapling overabundance makes forests harder to burn during mild conditions and carries more-intense fire during dry conditions.
- Implement a staged to target different sections of an area based on soil moisture and predicted fire movement. Ignite grassy areas first, followed by more shrubby areas and those with a developing rainforest layer.
- Use aerial incendiaries to efficiently access wet eucalypt open forest pockets.
- Ignite spot and short line fires to implement fingers of fire in good-condition, grassy forests with vehicle access.
- Implement a slow-moving, low to moderate-intensity backing-fire (lit on the leeward or smoky edge) in areas where saplings are common.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

## 3.2 Maintain wet eucalypt open forest with a shrub-dominated understorey

Good-condition shrubby wet eucalypt open forest will contain both shrubs and native grasses, such as kangaroo grass.

Common shrubs include *Banksia spinulosa, Breynia oblongifolia, Clerodendrum floribundum, Daviesia arborea, Daviesia ulicifolia, Dodonaea triquetra, Hovea acutifolia, Melaleuca linariifolia, Melaleuca saligna, Ozothamnus diosmifolius, Solanum* spp. and *Xanthorrhoea johnsonii*.

Small trees, such as *Acacia maidenii, Acacia melanoxylon, Allocasuarina torulosa, Alphitonia excelsa* and *Exocarpos cupressiformis*, will also be present in low densities.

Regular fire is required to ensure rainforest plants do not establish into a dense subcanopy and convert the eucalypt forest into rainforest.

Less-frequent fire will lead to rainforest saplings becoming taller and more common. Common rainforest shrubs and saplings that should be kept at a low height and in low abundance through regular burning include *Cryptocarya microneura, Elaeocarpus reticulatus, Ficus coronata, Glochidion ferdinandi, Guioa semiglauca, Macaranga tanarius, Neolitsea dealbata, Pilidiostigma rhytispermum, Polyscias elegans, Synoum glandulosum, Syzygium australe* and *Trema tomentosa*.

### 3.2.1 Monitoring vegetation condition

**Key indicators of good-condition wet eucalypt open forest with a shrub-dominated understorey**

- Scattered sclerophyllous (hard-leaved) shrub species (e.g. grass trees, banksia, pea-flowers) with healthy foliage.
- Scattered, small rainforest saplings.

### 3.2.2 Considerations for burning

- Many rainforest species survive fire by resprouting from the base or growing root suckers. Regular fire keeps rainforest species low in profile, allowing other species to compete.
- Several sclerophyll shrubs are fire-killed obligate-seed regenerators, including *Dodonaea triquetra* and *Hovea acutifolia*. Most, if not all, reach reproductive maturity within a few years. Patchy burns allow these species to persist, even with frequent burning. These burns should allow enough plants to survive and set enough seed between successive burns.
- High-intensity fires in dry conditions will promote excessive recruitment of some shrub species, especially *Acacia* spp. and *Dodonaea triquetra*.

### 3.2.3 Prioritising areas for burning

Wet eucalypt open forests with a low density of shrub-sized rainforest plants are rare in Southeast Queensland. These forests should be considered a high priority for regular burning.

Go to sections 3.1.4–3.1.7 for relevant fire parameters, objectives and fire tactics.

## 3.3 Maintain wet eucalypt open forest with a sparse rainforest mid-layer

Many wet eucalypt open forests in the Southeast Queensland bioregion have a tall, closed subcanopy of mature rainforest species sitting under tall eucalypt emergents. This mixed structure may have developed in the absence of regular fire (e.g. K'gari, Great Sandy National Park, Lamington and Springbrook national parks). Other disturbances (e.g. heavy, widespread logging) may have also contributed.

It is not possible or desirable to introduce fire into these communities under planned burn conditions. Fire is only likely to penetrate under extreme or catastrophic conditions (e.g. severe bushfire following drought or cyclone damage).

Forests with a rainforest subcanopy and emergent eucalypts are a significant fire hazard in extreme conditions because they can carry high-intensity fires during prolonged drought. Some of these forests are near residential areas, especially on the Sunshine

Coast. Regular fire must be implemented in neighbouring fire-adapted ecosystems to protect mixed forests from being ignited and carrying dangerous, intense fires in extreme fire weather conditions.

Go to chapter 2 for relevant fire management guidelines.

Tall open satinay forest with a closed mid-layer of rainforest species, Great Sandy National Park (2008).
*Photo: © Qld Govt.*

# 4. Eucalypt woodlands to open forests

Eucalypt woodlands to open forests dominate the landscape across the Southeast Queensland bioregion. They are dominated or co-dominated by eucalyptus (e.g. gums, ironbarks, boxes, angophoras and bloodwoods).

The understorey of eucalypt woodlands to open forests is variable, depending on geology, rainfall, altitude, slope and aspect. It can be dominated by grass, shrubs or a mixture of both.

This broad vegetation group is found on coastal lowlands, inland hills, mountain ranges and in some cases beach ridges throughout the bioregion.

Fire management is critical to maintaining the condition of eucalypt woodlands to open forests.

Major fire management considerations in this broad vegetation group include:

- senescence and loss of native grass cover (caused by long intervals between fire)
- invasion by a variety of woody weeds (e.g. lantana) and exotic grasses
- an overabundance of tree saplings (e.g. eucalypts, wattles and rainforest pioneers) in the mid-layer (sometimes triggered by high-intensity fires and burning during dry conditions).

Overabundant saplings reduce the health and diversity of shrubs, grasses and other herbs in the ground layer through competition and shading.

Left unmanaged, overabundance and woody weed infestations can threaten an open structure. In the southern half of the bioregion, this may also contribute to bell miner associated canopy dieback of eucalypts.

Read more about fire and weeds in the ***Introductory Volume***.

**Fire management considerations:**

- Maintain good-condition woodlands and open forests (see section 4.1).
- Restore native grass cover and its health and reproductive vigour (see section 4.2).
- Reduce overabundant saplings (see section 4.3).
- Manage invasive grasses (see section 4.4).
- Reduce Lantana camara (see section 4.5).
- Manage bell miner associated canopy dieback (see section 4.6).
- Maintain good-condition beach ridge eucalypt, brush box and cypress communities (see section 4.7).

**Open forests and woodlands as cultural landscapes**

Open forests and woodlands are in decline in Southeast Queensland. In many areas, suppression of Aboriginal burning has led to changes in forest structure.

Before colonisation, the forest structure contained old mature trees (200 to 1500 years old), over a relatively open mid-storey, with a mixed grassy/shrubby ground layer.

This structure supported a very diverse biota, including most of Australia's iconic wildlife species. Many of these species are now threatened by the changes resulting from a lack of appropriate fire. The outcomes of these changes include eucalypt dieback, bell miner associated dieback, loss of grassy forests and weed invasion.

This change in forest structure also contributes to an increase in the severity of bushfires under extreme conditions and greater difficulty in applying low to moderate-intensity fire under planned burn conditions. Unfortunately, these forests are no longer considered 'easy to burn at low-intensity systems'.

The principles of burning in these forests are outlined in the relevant sections of this guideline generally. Working with First Nations people will provide additional insight.

Open forests and woodlands often contain important cultural sites and appropriate management should be led by First Nations partners.

## 4.1 Maintain good-condition eucalypt woodlands to open forests

The composition and structure of eucalypt woodlands to open forests are influenced by fire frequency and how fire is applied.

Maintaining woodlands and open forests in good condition requires regular, low to moderate-intensity, patchy burning when there is good soil moisture.

Relatively frequent fire is critical to maintaining dense, continuous native grass cover in grassy woodlands and open forests. This maintains the capacity to carry out early-season burning. It also helps sustain healthy habitats and diversity.

In some good-condition eucalypt open forests, plant diversity is naturally low. Maintaining the condition of these forests helps conserve unique habitats and increase landscape-level diversity.

### 4.1.1 Monitoring vegetation condition

The location of forests in good condition should be recorded. This allows them to be protected with appropriate long-term management.

**Key indicators of good-condition eucalypt woodlands to open forests**

- A grass, sedge or shrub-dominated understorey, or a mixture of these.
- Tree saplings (e.g. eucalypts, wattles and/or she-oaks) scattered through the lower and mid-layers. Tree density does not significantly reduce visibility through the forest or noticeably impact ground-layer plants with shading.
- Fallen logs and hollow-bearing trees.
- A shrub layer dominated by sclerophyllous (hard-leaved) species (e.g. grass trees, epacrids, banksia, pea-flowers) with healthy foliage (in shrubby open forest only).
- Well-formed and healthy-looking grass tussocks and/or sedges (in grassy and mixed open forest only).
- A mid-layer and understorey that is easy to see and walk through, with a near-continuous grass layer.
- Few to no weeds, with ecosystem-changing weeds inconspicuous or absent.

**Layers used to describe eucalypt woodlands to open forests**

**Canopy:** tallest tree layer; **Mid-layer** (not always obvious): shorter trees, saplings of canopy species, tall shrubs and other plants over one metre; **Ground layer:** a ground layer of grasses, sedges, herbs, small shrubs and seedlings up to one metre. *Photo: © Qld Govt.*

Open forest with a good-condition ground layer. Tree recruitment is significant but not so abundant that it impacts understorey health, Tamborine National Park.
*Photo: Mark Burnham © Qld Govt.*

Although there is limited tree recruitment or variation in the age of eucalypts, the grassy understorey of this woodland is healthy, and there are sufficient young trees to replace the canopy in the long term, Glenrock.
*Photo: Mark Daly © Qld Govt.*

Open forest with a mix of canopy tree ages and healthy grass tussocks, Lamington National Park (2005).
*Photo: Sylvia Millington © Qld Govt.*

The healthy dense grass cover indicates the sparse mid-layer of she-oaks has no shading effects on the ground layer, Glass House Mountains National Park (2010). *Photo: Rowena Thomas © Qld Govt.*

Geology and soil properties largely determine the diversity of understorey shrubs and grasses. However, fire regimes can alter the balance. Planned burning at more frequent intervals when there is good soil moisture will generally encourage grasses. Longer burn intervals tend to favour shrubs, Nerang National Park.
*Photo: David Kington © Qld Govt.*

Open coastal woodland with a good-condition mixed grassy/shrubby understorey, Teewah (2009).
*Photo: Peter Leeson © Qld Govt.*

Good-condition shrubby open woodland, Glasshouse Mountains National Park (2006).
*Photo: Rowena Thomas © Qld Govt.*

This shrubby understorey has a good diversity of species but is showing early signs of decline in health with some shrub crowns beginning to die off, D'Aguilar National Park (2007).
*Mark Burnham © Qld Govt.*

**Key indicators of declining condition in eucalypt woodlands to open forests**

- Grasses with a build-up of older dead leaves under the healthy green leaves.
- Dying shrubs or many shrubs with sparse crowns.
- A decline in the diversity of mid or ground-layer species (e.g. grasses, herbs, sedges and shrubs).
- A progressive loss or reduction of shrub numbers, either resprouters or obligate-seed regenerators (species that can only regenerate after fire from seed) (in shrubby open forests only).
- A significant build-up of fine fuels, such as dead grass material, leaf litter, suspended leaf litter, bark and twigs.
- An accumulation of elevated fuels measuring high or above according to the ***Overall Fuel Hazard Guide***.
- Grass trees with dense brown skirts.
- An abundance of blady grass, bracken, dodder, a single shrub species or a flush of trees or weeds of the same age. Be aware that some forests have an understorey naturally dominated by one or a few species.
- An abundance of saplings in the mid-layer, especially eucalypts, wattles and she-oaks, from mass seed germination.

Declining grass health due to the absence of fire. There is poor grass clump formation and an accumulation of dead material, Lamington National Park 2009.
*Photo: Wayne Kington © Qld Govt.*

An understorey in decline due to the absence of fire. In the grass and shrub understorey, grass trees have drooping dead skirts and grass clumps are sparse, D'Aguilar National Park.
*Photo: Mark Burnham © Qld Govt.*

A shrubby understorey in decline due to the absence of fire. There are dead shrubs and dying shrub crowns, D'Aguilar National Park. *Photo: David Kington © Qld Govt.*

A sequence illustrating shrub decline. The bottom row indicates where fire has been absent too long, D'Aguilar National Park. *Photo: David Kington and Mark Burnham © Qld Govt.*

(Above) High-severity bushfires or planned burns conducted when soil moisture is low can favour regrowth and dominance of a single shrub like bush pea *Pultenaea* sp., Moogerah Peaks National Park 2008 or (below) grass species, such as blady grass, Lamington National Park.

*Photo (above): Mark Daly © Qld Govt. Photo (below): Mark Burnham © Qld Govt.*

## 4.1.2 Considerations for burning

### Weather conditions

- Weather cycles should be considered during planning to help ensure suitable weather and fuel conditions for fires. Long-term weather patterns can influence opportunities for planned burning (e.g. prompting increased burning in wet years to allow for pauses in drought years).

Read more about season or seasonal conditions; burn timing and climate change in the *Introductory Volume*.

### Poor-condition ecosystems

- Dominance of bracken fern *Pteridium esculentum* and blady grass *Imperata cylindrica* can be caused by fire during dry conditions, recent high-severity fire, too-frequent fire or heavy grazing. This dominance can reduce plant diversity. Subsequent fires should be low intensity when there is adequate soil moisture to promote the growth of other native grasses and herbs.
- Poor-condition communities can be a result of drought. Implementing fire during drought conditions is not recommended as this can compound ecosystem issues. Alternatively, consider if the area has naturally poor soil where grasses may appear less vigorous.
- Soil type and geology can also influence the composition of grassy ground cover and its condition.

### Habitat requirements

- Maintaining habitat features like fallen logs and hollow-bearing trees is critical in eucalypt woodland and open forest ecosystems.
- To provide for an array of plant and animal habitat requirements, a mosaic of different age-classes should be maintained across an ecosystem. This should include patches that have not been burnt for a relatively long period.
- Threatened flora and fauna may have specialised requirements or critical habitat that should be considered during burning. Particular attention may be needed to minimise the loss of hollow-bearing trees.

Read more about fauna response to fire in the ***Introductory Volume***.

### Disturbed areas

- Within Southeast Queensland, many protected areas contain heavily disturbed or immature forests due to previous land uses like logging. These forests may be under or overstocked with sapling regeneration or consist of an even-aged population of canopy species.
- Provided the structure of the understorey appears in good condition, this guideline should help develop a more varied and mature structure over time.

- It is important to recognise early forest or woodland deterioration due to broad-scale mid-layer sapling thickening (e.g. dense wattle seedlings and suckers) and/or grass declines in open forests.
- An overabundance of saplings across a broad area can suppress the grass layer and enable flames to reach into the canopy. These areas should be considered a priority for burning before thickening and/or grass decline progresses.

Read more about refining planning burning after disturbance events in the *Introductory Volume*.

### Obligate-seed regenerators

- Some shrubs are obligate-seed regenerators, which are plants that can only regenerate after fire from seed. Many grow quickly and begin producing seeds within two to four years of germination. These shrubs are a natural part of many good-condition forests.
- To maintain condition, the fire interval must be long enough for obligate-seed regenerators to reach reproductive maturity and set seed (preferably more than one seed crop). When fire intervals are shorter than the primary juvenile period, patchy burning across a landscape will allow some obligate-seed regenerators to survive unburnt.

### Species encroachment

- An absence of fire in some open forests can cause an increase in rainforest pioneers and other trees. This increase can shade out ground layer plants, inhibit fire and create conditions favouring further rainforest recruitment.
- Rainforest recruitment does not necessarily lead to a transition to rainforest but may impact the ground layer and inhibit the regeneration of canopy species.
- Rainforest species, such as blueberry ash and laurels, can naturally coexist with sclerophyll shrubs, grasses and sedges in the open forest shrub layer. After fire, most rainforest plants only resprout from ground level. This allows their growth to be pushed back with regular fire, preventing them from becoming dominant.
- Some open forests have a sedge-dominated understorey (e.g. scribbly gum *Eucalyptus racemosa* subsp. *racemosa* forest on sedimentary rocks, RE 12.9-10.4a). These forests respond well to regular burning to promote herb and grass tree growth and keep she-oak density in check.

Read more about flora fire response in the *Introductory Volume*.

**Fire management guide for open forests on sand to minimise mature tree damage and maintain or regenerate a good-condition mixed grassy/shrubby understorey**

Areas of open forest on sand are maintained in a good condition by applying frequent, low to moderate-intensity fire when there is good soil moisture. This ensures the maintenance and regeneration of grasses, sedges, forbs, shrubs and canopy species and helps maintain the open forest structure.

Conversely, these ecosystems may be degraded by fires in dry conditions or fires of high intensity. These types of fires can kill canopy trees and change the forest structure.

High-intensity fires disadvantage or kill the grass/shrub mix while promoting mass germination of *Acacia, Epacris, Allocasuarina, Banksia, Leptospermum* and sometimes canopy species. These fires tend to burn down into the organic layer of the soil profile, damaging the soil structure.

In areas next to heath, infrequent, high-intensity fires promote a dense heathy understorey that fosters progressively hotter fires. This leads to complete canopy death, structural collapse and loss of the open forest

Dense thickets of heath prevent the regrowth of grasses and shrubs. Without grasses, sedges or shrubs, it is difficult to reintroduce a regime of low-intensity fire.

Heath thickets also dramatically change the fuel hazard/risk profile, creating high levels of ladder fuels (vegetation that allows fire to climb from the ground level into trees). They compete with existing canopy trees and cause premature drought stress in dry times. This also increases the impact of bushfires under extreme conditions.

### 4.1.3 Prioritising areas for burning

Areas where eucalypt woodlands to open forests are in good condition should be prioritised in a burn program.

| Priority | Priority assessment |
|---|---|
| **Very high** | Planned burns to maintain areas with key values and other values. |
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good. |

### Case study: Bauple long-term fire experiment

The Bauple fire experiment, located between Gympie and Maryborough in Southeast Queensland, has been the site of fire treatments since 1952. It is the longest-running fire study in Australia, providing robust data on the effects of fire treatments on fauna, flora, fuel loads and soil chemistry in a subtropical dry sclerophyll forest.

Bauple Forest is an open, dry sclerophyll forest (RE 12.9-10.17) dominated by spotted gum *Corymbia citriodora* subsp. *variegata* and Queensland grey ironbark *Eucalyptus siderophloia*. The study is designed around permanent monitoring plots with two low-intensity burn treatments:

- annual burning in winter or spring
- triennial burning since 1973 (both conducted in winter or spring).

An adjacent area has been left unburnt since 1946.

In 2006, a bushfire burnt through two-thirds of this area, creating another treatment area. This area is now infrequently burnt at an interval of 10–15 years. The study applies low-intensity fire (‹500 kW), while the higher-intensity bushfire is likely to produce different results.

Plots at Tiaro and St Mary state forests, with a range of fire histories, have been included in analyses more recently to further examine the impacts of fire frequency on the structure and composition of the vegetation, fauna habitat and fauna species.

Frequent, low-intensity burning regimes were found to improve grass cover and tree growth while reducing lantana and fuel load.

The studies have shown that annual burning simplifies plant diversity among all layers and the structural diversity in the ground and shrub layers. Obligate-seed regenerators were found to persist in areas burnt annually because of the patchiness. However, longer intervals were recommended for some groups.

Small mammals and amphibians were generally found to be resilient to all treatments, while reptiles were more vulnerable, particularly to annual treatments.

The studies demonstrate that these ecosystems are resilient to frequent application of fire. However, some species and structural or habitat characteristics benefit from frequent burning, while others benefit from less-frequent burning. There are also some species and characteristics favoured by long-unburnt conditions.

The studies indicate that a mix of frequently burnt, less-frequently burnt and long-unburnt areas across these ecosystems is appropriate. The research also emphasises the importance of having clear and measurable objectives when implementing burn programs.

## 4.1.4 Assessing outcomes

### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Burn 35–45% of the target area (adjust the percentage as appropriate). | Choose one of the following options:<br>a) Visually estimate the percentage of burnt vegetation taken from one or more vantage points or the air.<br>b) Map the boundaries of the burnt areas with GPS then plot in FLAME to determine the percentage of the area burnt.<br>c) Choose three locations that represent the variability of landform and ecosystems within the burn area. Walk approximately 300 or more metres through the burn area estimating the percentage of ground area that is visibly burnt. | **Achieved:** 35–45% burnt.<br>**Not achieved:** <35% burnt. Consider a follow-up planned burn.<br>**Or**<br>>45% burnt. Assess results of other relevant objectives. |
| Retain >90% of tussock grass bases as stubble and promote regrowth after rain. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire intensity. Estimate the percentage of tussock grass bases remaining after fire and the percentage that reshoot green leaves following rain. | **Achieved:** >90% of bases remain and regrow green shoots following rain.<br>**Partially achieved:** 75–90% of bases remain.<br>**Not achieved:** <75% of bases remain. |
| Burn approximately 80% of grass tree skirts and encourage regrowth of shoots. | Select one or more sites or walk one or more transects and estimate the percentage of grass skirts removed after the fire. | **Achieved:** 80% of grass tree skirts are removed.<br>**Partially achieved:** 40–80% of grass tree skirts are removed.<br>**Not achieved:** <40% of grass tree skirts are removed. |
| Resprouter shrubs resprout post-fire. | Approximately three months after the fire, select three or more sites that represent the variability of landform and fire intensity. Estimate the percentage of resprouter shrubs resprouting. | **Achieved:** >75% resprouting.<br>**Not achieved:** <75% resprouting. |

### Choosing locations for evaluation

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

### Monitoring over time

Good-condition forests are maintained with regular burning when there is good soil moisture and mild weather conditions. Where forest conditions have started to decline, a single planned burn may not resolve the issues.

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the *Introductory Volume*.

Retaining the stubble base of tussock grasses during a planned burn enables rapid regeneration. The humus layer is also retained with good soil moisture. *Photo: Jenise Blaik © Qld Govt, 2011.*

### 4.1.5 Fire parameters

Planned burns should aim for specific fire characteristics to help maintain forests in good condition.

Read more about fire parameters in the ***Introductory Volume***.

#### Fire severity

Aim for low to moderate fire severity, noting that small areas of high severity may occur.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm$^{1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | ‹500 | ‹1.5 | ‹2.0 | Produces considerable patchiness of burnt and unburnt ground. Litter may be retained but charred. Humus layer is retained. No canopy scorch or very limited. Some scorching of the mid-layer. Fallen logs and tussock grass stubble are retained. |
| **Moderate (M)** | 500–3000 | 1.5–3.0 | 2.0–6.0 | Some patchiness. Some scorched litter remains. Some humus layer and tussock grass stubble remain. Limited effect on fallen logs. Scorching of the mid-layer. Small amount of canopy scorch. |
| **High (H)** | ›3000 | ›3.0 | ›8.0 | Little or no patchiness. Limited humus remains. Some full-canopy scorch in ‹20m-tall canopy, with the mid-layer burnt completely or near completely. |

*Note: This table assumes good soil moisture and optimal planned burn conditions.*
*State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

#### Fire extent

In each planned burn, a mosaic of burnt and unburnt ground should result from the ignitions. A goal of 40–45% burnt within the target communities is ideal.

A mosaic should also be maintained at a landscape level by targeting different areas at different times. Aim to create a landscape mosaic where 25–50% of included vegetation communities are burnt each year. This will help create a varied age-class structure that supports a diversity of habitats and species.

#### Fire frequency

Eucalypt woodlands to open forests need regular fire to maintain their condition.

The appropriate range of fire frequencies will depend on:

- an on-ground assessment of vegetation condition and fuel accumulation
- previous fire history

- objectives of the fire strategy and burn program.

Planned burns can be brought forward or delayed due to bushfire risk and drought cycles.

**The right fire frequency for each regional ecosystem**

Consider the fire management guidelines for the regional ecosystem (RE) before determining fire frequency. These guidelines indicate the best season, intensity and intervals for keeping forests in good condition. As with any guideline, they are not a precise formula for applying fire.

Access the guidelines online at https://apps.des.qld.gov.au/regional-ecosystems/.

High levels of internal patchiness within a burnt area (e.g. ‹40% burnt) also help provide variation in fire frequency within a patch of forest.

Mosaic planned burning should be used across the landscape at a range of frequencies. This creates varying stages of post-fire response, from recently burnt through to the maximum time frame. Consider a broad fire interval range of between one to six years for a grassy understorey and four to ten years for a shrubby understorey.

Across the landscape, burning some areas at shorter intervals and others at longer intervals will also increase diversity. Very frequent fires in shrubby communities can potentially reduce the abundance of obligate-seed regenerator shrubs. Unburnt areas can be retained using a patchy fire within the broader burn area, ensuring mature obligate-seed regenerators survive to sustain the population.

Similarly, when intervals between fires are too long, resprouters or annual species decline in the absence of burning. High fire intensity after long intervals can damage trees and shrubs and cause the loss of fallen logs and hollow-bearing trees.

This planned burn in grassy open forest resulted in significant unburnt patches. With good rainfall, another planned burn could be considered in two years, spot-lighting larger areas that did not burn on this occasion, Mount Barney National Park 2009. *Photo: Peter Cavendish © Qld Govt.*

### Case study: Grassy and shrubby eucalypt forests on the D'Aguilar Range

Shrubby and grassy eucalypt forests grow together on the D'Aguilar Range. RE 12.11.5, dominated by spotted gum, ironbark and stringybark, has an open grassy structure with a diverse ground layer dominated by kangaroo grass. It grows on metamorphic hills and ridges.

Growing on lower slopes next to RE 12.11.5 is RE 12.11.25. It is dominated by large-leaved spotted gum and broad-leaved ironbark. This lower slope forest often contains a mid-layer of shrubs, such as *Acacia penninervis, Daviesia villifera* and *Hovea acutifolia*.

Brisbane City Council monitoring has found these obligate-seed regenerator shrubs only germinate following fire. Populations significantly declined around nine years post-fire.

The fire requirements of these adjacent ecosystems are subtly different. The needs of both ecosystems can be met with a fire program that starts with the ignition of grassy ridgeline forests soon after rain. Weeks later, further patchy burning lower down the slope can ignite sections of the shrubby forest. This fire protects some mature shrubs in unburnt patches while promoting the recruitment of more shrub seedlings.

Frequent burning along the ridgelines while soil moisture is high promotes the grassy forest. In contrast, burning the grassy forest when soils are dry, especially in late winter to spring, can promote dense regrowth of wattle saplings, such as *Acacia disparrima* and *Acacia leiocalyx*. This overabundance can increase fire intensity and shade out grasses.

Patchy burning in the shrubby forest creates a mix of burnt and unburnt patches, ensuring mature obligate-seed regenerator shrubs persist while encouraging new seedling growth.

## 4.1.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | • January to July. Burns can be undertaken later when recent rain has occurred.<br>• Burning during late summer and autumn will generally create better regenerative conditions for plants and animals. However, drought conditions leading up to this period can instead cause poor regeneration.<br>• Some years may be wetter or drier than normal, influencing post-fire recovery and rates of fuel accumulation. More burning should be implemented across the landscape in wet years and less in dry years.<br>• Take care when undertaking planned burning in late winter/early spring. Strong, dry westerly winds are common then, increasing the risk of reignition.<br>• Wind speed and direction can change in the mid to late afternoon in coastal areas. |
| **FFDI** | ‹11 (7 is optimal to promote a grassy ground layer) |
| **DI (KBDI)** | ‹120 (good soil moisture is the critical factor) |
| **DI (KBDI) sand substrates** | ‹100 (generally lower because of quicker drying times) good soil moisture is the critical factor |
| **Wind speed** | ‹20km/hr |
| **Soil moisture** | • Good soil moisture conditions are important to reduce the impacts of fire on tussock grass bases, resprouters, hollow trees and fallen logs. This will promote a rapid post-fire response and minimise the likelihood of weed invasion.<br>• The rate of soil drying can be rapid at sandy sites, with significant variations between locations. |

Read more about fire and climate in section 1.3.

## 4.1.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Start lighting on the leeward (smoky) edge to establish the initial fire line, create a safe perimeter and promote a low-intensity backing-fire. Depending on available fuels and the prevailing wind on the day, use spot or strip lighting or a combination of both.
- Use progressive lighting or staged burning to achieve a mosaic pattern. Light multiple small fires over weeks or months to safely burn fuels of varying flammability within slightly different weather conditions. This will establish a complex mosaic with highly-variable season and flame characteristics. Burning should always coincide with good humidity and soil moisture (for example, beginning ignitions in the early part of the year after rain). Multiple ignitions over several weeks or months extend the period of fire-promoted grass and herb flowering and seeding.
- Delay the ignition of fires until mid-afternoon, when weather conditions are likely to become milder as the fires increase in size. Allowing the fire to burn into the night creates a greater mosaic than morning ignition. It is also a useful way to achieve the targeted weather conditions when daytime conditions are not ideal. However, be aware of conditions predicted for the following days and the potential increase in wind speed and change of wind direction in the late afternoon near the coast.
- Burn downwards from ridgetops and away from the edges of fire-sensitive vegetation and creeks. This reduces fire intensity, increases patchiness and protects sensitive vegetation from a running fire front.
- Use widely-spaced aerial incendiaries to cover large or inaccessible burn areas and maximise the efficiency of resources. Lighting along ridgelines allows the fire to trickle down slopes and extinguish in moister areas. Igniting from the edges of fire-sensitive vegetation reduces the risk of burning them with high-intensity fires.
- Use timing and moisture to tactically burn adjoining vegetation with differing fire requirements (e.g. lighting grassy open forest ridgelines early in the season when there is good soil moisture and when adjoining shrubby open forest is too moist to burn).

Read more about ignition and lighting patterns in the ***Introductory Volume***.

A low-intensity backing-fire lit against the wind, Moogerah Peaks National Park, May 2007. *Photo: Peter Cavendish © Qld Govt.*

Aerial ignition is essential for burning inaccessible areas of open forest, Kroombit Tops National Park 2009. *Photo: Betty Waugh © Qld Govt.*

Igniting grassy ridgelines in cooler weather when there is good soil moisture can encourage grass regeneration while limiting fire encroachment into adjoining communities that require less-frequent fire, Mount Barney National Park. *Photo: David Kington © Qld Govt.*

## Case study: The ecological consequences of rainforest invasion in long-unburnt eucalypt forest

The impact of invading rainforest pioneers in dry open forests was examined in Bundjalung National Park on the far north coast of New South Wales. The studies compared understorey plant communities, insectivorous bats and ecosystem flammability in heathy eucalypt forests that were:

- recently-burnt (4 years post-fire)
- unburnt for 16 years with abundant rainforest pioneer saplings (e.g. cheese tree, red ash)
- unburnt for 16 years with abundant sclerophyll saplings (e.g. she-oaks, wattles).

The dense mid-layer of rainforest pioneers eliminated over half of the understorey plant species through shading. It also reduced ground cover and the density of dry forest specialists by approximately 90%.

Understorey losses also occurred beneath dense sclerophyll saplings, although losses were typically less than half that of rainforest-invaded sites. Around 20% of displaced species lacked any capacity for population recovery, as they had no soil seed bank or long-distance dispersal capacity. A further 68% may be hindered by the absence of either a soil seed bank or long-distance dispersal capacity.

In open eucalypt forests, most of the floristic diversity is contained in the shade-intolerant ground layer. This layer also provides habitats for a range of wildlife species.

Dense rainforest saplings affected insectivorous bat communities, with rainforest-invaded forests having 63% lower bat activity and 35% lower species richness. In contrast, overall bat species richness was unaffected by dense sclerophyll saplings. These results support other Australian and international studies that show that many bat species are sensitive to increased vegetation 'clutter' that interferes with echolocation during foraging and moving below the canopy.

Rainforest pioneers also decreased open forest flammability through near-elimination of grassy and shrubby ground-layer fuels and the replacement of flammable sclerophyll saplings with less-flammable rainforest saplings.

Rainforest pioneers modify open forests to their advantage by reducing open forest flammability. The frequency and severity of future fires will continue to decrease, supporting the transition to a fire-resistant closed forest.

Reduced flammability can hinder planned burns in mild weather. These forests may become a significant fire hazard during drought because they can carry high-intensity fires.

Importantly, declines in understorey flora, bats and flammability all occurred before the maximum recommended fire interval in New South Wales of 25 years for shrubby open forests. Rainforest pioneer growth may have been accelerated by favourable plant growth conditions during the study (i.e. high soil moisture and nutrients). This highlights the importance of field-based condition assessments in determining when a site is due for fire.

**Different fire and mid-layer classes in heathy open forests of Bundjalung National Park:**

a. Burnt forest with an open mid-layer (four years post-fire),

b. Unburnt forest with abundant sclerophyll saplings (16 years post-fire),

c. Unburnt forest with abundant rainforest saplings (16 years post-fire).

*Photos: © Andy Baker.*

## 4.2 Restore native grass cover and vigour

Grasses and other herbs provide most of the plant diversity in good-condition eucalypt woodlands to open forests.

The abundance and vigour of native grasses (e.g. kangaroo grass) are affected by fire. A decline in abundance and vigour may result from:

- the absence of regular fire
- intense fire during dry conditions
- competition and shading from an overabundance of saplings.

Grass cover is more abundant in grassy open forests than in shrubby forests. Specific sites must be monitored to understand whether grass cover is changing over time. Even in shrubby forests, grass tussocks should look healthy with a solid crown.

Native perennial grass abundance begins to decline several years after fire and can significantly diminish once fire has been absent for around five to ten years.

As grass cover declines, restoration becomes increasingly difficult. The soil seed reserves of most common native grasses are short-lived. When only a few clumps remain, several fires will be required to restore grass cover.

### 4.2.1 Monitoring vegetation condition

**Key indicators of declining grass cover**

- Grasses overall appear sparse, or tussocks are poorly formed and collapsing.
- Increasing gaps between grasses, and there are small-sized individual grass clumps.
- Sedges are more common than grasses.
- Dead leaf litter and/or bare ground covers more ground than live grasses and herbs.

A sequence illustrating tussock grass decline in the absence of fire. The bottom row indicates where fire has been absent for too long, Lamington National Park. *Photo: Wayne and David Kington © Qld Govt.*

### 4.2.2 Considerations for burning

- A dense grass cover provides valuable wildlife habitat. Grass seeds are crucial for granivorous birds.
- Burning when there is good soil moisture is important for grass clump survival and post-fire recruitment.
- Planned burning under mild conditions during wet and early dry seasons is easiest when there is a healthy cover of grasses. If leaf litter has replaced most of the grass cover, early burns do not carry easily. This means that burning must be delayed until conditions are drier, which leads to more intense and extensive fires.
- Shrubby eucalypt forests and woodlands should contain a balance of shrubs and grasses. Assessments can compare the post-fire density of shrub seedlings with pre-fire density. Post-fire survival of grass clumps can also be noted.
- Burning in dry conditions or too frequently promotes blady grass and bracken fern over other grasses in some ecosystems.

### 4.2.3 Prioritising areas for burning

To prioritise locations for the restoration of native grass cover and vigour, consider the:

- degree of grass layer decline
- importance of the area as a threatened species habitat.

Locations where moderate grass cover remains (i.e. >20%) should be considered high priority because grass cover can be more readily restored. Locations with lower grass cover (i.e. 3–20%) should be considered medium priority, and locations where very little grass remains (<3% of the ground layer) are a low priority.

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good. |
| **Medium** | Planned burns in areas where ecosystem health is poor but recoverable. |
| **Low** | Planned burns in areas where ecosystem structure and function have been significantly disrupted. Ground layer is absent or sparse, and fire is no longer viable. |

### 4.2.4 Assessing outcomes

#### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Protect existing large grass tussocks from fire. | A week or fortnight after the fire, look for reshooting grass clumps. Return to pre-fire assessment locations or simply select one or more areas to inspect. Dead clumps are indicated by burnt grass stubble with no fresh leaf regrowth. After rain, look for seedlings and resprouting grass tussocks. | **Achieved:** >90% of bases remain alive and regrow leaves from burnt stubble after rain.<br>**Partially achieved:** 75–90% of bases remain, and there are occasional small grass clumps.<br>**Not achieved:** <75% of bases remain, and there are no new small grass clumps. |
| Increase grass cover following a burn. | Return to pre-fire assessment locations or simply select one or more areas to inspect. Estimate the percentage of grass cover and take photos. Allow a year or two to pass and significant rain to fall after the burn before reassessing the same locations.<br>The return of full grass coverage and biomass will take a couple of years post-fire. | **Achieved:** Grass cover has increased considerably (x 1.5 times) after two or three years.<br>**Partially achieved:** Grass cover appears to have slightly increased after two or three years.<br>**Not achieved:** After two or three years, grass cover is the same or less than its pre-fire extent. |

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 over time

Many objectives are not achieved with a single planned burn, and it is important to keep observing the land. Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

## 4.2.5 Fire parameters

Planned burns should aim for specific fire characteristics to restore native grass cover and vigour.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for low to moderate fire severity, noting that small areas of high severity may occur.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm$^{1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | <500 | <1.5 | <2.0 | Produces considerable patchiness of burnt and unburnt ground. Litter may be retained but charred. Humus layer is retained. No canopy scorch or very limited. Some scorching of the mid-layer. Fallen logs and tussock grass stubble are retained. |
| **Moderate (M)** | 500–3000 | 1.5–3.0 | 2.0–6.0 | Some patchiness. Some scorched litter remains. Some humus layer and tussock grass stubble remain. Limited effect on fallen logs. Scorching of the mid-layer. Small amount of canopy scorch. |
| **High (H)** | >3000 | >3.0 | >8.0 | Little or no patchiness. Limited humus remains. Some full-canopy scorch in <20m-tall canopy, with the mid-layer burnt completely or near completely. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

## Fire frequency

It is possible that multiple planned burns will be required to restore native grass cover. A fire two or three years after the initial planned burn is likely to help promote grass restoration.

Progressive burning with multiple ignition dates over a few months can also be useful. This will increase the duration of grass seed production across the landscape.

If the initial fire triggers a flush of new tree seedlings, use a follow-up planned burn when fuel is suitable to produce a low to moderate-severity fire.

Planned burns should ideally be carried out before significant seeding from overabundant saplings occurs. A fire frequency shorter than normally recommended for this community may be needed.

Once the area has recovered, the recommended burn regime for good-condition eucalypt woodlands to open forests should be resumed.

## Scorch height

Fire must reach sufficient scorch height to reduce overabundant saplings. The height required varies depending on the sapling species being targeted.

### 4.2.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

#### Optimum conditions

| | |
|---|---|
| **Season** | Depends on the accumulation of fuel and sufficient moisture to favour grass regeneration. In general, burning can begin once significant wet season rainfall has occurred and immediately after the wet season, which can provide moist conditions for grass recovery. |
| **FFDI** | <11 |
| **Wind speed** | <15km/hr |

Read more about fire and climate in section 1.3.

### 4.2.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Use a low to moderate-intensity fire and burn only when soil moisture is high to promote grass cover. Burn at the end of or soon after the wet season. Burning at the start of the wet season storms may also be viable.
- Burn downhill wherever possible to produce a beneficial fire for grass recruitment.
- Use spot ignitions targeting existing grass clumps to promote grasses within a patchily-burnt landscape.
- Light a slow-moving backing-fire against the wind on the smoky edge or down slopes. This will ensure the fire has a greater amount of residence time, while keeping fire severity and rate of spread to a minimum. Greater residence time is useful in reducing overabundant seedlings and saplings.
- Where there is a lack of surface and near-surface fuels, use an initial higher-intensity running fire (e.g. a fire lit along the mid-ridge running uphill). A follow-up planned burn will be required to thin surviving saplings and new seedlings.

Read more about ignition and lighting patterns in the *Introductory Volume*.

## 4.3 Reduce overabundant saplings

Saplings are juvenile trees growing among grasses or in the mid-layer.

Only a small number of canopy and mid-layer saplings are needed in a forest to maintain a variety of ages and allow mature canopy species to eventually be replaced.

Saplings can sometimes become overly abundant in eucalypt woodlands to open forests. While isolated thickets of dense growth may not affect forest condition, a broadscale overabundance can compete with and shade out the ground layer. Shading causes grasses to become scattered, poorly formed and collapsed.

Increased mid-layer density also creates ladder fuel that can draw intense fire into the canopy. This can damage trees and promote the regeneration of woody species rather than grasses and herbs.

Sapling abundance can be assessed by considering how a landscape has looked over several decades, the fire history, and the fire response of sapling species. Other relevant factors may include logging history, geology, soil type and the fire strategy objectives.

Sapling overabundance should be managed as soon as possible. Once thickets have developed, it can become increasingly difficult to reintroduce fire into that area.

### 4.3.1 Monitoring vegetation condition

**Key indicators of overabundant saplings**

- Broadscale mass germination of young wattles, she-oaks, eucalyptus, rainforest pioneers or other saplings emerging in the ground layer.
- Broadscale overabundance of young wattles, she-oaks, eucalyptus, rainforest pioneers or other saplings in the mid-layer, indicating later stage overabundance.
- A monoculture of plants in the understorey.
- An understorey or mid-layer that is difficult to see through or walk through.
- Dying grass clumps and thinning of a once-continuous or near-continuous grass cover due to sapling growth. Reduced health and abundance in other ground-layer plants.
- Shrubs with dead or dying branches and reduced diversity and abundance.

Without intervention, this mass germination of wattles will eventually shade out the ground-layer grasses, making it difficult to reintroduce planned burns, Littabella National Park 2008. *Photo: Paul Horton © Qld Govt.*

An overabundance of she-oaks in the understorey has led to a decline in the condition of grasses, Springbrook National Park 2007. *Photo: Mark Burnham © Qld Govt.*

Rainforest pioneers in the mid stratum are scattered but grasses have become sparser in the ground layer. Fire is required to restore the health of grasses, Lamington National Park 2007.
*Photo: Dave Kington © Qld Govt.*

## 4.3.2 Considerations for burning

### Sapling overabundance

- An overabundance of saplings in the understorey may be caused by:
    - a high-severity fire event with no subsequent fire to thin the resulting mass germination of tree saplings (see the photo below)
    - a consistent fire regime that favours one species. For example, late winter fires in dry conditions favour wattle density
    - prolonged absence of fire leading to a gradual increase in woody species
    - removal of many canopy trees due to a past natural disaster (drought or severe storm) or logging
    - mass eucalypt germination during a very wet year. Competition, especially during dry periods, will help thin out these saplings.

A small thicket of casuarina saplings has germinated after a planned burn. This is not considered an issue as it resulted from a localised hotspot and is not widespread, D'Aguilar National Park 2012.
*Photo: Jenise Blaik © Qld Govt.*

### Variations in abundance

- Small, isolated thickets of saplings can result from localised hotspots or normal variations in fire severity and should not be mistaken for a broadscale issue.
- Some wattles and other tree species build up large seed banks in the absence of fire. This is likely to lead to mass germination after bushfires, particularly high-severity fires. Post-fire observations and monitoring are needed to determine whether this is a broadscale issue requiring follow-up fire.

### Treatment of particular species

- It is important to distinguish between the few fire-killed species (e.g. Acacia decurrens, *Acacia penninervis* and *Allocasuarina littoralis*) and those that survive fire by epicormic regrowth and/or resprouting from the base or root suckers (e.g. *Acacia disparrima, Acacia leiocalyx, Allocasuarina torulosa,* eucalypts and many rainforest pioneers). This will help determine the best management action. A follow-up fire within three years will more easily thin fire-killed saplings but may only cause resprouting saplings to resprout from ground level. However, fire will keep these resprouting saplings low in profile so that other species can compete.
- An abundance of some shrubs and trees can be part of a natural cycle. Appropriate fire management will maintain these areas.
- Rainforest pioneers can colonise the ground layer in wetter parts of the bioregion. In the absence of fire, pioneers will grow into the mid-layer. It may be difficult to reintroduce fire into that area if left too long.

- Fires are less likely to carry in moist conditions when forests have scattered, poorly formed and collapsed grasses. This makes recovery more difficult. These forests should be a lower priority for planned burning.

### 4.3.3 Prioritising areas for burning

Maintaining forests and woodlands that are already in good condition is always the highest priority for burning. Priorities for managing overabundant saplings with fire should be based on the height and density of saplings.

If a forest in good condition has recently experienced mass broadscale sapling regrowth following a fire, this is a high-priority area to burn. A follow-up burn within two or three years is essential to thin saplings before they establish a thicket.

Lower priority should be given to sites where the saplings:

- have grown to eye height or taller
- are dense
- are primarily resprouting species.

Lower priority should also be given to sites where geology does not support dense grasses.

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good (e.g. recent mass germination of wattles that can be thinned with one burn). |
| **Medium** | Planned burns in areas where ecosystem health is poor but recoverable. |
| **Low** | Planned burns in areas where ecosystem structure and function have been significantly disrupted. Saplings are dense and over 3m tall. Ground layer is absent or sparse, and fire is no longer viable. |

### 4.3.4 Assessing outcomes

#### Setting objectives for planned burns

The key objective is to thin overabundant saplings and open the structure of the forest or woodland. This can be achieved by killing a proportion of saplings or their seedlings. It can also be achieved by pushing saplings back to ground level and increasing vision through the forest.

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Scorch the crown tops of ›75% of overabundant saplings. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire intensity. Estimate the percentage of overabundant saplings (above ground components) scorched. | **Achieved:** ›75% of crown tops are scorched.<br>**Partially achieved:** 25–75% of crown tops are scorched.<br>**Not achieved:** ‹25% of crown tops are scorched. |
| Kill ›75% of the tree seedlings that mass germinated after a fire. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire intensity. Estimate the density of wattle and other tree seedlings. For example, estimate the number of seedlings within a 1m x 1m area. Average the number from estimates taken over several areas. Return to the same area a few weeks post-fire to look for regrowing young saplings. | **Achieved:** ›75% of pre-fire seedlings are thinned (i.e. the average post-fire count is only a quarter of the pre-fire average per 1m x 1m).<br>**Partially achieved:** 20–75% of seedlings are thinned.<br>**Not achieved:** ‹20% of seedlings are thinned. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

### Monitoring over time

Excessive saplings are often not resolved with a single planned burn. It is important to monitor change with ongoing observations. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Read more about assessing, monitoring and evaluation in the *Introductory Volume*.

## 4.3.5 Fire parameters

Planned burns should aim for specific fire characteristics to manage an overabundance of saplings.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for moderate fire severity, noting that small areas of high severity may occur.

Where there has been new dense sapling growth, a low to moderate-intensity fire will successfully thin small young saplings.

For medium-priority planned burns, a low-severity fire may do more harm than good, reducing available ground fuel without scorching the targeted saplings.

More-intense fires with a higher scorch height will be required to push taller saplings (e.g. ›2m tall) back to ground level. High to moderate-intensity fire should be implemented outside August to October when there is good soil moisture. A brief continuous line of fire (e.g. 100m long), rather than a spot ignition, can be used to increase scorch height under mild burning conditions.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm$^{1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | ‹500 | ‹1.5 | ‹2.0 | Produces considerable patchiness of burnt and unburnt ground. Litter may be retained but charred. Humus layer is retained. No canopy scorch or very limited. Some scorching of the mid-layer. Fallen logs and tussock grass stubble are retained. |
| **Moderate (M)** | 500–3000 | 1.5–3.0 | 2.0–6.0 | Some patchiness. Some scorched litter remains. Some humus layer and tussock grass stubble remain. Limited effect on fallen logs. Scorching of the mid-layer. Small amount of canopy scorch. |
| **High (H)** | ›3000 | ›3.0 | ›8.0 | Little or no patchiness. Limited humus remains. Some full-canopy scorch in ‹20m-tall canopy, with the mid-layer burnt completely or near completely. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire frequency

Multiple planned burns may be needed to manage an overabundance of saplings. If the initial fire triggers a flush of new seedlings, conduct a follow-up planned burn when fuel is suitable for low to moderate-severity fire.

Planned burns should ideally be carried out before significant seeding from overabundant saplings occurs. The appropriate fire frequency will depend on whether the target species has a long-lived seed bank. A shorter fire frequency than normally recommended for this community may be needed.

Complementary strategies to enhance sapling kill may be suited to some locations. Strategies include cutting overabundant saplings of species that do not resprout (e.g. *Allocasuarina littoralis*).

Once the area has recovered, the recommended regime for good-condition eucalypt woodlands and forests should be resumed.

The time that saplings spend exposed to heat from the fire front may also influence sapling mortality. Backing-fires against the wind may prolong the heat against sapling stems and increase mortality. However, this strategy may have a negative impact on some features in the environment (e.g. hollow-bearing trees, cycads).

### Scorch height

Fire must reach sufficient scorch height to reduce overabundant saplings. The height required varies depending on the sapling species being targeted.

## 4.3.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | Depends on the accumulation of fuel and sufficient moisture to favour grass regeneration. Late summer burning is generally preferable to provide higher scorch and better conditions for grass recovery. |
| **FFDI** | <11 |
| **Wind speed** | <15km/hr |

## 4.3.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Implement a backing-fire with good residence time. A slow-moving backing-fire lit against the wind on the smoky edge or down slopes will ensure maximum residence time while minimising fire severity and rate of spread. While greater residence time helps reduce overabundant seedlings and saplings, it should be considered in the context of other key values and environmental features.
- Where there is a lack of surface and near-surface fuels, use an initial higher-intensity running fire (e.g. a fire lit along the mid-ridge running uphill). A follow-up planned burn will be required to thin surviving saplings and new seedlings.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

Overabundant eucalypts in the understorey have been scorched. This site will need to be monitored to ensure fire has not triggered another flush of seedlings. *Photo: © Qld Govt.*

## 4.4 Manage invasive grasses

Invasive grasses are generally taller than native species and also produce significantly more dry matter. Some invasive grasses of concern in the Southeast Queensland bioregion are guinea, thatch, signal, molasses, giant rat's tail and whiskey grass.

Invasive grasses increase fuel loads, fire intensity, spotting and flame height, which leads to increased fire severity and spread. Their presence can significantly impact planned burn operations and the maintenance of fire lines.

Ideally, planned burns would avoid burning invasive grasses due to the likelihood of increased fire severity and further promotion of these grasses. However, it is unrealistic to exclude areas with exotic grasses from burning.

### 4.4.1 Monitoring vegetation condition

**Key indicators of invasive grass**

- Tall, dense stands of grasses (often single-species dominated).
- Early growth and spread of invasive grasses along fire lines, access roads and historically-cleared or otherwise disturbed areas.
- Dead trees with charring high up the trunk.

A monoculture of thatch grass has replaced native pasture and begun to encroach adjoining communities, Gladstone 2009. *Photo: Dan Beard © Qld Govt.*

## 4.4.2 Considerations for burning

### Weather conditions

Planned burning of invasive grasses is often undesirable. However, it may be preferable in some situations to proactively burn invasive grasses when there is good soil moisture. This may reduce the risk of grasses burning with bushfire during hot, dry conditions.

### Weed control

- Fire may be useful as part of an integrated weed control program. It can help reduce dead biomass and promote new growth and mass germination of the seed bank in preparation for herbicide control.
- Planned burning of exotic grasses should coincide with native grasses being in active growth, making them more competitive. This should always be combined and followed up with other treatment.Weed hygiene procedures should be followed when maintaining fire lines or conducting planned burning in areas with invasive grasses.
- Routinely burning from roads or tracks can promote weed establishment and spread.
- Some invasive grasses have short seed viability (e.g. grader grass). Withholding fire for a period may favour native grasses and help control invasive grasses. The biology and current treatment recommendations for each species should be considered.

### Grader grass *Themeda quadrivalvis*

- Grader grass is an annual exotic grass. It resembles kangaroo grass *Themeda triandra* but has thicker seed heads and turns orange or brown as it dies off in the middle of the year.
- Grader grass does not form thick individual basal clumps. It develops dense infestations of many individual plants with thin stem bases.
- Grader grass does best in more fertile basalt-derived black soil and in alluvial ecosystems.
- Any disturbance that bares the soil, including fire and heavy cattle grazing, promotes grader grass.
- The best management of grader grass is to leave the site protected from burning and grazing for four to six years.
- Burning in the middle of the wet season may help control grader grass. This should be done after plants have established but before flowering, usually around January.

Kangaroo grass seed head on the left.
Grader grass seed head on the right.
*Photo: Paul Williams © Vegetation Management Science Pty Ltd.*

### Guinea grass *Megathyrsus maximus* var. *maximus*

- Guinea grass remains greener longer than some native grasses. It holds more biomass than native grasses and will burn with higher intensity when it has cured.
- Fire is generally not effective in controlling guinea grass. If the infested area must be burnt, timing and follow-up treatment with herbicide are critical to control. Avoid burning late in the planned burn season as this will increase the risk of high-severity fire and potential damage to riparian and other sensitive areas. Late burning also increases the risk of significant canopy scorch and loss of hollow-bearing trees.
- Maintaining the canopy cover will provide shade, helping to manage this grass.
- Herbicide spraying of resprouting guinea grass can successfully reduce its abundance. Follow-up herbicide treatment is essential.

Close up of Guinea grass.
*Photo: Paul Williams © Vegetation Management Science Pty Ltd, 2005.*

### Molasses grass *Melinis minutiflora*

- While molasses grass is often killed by fire, it will regenerate rapidly from large seed banks. Observation of post-burn seedlings in North Queensland found that seed production did not occur until the second year (Williams and Bulley 2003). However, seedlings in Southeast Queensland have reached reproductive maturity within the first year.

- Short fire intervals have been successfully trialled in North Queensland. Burning before seedlings have matured to seed production has led to the recovery of native tussock grasses, such as giant spear grass and kangaroo grass (Williams and Bulley 2003). Very short intervals may be similarly effective in Southeast Queensland.
- Caution is required when burning at short intervals. Over a long timeframe, this method may damage populations of native perennials through seedling death (Williams 2002).
- Herbicide spraying of molasses grass after fire can successfully reduce its dominance. Molasses grass increases rapidly following fire and begins to slowly thin from around three years post-fire before returning in great abundance after the next fire.

Molasses grass infestation in flower. This invasive grass is particularly common along roadsides and disturbed areas of open forest in Southeast Queensland.
*Photo: Paul Williams © Vegetation Management Science Pty Ltd, 2004.*

### Signal grass *Urochloa decumbens*

- Signal grass is not as tall as other invasive grasses but can form a dense monoculture in disturbed areas.
- This invasive grass recovers rapidly after fire from stolons (runners). It seeds with the onset of rains. Little is known about how signal grass responds to different fire regimes. Monitoring and more observation are required.

Signal grass forms a dense monoculture outcompeting native grasses in open forests.
*Photo: John McQueeney © Qld Govt, 2012.*

Distinctive flowers of signal grass.
*Photo: Donovan Sharp © Queensland Herbarium, 2012.*

## Whiskey grass *Andropogon virginicus*

- Whiskey grass is a tall tussock grass that grows up to one metre with a distinctive erect, column-like habit. It is orange-brown during the warmer months and fades to a straw colour during winter.
- This species invades disturbed areas along tracks. It is a high-biomass exotic grass and can become a fire hazard.

Whiskey grass is very distinctive in colour and appearance during warmer months.
*Photo: Kim Sparshott © Qld Govt, 2006.*

## 4.4.3 Prioritising areas for burning

Controlling small and new exotic grass infestations should be considered a high priority. Early infestations can be removed with moderate effort, but if left uncontrolled, can considerably damage the ecosystem.

Fire may not be the appropriate control agent but can form part of an integrated control program.

There is a lower priority where exotics are the dominant grasses over a large area. This is because their control would require large, ongoing efforts. These resources could be better spent maintaining good-condition forest and restoring moderately poor-condition forest back to good condition.

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good and contain only small areas of exotic grass infestations. |
| **Low** | Planned burns in areas where ecosystem structure and function have been significantly disrupted where exotic grass species occur over a large area. |

## 4.4.4 Assessing outcomes

### Setting objectives for planned burns

The key objective is to reduce the impact of invasive grasses on the ecosystem, preferably eradicating them from a local area.

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table on the next page lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Promote mass germination of invasive grass seeds in preparation for herbicide control. | Assess the site after the burn (preferably after rain) for germination of invasive grass seeds. | **Achieved:** Mass germination of weed seedlings. Follow-up herbicide is successful in controlling weed seedlings and coppicing exotic grasses.<br>**Partially achieved:** Moderate germination of weed seeds (sufficient to warrant follow-up spraying).<br>**Not achieved:** Insufficient germination to warrant follow-up spraying. |
| Reduce fuel hazard to low to limit impacts of bushfire. | After 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, noting this outcome will be very short-lived.<br>**Not achieved:** Fuel hazard has not been reduced to low. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

## Monitoring over time

Fire management techniques for most species of invasive grasses in the Southeast Queensland bioregion are not yet established and will be subject to experimentation.

Ongoing observation is necessary to monitor change. Recording fire details and results will help to refine the most appropriate objectives, timing and conditions.

Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Read more about assessing, monitoring and evaluation in the *Introductory Volume*.

## 4.4.5 Fire parameters

Planned burns should aim for specific fire characteristics to manage invasive grasses.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim to minimise fire severity. This may be difficult depending on the species of invasive grass being targeted.

## 4.4.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | Late wet season to early dry season (February–April) is preferable. |
| **FFDI** | <7 |
| **DI (KBDI)** | <100 |
| **Wind speed** | <10km/hr |
| **Soil moisture:** | Ensure good soil moisture to retain a duff layer and limit the opening of bare ground and further encroachment of weeds. |

## 4.4.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Use fire as part of a weed control program. Do an initial over-spray of invasive grasses with herbicide, followed by a low to moderate-severity planned burn about a month later. Successful treatment of these grasses will require monitoring the site and implementing follow-up fire or herbicide on any remaining plants and new seedlings.
- Ignite spot fires to effectively alter the desired intensity of a fire, particularly where there is an invasive grass infestation. Increased spacing between spots will result in a lower-intensity fire. The spacing of spots may vary throughout the burn due to changes in weather conditions, topography and fuel loads.
- Implement a backing-fire (lit against the wind or slope) to minimise fire intensity when burning invasive grass infestations and reduce the risk of encroachment into non-target communities.
- Use a running fire early in the season when there is good soil moisture. This can be achieved by shortening the spacing of lit spots or using line or strip ignition. A running fire will carry through the infestation if weather conditions are too mild or grasses are not sufficiently cured.
- Burn areas adjacent to invasive grass infestations when the grass is green and not cured, under mild conditions, and in the early morning or late afternoon/evening. This will promote a low-intensity fire that burns away from the non-target community. Where the non-target community is in low-lying areas (e.g. in drainage lines), use the surrounding topography to create a low-intensity backing-fire that travels downslope towards the non-target community. There should always be good soil moisture present within the non-target community.

Read more about ignition and lighting patterns in the *Introductory Volume*.

## 4.5 Reduce *Lantana camara*

In locations where *Lantana camara* occurs as a scattered understorey plant and grass fuels are still continuous, apply the recommended fire regime for good-condition eucalypt woodlands to open forests.

Areas heavily infested with lantana can be restored with fire. However, resources may be better used to maintain healthier areas.

Scattered lantana in the understorey. Grass fuels are still continuous, meaning the standard fire regime for open forests could be applied to control lantana, Glenrock State Forest (2006). *Photo: Mark Burnham © Qld Govt.*

## 4.5.1 Monitoring vegetation condition

**Key indicators of *Lantana camara***

- Dense infestations of *Lantana camara*.
- No grass or fine fuels.

## 4.5.2 Considerations for burning

- In areas where lantana density is high but some native grasses remain underneath, a low to moderate-severity fire may be sufficient to control lantana and favour native grasses.
- Extremely low fire intensity under green lantana will successfully kill the plant. These conditions are rare and very difficult to predict. However, if this type of fire behaviour is noted, then it should be encouraged where Lantana is prevalent.
- Implementing the recommended regime for the broad vegetation group is effective in the management of lantana where it occurs as a scattered understorey plant.
- Where dense lantana is widespread, a series of fires with increased fire frequency may be the only practical control method. This can reduce the abundance and density of lantana or reduce the size of individual plants, allowing native ground covers to compete.
- In areas with dense but limited lantana infestation, herbicide spraying can be followed by a planned burn. A splatter gun technique is recommended for spraying (Somerville et al. 2011).
- Post-fire herbicide spraying of lantana regrowth is highly effective when regrowth is fresh and growing strongly.
- Although high-intensity fire may kill lantana, it also favours regrowth of woody species, such as wattle or more lantana. These fires disadvantage grasses and herbs.

## 4.5.3 Prioritising areas for burning

| Priority | Priority assessment |
|---|---|
| **Medium** | Planned burns in areas where ecosystem health is poor but recoverable. |
| **Low** | Planned burns in areas where ecosystem structure and function have been significantly disrupted. |

## 4.5.4 Assessing outcomes

### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Reduce lantana abundance by 75%. | Approximately three months post-fire, count the living and dead lantana plants within a 10m radius in three locations. | **Achieved:** 75% or more of lantana is killed.<br>**Partially achieved:** 25–75% of lantana is killed.<br>**Not achieved:** ‹25% of lantana is killed. |
| Reduce the majority of lantana clumps to promote basal resprouting and enable efficient and effective follow-up spraying. | After the burn (preferably after rain), walk through the burn area and visually estimate the percentage of clumps that are reduced to basal resprouting. | **Achieved:** ›75% of clumps are reduced to basal resprouting.<br>**Partially achieved:** 25–75% of clumps are reduced to basal resprouting.<br>**Not achieved:** ‹25% of clumps are reduced to basal resprouting. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

## Monitoring over time

Lantana may not be controlled with a single planned burn, and it is important to keep observing the land.

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

## 4.5.5 Fire parameters

Planned burns should aim for specific fire characteristics to control lantana. Repetitive use of fire is critical for success.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for low to moderate fire severity, which is generally within the recommendations for the broad vegetation group in which the lantana occurs.

### Fire extent

In each planned burn, a mosaic of burnt and unburnt ground may result from the ignitions. A goal of 75–100% burnt is suitable where lantana has become a dense infestation.

If lantana is a scattered understorey plant, fire coverage to 50–75% is appropriate.

### Fire frequency

Planned burns should be repeated within three years until lantana is under control. At this point, the recommended fire regime for the vegetation group should be reinstated.

If lantana is a scattered understorey plant, the standard frequency for the vegetation group may be sufficient.

## 4.5.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | Late summer to autumn. |
| **FDI** | ‹11 |
| **DI (KBDI)** | ‹120 (‹80 is optimal for good soil moisture) |
| **Wind speed** | ‹15km/hr (10–15 km/hr is optimal) |

## 4.5.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Ignite a line or strip fire along the leeward (smoky) edge to contain the fire. This tactic can also be used if there is minimal surface fuel (e.g. lantana has shaded out grasses).
- Use a running fire to carry fire through the infestation if the fuel load is low or discontinuous.
- Where lantana is scattered in the understorey, implement a low to moderate-intensity backing-fire when there is good soil moisture and sufficient surface fuel. This will ensure a greater residence time at ground level, killing both seedlings and mature lantana plants.
- Use mechanical methods to subdivide lantana infestations. This will improve access for chemical control and allow the infestation to be burnt in sections for better-managed fire severity and behaviour.
- Implement fire as part of a control program. Initially over-spray lantana with herbicide (e.g. using a splatter gun). After around a month, knock down the lantana frames and implement a low to moderate-severity burn into the remaining material. This tactic is particularly useful along rainforest margins. Alternatively, knock down the lantana first, prior to herbicide control. Successful treatment of lantana will require monitoring the site and implementing follow-up fire or herbicide treatments to any remaining plants and new seedlings.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

Low to moderate-intensity backing-fires allow good residence time, maximising the lantana kill rate without impacting on native species regeneration, D'Aguilar National Park (2005).
*Photo: Dave Kington © Qld Govt.*

## 4.6 Manage bell miner associated dieback

Bell miner associated dieback (BMAD) of eucalypts is a significant issue in the southern half of the bioregion.

There are various theories on the cause of BMAD and how it can be addressed. It is associated with a combination of factors, including:

- disturbance that opens the canopy
- dense shrubby understorey (often invaded by Lantana camara)
- moist soils
- reduced fire frequency
- the presence of bell miners and psyllids (sap-sucking insects).

Areas adjacent to BMAD that are in good condition or show early signs of decline are a priority for planned burning. This helps prevent dieback spread while also protecting affected areas from bushfire.

### 4.6.1 Monitoring vegetation condition

**Key indicators of BMAD**

- Bell miner birds (bellbirds) in the local area. Their call is a high-pitched 'tink'.
- A dense mid-layer, featuring *Lantana camara* in particular.
- Leaves with an underside coated in a sugary substance (secreted by psyllids).
- Dying foliage in the upper branches of many canopy trees.
- Epicormic regrowth on branches.
- Numerous dead or dying trees.

Numerous dead and dying trees combined with a dense mid-layer can be indicators of a BMAD-affected open forest, Mount Barney National Park. *Photo: Mark Burnham © Qld Govt.*

Areas where dieback is well-established will be difficult to recover and are therefore a very low priority for planned burning, Main Range National Park 2011.
*Photo: Mark Burnham © Qld Govt.*

Planned burning in adjacent grassy open forests should be a high priority to minimise the risk of BMAD, Main Range National Park. *Photo: Dave Kington © Qld Govt.*

Upper branches showing signs of decline. A dense woody understorey often accompanies BMAD, D'Aguilar National Park 2008.
*Photo: Wayne Kington © Qld Govt.*

Dead and dying tree branches in the crown of a eucalyptus tree, D'Aguilar National Park 2008.
*Photo: Wayne Kington © Qld Govt.*

Epicormic regrowth on branches may be common in a BMAD area, Main Range National Park 2011.
*Photo: Jenise Blaik © Qld Govt.*

### 4.6.2 Considerations for burning

- Eucalypt dieback, strongly linked with psyllids (sap-sucking insects), is sometimes associated with the native bell miner or bellbird and has become common in some parts of the bird's range. Psyllid associated dieback can occur without the presence of bell miners, but management will be the same as for BMAD.
- Not all dieback is due to BMAD. Drought and Phytophthora can also cause dieback. In these situations, fire may be detrimental. There is some evidence that suggests fire contributes to Phytophthora dieback.
- Areas with well-established dieback will be difficult to recover and are therefore a very low priority for planned burning.

### 4.6.3 Prioritising areas for burning

Areas next to BMAD-affected areas should be considered a high priority in a burn program. Prioritising these areas will help maintain ecosystem health and prevent the expansion of dieback.

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

Refer to sections 4.3 for relevant fire parameters, objectives and fire tactics. If lantana is an issue, see also sections 4.5.

## 4.7 Maintain good-condition beach ridge eucalypt, brush box and cypress communities

Eucalypt woodlands often grow on beach dunes and swales inland from the beach foredune.

Two beach ridge woodland communities occur in the Southeast Queensland bioregion:

- RE 12.2.5, dominated by pink bloodwood *Corymbia intermedia*, brush box *Lophostemon confertus,* cypress pine *Callitris columellaris*, Moreton Bay ash *Corymbia tessellaris* and blue gum/forest red gum *Eucalyptus tereticornis*. Associated trees and shrubs include *Banksia integrifolia* and *Banksia aemula*, weeping cabbage palm *Livistona decora* and wattles *Acacia* spp. Rainforest species can be present in the mid-layer.

- RE 12.2.11, dominated by bloodwood *Corymbia tessellaris*. Some communities may have blue gum/forest red gum *Eucalyptus tereticornis*, pink bloodwood *C. intermedia* and weeping cabbage palm *Livistona decora*.

Beach ridge woodlands can be extensive and contain areas of cultural significance. Culturally significant areas include pink bloodwood, brush box and cypress pine woodlands and thickets (RE12.2.5) on Minjerribah (North Stradbroke Island) and Mulgumpin (Moreton Island). Either bloodwood or brush box dominate the canopy, with scattered cypress pines dominating small areas.

Regular burning when there is good soil moisture is critical to maintaining these beach ridge communities. Appropriate fire management depends on the landscape.

### 4.7.1 Monitoring vegetation condition

**Key indicators of good-condition beach ridge eucalypt, brush box and cypress communities**

- Overabundant wattles and she-oak *Allocasuarina littoralis* saplings following high-intensity and dry fires.
- Weeds, including high-biomass grasses.

### 4.7.2 Considerations for burning

- Coastal cypress is killed by fires that scorch the canopy. First Nations people have used burning to protect old trees from intense fires for thousands of years.
- Beach ridge communities require very low-intensity fires with good soil moisture. They are very sensitive to damage from moderate to high-intensity fires and burning under dry conditions.
- Where these communities occur interspersed with bands of eucalypts, melaleuca and rainforest species, their composition is likely to be the result of hydrology rather than fire regimes. In these situations, they should not be burnt.
- Brush box can form a closed canopy of small trees in areas that have experienced intense fires. If the brush box canopy is scorched in a moderate to high-intensity fire, trees are reduced to ground level but reshoot from the lignotuber, resulting in multiple stems. These may form a dense ‘whipstick’ thicket that alters the vegetation structure for decades. Brush box woodlands must only be burnt in low-intensity fires, and surrounding vegetation regularly burnt to protect it from bushfires.

Beach ridge communities with vine forest understorey are vulnerable to fire during dry conditions. Ensure good soil moisture when implementing planned burns in surrounding fire-adapted vegetation, Woodgate, Burrum Coast National Park (2012). *Photo: Paul Horton © Qld Govt.*

Sections of beach ridge communities may be more open with a mainly blady grass understorey, requiring low-intensity burns with high soil moisture to reduce impacts from potential bushfires during dry conditions, Woodgate, Burrum Coast National Park (2012). *Photo: Paul Horton © Qld Govt.*

**Fire management guide to protect cypress-dominated cultural landscapes known as Cypress Camps**

The first step in managing cultural sites with fire is always consulting with the First Nations people whose Country the site is on.

Cypress Camps are ancient sites of extremely high cultural value found along the east coast of Australia.

This section is based on work done on Minjerribah by Quandamooka Yoolooburrabee Aboriginal Corporation. The guidelines below are based on Quandamooka cultural knowledge of the protection and management of Cypress Camps. See Appendix 1 for more detail.

The landscapes in and around the Cypress Camps along the east coast of Australia are of extremely high cultural significance to First Nations people. These are sites with ancient shell middens and sacred stands of trees that shade known occupation and ceremony sites. These places have been used for many millennia by First Nations people, including the Quandamooka and Kabi Kabi.

These landscapes are dominated by ancient coastal cypress trees *Callitris columellaris*. The Quandamooka People refer to these trees as *Boogari*, while the Kabi Kabi and Butchulla peoples call them *Coolooloi*.

Bloodwood *Corymbia intermedia*, blue gum/forest red gum *Eucalyptus tereticornis*, brush box *Lophostemon confertus* and scribbly gum *Eucalyptus racemosa* are also present.

Coastal cypress *Callitris columellaris* is intolerant of even moderate-intensity fire. Their presence as large old trees within a landscape that is highly prone to extreme fire events can only occur where fuel loads and fire hazards have been effectively managed throughout time. The age of old trees is commonly underestimated.

Unfortunately, many of the stands of these old trees have disappeared because of intense bushfires since the suppression of Aboriginal burning and vegetation management practices during the 20th and 21st centuries.

As a result of the high-intensity bushfires that have occurred, regeneration in the area is often very dense, creating a wall of banksias, acacias, epacrids, *Allocasuarina* spp. and other species of plants. The structure of the community has been altered and cultural values are affected.

The amount and arrangement of fuel pose a high risk of fire that could impact these ancient cultural landscapes.

**Management objectives**

Management objectives are determined through consultation with First Nations partners. Objectives may include:

- removing the immediate threat of dense highly-volatile vegetation and fuel load
- retaining the archaeological integrity of the area
- reintroducing cultural landscape management, including low-intensity fires to ensure the ongoing health and protection of these cultural landscapes.

Management recommendations may include:

- reviewing control lines to maximise chances of preventing bushfire impacts
- manually removing vegetation and removal off-site.

Manual removal involves felling vegetation, removing it from the site, and chipping and using the mulch on control lines. This method is usually preferred because it minimises impact on cultural sites and allows large volumes of vegetation to be processed and reused efficiently.

Mulching supports fire strategy objectives by improving the accessibility, stability and usability of the fire trail network.

### Fire parameters

Planned burning should occur as soon after rain as it will burn and stop when fire burns too intensely. On some sites, this may mean that burning commences the day after rain and stops as soon as two or three days after rain.

Frequent test burns and checks of the soil moisture are necessary to identify the right time to burn.

### Optimum conditions

| | |
|---|---|
| **Season** | Due to the strong onshore Easterlies on coastal sand country, the most appropriate burn window is May to July inclusive, with a caution that late July burns can potentially reignite in August and September. |
| **FFDI** | <15 |
| **KBDI** | <60 |
| **Wind speed** | 15kph |
| **Temperature** | <24$^{0}$C |


Low-intensity cultural burn on Minjerribah, 2017. *Photo: Courtesy of QYAC.*

# 5. Eucalypt open forests to woodlands on floodplains

Eucalypt open forests to woodland on floodplains commonly feature Queensland blue gum/forest red gum *Eucalyptus tereticornis*, Moreton Bay ash *Corymbia tessellaris*, pink bloodwood *Corymbia intermedia*, gum-topped box *Eucalyptus moluccana*, swamp mahogany *Lophostemon suaveolens*, broad-leaved paperbark *Melaleuca quinquenervia* and river she-oak *Casuarina cunninghamiana*.

A mid-layer and understorey of rainforest or paperbark trees may be present.

This vegetation community grows along drainage lines and adjacent alluvial floodplains.

Floodplain communities require fire to maintain a diverse, grassy ground layer. Fringing drainage lines in these forests and woodlands have less requirement for fire to regenerate. For some communities (e.g. those dominated by *Eucalyptus coolabah*), flood events, rather than fires, are critical for seedling germination and establishment.

These communities provide critical habitat for a wide range of fauna because of the water supply, often dense, shady canopy relative to surrounding vegetation, and large trees commonly with hollows.

Fire management in floodplain communities aims to:

- maintain vegetation structure and composition
- protect important habitat features, such as logs and large trees that may contain hollows
- protect crowns from scorching
- protect fire-sensitive species that only occur in these areas (e.g. *Casuarina cunninghamiana*)
- control weeds.

**Fire management considerations**

- Limit the encroachment of high-severity fire into eucalypt open forests to woodlands on floodplains (see section 5.1).
- Ensure low to moderate-intensity fires in eucalypt open forests to woodlands on floodplains (see section 5.2).
- Manage invasive grasses (see section 5.3).
- Reduce *Lantana camara* (see section 5.4).

## 5.1 Limit the encroachment of severe fires into eucalypt open forests to woodlands on floodplains

Most species in this community regenerate after fire. However, some are slow to reach mature height. Severe fires can scorch the tops of shrubs and trees. Damage to canopies can remain apparent for many years.

High-severity fires simplify vegetation structure and increase the risk of soil erosion and weed invasion. This can increase the intensity of future fires.

### 5.1.1 Monitoring vegetation condition

**Key indicators of good-condition eucalypt open forests to woodlands on floodplains**

- Very large, old trees with substantial hollows.
- A canopy with good vigour and foliage cover.
- A ground layer dominated by grasses, sedges or leaf litter.
- Exotic shrubs (especially *Lantana camara* and rubber vine *Cryptostegia grandiflora*) and introduced grasses (e.g. guinea grass and green panic grass) are commonly present; however, healthy riparian forests usually have low weed cover.

Avoid burning into most good-condition riparian communities. Implementing appropriate planned burns in surrounding fire-adapted communities when there is good soil moisture will limit potential impacts on this community, Kroombit Tops National Park.
*Photo: Paul Lawless-Pyne © Qld Govt.*

## 5.1.2 Considerations for burning

### Habitat requirements

- Eucalypt open forests to woodlands on floodplains form a network of long, very narrow habitats across the bioregion. These ecosystems are critical to flora and fauna movement. They are also important fauna habitat, offering refuge during drought.
- Across the bioregion, the species composition of flora and fauna varies within this broad vegetation group. Vegetation structure also varies.
- Scorch height should be limited as eucalypt open forests to woodlands on floodplains are important nesting habitats for many birds. They also provide critical food resources for greater gliders and koalas and hollows for a wide range of species.

### Seasonal conditions

- Drainage lines may hold water throughout the year or be seasonally dry, depending on the location and stream order.
- Vegetation in good condition (e.g. lacking high-biomass exotic grasses) can break the spread of fires across a landscape, depending on seasonal conditions.
- Wet and early dry season burning out from the margins of these forests can protect the forest from damaging fires. It can also increase the value of these areas as fire breaks later in the season. Burning should always be carried out when the soil and fuel are moist and water is present in the drainage line.

## 5.1.3 Prioritising areas for burning

The highest priority should be given to regular burning on the outer edges of these communities. This should include sites where the location of eucalypt open forests to woodlands on floodplains offers a strategic advantage to bushfire mitigation.

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good or where the ecosystem may not be in good condition, but there are critical habitat features (e.g. large trees).<br><br>Early burning against a fringing community is a high priority if planned burns are proposed for surrounding ecosystems in that year or where bushfire risk in the surrounding landscape is high. |
| **Medium** | Planned burns in areas where ecosystem health is poor but recoverable. |
| **Low** | Planned burns in areas where ecosystem structure and function have been significantly disrupted. |

### 5.1.4 Assessing outcomes

#### Setting objectives for planned burns

The primary reasons for burning the edges of eucalypt open forests to woodlands on floodplains are:

a) to protect them from the incursion of damaging bushfires

b) to increase their value as a fire break.

Unlike other eucalypt communities, these areas do not require burning for regeneration.

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table on the next page lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Achieve no scorch of small or large tree canopies. | Immediately after the burn, visually estimate the percentage length of the scorched forest margin. Walk the margin, assess one or more representative sections (e.g. a 100m-long section of the margin in three locations) or evaluate scorch from the air. | **Achieved:** No or very little scorch.<br>**Partially achieved:** ‹5% scorched.<br>**Not achieved:** ›5% scorched. |
| Limit penetration of severe fire into the fringing community. | Select one or more sites on the forest edge and walk from the burnt edge towards the drainage line. Estimate the distance that shrub-scorching fire penetrated the riparian forest as a proportion of the width of the habitat. If the riparian zone is very narrow or the vegetation is very resilient to fire (e.g. a grassy eucalypt forest), fire penetration is not a problem. | **Achieved:** ‹10% penetration of the width of the community.<br>**Partially achieved:** 10–30% penetration of the width of the community.<br>**Not achieved:**›30% penetration of the width of the community. |
| Achieve no loss of habitat features or species endemic to this vegetation type. | Immediately after the burn, visually assess whether habitat features and/or endemic species were lost during the planned burn activity. | **Achieved:** No loss of habitat features or endemic species.<br>**Partially achieved:** ‹5% loss of habitat features or endemic species.<br>**Not achieved:** ›5% loss of habitat features or endemic species. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

### Monitoring over time

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

## 5.1.5 Fire parameters

Planned burns should aim for specific fire characteristics to help limit encroachment of severe fires.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for a low-severity fire.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm¹) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| Low (L) | ‹500 | ‹1.5 | ‹2.0 | Some patchiness. Most of the surface and near-surface fuels have burnt. Stubble is still evident. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

Generally, burning the edges of eucalypt open forests to woodlands on floodplains will help break up the spread of fires and increase the landscape mosaic. This provides critical habitat for a wide range of plant and animal species and corridors for wildlife movement.

## 5.1.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | • Concentrate efforts during years of good rainfall.<br>• Riparian edge burns should typically be implemented first in the year following good wet season rain.<br>• Avoid burning following frosts.<br>• Post-fire grass growth and recovery are slower in winter. This may result in longer periods of patchy bare ground and weed growth.<br>• Do not burn during dry conditions. |
| **FFDI** | <7 |
| **Wind speed** | <15km/hr |
| **Soil moisture** | Good soil moisture is critical to minimise margin scorch and fire penetration into the community. Burning in the days following rain (and before adjoining forests burn) will improve regeneration and limit weed growth. |

## 5.1.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Ignite fires from the outer edge of the forest (i.e. on the boundary against the adjacent sclerophyll ecosystem).
- Use spot aerial and ground ignition. Alter the distances between ignition points to achieve the desired fire intensity.
- Implement a slow-moving, low-intensity backing-fire (lit on the leeward or smoky edge). This generally results in a more complete coverage of an area and better fuel consumption.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

## 5.2 Ensure moderate to low-intensity fires in eucalypt open forests to woodlands on floodplains

Eucalypt open forests to woodlands on floodplains usually have a dense grass cover. However, they can often be invaded by weeds, including *Lantana camara* and exotic grasses.

Episodic flooding is an important trigger for plant germination in this community. Regular fire helps maintain dense grass cover and diversity in the ground layer. Fire also reduces weed abundance and limits overabundant saplings.

Without regular burning, these communities can thicken with saplings. This can increase the intensity of future fires.

In historically-logged areas, there may be a lack of age-class distribution. These areas should be actively managed for the successful regrowth of key species (e.g. Queensland blue gum). Burning just before seed release can help provide open ground, while burning should be avoided after regrowth to protect saplings.

Refer to chapter 3 for fire management guidelines.

## 5.3 Manage invasive grasses

Invasive exotic grasses should be noted during planned burn operations and while maintaining fire lines. These grasses can increase fire severity and spread.

Invasive grasses are generally taller and produce significantly more dry matter than native species. This creates increased fuel loads, fire intensity, spotting and flame height.

Some invasive grasses of concern in the Southeast Queensland bioregion are guinea, thatch, signal, molasses, giant rat's tail and whiskey grass.

### 5.3.1 Monitoring vegetation condition

**Key indicators of invasive grass**

- Tall, dense stands of grasses (often single species dominated).
- Early growth and spread of invasive grasses along fire lines, access roads and historically-cleared or otherwise disturbed areas.
- Dead trees with charring high up the trunk.

Refer to section 4.4 for relevant management guidance.

## 5.4 Reduce *Lantana camara*

In locations where *Lantana camara* occurs as a scattered understorey plant and grass fuels are still continuous, apply the recommended fire regime for good-condition eucalypt woodlands to open forests (see chapter 4).

Refer to section 4.5 for relevant management guidance.

A monoculture of thatch grass has replaced native pasture and begun to encroach into adjoining communities, Gladstone (2009). *Photo: Dan Beard © Qld Govt.*

Scattered lantana in the understorey. Grass fuels are still continuous, meaning the standard fire regime for eucalypt woodlands to open forests could be applied to control lantana, Glenrock State Forest (2006). *Photo: Mark Burnham © Qld Govt.*

# 6. Inland dry eucalypt woodlands

Inland dry eucalypt woodlands are dominated or co-dominated by silver-leaved ironbark *Eucalyptus melanophloia*, narrow-leaved ironbark *E. crebra*, poplar box *E. populnea*, variable-barked bloodwood *Corymbia erythrophloia* and Queensland blue gum *E. tereticornis*. These woodlands have a mixed grassy/shrubby understorey.

This broad vegetation group dominates extensive areas of central and western Queensland, especially the Brigalow Belt and Desert Uplands bioregions. Inland dry eucalypt woodlands also grow in western areas of Southeast Queensland, such as Ban Ban, Kroombit Tops and Mount Walsh national parks.

Regular burning is important to maintain native grass and herb cover and diversity, maintain the open woodland structure and control weeds.

Scorch height should be limited, as these forests provide critical resources for greater gliders and koalas. They also provide hollows and log habitats for a wide range of species.

In the absence of fire, inland dry eucalypt woodlands may experience shrub thickening (e.g. the development of excessive currant bush *Carissa ovata*).

Refer to chapter 4 for relevant management guidance.

Good condition *Eucalyptus melanophloia* woodland. *Photo: © Tim Ryan.*

# 7. Melaleuca communities

The dominant species found in melaleuca communities in the Southeast Queensland bioregion varies.

*Melaleuca quinquenervia* open forests and woodlands are common. These communities are in seasonally inundated lowland coastal areas and swamps.

Other species found in the bioregion include broad-leaved tea-tree *Melaleuca viridiflora* and Wide Bay white mahogany *Eucalyptus latisinensis*. Queensland peppermint *Eucalyptus exserta* is found on drainage lines in coastal parks in the north of the bioregion (e.g. Deepwater and Eurimbula national parks).

Swamp tea-tree *Melaleuca irbyana* low open woodlands and low open forests (RE 12.9-10.11, RE 12.3.18) are also part of this group. These regional ecosystems are endangered and highly restricted.

The understorey of melaleuca communities is dependent on hydrology. For example, in drier sites, the shrub layer may include southern salwood *Acacia disparrima* and red ash *Alphitonia excelsa,* while swamp banksia *Banksia robur* and blue tongue *Melastoma malabathricum* may be present in wetter sites. King ferns *Todea barbara* may occur along drainage lines, often with emergent swamp mahogany *Eucalyptus robusta*.

The ground layer is often dense. Wetter sites may be dominated by sedges, rushes and ferns, such as *Blechnum indicum* and *Lygodium microphyllum*, while grasses like *Themeda triandra, Entolasia marginata* and *Paspalum scrobiculatum* become more common in drier sites.

This vegetation group may vary considerably in moisture and species composition, influencing the approach to planned burning. Burns should be conducted when there is good soil moisture to prevent peat fires, which can smoulder for many weeks and damage tree roots.

**Fire management considerations**

- Maintain good-condition melaleuca communities (see section 7.1).
- Avoid peat fires (see section 7.2).
- Manage exotic pine wildings (see section 7.3).

## 7.1 Maintain good-condition melaleuca communities

Planned burns should be used to maintain melaleuca communities in good condition.

### 7.1.1 Monitoring vegetation condition

**Key indicators of a good-condition melaleuca community**

- An understorey dominated by native species reflective of the hydrology.
- Good-condition canopy.
- Few to no weeds or disease.

Melaleuca forest with a mixed fern/sedge understorey, subject to seasonal inundation, Pine Ridge Conservation Park (2005).
*Photo: Sylvia Millington © Qld Govt.*

Melaleuca community with a good-condition mixed grass/sedge understorey, Caloundra Conservation Park (2011). *Photo: Rowena Thomas © Qld Govt.*

Melaleuca swamp with a wet heath understorey. *Photo: Rowena Thomas © Qld Govt (2011).*

Melaleuca swamp with a mid-layer of cabbage tree palms and sedge understorey, South Stradbroke Island Conservation Park (2011). *Photo: Jenise Blaik © Qld Govt.*

Melaleuca communities can occur in narrow strips along drainage channels. Burning adjacent fire-adapted communities when standing water is present will limit impacts on melaleuca, particularly if adjacent ecosystems are burnt more frequently than typically applied to melaleuca communities, Teerk Roo Ra National Park (2011). *Photo: Jenise Blaik © Qld Govt.*

**Key indicators that fire management is required**

- Widespread dense accumulation of dead material (grasses, sedges, ferns) and grasses beginning to collapse.
- A substantial area with a high hazard accumulation of surface and near-surface fine fuels, such as leaf litter, bark and twigs (using the ***Overall Fuel Hazard Assessment Guide***).
- Mass germination of melaleuca seedlings.
- A flush of pine wildlings or groundsel that have begun shading out the ground layer. These may form dense stands.

Dead material is accumulating in the mixed fern/sedge ground layer, Glass House Mountains National Park (2009). *Photo: Rowena Thomas © Qld Govt.*

## 7.1.2 Considerations for burning

- The papery bark and leaves of melaleuca trees contain volatile, highly flammable oils. Planned burns following rain will help protect melaleuca trees, reducing the number of flames running up the trunk and ember spotting.
- The thick papery bark of some melaleucas promotes ladder fires that quickly run from the base to the top of the tree. In most cases, ladder fires self-extinguish without causing any damage, particularly in mature trees.
- Younger melaleuca trees will often respond post-fire with a flush of regrowth from epicormic buds, if weather conditions and fire severity are favourable.

- Thickets of young melaleucas can promote fire of much greater intensity, leading to significantly higher melaleuca mortality.
- Endangered swamp tea-tree communities are low forests with an open eucalypt overstorey. Regeneration of these melaleucas may be disrupted by overly-frequent, high-severity fires in dry conditions. Regeneration can also be affected if fire is not frequent enough.
- When managing melaleuca overabundance, observe post-fire germination and kill rates to ascertain the need for subsequent fires. Generally, multiple planned burns will be required to manage this issue. These burns should be of varying scale, timing and intensity.

Read more about mosaic burning in the ***Introductory Volume***.

## 7.1.3 Prioritising areas for burning

| Priority | Priority assessment |
|---|---|
| **Very high** | Planned burns to maintain areas with key values or other values. |
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good. |

## 7.1.4 Assessing outcomes

### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Reduce combined surface and near-surface fine fuel to moderate. | After the fire, use the ***Overall Fuel Hazard Guide*** to visually assess the remaining fuel in at least three locations. | **Achieved:** Fine fuel reduced to moderate.<br>**Not achieved:** The amount of fine fuel is still high. |
| Achieve ‹5% mortality of mature melaleuca trees. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire severity. Approximately six months after the fire, estimate the percentage of mature dead trees. | **Achieved:** ‹5% mortality of mature melaleuca trees.<br>**Not achieved:** ›5% mortality of mature melaleuca trees. |
| No peat fires | See section 9.4 | |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

## Monitoring over time

Many issues are not resolved with a single planned burn, and it is important to keep observing the land.

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Monitoring the presence and condition of specific species, such as the endangered swamp orchid *Phaius australis*, can be used as an indicator of appropriate fire.
*Photo: Sylvia Millington © Qld Govt, (2005).*

## 7.1.5 Fire parameters

Planned burns should aim for specific fire characteristics to help maintain forests in good condition.

Read more about fire parameters in the *Introductory Volume*.

### Fire severity

Aim for low to moderate fire severity in areas with a grass, sedge or fern-dominated understorey.

Aim for a moderate-severity fire, with small areas of high severity, in communities with a heath or shrub understorey.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm$^{1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | <500 | <1.5 | <2.5 (up to 8m on melaleuca trees) | Significant patchiness. Litter is retained but charred. Humus layer is retained. Nearly all habitat trees, fallen logs and grass stubble are retained. Some scorching of elevated fuels. Little or no canopy scorch. |
| **Moderate (M)** | 500–3000 | 1.5–3.0 | 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 are retained. Some scorch of elevated fuels. Little or no canopy scorch. |
| **High (H)** | >3000 | >3.0 | 7.5–15.0 (up to 20m on melaleuca trees) | Some patchiness. Some humus remains. Some habitat trees and fallen logs are affected. At least some canopy scorch in moderate-height (<20m) canopy. Mid-layer burnt completely or near completely |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

Mosaic planned burns should be implemented across the landscape at a range of frequencies. This will create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame).

### Fire frequency

Fire frequency should primarily be determined through on-ground assessment of vegetation health, fuel accumulation and previous fire patchiness. Burns may be brought forward or delayed in response to bushfire risk or drought.

Consider the understorey composition and moisture needs of melaleuca communities. A mixed grass/shrub understorey may have an interval range of six to twenty years. A heath understorey may have an interval of eight to 12 years and a mixed sedge/fern understorey may have an interval range of 12 to 20 years.

## 7.1.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | January to July (consider varying the season of burn). |
| **FFDI** | ‹11 |
| **DI (KBDI)** | Ideally 60–80, but ‹100 |
| **Wind speed** | ‹15km/hr |
| **Soil moisture** | Burn with good soil moisture in melaleuca communities. Communities that are seasonally inundated or where a peat layer has formed are vulnerable to peat fire in the drier months. These communities should always be burnt with standing water or when the peat layer is waterlogged. |

Melaleuca trees have papery bark that draws fire up the tree trunk. Planned burning soon after rain will help the fire self-extinguish and improve post-fire regrowth, Teerk Roo Ra National Park (2011). *Photo: Jenise Blaik © Qld Govt.*

### 7.1.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

For some melaleuca communities, particularly in small or narrow patches, the best approach is to burn surrounding vegetation using tactics and conditions that allow fire to periodically penetrate the melaleuca, rather than targeting melaleuca directly. Fire frequency and conditions should still be appropriate to the melaleuca.

It is important to understand variations in moisture between the melaleuca community and the surrounding vegetation. Sometimes, on-ground assessments may identify a need to directly target melaleuca.

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Use spot ignition to alter the desired intensity of a fire. Well-spaced spot lighting next to melaleuca stands limits the chance of forming hot, damaging junction zones.
- Implement a slow-moving backing-fire (lit against the wind on the smoky edge or down a slope). This generally results in more complete coverage of an area and greater residence time while keeping fire intensity and rate of spread to a minimum. Greater residence time is useful in reducing overabundant trees.
- Commence lighting on the leeward (smoky) edge to establish the initial fire line, a safe perimeter and promote a low-intensity backing-fire. Depending on available fuels and the prevailing wind on the day, this may require spot or strip lighting or a combination of both.
- Use areas with standing water to protect peat and create fires with a greater mosaic and variability of time since fire.
- Use line or strip ignition to create a higher-intensity fire or to help fire carry through moist or inconsistent fuel. This tactic is also useful to reduce overabundant trees through scorching.
- When burning surrounding fire-adapted areas, apply appropriate lighting patterns along the margin of the melaleuca woodland to create a low-intensity backing-fire that burns away from the non-target area. This will limit fire encroachment into non-target communities. Where melaleuca woodland is low-lying (e.g. in drainage lines), use the surrounding topography to create a low-intensity backing-fire that travels downslope towards the melaleuca community. There should always be good soil moisture present within the melaleuca community.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

## 7.2 Avoid peat fires

Melaleuca forests should only be burnt when there is some standing water and the soil in elevated areas is very moist. This will limit the ignition of peat layers.

When peat is dry, it can smoulder for many weeks and damage tree roots. However, when peat is moist, some minor smouldering can help remove deep, built-up organic layers obstructing water channels. This can restore appropriate hydrology and water movement.

Standing water will prevent peat fires and reduce the likelihood of ignition during planned burning in adjacent communities.

## 7.3 Manage exotic pine wildings

Germination of exotic pine wildings is an issue in areas next to pine plantations. Left unmanaged, pine wildings can displace native species, and pine needles can smother lower-layer plants.

Protected areas with historical clearing for pine plantations require intensive rehabilitation after gazettal.

### 7.3.1 Monitoring vegetation condition

**Key indicators of pine wildings germination**

- Pine plantation is adjacent to woodlands.
- Young pine wildings emerging above the ground-layer plants.
- Reduced abundance and health of ground-layer plants.
- Scattered, poorly formed and collapsing grasses (where naturally present).

A flush of pine wildings has formed a dense thicket in the understorey of this melaleuca community, Bribie Island National Park (2008). *Photo: Graeme Bulley © Qld Govt.*

Exotic pine wildings in a regenerating heath community, Bribie Island National Park (2011).
*Photo: Graeme Bulley © Qld Govt.*

## 7.3.2 Considerations for burning

- Pine seeds are primarily wind-dispersed (species dependent), and isolated wildings can be found up to 5km from the parent plant. However, most seeds will fall within 500m of the plantation. Regular reinfestation means ongoing management of wildings is crucial.
- Pine wildings may be triggered in response to:

a. prolonged absence of fire
b. repeated low-severity, early-season fires
c. a fire event with no subsequent fire to thin the resulting flush of wildings.

- If a fire triggers a flush of wildings, it will be necessary to plan a subsequent burn.
- Pine wildings less than 1m in height are relatively easy to manage, and most fires will kill the saplings. Wildings measuring 1–3m are more difficult to manage. Specific tactics may be required, such as a high-intensity or running fire that chars the tips of wildlings. Residence time on more established areas can also be effective. For example, a backing fire in high-intensity conditions, where it will penetrate further, may be more effective than a running fire. More advanced wildings will require other control methods.
- If subsequent fires are not hot enough, growing seedlings may not be killed. A hot fire is required to char the tip of the plant.
- Care should be taken when burning areas adjacent to pine plantations as high-intensity fires increase the risk of spot-over, which can reduce the quality and value of plantation trees.

## 7.3.3 Prioritising areas for burning

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

## 7.3.4 Assessing outcomes

### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Char pine wildings measuring <2m to the tip. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire intensity. Estimate the percentage of overabundant saplings with charred above-ground components. | **Achieved:** >75% of pine wildlings are charred.<br>**Partially achieved: 50–75% of pine wildlings are charred.**<br>**Not achieved:** <50% of pine wildlings are charred. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

## 7.3.5 Fire parameters

Planned burns should aim for specific fire characteristics to manage pine wildings.

Read more about fire parametersin the *Introductory Volume*.

### Fire severity

Aim for moderate to high fire severity, with flame height sufficient to char to the tip of the pine wildings.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm$^{1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Moderate (M)** | 500–2000 | 1.5–3.0 | 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 are retained. Some scorch of elevated fuels. Little or no canopy scorch. |
| **High (H)** | ›3000 | ›3.0 | 7.5–15.0 | Some patchiness. Some humus remains. Some habitat trees and fallen logs are affected. At least some canopy scorch in moderate-height (‹20m) canopy. Mid-layer burnt completely or near completely. |

### Fire extent

In each planned burn, a mosaic of burnt and unburnt ground should result from the ignitions. A goal of 80% burnt in the area dominated by understorey pine trees is ideal.

### Fire frequency

Multiple planned burns may be required to achieve this objective. If the initial fire results in a flush of wildings, a follow-up moderate to high-severity fire should be implemented within two years.

Before implementing a high-severity fire for pine wildings, consider burning adjacent fire-adapted communities to reduce risk of non-target impacts. Follow the guidelines relevant to those communities.

Avoid repeated very low-intensity fires as this will promote pine wildings and will not produce sufficient scorch to kill existing pine wildlings.

An initial high-intensity fire may replace pine with wattle, requiring further fire management to rehabilitate to a good condition.

## 7.3.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | As recommended for the area's primary ecosystem. |
| **Soil moisture** | Burn when there is good soil moisture. |

## 7.3.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Match fire intensity to the pine wildling heights by increasing the length of drip torch lines to increase flame height for taller pines. A running fire of a higher intensity may be required to increase flame height to ensure the tips of wildlings are charred.
- Use line or strip ignition to create a higher-intensity fire or to help fire carry through moist or inconsistent fuel. A second line of fire lit parallel to the initial strip can increase fire intensity between the two lines as they draw together.
- Implement a slow-moving backing-fire (lit against the wind on the smoky edge or lit from upslope). This generally provides a greater amount of residence time while keeping fire intensity and rate of spread to a minimum. Greater residence time is useful for killing wildings 1–2m in height.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

# 8. Acacia communities (other than mulga)

Acacia communities (other than mulga) occur in the Southeast Queensland bioregion and are dominated by brigalow *Acacia harpophylla*. The community has an endangered biodiversity status.

Brigalow is most abundant in the Brigalow Belt Bioregion. It has mostly been cleared for agriculture in the Southeast Queensland bioregion and now occurs as small, isolated remnants, especially in the Gatton district.

Belah *Casuarina cristata* and poplar box *Eucalyptus populnea* trees co-dominate in places. Species typical of semi-evergreen vine thickets commonly occur in association with brigalow (see section 2 for more information).

Acacia communities (other than mulga) are sensitive to fire. Many species in the community, including brigalow, can resprout after fire. However, their regrowth is slow, and burning opens the habitat to weed invasion.

Brigalow trees and shrubs typically resprout from the base and root suckers when fully scorched. This fundamentally alters the structure of the community.

Brigalow communities are particularly vulnerable to fire if there are invasions of high-biomass exotic grasses.

The fire management objective for brigalow communities is to protect them from fire by burning adjacent fire-adapted communities under low to moderate-intensity fires when good soil moisture is good.

# 9. Coastal communities and heaths

Coastal communities and heaths found in the Southeast Queensland bioregion include:

- strand and foredune complex and cays
- swamp oak *Casuarina glauca* woodland to open forest
- coastal heaths on dunes, sandplains and headlands
- montane heaths.

**Strand and foredune complex**

Foredune vegetation is typically a combination of:

- grassland dominated by beach spinifex *Spinifex sericeus* with coastal jack bean *Canavalia rosea* and goats foot *Ipomoea pes-caprae*
- coastal she-oak *Casuarina equisetifolia* woodland to open forest.

The shrub layer is generally sparse but may include species, such as octopus bush *Argusia argentea*, tuckeroo *Cupaniopsis anacardioides*, *Pandanus tectorius* and *Banksia integrifolia*. The ground layer beneath casuarina is sparse to mid-dense, dominated by grasses like beach spinifex and *Eragrostis interrupta*.

**Cays**

The cays of Southeast Queensland occur at the southern end of the Great Barrier Reef. Together, these islands form the Capricorn Bunker group and include Heron, Tryon and Lady Musgrave islands. They are made of sand, shingle and coral. Their maximum elevation is rarely more than 10m above sea level.

Coastal communities on the cays include grasslands and herblands dominated by species such as stalky grass *Lepturus repens, Sporobolus virginicus, Thuarea involuta, Boerhavia albiflora* and *Achyranthes aspera*.

Shrubland, scrubs and low woodlands occur on the margins of the cays and include species such as *Argusia argentea, Scaevola taccada, Pandanus tectorius* and *Abutilon albescens*, with *Casuarina equisetifolia* emergent in places.

Vegetation on coral cays provides significant nesting habitat for a range of sea birds.

**Coastal swamp oak *Casuarina glauca* woodland to open forest**

Coastal swamp oak *Casuarina glauca* forests are dense or open forests. The canopy is dominated by *Casuarina glauca*, often with paperbarks *Melaleuca quinquenervia*. The ground layer can range from a near-continuous cover of salt couch *Sporobolus virginicus* to bare salt pan.

**Coastal heaths on dunes, sandplains and headlands**

This vegetation group includes wet and dry coastal heaths, wallum banksia and low mallee woodland communities on dunes and sand or alluvial plains.

**Montane heaths**

This vegetation group covers montane heaths and rock pavement (generally located on rocky mountain peaks), exposed ridges and plateaus on poorer soils away from the coast.

Each of these coastal communities and heaths requires a specific approach to fire management.

**Fire management considerations**

- Maintain good-condition strand and foredune complex and cays (see section 9.1).
- Maintain good-condition swamp oak woodland to open forest (see section 9.2).
- Maintain good-condition coastal heaths on dunes, sandplains and headlands (see section 9.3).
- Avoid peat fires in heaths (see section 9.4).
- Manage exotic pine wildlings in coastal heaths on dunes, sandplains and headlands (see section 9.5).
- Maintain good-condition montane heaths (see section 9.6).

## 9.1 Maintain good-condition strand and foredune complex and cays

Strand and foredune complex and cays occur in an extreme environment, exposed to strong winds, salt spray, and sometimes tidal inundation in extreme weather events.

Vegetation communities on strand and foredune complex and cays are highly-sensitive to fire. Fire can also increase the risk of erosion, particularly in high-use recreation areas.

### 9.1.1 Considerations for burning

- These vegetation communities should not be burnt. They are very sensitive to fire and should be protected from bushfires.
- Only fire-sensitive vegetation communities are found on the cays. Planned burns are not conducted on these islands.
- Vegetation on the cays is typically not at risk from bushfires, except perhaps on high-visitation islands. Escaped campfires can cause significant damage to this vegetation.
- Campfires should be restricted or regulated to protect fire-sensitive vegetation.
- Fire-adapted communities adjacent to strand and foredune complex vegetation should be burnt with care. Burns should travel inland, using the sea breeze to direct fire away from fire-sensitive vegetation.
- Weed invasions into fire-sensitive vegetation can increase the risk of bushfires. Weeds should be managed to ensure they do not become a fire hazard.

### 9.1.2 Prioritising areas for burning

Planned burns are not conducted on the cays.

In other locations with strand and foredune complex vegetation, planned burns are only conducted in adjacent fire-adapted vegetation communities. Refer to the relevant chapter in this guide for information specific to that community.

## 9.2 Maintain good-condition coastal swamp oak forests

Coastal swamp oak forests can tolerate low-intensity fire that does not scorch the tree canopy. The dense salt couch ground layer can burn intensely. The high flammability of salt couch, combined with melaleucas in the tree layer, can result in this community becoming a high to extreme fire hazard.

Planned burns should be conducted at the same time as burning in surrounding fire-adapted communities. These areas may be subject to tidal inundation, which can help contain fire extent.

Legislation policies and regulations restrict burning of these communities outside of the protected area estate where there are marine plants, such as salt couch.

### 9.2.1 Monitoring vegetation condition

**Key indicators of good-condition coastal swamp oak woodland and forest**

- An open to very dense coastal swamp oak canopy with good-condition foliage.
- Paperbark and/or mangroves intermingled on the margins.
- A sparse to dense cover of salt-tolerant plants (e.g. salt couch) in the ground layer.
- A ground cover of fallen she-oak branchlets, bare salt pan or salt pan with samphires, reeds, sedges and/or ferns.
- Few or no weeds (e.g. groundsel).

Coastal swamp oak forest with a salt couch ground layer.
*Photo: © Paul Williams, Vegetation Management Science Pty Ltd, Bribie Island (2021).*

**Key indicators that fire management is required**

- Increasing infestation of weeds, particularly groundsel.
- Accumulation of dead material in the mixed sedge/fern understorey.
- Build-up of fine fuels, such as thick salt couch, dead grass material, leaf litter, suspended leaf litter, bark and twigs.
- A high or very high accumulation of elevated fuels.

## 9.2.2 Considerations for burning

- Coastal swamp oak trees are killed when their canopies are fully scorched in a bushfire. However, they are likely to survive low-intensity planned burns with low scorch height.
- Seed germination can be prolific after fire. Trees may return to their full canopy height (around 11m tall) in a decade.
- The ground layer can be a mix of salt couch *Sporobolus virginicus*, samphire herbs and salt pan. The fuel load from salt couch can be high and may also be continuous. It burns intensely and produces an irritating, thick acrid smoke.

## 9.2.3 Prioritising areas for burning

Managing this community is a high priority.

| Priority | Priority assessment |
|---|---|
| **Very high** | Planned burns to maintain areas with key values or other values. |
| **High** | Planned burns to maintain ecosystems in areas where ecosystem health is good. |

## 9.2.4 Assessing outcomes

### Setting objectives for planned burns

Maintaining a good-condition canopy is a key objective, which requires low-intensity planned burning.

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table on the next page lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Patchily burn salt couch in association with surrounding fire-adapted communities. | Choose one of the following options:<br>a) Visually estimate the percentage of burnt vegetation from one or more vantage points or the air.<br>b) Map the boundaries of the burnt areas with GPS then plot in FLAME to determine the percentage of the area burnt.<br>c) Choose three locations that represent the variability of landform and ecosystems within the burn area. Walk 300 or more metres through the burn area, estimating the percentage of ground area that is visibly burnt. | **Achieved:** 20–70% of the ground layer is burnt.<br>**Partially achieved:** 10–20% or 70–90% of the ground layer is burnt.<br>**Not achieved:** ‹10% or ›90% of the ground layer is burnt. |
| Achieve no canopy scorch. | Visually assess the area soon after a fire. | **Achieved:** No scorch of the lower or upper tree canopy.<br>**Partially achieved:** Some lower tree canopy scorch.<br>**Not achieved:** ›10% of the upper tree canopy is scorched. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

### Monitoring over time

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

## 9.2.5 Fire parameters

Planned burns should aim for specific fire characteristics to protect coastal swamp oak forests.

### Fire severity

Aim for low fire severity, with occasional fires of moderate severity.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm$^{1}$) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | <500 | <1.5 | <2.0 | Some patchiness. Most of the surface and near-surface fuels have burnt. Stubble is still evident. |
| **Moderate (M)** | 500–3000 | 1.5–3.0 | Complete grass biomass is consumed. | All surface and near-surface fuels are burnt. Stubble is burnt to blackened remnants. Scorching of shrubs and lower tree canopy. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

Aim to burn no more than 50% of coastal swamp oak forest within a reserve in any year.

### Fire frequency

Fire frequency should primarily be determined through on-ground assessment of vegetation health, fuel accumulation and previous fire patchiness. Burns may be brought forward or delayed due to bushfire risk or drought cycles.

Coastal swamp oak forest benefits from low-intensity planned burning when there is good soil and fuel moisture, approximately every three to six years.

If a bushfire has killed canopy trees, a longer fire interval may be needed to allow saplings time to reach reproductive maturity.

### 9.2.6 Weather conditions

Good soil moisture is important for the regeneration of grasses and samphire plants.

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### 9.2.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- When planning burns for surrounding fire-adapted areas, consider coinciding burns with high tides or seasonal inundation to limit fire encroachment into heath communities.

Read more about ignition and lighting patterns in the *Introductory Volume*.

## 9.3 Maintain good-condition heaths on dunes, sandplains and headlands

Many coastal heath communities on dunes, sandplains and headlands should contain a mix of age-classes of heath, from recently burnt to around six to twelve years after fire. Some patches may not have been burned for longer. This ensures a mix of food resources and vegetation structures are available for wildlife. It also allows small plants to persist, including the vulnerable *Acacia bauer*.

The prolonged absence of fire can lead to a decline in plant health and diversity in coastal heaths.

Planned burns in heaths should be implemented when the soil is moist. Recurring bushfires of high intensity have a negative impact on heath management. Extensive bushfires in dry conditions can reduce plant health and lead to long-term loss of diversity.

Peat fires can also be an issue in wet heaths and associated sedgelands, particularly during prolonged drought. Peat can smoulder for long periods and take many years to reform. There is also an increased risk of inappropriate fire when wet heaths dry out.

Heath communities in good condition can be maintained with mosaic burning on a landscape level. Burning should take place when soil moisture is good, at the same time as surrounding fire-adapted vegetation communities.

### 9.3.1 Monitoring vegetation conditions

**Key indicators of good condition coastal heath communities**

- A diversity of vigorous shrub species, including banksias, hakeas, pea flowers, tea-trees *Leptospermum* spp. and grass trees.
- Obligate-seed regenerators such as small-leaved geebung *Persoonia virgata, Hakea actites* and wedding bush *Ricinocarpos pinifolius*.
- Herbs (including rushes, sedges and lilies) in the ground layer of wet heath.
- No trees or emergents, or a low tree layer dominated by wallum banksia or mallee-form trees (in dry heaths).
- A canopy dominated by shrubs (e.g. *Banksia robur*) (in wet heaths).
- Seasonal waterlogging of low-lying areas.

Good-condition coastal open heath with emergent melaleucas, Glass House Mountains National Park (2011). *Photo: Rowena Thomas © Qld Govt.*

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Good-condition wallum banksia heath, Glass House Mountains National Park (2011).
*Photo: Rowena Thomas © Qld Govt.*

Good-condition low mallee heath woodland, Burrum Coast National Park (2012).
*Photo: Paul Horton © Qld Govt.*

### Key indicators that fire management is required

- Shrubs have lost a significant amount of lower-level leaves or have dying crowns. An accumulation of dead material on shrubs.
- A noticeable loss of diversity in the shrub layer.
- Dense matting of dead vegetation under banksias.
- Grass trees with accumulating dense brown skirts.
- Dodder smothering the canopy.
- Substantial dead material amongst sedges and rushes.
- Encroaching melaleuca saplings into wet heath or increasing abundance of saplings in dry heath.

Dead branches, spindly growth and a loss of diversity in the understorey indicate fire has been absent from this wallum banksia woodland for too long, Glass House Mountains National Park. *Photo: Rowena Thomas © Qld Govt.*

Shrubs are losing lower leaves, and grass trees are accumulating dead skirts in this open heath, Noosa National Park (2011). *Photo: Rowena Thomas © Qld Govt.*

Sedges and rushes are starting to accumulate dead material in this wet heath, Teerk Roo Ra National Park (2011). *Photo: Jenise Blaik © Qld Govt.*

Dodder is smothering the shrub layer in this long unburnt heath, Burrum Coast National Park (2012). *Photo: Paul Horton © Qld Govt.*

*Hakea actites* shrubs are abundant in some wet heath communities and can become dominant when fully grown (left). Combined with the weight of large, woody seed clusters (above), mature plants may fall over, impacting ground-layer plants, Noosa National Park (2008).
*Photo: Rowena Thomas © Qld Govt.*



## 9.3.2 Considerations for burning

### Fire frequency

- Many coastal heath communities are at the urban interface or in high-use recreation areas. This makes them susceptible to arson and bushfire, which can create a regime of high-intensity, often frequent, bushfires in dry conditions. This has long-term impacts on plant diversity and health.
- In comparison, other coastal heath communities experience too-infrequent fire, which also leads to a decline in plant health and diversity.

### Obligate-seed regenerators

- Coastal heath communities feature a relatively high proportion of obligate-seed regenerators (i.e. regenerating only from seed) that can take several years to reach reproductive maturity. Some plants should be allowed sufficient time to mature and set seed over several years. This will build an adequate seed supply between planned burns.
- Some obligate-seed regenerators (e.g. hakea) become overabundant due to mass germination following fire, particularly in low soil moisture. If this is seen in a large area, a follow-up fire can be used to prevent reseeding.
- Some hard-seeded species (e.g. pea flowers) require heat penetration into the topsoil to trigger germination.

### Peat in heaths

- Heaths on seasonally waterlogged soils (wet heaths) gradually accumulate peat (partially decayed, densely-packed vegetation). Peat forms where waterlogged conditions impede the flow of oxygen from the atmosphere, slowing the rate of decomposition.
- Peat has a high carbon content and can burn when it becomes sufficiently dry. It can smoulder for very long periods, sometimes undetected. Peat takes many years to reform, even centuries if severely impacted.
- Peat fires are very difficult to extinguish. Fires may travel underground and reignite elsewhere in the landscape.
- In wet heath communities with a peat layer, planned burns should be conducted when there is standing water at the site. At minimum, there should be saturated soil to protect the peat layer.
- Implementing planned burns during drought conditions, where peat is present, is not recommended. Plants are likely to be stressed and find it difficult to recover from fire.

### Habitat needs

- Unburnt patches (especially in isolated patches of heath) should remain, providing refuge for wildlife.

#### Fire management guideline: New Holland mouse habitat

The New Holland mouse *Pseudomys novaehollandiae* has a vulnerable status under both the Queensland *Nature Conservation Act (1992)* and Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)*. Southeast Queensland is its northernmost distribution, with populations found on the east coast as far south as Tasmania.

New Holland mice live in heath and shrubby eucalypt communities. They have been found in recently-burnt and long-unburnt ecosystems. The population response to burning depends on the fire's impact on habitat factors, such as the presence of unburnt patches that provide immediate shelter and seeds. New Holland mice are thought to survive the passage of fire by sheltering in their underground burrows. However, they may be vulnerable to food shortages and increased predation after extensive fires.

Low-intensity, patchy planned burns that promote seeding of herbs while leaving unburnt habitat for shelter are considered most suitable for New Holland mice populations. Planned burns should be undertaken outside their breeding season (from mid-April to mid-September), though they can have multiple litters in a year. Controlling predators such as cats and foxes can be beneficial, particularly following an extensive planned burn.

Photo: © James Sparshott.

Chapter 9—Coastal communities and heaths

## Fire management guideline: Ground parrot fire management

The ground parrot *Pezoporus wallicus* subspecies *wallicus* is listed as vulnerable under the *Nature Conservation Act (1992)*. Ground parrots are found in coastal wet and dry heath and sedgelands, from Victoria to Wide Bay, including K'gari.

Their home range averages around nine hectares but varies considerably amongst individuals and age groups and across seasons.

From late autumn to early spring, ground parrots appear to prefer dry microhabitats within their home ranges. Wet microhabitats are preferred in summer.

Ground parrot habitat is prone to fire. However, the presence of ground parrots does not mean that burns should be excluded. A long-term absence of fire will negatively impact ground parrots.

Birds are found in their preferred habitat soon after fire and in habitat up to 20 years post-fire. However, they are most abundant in habitat five to eight years after fire. This preference broadly correlates to peak plant seed abundance.

Breeding also appears to be influenced by the age of vegetation post-fire. Breeding has been recorded in patches of dry coastal heath that have not burnt for at least three or four years.

Appropriate fire management is essential to ground parrot survival.

Ground parrots predominately breed in spring but have been recorded nesting from as early as July through to October. Burning outside of August and September helps reduce the risk to nesting birds.

A regime that provides patches of heath and sedgeland at different ages (up to eight to ten years) across a local landscape is appropriate.

Rotational planned burning, when the ground is moist shortly after the wet season and at the beginning of the dry season, supports this regime and creates possibilities for further staged burning.

Some planned burns should be completed at the lower end of the reaccumulation phase but should only cover 50–60% of the treatment area. This provides the best opportunity for creating a diverse range of age-class structures and plant life cycle diversity.

The aim of planned burning should be to create patchiness within the heath across the landscape. Maintaining a mosaic of different fuel levels in the landscape will help preserve some areas in long- unburnt conditions.

Before any planned burns, activity areas for ground parrots should be ascertained using automated acoustic recording units (AARU). Follow-up monitoring with AARUs should be undertaken to establish if ground parrots re-establish and use mosaic burn areas. QPWS health checks can be used to monitor the ecosystem condition of key-value heath communities over time.

Ground parrot

### 9.3.3 Prioritising areas for burning

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

### 9.3.4 Assessing outcomes

#### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Create age-class diversity<br><br>within a heath community using landscape-level mosaic burning. | Choose one of the following options:<br>a) Visually estimate the percentage of burnt vegetation from one or more vantage points or the air.<br>b) Map the boundaries of the burnt areas with GPS then plot in FLAME to determine the percentage of the area burnt.<br>c) Choose three locations that represent the variability of landform and ecosystems within the burn area. Walk 300 or more metres through the burn area estimating the ground area that is visibly burnt. | **Achieved:** 25–50% of the area is burnt.<br>**Partially achieved:** 0–25% or 50–75% of the area is burnt (adjust future planned burn objectives depending on the result).<br>**Not achieved:** ›75% of the area is burnt. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

A successful mosaic burn in open heath. This can be difficult to achieve within small areas, so it is generally better to aim for a landscape-level mosaic, Currimundi Lake Conservation Park (2009).
*Photo: Rowena Thomas © Qld Govt.*

## Monitoring over time

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

Mosaic burn achieved in coastal heath at a landscape scale by using aerial ignition, Moreton Island National Park (2009). *Photo: Galen Matthews © Qld Govt.*

Monitoring the presence of common obligate-seed regenerators like wedding bush can provide an indicator of appropriate fire regimes in some heath communities, Bribie Island National Park (1995).
*Photo: Lisa Ford © Qld Govt.*

## 9.3.5 Fire parameters

Planned burns should aim for specific fire characteristics to help maintain coastal heaths in good condition.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for moderate fire severity in coastal heaths, though expect small pockets of extreme severity.

| Fire severity class | Fire intensity (during the fire) | Fire severity (post-fire) |
|---|---|---|
| | Average flame height (m) | Description (loss of biomass) |
| Low (L) | ‹1.5 | Substantial unburnt vegetation (green patches) in the shrub layer. Fire does not remove all surface fuels (litter) and near-surface fuels. Distinct holes may be created in closed heaths. Some scorching of shrubs and small trees |
| Moderate (M) | 1.5–3.0 | Most vegetation is burnt. Skeletal frames of shrubs remain. Trunks of grass trees are intact. Charred duff layer remains. |
| Extreme (E) | ›3.0 | Extensive or total biomass is burnt. Area is burnt to mineral earth. |

Skeletal frames of shrubs remain intact after a moderate-severity fire. These are important to allow for species regeneration and to maintain vegetation structure, Teerk Roo Ra National Park (2002).
*Photo: Jenise Blaik © Qld Govt.*

In areas of wallum banksia and low mallee woodland (<10m), aim for moderate fire severity, though expect small pockets of extreme severity.

| Fire severity class | **Fire intensity** (during the fire) | **Fire severity** (post-fire) | |
|---|---|---|---|
| | **Average flame height (m)** | **Average scorch height (m)** | **Description** (loss of biomass) |
| **Patchy (P) to Low (L)** | <1.5 | <5.0 | Approximately 40–60% of vegetation is burnt. Unburnt vegetation (green patches) remains in the ground and shrub layer. Fire does not remove all surface fuels (litter) and near-surface fuels. Distinct holes may be created in closed heaths. Little canopy scorch overall. Some scorching of shrubs and small trees. |
| **Moderate (M) to Extreme (E)** | 1.5–3.0 | >5.0 | Understorey is burnt to mineral earth. Greater than 60% of vegetation is burnt. Extensive or total foliage is burnt. Minimal evidence of green vegetation remains. Only skeletal frames of shrubs and small trees remain. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

Coastal heath communities may burn all at once, and it can be difficult to achieve a mosaic of burnt and unburnt ground in a single planned burn.

This means it is important to create a mosaic at a landscape level. Aim to burn less than 30% of heath communities within a management area in the same year.

Landscape mosaic burning when soil moisture is good helps maintain the condition of heath communities, provide a range of vegetation age-classes and mitigate bushfire impacts.

Landscape mosaic burning should aim to provide sufficient areas of long-unburnt habitat that can offer refuge to wildlife, providing resources and protection against predation.

Surrounding fire-adapted vegetation communities should also be appropriately managed with mosaic burning when soil moisture is good. Managing surrounding vegetation helps provide additional protection to heath communities from bushfires.

### Fire frequency

Fire frequency should primarily be determined through on-ground assessment of vegetation health, fuel accumulation and previous fire patchiness. Burns may be brought forward or delayed due to bushfire risk or drought cycles.

Mosaic planned burning should be used across the landscape at a range of frequencies. This creates varying stages of post-fire response, from recently burnt through to the maximum time frame.

A broad fire interval range of between six and twelve years is appropriate. Some burning of arrow fingers in years immediately following an extensive bushfire will help break up the landscape fuel.

Individual areas should not always be burnt at the same time of year or with the same time interval between fires.

Only a small percentage of the total planned burn area was burnt in this coastal heath, Moreton Island National Park (2009). *Photo: Galen Matthews © Qld Govt.*

### 9.3.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

**Optimum conditions**

| | |
|---|---|
| **Season** | • January to August.<br>• May to August for southern Moreton Bay islands.<br>• Wet years are ideal for planned burns. |
| **FFDI** | ‹11 |
| **DI (KBDI)** | ‹120 (‹80 southern Moreton Bay islands) |
| **Relative humidity** | ›50% (only relevant to southern Moreton Bay islands) |
| **Wind speed** | ‹15km/hr |
| **Soil moisture** | • Ensure good soil moisture is present. Although coastal heaths can receive regular moisture or rain, they are also exposed to strong winds and can dry out very quickly, particularly where they occur on sandy soils.<br>• Standing water or waterlogged peat is the critical factor that will help to minimise risk of reignition in wet heath. |

## 9.3.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Use spot aerial ignition, topography and weather conditions on the day to mosaic burn large areas. Refer to GIS mapping before burning to determine previously burnt areas and appropriate ignition points. It may be useful to record ignition points as GPS coordinates. Post-burn aerial observation is required to accurately record the percentage of area burnt.
- Burn during high-humidity conditions (e.g. just before rain, during low cloud cover or in the evening) to help limit the spread of fire into these communities and create a lower intensity fire that ideally extinguishes overnight.
- Burn sections of coastal heaths as they dry out to reduce fire intensity and increase patchiness. Consider progressively burning to treat more volatile fuel types early in the season (especially in wet heaths).

Read more about ignition and lighting patterns in the ***Introductory Volume***.

## 9.4 Avoid peat fires in heaths

Heaths on seasonally waterlogged soils (wet heaths) gradually accumulate peat (partially decayed, densely-packed vegetation). Peat forms where waterlogged conditions impede the flow of oxygen from the atmosphere, slowing the rate of decomposition.

Peat fires can burn for weeks and months and can take many years to reform. This can have major impacts on vegetation communities.

### 9.4.1 Monitoring vegetation condition

**Key indicators for burns to prevent peat fires in heath**

- Visible standing water on the peat surface or surface water that covers the bases of sedges and grasses.
- Waterlogged peat in the absence of standing water.

### 9.4.2 Considerations for burning

- In wet heath communities with a peat layer, planned burns should be conducted when there is standing water at the site. At minimum, there should be saturated soil to protect the peat layer.
- Peat is porous and has a high carbon content, causing it to easily ignite when sufficiently dry. It can smoulder for very long periods, causing reignitions and long-term damage to ecosystems.
- Peat fires are very difficult to extinguish. Fires may travel underground and reignite elsewhere in the landscape.
- The condition of peat in areas adjacent to melaleuca communities or wet heath should be checked to ensure it will not ignite if fire encroaches.
- Implementing planned burns during drought conditions is not recommended. Plants are likely to be stressed and find it difficult to recover from fire.

### 9.4.3 Prioritising areas for burning

| Priority | Priority assessment |
|---|---|
| **Very high** | Where peat is present, consider the most appropriate management during burn planning and implementation. |

### 9.4.4 Assessing outcomes

#### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table on the next page lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Implement a planned burn with no resulting peat fire. | Conduct ongoing visual assessments during the fire and post-fire to ensure fire has not carried into the peat layer and developed into a peat fire. | **Achieved:** Fire did not carry into the peat layer and develop into a peat fire.<br>**Not achieved:** Fire carried into the peat layer and developed into a peat fire. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

## 9.4.5 Fire parameters

### Fire severity

Refer to section 9.3.5 for fire severity information relating to heath communities.

## 9.4.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimal conditions

| | |
|---|---|
| **Season** | Avoid dry season fires in the vicinity of peat. |
| **Soil moisture** | Standing water, or waterlogged peat, is the critical factor that will avoid peat fires. |

## 9.4.7 Burn tactics

Adjacent fire-adapted areas may need to be burned when the peat is not waterlogged and does not have standing water. In these conditions, treat the peat area as non-target vegetation. However, be aware that the site is flammable and may not self-protect. Use tactics that will limit the encroachment of fire in areas with peat.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

## 9.5 Manage exotic pine wildings in heaths

Germination of exotic pine wildings is an issue in areas next to pine plantations. Left unmanaged, pine wildings can displace native species, and pine needles can smother lower-layer plants.

Protected areas with historical clearing for pine plantations require intensive rehabilitation after gazettal.

See section 7.3 for guidance on pine wildling management.

Exotic pine wildings in a regenerating heath community, Bribie Island National Park (2011).
*Photo: Graeme Bulley © Qld Govt.*

## 9.6 Maintain good-condition montane heaths

Recurring broadscale, high-intensity bushfires in dry conditions have a negative impact on the condition of heaths. Extensive bushfires in dry conditions can reduce plant health and cause long-term loss of diversity.

Peat fires can also be an issue in wet heaths, particularly during prolonged drought. If ignited, peat can smoulder for long periods and take many years to reform.

Planned burns in heaths should be conducted when soil is moist to help maintain heath communities in good condition.

These ecosystems rely on appropriate fire management (including planned burns) in adjacent fire-adapted vegetation communities. Mosaic burning in surrounding vegetation communities helps protect heaths from bushfires.

### 9.6.1 Monitoring vegetation condition

**Key indicators of good-condition montane heaths**

- A diversity of shrub and herb species.
- Shrubs, including banksias, hakeas, pea flowers, tea-trees *Leptospermum* spp., she-oaks and grass trees.
- Obligate-seed regenerator shrubs such as *Allocasuarina rigida*, steelhead *Callitris monticola* and narrow-leaved *boronia anethifolia*.
- Herbs, including *Coleus* spp., *Wahlenbergia* spp., *Lobelia* spp., daisies, lilies and orchids.

Montane heath is often fragmented by rock pavement. This arrangement can help integrate ecological heterogeneity, Mount Maroon (2009). *Photo: Justin O'Connell © Qld Govt.*

**Key indicators that fire management is required**

- Shrubs have lost a significant amount of lower-level leaves or have dying crowns.
- Accumulating dead material on shrubs.
- A loss of diversity in the shrub and/or herb layer.
- Increasing abundance or dominance of a single species (e.g. hakea, she-oaks or tea-trees). Local knowledge needs to be exercised, as this may also indicate too much fire.
- Grass trees with dense brown skirts.
- Dying banksias.

## 9.6.2 Considerations for burning

- Montane heath communities typically require longer fire intervals than surrounding vegetation communities.
- Montane heath communities are often self-protecting due to the fragmentation of vegetation by rock pavement.
- An extended absence of fire can be detrimental to plant health and diversity. Too-frequent fire can also be detrimental, particularly broadscale high-intensity bushfires in dry conditions.
- An imbalance of hakea, she-oaks or tea-trees may result from dry, high-intensity fires (either a single fire or a series of fires). An absence of fire for an extended period can also cause this imbalance.
- Obligate-seed regenerators need sufficient time to mature and set seed over several years. An adequate seed supply must be maintained between fires.
- Burning the landscape in a mosaic helps provide a range of vegetation age-classes. Entire habitat patches should not be burnt at once. Instead, patches containing montane heaths should be burned in different years.
- Montane heaths are naturally isolated in the landscape. Regular burning of surrounding eucalypt forests can help ensure that some patches of montane heath remain unburnt for many years.
- Montane heaths are often vulnerable to lightning strike-initiated bushfire.

## 9.6.3 Prioritising areas for burning

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

## 9.6.4 Assessing outcomes

### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table on the next page lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Create age-class diversity within a heath community using landscape-level mosaic burning. | Choose one of the following options:<br>a) Visually estimate the percentage of burnt vegetation from one or more vantage points or the air.<br>b) Map the boundaries of the burnt areas with GPS then plot in FLAME to determine the percentage of the area burnt.<br>c) Choose three locations that represent the variability of landform and ecosystems within the burn area. Walk 300 or more metres through the burn area estimating the ground area that is visibly burnt. | **Achieved:** 25–50% of the area is burnt.<br>**Partially achieved:** 0–25% or 50–75% of the area is burnt (adjust future planned burn objectives depending on the result).<br>**Not achieved:** >75% of the area is burnt. |

Read more about the principles and goals of planned burns and setting SMART objectives in the ***Introductory Volume***.

Good condition montane heath at Glass House Mountains National Park.
*Photo: Cheryl Thomson © Qld Govt.*

### Monitoring over time

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the *Introductory Volume*.

Monitoring the presence of common obligate-seed regenerators like wedding bush can provide an indicator of appropriate fire regimes in some heath communities, Bribie Island National Park (1995). *Photo: Lisa Ford © Qld Govt.*

## 9.6.5 Fire parameters

Planned burns should aim for specific fire characteristics to help maintain montane heaths in good condition.

Read more about fire parameters in the *Introductory Volume*.

### Fire severity

Aim for low to moderate fire severity.

| Fire severity class | Fire intensity (during the fire) | Fire severity (post-fire) |
|---|---|---|
| | Average flame height (m) | Description (loss of biomass) |
| Low (L) | ‹1.5 | Substantial unburnt vegetation (green patches) in the shrub layer. Fire does not remove all surface fuels (litter) and near-surface fuels. Distinct holes may be created in closed heaths. Some scorching of shrubs and small trees. |
| Moderate (M) | 1.5–3.0 | Most vegetation is burnt. Skeletal frames of shrubs remain. Trunks of grass trees are intact. Charred duff layer remains. |

### Fire extent

Maintain good-condition montane heath communities by mosaic burning on a landscape level and burning in association with the surrounding fire-adapted communities when soil moisture is good.

Due to the presence of narrow-range endemic and threatened species within these communities, avoid burning all of a habitat patch or peak at one time to ensure some unburnt habitat remains.

### Fire frequency

Fire frequency should primarily be determined through on-ground assessment of vegetation health, fuel accumulation and previous fire patchiness. Burns may be brought forward or delayed due to bushfire risk or drought cycles.

Mosaic planned burning should be used across the landscape at a range of frequencies. This creates varying stages of post-fire response, from recently burnt through to the maximum time frame.

Consider a broad fire interval range of between twenty to fifty years.

## 9.6.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | Late wet season to early dry season (e.g. February to August). |
| **FFDI** | ‹11 |
| **DI (KBDI)** | ‹120 |
| **Wind speed** | ‹15km/hr |
| **Soil moisture** | The presence of good soil moisture is crucial for good regeneration and protection of peat, soil carbon and nutrients. These communities are heavily influenced by local weather conditions, drying and exposure due to topography and shallow soils. |

## 9.6.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Burn in association with the surrounding landscape. Allow fire to penetrate naturally into heaths when burning surrounding areas. Do not attempt to reignite unburnt areas.
- Use aerial or manual spot ignition along spurs and ridgelines to encourage variability or introduce fire into long-unburnt areas.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

Spot lighting montane heath in the late afternoon will help reduce the fire severity and promote mosaics, Moogerah Peaks National Park (2008). *Photo: © Qld Govt.*

# 10. Tussock grasslands and forblands

Remnant tussock grasslands and forblands have an extremely restricted distribution in the Southeast Queensland bioregion. They are most abundant in the Bunya Mountains, but there are small patches of poa grasslands at the southern end of Main Range National Park.

The grasslands at the Bunya Mountains are referred to locally as grassy balds. These small patches are mostly-dominated by tussock grasses (e.g. *Poa labillardierei* and *Sorghum leiocladum*) with surrounding eucalypt or rainforest communities.

Encroachment of surrounding rainforest and eucalypt forest changes these vegetation communities. Regular burning is required to maintain grassy balds and restrict the expansion of adjoining rainforest and eucalypt forest.

**Cultural landscape**

Grassy balds in the Bunya Mountains are a cultural landscape. They are the result of regular burning conducted by First Nations people, particularly before the early 1900s. After this time, invasion by wattles, eucalypts and rainforest species reduced their extent.

Bunya Peoples' Aboriginal Corporation works closely with QPWS, land managers and scientists to return fire and restore the grassy balds.

**Fire management considerations:**

- Maintain good-condition tussock grasslands (see section 10.1).
- Restore tussock grassland after woody invasion (see section 10.2).

## 10.1 Maintain good-condition tussock grasslands

Maintaining good-condition tussock grasslands requires planned burns when there is good soil moisture. Burns limit the encroachment of rainforest and eucalypt forest species.

### 10.1.1 Monitoring vegetation condition

**Key indicators of good-condition grasslands**

- Well-formed grass clumps.
- Few to no trees and shrubs.
- Few weeds.

Grasslands in good health with only a few weeds (balloon cottonbush) present, Bunya Mountains National Park.
*Photo: © Qld Govt.*

**Key indicators that fire management is required**

- Poorly formed grass tussocks.
- Collapsing grass tussocks and accumulating thatch (dead material).
- A flush of eucalypt or wattle saplings/seedlings emerging amongst the grass tussocks.
- Rainforest pioneers emerging amongst the grass tussocks.

Grass tussocks are collapsing with an accumulation of thatch (dead material).
*Photo: Peter Cavendish © Qld Govt.*

Gradual encroachment of rainforest into grassy balds, Bunya Mountains National Park (2007).
*Photo: Peter Leeson © Qld Govt.*

### 10.1.2 Considerations for burning

#### Weather conditions

- Signs of poor health can be a result of drought. Implementing fire during drought conditions can compound problems and is not recommended.
- Grasslands will dry out more quickly after rain than surrounding forests so consider this when planning and prioritising burns.

#### Weeds and exotic grasses

- Balloon cottonbush *Gomphocarpus physocarpus* is a widespread weed on the grassy balds. It may increase in abundance soon after fire before decreasing with grass regrowth.
- Exotic kikuyu grass *Pennisetum clandestinum* is a major threat to grasslands in the Bunya Mountains. It has the potential to replace native species.
- Burning when there is good soil moisture will promote rapid grass regeneration and limit the germination and spread of balloon cottonbush and exotic grasses.

#### Wattle saplings

- Wattles *Acacia* spp. are promoted when planned burns are undertaken in dry conditions. In these grasslands, wattles are known to establish when planned burns or bushfires occur at high intensity. These conditions allow wattles to survive and root sucker in these grasslands.

- Where saplings are well-established and taller than 4m, manual removal may be necessary, including herbicide use for resprouters. This is likely to be appropriate in areas of high cultural and or ecological value.

### 10.1.3 Prioritising areas for burning

| Priority | Priority assessment |
|---|---|
| **High** | Planned burns to maintain ecosystems in areas with key values and other values. |

### 10.1.4 Assessing outcomes

#### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to assess | How to report (in fire report) |
|---|---|---|
| Retain ›90% of the tussock grass bases as stubble. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire severity. Estimate the percentage of grass bases remaining after fire. | **Achieved:** ›90% of bases remain.<br>**Partially achieved:** 75–90% of bases remain.<br>**Not achieved:** ‹75% of bases remain. |
| Scorch ›75% of woody saplings/ seedlings to the tip. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire severity. Estimate the percentage of saplings/seedlings scorched. | **Achieved:** ›75% of saplings/ seedlings are scorched.<br>**Partially achieved:** 25–75% of saplings/seedlings are scorched.<br>**Not achieved:** ‹25% of saplings/seedlings are scorched. |
| Promote grass reshoots from tussocks after a few days. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire severity. Estimate the percentage of grass reshooting from tussocks | **Achieved:** ›75% of tussocks have shoots.<br>**Partially achieved:** 25–75% of tussocks have shoots.<br>**Not achieved:** ‹25% of tussocks have shoots. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

### Monitoring over time

Many issues are not resolved with a single planned burn, and it is important to keep observing the land.

The extent of these grassy areas should be monitored to identify any encroachment of rainforest and eucalypt forest species.

Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations. Satellite imagery, aerial photography and drone imagery may all assist with monitoring.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the *Introductory Volume*.

## 10.1.5 Fire parameters

Planned burns should aim for specific fire characteristics to help maintain grasslands in good condition.

Read more about fire parameters in the *Introductory Volume*.

### Fire severity

Aim for low-severity fire, with the occasional fire of moderate severity.

A moderate-severity fire may be required when targeting woody species that are becoming abundant. Good soil moisture at the time of burning will prevent further recruitment of woody species (especially wattles) and favour grass regeneration.

| Fire severity class | Fire intensity (during the fire) | | Fire severity (post-fire) | |
|---|---|---|---|---|
| | Fire intensity (kWm1) | Average flame height (m) | Average scorch height (m) | Description (loss of biomass) |
| **Low (L)** | ‹500 | ‹1.5 | ‹2.0 | Some patchiness. Most of the surface and near-surface fuels are burnt. Stubble and humus/duff layer are still evident. |
| **Moderate (M))** | 500–3000 | 1.5–3.0 | Complete grass biomass consumed. | All surface and near-surface fuels are burnt. Stubble is burnt to blackened remnants. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

In an individual burn, the entire area is likely to burn because fuel is continuous and evenly distributed.

Aim for a landscape-level mosaic by targeting different areas at different times. Generally, avoid burning more than 50% of grasslands in any one year.

### Fire frequency

Fire frequency should primarily be determined through on-ground assessment of vegetation health, fuel accumulation and previous fire patchiness. Burns may be brought forward or delayed due to bushfire risk or drought cycles.

Planned burns should be used across the landscape at a range of frequencies. This creates varying stages of post-fire response, from recently burnt through to the maximum time frame. Consider a fire interval range of between two to five years.

## 10.1.6 Weather conditions

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | • Burn with good soil moisture, typically towards the end of the wet season and in the very early dry season. This period typically promotes rapid regrowth and grass flowering.<br>• Concentrate efforts during years of good rainfall.<br>• Avoid burning following frosts.<br>• Post-fire grass growth and recovery are slower in winter. This may result in longer periods of patchy bare ground and weed growth. |
| **GFDI** | <7 |
| **DI (KBDI)** | <80 |
| **Wind speed** | <20km/hr |
| **Soil moisture** | Good soil moisture is critical when burning grasslands to help retain grass bases and encourage grass regeneration. Burning in the days following rain (and before adjoining forests burn) will improve regeneration and limit weed growth. |

## 10.1.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Use spot aerial and ground ignition to alter the desired intensity of a fire. Spots placed closer together will merge and create high-intensity junction zones. Wider spacing or single-spot ignition creates a lower-intensity fire and a mosaic of unburnt and burnt patches. The spacing of spots may vary throughout the burn due to changes in weather conditions, topography and fuel load.
- Implement a slow-moving, low-intensity backing-fire (lit on the leeward o smoky edge). This generally results in more complete coverage of an area and better fuel consumption. This tactic creates high residence time, which can help reduce overabundant seedlings while keeping fire intensity and rate of spread to a minimum.
- Use aerial ignition to burn inaccessible grassy pockets and maximise the efficiency of resources. Consider burning soon after rain and/or lighting these areas later in the day to limit intensity.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

Spot ignition on the smoky edge can minimise intensity, helping retain grass clump bases and improve post-fire regeneration, Bunya Mountains National Parks (2004).
*Photo: Mark Cant © Qld Govt.*

## 10.2 Restore grassland after woody invasion

Encroachment of eucalypt, wattle or rainforest saplings from surrounding communities reduces the condition of tussock grasses and eventually leads to forest transition.

Fire promotes the germination of woody species, particularly in dry conditions. When germination is followed by a prolonged absence of fire, woody plants become established.

As grass cover thins, further colonisation from surrounding forests can occur.

### 10.2.1 Monitoring vegetation condition

**Key indicators of woody invasion that can be managed with burning**

- Colonies of eucalypt, wattle or rainforest species, including vines, emerging above the grass layer.
- Stinging nettle and balloon cottonbush.
- Scattered, poorly formed and collapsing grasses.
- Reduced health and abundance in other ground-layer plants.
- A less-continuous grass layer.

### 10.2.2 Considerations for burning

- If woody species have colonised an area and fire has been absent for several years, a bushfire or high-intensity fire can trigger certain rainforest plants and other tree species to germinate.
- An altered regime of higher-intensity fires with low soil moisture can promote woody species over grasses.
- Shading by woody species will lead to a decline in grass condition and abundance. This reduces ground fuel and makes it difficult to conduct low-intensity fires in the future.
- Once a woody thicket has developed, it can become increasingly difficult to reintroduce fire.
- Fire intensity will often be higher when the community does burn. This favours further regeneration of woody species rather than grasses and herbs.
- Grassland may eventually transition into an open woodland community or rainforest.

### 10.2.3 Prioritising areas for burning

| Priority | Priority assessment |
|---|---|
| **Very high** | Planned burns to maintain areas with key values or other values. |

### 10.2.4 Assessing outcomes

#### Setting objectives for planned burns

The objectives for burns should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Scorch >75% of saplings to the tip. | Select one or more sites or walk one or more transects that represent the variability of landform and likely fire severity. Estimate the percentage of saplings scorched. | **Achieved:** >75% of saplings are scorched.<br>**Partially achieved:** 50–75% of saplings are scorched.<br>**Not achieved:** <50% of saplings are scorched. |
| Most grasses recover after fire. | Before and after fire, select three or more sites that represent the variability of landform and likely fire intensity. Estimate the percentage of grass cover that has recovered one to three months after fire. | **Achieved:** >75% of grasses recover.<br>**Partially achieved:** 50–75% of grasses recover.<br>**Not achieved:** <50% of grasses recover. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

### Monitoring over time

Many issues are not resolved with a single planned burn, and it is important to keep observing the land.

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations. Transects on the ground, remote sensing or drones can also be used to monitor the area.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the *Introductory Volume*.

## 10.2.5 Fire parameters

Planned burns should aim for specific fire characteristics to help restore grassland.

Read more about fire parameters in the *Introductory Volume*.

### Fire severity

Aim for moderate fire severity.

A low-severity fire may do more harm than good, reducing available ground fuel without reducing the targeted saplings.

| 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 | Limited patchiness. Some scorched litter remains. Some of the humus layer and tussock grass stubble remain. Scorching of saplings. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

### Fire extent

Burn as much of the area dominated by saplings as possible.

### Fire frequency

It is likely that multiple burns will be required to restore grassland after a woody invasion. If the initial fire triggers a flush of new seedlings, conduct a follow-up planned burn when there is sufficient fuel for a low to moderate-severity fire.

Once the area has recovered, the recommended regime for good-condition tussock grassland should be resumed (see section 10.1).

### Scorch height

Fire must reach sufficient scorch height to reduce overabundant saplings. The height required varies depending on the sapling species being targeted. For example, only the lower branches of green wattles require scorching, while brush box saplings should be scorched to the tip.

## 10.2.6 Weather conditions

Burning tussock grasslands requires appropriate weather to avoid promoting woody plants.

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

### Optimum conditions

| | |
|---|---|
| **Season** | Depends on the accumulation of fuel (including the level of woody invasion) and sufficient moisture to favour regeneration of grasses. |
| **GFDI** | <10 |
| **Wind speed** | <15km/hr |

## 10.2.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Start lighting on the leeward (smoky) edge to create a safe edge to support a higher-intensity internal fire. Depending on available fuels and the prevailing wind on the day, use spot or strip lighting or both.
- Create a running fire by using closely spaced spot ignition or line ignition with the wind. This may help address the encroachment of woody species.
- Use line ignition to create a higher-intensity fire or to help fire carry through moist or inconsistent fuels. This tactic is also useful to reduce overabundant trees through scorching.

Read more about ignition and lighting patterns in the ***Introductory Volume***.

# 11. Wetlands (swamps, lakes and springs)

Wetlands in the Southeast Queensland bioregion include:

- freshwater swamps on coastal floodplains dominated by sedges
- fringing communities associated with freshwater swamps or billabongs on floodplains
- fringing communities around permanent lakes, including window and perched lakes
- sedgelands/grasslands on seeps and soaks on wet peaks, coastal dunes and non-floodplain features.

The seasonal drying cycle of many wetlands makes them adapted to fire. Where these communities occur close to residential areas, they can be a fire hazard.

There is also a potential increased risk of inappropriate fire when peat dries out. Peat is partially decayed, densely-packed vegetation. Peat forms where waterlogged conditions impede the flow of oxygen from the atmosphere, slowing the rate of decomposition.

Closed sedgelands in good condition. *Photo: © VJ Nelder*

**Fire management considerations:**

- Manage paperbark *Melaleuca quinquenervia* incursion into sedgelands (see section 11.1).
- Maintain peat (see section 11.2).

## 11.1 Manage paperbark *Melaleuca quinquenervia* incursion into sedgelands

Paperbark *Melaleuca quinquenervia* has colonised significant areas of sedgelands along the Southeast Queensland coast and coastal islands. Infrequent fire and hydrological changes are known to promote colonisation.

Areas of mass paperbark germination are often considered to be natural vegetation communities, referred to as *Melaleuca* wetlands. These wetlands have dense thickets of single-age, small-diameter trees. A scattering of old paperbark trees is likely to be seen around the edges.

In comparison, genuine *Melaleuca* communities contain a range of size classes, including old trees with large trunk diameters.

Dense thickets of paperbark promote intense fire. Fire becomes progressively more severe, killing swamp mahogany, coastal cypress, bloodwood and scattered rainforest trees at the edges of these sedgelands.

### 11.1.1 Monitoring vegetation condition

**Key indicators of good-condition open to closed sedgelands**

- A mid-layer and understorey dominated by sedges.
- Visibility across the entire sedgeland.
- A variety of sedges, including scattered or patchy low shrubs (e.g. *Epacris microphylla, Leptospermum liversidgei*).
- Widely scattered or small clumps of paperbark saplings (if present).

**Key indicators of paperbark incursion into sedgeland**

- Mass germination of paperbarks into sedgelands, often beginning from the edges or expanding from small islands surrounding scattered paperbark trees.
- Many small paperbark seedlings and saplings amongst the sedges, indicating early-stage paperbark expansion.
- Dense, single-age, small-size paperbark trees, indicating established paperbark expansion.

### 11.1.2 Considerations for burning

- Sedgelands provide significant fauna habitats, especially for frogs and birds.
- Where paperbark incursion has occurred, there is an increased risk to nearby vegetation and assets.
- After paperbarks have formed lignotubers they become more difficult to kill with fire. Fire is best applied straight after germination is detected in sedgeland before plants can form lignotubers.

- Planned burns should be implemented while some standing water remains.
- Fires can burn across the vegetation above standing water.

### 11.1.3 Prioritising areas for burning

The priority for burning depends on the extent and height of the paperbarks.

Good-condition sedgelands, or sedgelands with only scattered paperbark saplings or masses of very small paperbark seedlings, should be given a high priority for burning. A low to moderate-intensity fire is sufficient, provided there is high soil or peat moisture.

Sites with extensive areas of established young paperbark trees are a lower priority for burning. Fire intensity in these areas needs to be sufficient to scorch the canopy.

Burning at an elevated intensity requires careful management of adjoining vegetation to keep fire contained.

In areas near control lines, with high cultural values or housing, consider using mechanical removal as well as fire.

Fire should be repeated at less than three-year intervals until paperbarks are removed. Regular observation and appropriate fire regimes will keep sedgelands relatively free of paperbark trees.

| Priority | Priority assessment |
|---|---|
| High | Planned burns to maintain ecosystems in areas where ecosystem health is good.<br>The sedgeland is open and contains a diversity of wetland plants.<br>The paperbarks are very small or very scattered |
| Medium | Planned burns in areas where ecosystem health is poor but recoverable.<br>Islands of large paperbark saplings are present but most of the sedgeland can be maintained in an open state if regular fire is implemented. |
| Low | Planned burns in areas where ecosystem structure and function have been significantly disrupted.<br>Extensive areas of young paperbark trees are established. |

### 11.1.4 Assessing outcomes

#### Setting objectives for planned burns

A key objective for burning sedgelands is to restore and maintain the open structure. This can be done by thinning and reducing the size of paperbark saplings and promoting a variety of sedges and small shrubs.

Burn objectives should be practical and easily assessed. Some measurable objectives can be evaluated immediately after a fire and recorded in FLAME. However, observations of the vegetation response to a burn must wait until good rain has fallen.

The table below lists examples of objectives, accompanied by methods of assessment and reporting for each. You can select those suitable for your site or consider developing your own objectives.

| Measurable objectives | How to be assessed | How to be reported (in fire report) |
|---|---|---|
| Thin and reduce paperbark thickets to allow sedges to flourish. | Inspect the sedgeland before burning. Take photos from the edge, looking towards the centre of the sedgeland, and make notes of the average height and cover of paperbark thickets.<br>Re-examine the same areas several weeks or months after burning. Estimate the percentage of fire-affected paperbark thickets (i.e. percentage scorched).<br>Record the heights of regenerating paperbark saplings, including those reduced to ground-level coppice shoots. | **Achieved:** >75% of paperbark thickets are scorched by the burn and most paperbarks are reduced to ground-level coppice shoots.<br>**Partially achieved:** 25–75% of paperbark thickets are scorched.<br>**Not achieved:** <25% of paperbark thickets are scorched. |
| Protect the non-target fire vegetation group margins from scorch.<br>Scorch includes penetration by mild surface fire. | Choose one of the following options:<br>a) Immediately or very soon after the burn, estimate the percentage of margins scorched from one or more vantage points, or the air.<br>b) Immediately or very soon after the burn, walk the margin of the non-target vegetation community or representative sections (e.g. a 100m-long section of the margin in three locations) and estimate the percentage of margins scorched. | **Achieved:** No scorch of the non-target vegetation community margin.<br>**Partially achieved:** <5% of the non-target vegetation community margin is scorched.<br>**Not achieved:** >5% of the non-target vegetation community margin is scorched. |

**Choosing locations for evaluation**

Proposed burn areas will usually contain natural variations. Select at least three locations to act as good indicators for the whole burn area. Monitoring locations should not be chosen based on convenience (e.g. 5m from the road). At these locations, walk around and estimate an average for the results.

Improve estimations by returning to the same locations before and after fire, and by using counts where relevant.

Read more about the principles and goals of planned burns and setting SMART objectives in the *Introductory Volume*.

### Monitoring over time

Ongoing observation may be necessary to monitor change. Establishing observation points will ensure that the area can be monitored consistently, with photographs and records of specific locations. This will visibly record changes in structure over time.

Consult with your local health check assessors to verify current health check sites or discuss adding new sites. Details of new observation points or health check sites should be recorded in the park's monitoring and research strategy.

Read more about assessing, monitoring and evaluation in the ***Introductory Volume***.

## 11.1.5 Fire parameters

Planned burns should aim for specific fire characteristics to help manage paperbark incursion.

Read more about fire parameters in the ***Introductory Volume***.

### Fire severity

Aim for moderate fire severity.

A moderate-severity fire may be required when targeting paperbark saplings. Good soil moisture at the time of burning is vital to avoid promoting further regrowth of paperbarks. A follow-up fire will be necessary within a few years if mass paperbark tree regrowth occurs.

| **Fire severity class** | **Fire intensity** (during the fire) | | **Fire severity** (post-fire) | |
|---|---|---|---|---|
| | **Fire intensity (kWm$^{1}$)** | **Average flame height (m)** | **Average scorch height (m)** | **Description** (loss of biomass) |
| **Low (L)** | ‹500 | ‹1.5 | ‹2.0 | Some patchiness. Most of the surface and near-surface fuels are burnt. Stubble is still evident. |
| **Moderate (M))** | 500–3000 | 1.5–3.0 | Complete grass biomass consumed. | All surface and near-surface fuels are burnt. Stubble is burnt to blackened remnants. Saplings are scorched by fire. |

*Note: This table assumes good soil moisture and optimal planned burn conditions. State-wide fire severity descriptions have been adjusted for Southeast Queensland conditions.*

**Fire extent**

In each planned burn, the entire area is likely to burn because of the mostly continuous, evenly-distributed fuel.

Aim for a landscape-level mosaic by alternating the years that sedgelands are burnt. Burn surrounding vegetation regularly and early in the year to increase manageability.

## 11.1.6 Weather conditions

Stay aware of weather patterns to try and reduce smoke from sedgeland burns sitting over densely populated areas.

Consider the weather forecast for the period before and after a planned burn. Knowledge of these conditions can allow burning to be rescheduled to avoid undesirable or changeable conditions.

**Optimal conditions**

| | |
|---|---|
| **Season** | • Concentrate efforts during years of good rainfall.<br>• Avoid burning following frosts.<br>• Post-fire grass growth and recovery are slower in winter. This may result in longer periods of patchy bare ground and weed growth. |
| **GFDI** | <7 |
| **DI (KBDI)** | <100 |
| **Wind speed** | <15km/hr |
| **Soil moisture** | Good soil moisture is critical to help retain grass bases and encourage grass regeneration. Burning in the days following rain (and before adjoining forests burn) will improve regeneration and limit weed growth. |

## 11.1.7 Burn tactics

The burn tactics used will be specific to the site. Different tactics may also be needed within the same burn area (e.g. due to topographical variation).

A test burn will help confirm the tactics and ignition pattern that will achieve the burn objectives on the day. Tactics should be reviewed during the burn and adjusted as required to achieve the burn objectives.

**A toolkit of possible tactics**

- Use spot aerial and ground ignition to alter the desired intensity of a fire.
- Implement a slow-moving, low-intensity backing-fire (lit on the leeward or smoky edge). This generally results in more complete coverage of an area and better fuel consumption.

Read more about ignition and lighting patterns in the *Introductory Volume*.

## 11.2 Maintain peats

Patterned fens are a type of peat wetland found in the Southeast Queensland bioregion. These peat-forming mire systems are usually found in boreal and subarctic regions of the northern hemisphere and small areas in the temperate regions of the southern hemisphere. They form a mosaic of peat ridges and pools, fed by slow surface groundwater.

Patterned fens in the Great Sandy Region are the only global subtropical example. They occur on K'gari, along the Noosa River in Cooloola Recreation Area, the East Weyba section of Noosa National Park, Mooloolah River National Park and the northern part of Mulgumpin (Moreton Island). Patterned fens provide important habitat for several threatened wetland species.

Patchy burning around the edges of wetlands is recommended to reduce vegetation thickening, limit ecotonal shifts and provide varied habitat for biodiversity. Although peats are resilient to varied fire regimes, peat loss is most likely during periods of drought. Burning when moisture and water levels are high is recommended.

Frequency and season must be noted. For example, wet heath recruitment on K'gari reaches peak density two years post-fire. Shorter fire intervals may cause local extinction of obligate-seed regenerators and species that take longer to reach maturity. Fire intervals of seven to ten years across varied seasons are recommended to prevent favouring particular species.

Refer to section 9.4 for information about avoiding peat fires in heaths.

# 12. Mangroves and tidal saltmarshes

Mangroves and tidal saltmarshes are found near or within estuarine or brackish water. They are periodically inundated through tidal action and storms.

Mangroves occur in stands along tidal zones as low trees or shrubs with very little other vegetation present. Saltmarshes are dominated by salt-adapted succulents, sedges and/or grasses and typically have large areas of bare ground.

Mangroves and tidal saltmarshes do not require fire and generally do not burn. Sometimes, they can be scorched by planned burns in adjacent ecosystems or by bushfires. While lasting damage is rare, burning in adjacent ecosystems should be undertaken on or near high tide where possible.

**Fire management considerations:**

- Limit fire encroachment into mangroves and tidal saltmarshes.

## 12.1 Limit fire encroachment into mangroves and tidal saltmarshes

Mosaic burning of surrounding fire-adapted vegetation communities will help limit bushfire impacts on mangroves and saltmarshes.

Due to their tidal location, mangrove and tidal saltmarsh communities are generally self-protecting during planned burning in appropriate conditions. Timing planned burns to coincide with high tides also helps limit the chance of fire encroaching into these communities.

However, care should be taken when burning around saltmarsh that contains highly-flammable salt couch *Sporobolus virginicus* (see section 9.2 for more information). Burning with high tides or recent rain with groundwater seepage will help protect saltmarsh vegetation.

Occasional low-intensity fires in saltmarsh are generally not damaging. These communities demonstrate good post-fire recovery, and fire may promote some species, though regrowth can be slow.

Tidal inundation can be used to limit fire encroachment into saltmarsh communities Coombabah Conservation Park (2005). *Photo: Sylvia Millington © Qld Govt.*

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# 14. Glossary

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

| Term | Definition |
|---|---|
| **Aerial ignition** | Lighting fine fuels for a planned burn by dropping incendiary devices or materials from an aircraft. |
| **Available fuel** | The portion of the total fuel (e.g. grass, leaf litter) 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. |
| **Burn severity** | An observable effect on the ecosystem that influences how long the ecosystem will take to recover its structure, composition and function. |
| **Backing-fire** | A fire which is burning back against the wind or down slope, where the flame height, intensity and rate of spread are reduced. |
| **Beaufort scale** | A system of estimating and reporting wind speeds that relies on visual indicators rather than instruments. |
| **BOM** | Bureau of Meteorology |
| **Crown scorch** | When the needles or leaves in the crown of a tree or shrub are turned brown by the heat of a fire. |
| **Char height** | The height at which formerly green leaves are now black from the flames of the fire. This does not apply to stems, as fire climbs the bark. |
| **Dew point temperature** | The temperature that air must be before dew will form. The dew point is derived from dry and wet-bulb temperatures, with a correction for the site's elevation. It is a measure of the air's moisture content. |
| **Drought** | An acute rainfall deficiency. It may be serious (rainfall between 5 and 10% for the period in question) or severe (rainfall less than 5% for the period in question). For more information, refer to ‹www.bom.gov.au/climate/glossary/drought.shtml› |
| **Drought index (DI)** | A numerical value reflecting the dryness of soils, deep forest litter, logs and living vegetation e.g. the Byram-Keetch Drought Index. |
| **Duff layer** | Refer to humus layer. |
| **Fire behaviour** | The way a fire reacts to variables such as fuel, weather and topography. |
| **Fire Danger Index (FDI)/ Fire Danger Rating (FDR)** | A measure of the potential danger of a fire on a given day and location. It provides a relative number and rating based on the rate of spread or suppression difficulty for specific combinations of fuel moisture and wind speed. |
| **FFDI/FFDR** | Forest Fire Danger Index/Forest Fire Danger Rating |
| **Fire frequency** | The number of fires that occur at a specific point in the landscape within a specific period; how often fire occurs at a point in the landscape. Refer to fire interval. |

| Term | Definition |
| --- | --- |
| **Fire extent** | Refer to patchiness. |
| **Fire intensity** | The energy output of a fire. It is measured as the amount of energy released in kilowatts per metre of the fire line (kW m-1) (also known as the Byram fire-line intensity). |
| **Fire interval** | The time between fires at a specific location. |
| **Fire perimeter** | The outer containment boundary of a fire. |
| **Fire regime** | The sequences of fires at a point in the landscape, consisting of the components: fire frequency (or fire interval, between-fire interval), intensity, season and type (e.g. surface versus subterranean/peat fire). |
| **Fire regime group (FRG)** | A group of related ecosystems that have similar fire management and fire regime requirements. |
| **Fire season** | The period or periods of the year when fires are likely to occur, spread and cause damage, requiring organised fire control. |
| **FLAME** | QPWS's web-based system for capturing basic fire (and pest) information including burn proposals, burn plans (approved burn proposals) and reports and associated maps. |
| **Flame height** | The vertical distance between ground level and the average tip of the flame, excluding higher flares. |
| **Forb** | An herbaceous flowering plant that is not a grass, sedge or rush. |
| **Fuel** | Any material, such as grass, leaf litter and live vegetation, that can be ignited and sustain a fire. Fuel is usually measured in tonnes per hectare. |
| **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 or its state or structure (Hines et al. 2010). |
| **Fuel moisture content** | The amount of moisture in the fuel, expressed as a percentage of the fuel's oven dry weight (% ODW). |
| **Grid ignition** | A method of lighting fires where ignition points are set out like a grid. The spacing between ignition points is predetermined. |
| **GFDI/GFDR** | Grassland Fire Danger Index/Grassland Fire Danger Rating |
| **Herb** | An herbaceous (non-woody) seed-bearing plant. |

| Term | Definition |
|---|---|
| **High-biomass grasses** | These grasses are usually introduced species that out-compete natives. They are generally taller than native species and their thick, single-species stands can lead to:<br>• decreased biodiversity<br>• increased biomass and fuel load<br>• increased fire intensity and severity<br>• increased threat to life and property |
| **Humus (or duff layer)** | The mat of partly decomposed vegetation on the forest floor. The original vegetative structures, such as leaves and twigs, are still 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. It is 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, bioregion or broader area. |
| **Lighting pattern** | The pattern of ignition used 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, with little structural alteration by decomposition. |
| **Mineral earth** | Soil that is free of any vegetation or other combustible material. |
| **Mosaic burn** | An approach that aims to create spatial and temporal variation in fire regimes. Spatial variability can occur within an individual burn (refer to the Introductory Volume). |
| **Obligate-seed regenerators** | Shrubs and trees that are killed by fire and rely on seeds stored in the soil or canopy to regenerate. It is important to know the time it takes obligate-seed regenerators to mature and establish a seed bank. This is the minimum frequency a vegetation community should be burnt to avoid the local extinction of these species. |
| **Patchiness** | A percentage or proportion of the ground-layer vegetation (herbs and trees or shrubs less than one metre) not affected by fire e.g. 20% unburnt. |
| **Perennial plants** | Plants with a lifespan of more than two growing seasons. |
| **Planned burn** | A controlled application of fire under specified environmental conditions to a predetermined area; at the time, intensity and rate of spread required to attain planned resource management objectives (e.g. species conservation, protecting life and property). Also known as a prescribed burn. (AFAC). |

| Term | Definition |
|---|---|
| **Progressive burning** | An approach to planned burning where ignition is carried out over a prolonged period 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 provide barriers to fire for burns conducted later in the year. Progressive burning helps create a mosaic of intensities, burnt and unburnt areas and seasonal variability. |
| **Rate of spread (ROS)** | The forward progress in metres per hour of the head fire or another specified part of the fire perimeter. |
| **Relative humidity (RH)** | The amount of water vapour in the air, expressed as a percentage of the maximum amount of water vapour the air can hold at that temperature. |
| **Resprouting species** | Plant species that survive fire and regrow by activating dormant vegetative buds. |
| **Scorch height** | The height to which former green leaves still suspended on plants are turned brown by the heat of a fire. |
| **Soil moisture** | The water stored in the unsaturated soil. To identify the soil moisture, take a clump of topsoil from the upper 5–10cm of the soil profile and squeeze it into a ball in the palm of your hand. Moist soil will hold together fairly well, whereas dry soil will completely crumble.<br>Clay will increase holding capacity and sand will increase crumbling. |
| **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. |
| **Systematic burning** | Planned burns that are aerially ignited and regularly spaced in typically parallel lines across the landscape. Burning is timed so that fires self-extinguish and do not meet between the parallel lines. |
| **Test fire** | A controlled fire of limited extent ignited to evaluate fire behaviour before undertaking a planned burn. |

# Appendix 1

## Preventing the loss of cypress-dominated cultural landscapes on the southern end of Minjerribah (known as the Cypress Camps) from the impacts of infrequent high-intensity fires

*Authorship of this case study has been led by the Quandamooka Aboriginal Land and Sea Management Agency (QALSMA), with guidance from Quandamooka Elders and supported by Quandamooka Rangers.*

**Background**

The landscapes in and around what is known as the Cypress Camps on the southern end of Minjerribah (North Stradbroke Island) are of extremely high cultural significance to the Quandamooka people, the First Nation and traditional custodians of much of Moreton Bay and its islands in South East Queensland, Australia. Located at these sites are ancient shell middens and sacred stands of trees that shade known occupation and ceremony sites used for many millennia by Quandamooka People.

These landscapes are dominated by coastal cypress trees *Callitris columellaris* with pink bloodwood *Corymbia intermedia*, Queensland blue gum *Eucalyptus tereticornis*, brush box *Lophostemon confertus* and scribbly gum *Eucalyptus racemosa*.

In 2014, a bushfire caused by a lightning strike in the Eighteen Mile swamp resulted in a fire emergency event that impacted approximately 80% of Minjerribah's landscapes. Following this bushfire, a number of stakeholders, including the Quandamooka Yoolooburrabee Aboriginal Corporation (QYAC), Queensland Parks and Wildlife Service (QPWS) and Healthy Land and Water, recognised that a coordinated strategy and actions were required to improve fire management, reduce negative impacts to Country and culture, and improve the safety of residents.

In 2015, QYAC initiated planning discussions with a wide array of stakeholders to progress fire management on the island. As a result, QYAC, through its land management agency, the QALSMA, initiated a Traditional Owner-led and driven fire management strategy over the Naree Budjong Djara National Park, supported by QPWS and a range of government stakeholders and community. Early stages of the strategy development included introducing stakeholders to traditional land management concepts, documenting ecosystem structures, engaging with Elders to further understand historical practices, recording the cultural and archaeological values, and analysing fuel structures and hazards.

Throughout this process, Quandamooka People highlighted the need to respect the cultural significance of the landscape and maintain the values that underpin the historical and ongoing connections between the landscape and its people, including archaeological features such as shell, stone and bone, ceremony areas and the presence of extremely old coastal cypress trees. These old coastal cypress trees, often referred to by Quandamooka People as Boogari, have deep spiritual meaning for many Aboriginal people.

**Figure 1:** Midden site adjoining Cypress Camp on Boorabee.
*Photo: © Susie Chapman*

Coastal cypress *Callitris columellaris* is a species that is intolerant of even moderate-intensity fire. Their existence as large old trees within a landscape highly prone to extreme fire events can only occur where fuel structure and fire hazards have been effectively managed throughout time. The age of old trees is commonly underestimated, particularly as mainstream Australian society tends to have a 230-year ceiling (aligned with European arrival) in the perception of the landscape. While the understanding of much larger time frames is often outside people's thinking, the use of tree age modelling and fire ecology, supported by radiocarbon dating, is revealing that only through Aboriginal land management can these trees have developed and persisted through time to their great ages.

**Cultural landscape assessment**

To enable detailed evaluation and assessment of the landscapes, much of the island was walked by Quandamooka People together with experienced fire practitioners and fire ecologists, providing a knowledge-sharing, on-ground appreciation of the landscape.

Part of developing the fire management strategy was establishing an estimated age of the island's old canopy trees. Through the Queensland Department of Environment and Science (DES) and the Queensland Herbarium, growth figures from over 75 years of forestry information have been collated to produce an age predictor by diameter, species and location. This modelling has indicated that many of the older trees on the island are between 500 and 1500 years old.

To add rigour to these estimates, retired Forester John Turner from New South Wales was consulted. John has samples from historical logging operations that include additional radiocarbon dating. Together, this information supported the modelling estimates undertaken by the Queensland Herbarium and corroborated the Traditional Knowledge held within the Quandamooka community regarding the great age of these trees.

Unfortunately, many of the stands of these old trees have disappeared as a result of intense wildfire since the suppression of Aboriginal burning and vegetation management practices during the 20th and 21st centuries. At the Cypress Camps cultural sites there was evidence of death and damage to the old cypress trees with a considerable number of these ancient trees still lying on the ground from previous wildfire impacts (the most recent at this location being a 1995 wildfire). The 2014 wildfire did not impact the Cypress Camps area, partly due to efforts of Quandamooka people to highlight the significance supported by Queensland Parks and Wildlife Services (QPWS) fire crews containment efforts following aerial suppression by Queensland Fire and Emergency Services (QFES).

As a result of the high intensity fires that have occurred, regeneration in the area is often very dense, creating a wall of banksia, acacia, epacrids, allocasuarina and other species of plants which can effectively suffocate the ecological and cultural values of the site. Recording of this thickening in 2015 showed significant ,dense fuel structures right up to the crown of the old trees, and the obvious threat fire posed to the area, which could destroy what was left of these ancient cultural landscapes.


**Figure 2:** Rangers plan management activities for the culturally significant landscape values in the south of Minjerribah. *Courtesy of QYAC.*

**Delivery approach**

The initial work objectives were to:

- Establish a network of workable fire lines to provide access and manage fire.
- Remove the immediate threat of dense highly volatile vegetation structures and fuel loads,
- Retain the archaeological integrity of the area, and
- Reintroduce cultural landscape management including low intensity fire to ensure the ongoing health and protection of these cultural landscapes.

The first step was to remove the thickening. Options to do this are discussed below.

**Option 1 - Burning**

This was ruled out in areas of very high fuel loads because burning this material would be highly detrimental to the old trees, and likely result in death or damage.

**Option 2 - Machine mulching**

This was ruled out due to the potential of damage to the extensive cultural artefacts such as shell midden present in the soil surface and subsurface as a result of machine operations. The addition of a significant volume of organic material to the soil surface also risked changing the ecosystem structure, nutrient levels, and flammability of the ground layer which could result in further damage to cultural values.

**Option 3 - Manual control of vegetation - Felling of plants in situ and leaving them to rot**

This was ruled out due to the contribution to smothering of ground plants, soil impacts and increased risk of high intensity fire. Manual control and stacking of timber on site for burning was also ruled out due to the potential impact of high intensity surface fire on the site's archaeological values.

**Option 4 - Manual control of vegetation and removal off site**

This involved the felling of timber and manual removal of vegetation to designated stacking areas located away from high value cultural precincts. This was considered suitable but not adopted in this instance due to consideration of preferred alternative uses of the organic resource.

**Option 5 - Manual control of vegetation and removal off site**

Involving the felling and manual removal of vegetation followed by chipping and use on control lines. This was the preferred method adopted as it minimised the impact on the cultural sites, contributed to efficient processing of large volumes of vegetation, and led to the sound use of a valuable resource being mulch. The mulching of fire trails contributed to the overall fire strategy objectives by improving accessibility, stability, and the ongoing usability of the fire trail network.

A team of rangers, considered culturally appropriate by QYAC from across workforces, undertook manual works involving the careful selection, felling, cutting and dragging of considerable volumes of woody material out of the bush to be pushed through a mulching machine for processing into chip. All works were done in a way that prioritised the protection of cultural and environmental values of the site.

Quandamooka rangers worked many long hard days for the protection of these ancestral cultural landscapes, often drinking six to eight litres of water each day to sustain their efforts.


**Figure 3:** Quandamooka rangers undertaking vegetation management works within a culturally significant landscape. *Courtesy of QYAC.*

As the vegetation management practices took place, a number of observations were made. Firstly when the last ten or so meters of brush were taken out to the edge of the Eighteen Mile Swamp, the sea breeze noticeably increased and was noted as being like a breath of fresh air in what had been a hot, still environment; almost as though the landscape was taking a breath. At the same time, the incessant haze of sandflies and mosquitos noticeably reduced, contributing to a much more pleasant environment for humans and wildlife in the area with kangaroos increasingly present. Within several days Eastern Grey Kangaroos appeared to now reside on the site along with a notable increase in the presence of goannas, birds and smaller lizard species. Koala scats were also observed under Blue Gum trees as works improved their access between the trees.

In order to progress the fire strategy for the whole of the Naree Budjong Djara National Park, a number of fire and vegetation experts worked alongside the Traditional Owners to support their aspirations of a holistic approach to landscape management.

This supported another part of the strategy where control lines were designed and established to support the management of both planned burns and wildfire response. The resulting construction of a complex system of fire control lines has greatly supported fire management activities across the complicated multi tenure landscape of Minjerribah. Over 150km of control lines were constructed by QYAC in collaboration with land management agencies between 2016 and January 2021.

After completing the establishment of control lines in accordance with the Naree Budjong Djara fire management strategy, woodland areas adjacent to the culturally significant areas have been progressively burned both to maintain ecosystem health and reduce fire hazard. This burning has been done at low intensity during times of high levels of soil moisture. This has been supported through QYAC/QPWS joint management activities which has provided learning and development opportunities for many young Quandmooka rangers.

Following the initial vegetation management activities, Quandamooka rangers undertook low intensity patch burning through the Cypress Camps areas, taking special care around old trees. This has been especially important given the suppression of Quandamooka management practices during the 20th and 21st centuries has contributed to the remaining remnant vegetation becoming more vulnerable to even low intensity fire.


**Figure 4:** Quandamooka Ranger undertaking a low intensity burn following completion of initial vegetation management activities. *Courtesy of QYAC.*

Appendix 1


Figure 5: Ecosystem structure before and after vegetation management works undertaken by Quandamooka Rangers in a culturally significant landscape. *Courtesy of QYAC.*

In November 2018, lightning ignited a wildfire within the Eighteen Mile Swamp, close to the location of the 2014 wildfire ignition point. The 2014 wildfire resulted in almost 80% of the island being impacted and threatened all three main townships of Minjerribah. The 2018-19 event impacted a significantly smaller area and it is considered that this is in large part due to land management improvements, fire line construction, and the availability of 30 Quandamooka rangers with advanced firefighting qualifications leading the emergency response. The 2018/2019 fire event was largely contained to approximately 5,000 hectares (about 15%) and no townships were threatened despite similar extreme environmental conditions.

As the 2018/19 fire event impacted the landscapes in proximity of the culturally significant Cypress Camps, it was observed burning in landscapes with dense vegetation which in some instances had not seen significant wildfire since the 1995 wildfire event. Through control line construction and the on-ground fire response efforts of the Quandamooka and QPWS joint management rangers supported by QFES aerial water bombing activities, the fire was kept out of most of the Cypress Camps and culturally significant landscapes. In instances where the wildfire did move through some culturally significant landscapes it was generally of very low intensity and had minimal impact on the ancient trees and archaeological values of significance. It is recognised that the work undertaken by the Quandamooka rangers had contributed significantly to the protection of these valuable cultural landscapes and a dramatic reduction in the environmental impact of the wildfire when compared to the 2014 event.

**Benefits of approach**

The benefits of the strategic fire management approach undertaken by the Quandamooka people in partnership with stakeholders on Minjerribah are wide and varied. This includes but is not limited to the protection of irreplaceable cultural landscapes including living artefacts (being the old significant trees) and associated intact cultural sites that have been managed by Quandamooka people for many hundreds of generations.

The program of works has also supported the Quandamooka people to re-establish their leadership role in caring for Country using contemporary methods informed by longstanding cultural practices.

For many Quandamooka people this project provided a first ever opportunity to protect and restore cultural landscapes that were previously managed by their ancestors. Quandamooka Elders and experts in the field have considered this work as being essential for supporting the cultural and social wellbeing of the Quandamooka community whilst it has also delivered on the aspirations to ensure Quandamooka people are actively engaged in managing their lands.

The ecological benefits of this approach are expected to be far reaching including the continued long-term conservation of ecological communities containing cypress and eucalypt stands that are susceptible to negative impacts from intense wildfire events. The approach undertaken by Quandamooka people has delivered the recovery of ecosystems where they are now in a dramatically improved condition, and far more resilient to the hazards associated with future wildfire events and climate change.

**Future recommendations**

Traditional Owners of these areas will require ongoing support from other stakeholders who are willing to adopt and recognise the fire management practices undertaken. This will allow a whole of landscape approach whereby ecosystem and cultural values are retained whilst reducing fire hazard and associated risks. This requires land managers to invest in Traditional Owner collaboration and understanding of the land management and cultural values within the landscapes they manage.