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

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

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

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

Discussion

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

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

Jeanette Kemp, Queensland Herbarium (2002).

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Select from below as most appropriate for the site:

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

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

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

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

Monitoring the issue over time

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

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

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

Fire severity class	Fire intensity (during the fire)		Fire severity (post-fire)	
	Fire intensity (kWm^{-1})	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	< 150	< 0.5	< 2.5	Significant patchiness. Litter retained but charred. Humus layer retained. Nearly all habitat trees, fallen logs, and grass stubble retained. Some scorching of elevated fuels. Little or no canopy scorch.
Moderate (M)	150–500	0.5–1.5	2.5–7.5	Moderate patchiness. Some scorched litter remains. About half the humus layer and grass stubble remain. Most habitat trees and fallen logs retained. Some scorch of elevated fuels. Little or no canopy scorch.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate less than 20 metre height canopy, mid stratum burnt completely (or nearly so).

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

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

- Fire frequency should primarily be determined through **on-ground assessment of vegetation health, fuel accumulation** and **previous fire patchiness** and adjusted for wildfire risk and drought cycles.
- Apply mosaic planned burns across the landscape at a range of frequencies to create varying stages of post-fire response (i.e. recently burnt through to the maximum time frame). Consider a broad fire interval range of between seven to ten years.
- Some dune communities dominated by acacia and/or with a shrub understorey can be left up to fifteen years.

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

Other considerations

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

What weather conditions should I consider?

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

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

FFDI: 5–12

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

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

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

What burn tactics should I consider?

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

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

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

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

Issue 2: Limit fire encroachment into fire-sensitive communities

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

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

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

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

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

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

T. Kitchener, Queensland Herbarium (2002).

Issue 3: Reduce *Lantana camara*

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

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

Issue 4: Manage high-biomass grasses

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

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

Chapter 7: Rainforest

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

Fire management issues

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

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

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

Issue:

1. Limit fire encroachment into rainforests.

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

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

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

Issue 1: Limit fire encroachment into rainforests

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

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

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

Chapter 8: Mangroves and saltmarsh

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

Fire management issues

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

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

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

Issues:

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

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

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

Issue 1: Limit fire encroachment into saltmarsh

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

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

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

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

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

Issue 2: Manage rubber vine in saltmarsh

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

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

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

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

Chapter 9: Common issues

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

Fire management issues

1. Hazard reduction (fuel management) burns.
2. Planned burning near sensitive cultural heritage sites.
3. Manage high biomass exotic grasses.
4. Reduce *Lantana camara* infestations.
5. Limit fire encroachment into non-target fire vegetation groups.
6. Reduce rubber vine.
7. Post cyclone planned burning.
8. Manage exotic pine wildings.

Issue 1: Hazard reduction (fuel management) burns

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

Awareness of the environment

Main indicators of where fire management is required:

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

Or

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

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

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

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

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

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

Robert Miller, QPWS, Davies Creek (2008).

Discussion

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

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

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

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

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

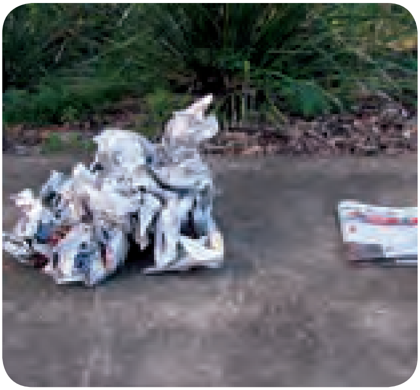


Photo 1a: The two samples above have the same **fuel load** (eighteen pages of newspaper) but a different fuel arrangement.

Troy Spinks, QPWS (2010).

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

Troy Spinks, QPWS (2010).

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

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

What weather conditions should I consider?

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

Season: January–August

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

FFDI: < 12

DI (KBDI): < 120

Wind speed: < 15 km/hr

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

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

What burn tactics should I consider?

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

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

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

Issue 2: Planned burning near sensitive cultural heritage sites

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

Awareness of the environment

Key indicators of Indigenous cultural heritage sites:

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

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

David Cameron, DNRM (2004).

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

David Cameron, DNRM, Atherton (2002).

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

David Cameron, DNRM, Bribie Island (2005).

Key indicators of European cultural heritage sites:

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

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

David Cameron, DNRM, Dogwood Creek (2005).

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

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

Discussion

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

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

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

Fire parameters

What fire characteristics will help address this issue?

Fire severity

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

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

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

Season: Favour early season burning and moist conditions

FFDI: < 7

DI (KBDI): < 160

Wind speed: < 15 km/hr

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

Soil moisture: Ensure good soil moisture.

What burn tactics should I consider?

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

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

Issue 3: Manage high biomass exotic grasses

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

Awareness of the environment

Key indicators:

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

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

Kerensa McCallie, QPWS, Jubilee Pocket (2012).

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

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

Grader grass infestation.

John Clarkson, QPWS, Mareeba (2007).

Grader grass seed head.

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Molasses grass flowering.

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

Para grass infestation.

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Elephant grass seed head.

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Fruiting para grass.

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

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

Kerensa McCallie, QPWS, Jubilee Pocket (2011).

Discussion

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

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

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

Molasses grass *Melinis minutiflora*

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

Para grass *Urochloa mutica*

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

Grader grass *Themeda quadrivalvis*

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

Elephant grass *Pennisetum purpureum*

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

Other high biomass grasses

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

What is the priority for this issue?

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

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

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

Evaluating outcomes

Formulating objectives for burn proposals

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

Choose from below as appropriate:

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

Significant reductions in grass weed species. *Be aware that more than one fire may be required before assessment.	The species of grass and abundance will determine whether the assessment should focus on frequency of occurrence, cover or density, and the most appropriate technique. Seek advice from resource staff and/or publications such as the Parks Victoria Pest Plant Mapping and Monitoring Protocol (Anon 2005). One option is given here. **Before and after the burn** (after suitable germination/ establishment conditions, and if using cover – a growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Anon 2005]): • Rare (Up to four per cent cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–50 % cover) = 1/4 weed cover to equal proportions of weed to native species. • Medium-Dense (51–75 %) = equal proportions of native to ¾ weed cover. • Dense (> 75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation 'drops' two 'density categories' (e.g. goes from medium before the fire to rare after the fire). **Partially Achieved:** Weed infestation 'drops' one 'density category' (e.g. goes from dense before the fire to medium-dense after the fire). **Not Achieved:** No change in density category or weed density gets worse.

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

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

Monitoring the issue over time

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

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

Fire parameters

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

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

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

What burn tactics should I consider?

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

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

Issue 4: Reduce *Lantana camara* infestations

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

Awareness of the environment

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

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

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

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

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

Discussion

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Choose from below as appropriate:

Measurable objectives	How to be assessed	How to be reported (in fire report)
Significant reduction in cover lantana.	**Before and after the burn** (after suitable germination/ establishment conditions, and if using cover – a growing season): define the density of the infestation using the following criteria (from Parks Victoria Protocol [Anon 2005]): • Rare (0–4 % cover) = Target weed plants very rare. • Light (5–24 % cover) = Native species have much greater abundance than target weed. • Medium (25–50 % cover) = 1/4 weed cover to equal proportions of weed to native species. • Medium-Dense (51–75 %) = Equal proportions of native to ¾ weed cover. • Dense (> 75 %) = monoculture (or nearly so) of target weed.	**Achieved:** Weed infestation ‘drops’ two ‘density categories’ (e.g. goes from medium-dense before the fire to light after the fire). **Partially Achieved:** Weed infestation ‘drops’ one ‘density category’. **Not Achieved:** No change in density category or weed density gets worse.

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

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

Monitoring the issue over time

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

Fire parameters

What fire characteristics will help address this issue?

Key factors

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

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

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

Mosaic (area burnt within an individual planned burn)

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

Fire severity

- **Low** to **moderate**. Best results have been achieved using a slow-moving backing fire with good residence time at the base of the plant, in combination with high soil moisture.
- For a dense infestation, **moderate** to **high**-severity fire may initially be required. A sequence of fires later in the year (ensuring good soil moisture exists) may be used to reduce the biomass of high-density infestations. This may assist in creating better access for herbicide control. Be aware of potential damage to ecosystems and be cautious when using this method adjacent to fire-sensitive vegetation.

What weather conditions should I consider?

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

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

FFDI: < 12 and sometimes 18 for higher severity fires

DI (KBDI): < 120

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

What burn tactics should I consider?

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

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

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

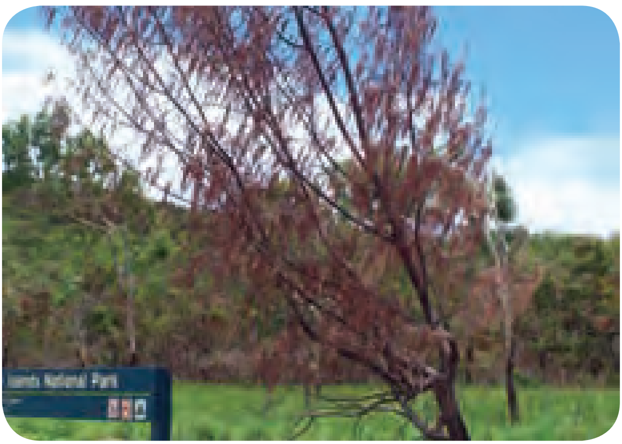
Issue 5: Limit fire encroachment into non-target fire vegetation groups

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

Awareness of the environment

Indicators of fire encroachment risk:

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



Beach she-oaks are killed by fire. Wildfire carried through the dense blady grass in the hind dunes fanned by strong south-easterly winds.
Kerensa McCallie, QPWS, South Repulse Island (2010).

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

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

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

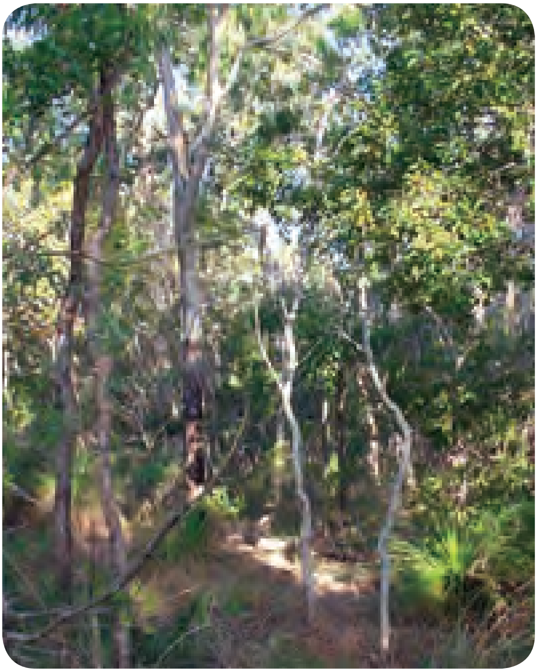
Bill McDonald, Queensland Herbarium, North Molle Island (2010).

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

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

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

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



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

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

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

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

Discussion

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

What is the priority for this issue?

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

Assessing outcomes

Formulating objectives for burn proposals

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

Measurable objectives	How to be assessed	How to be reported (in fire report)
No scorch of margin of non-target fire vegetation group.	**After the burn** (immediately or very soon after): visual estimation of percentage of margins scorched from one or more vantage points, or from the air. **Or** **After the burn** (immediately or very soon after): walk the margin of the non-target community or representative sections (e.g. a 100 metre long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** No scorch. **Partially Achieved:** < 5 % scorched. **Not Achieved:** > 5 % scorched.
Fire penetrates no further than one metre into the edge (if there is a well defined edge).	**After the burn** (immediately or very soon after): visual assessment from one or more vantage points, or from the air. **Or** **After the burn** (immediately or very soon after): walk the margin of the non-target community, or representative sections (e.g. a 100 metre long section of the margin in three locations) and determine whether the fire has penetrated further than 1m into the edge.	**Achieved:** In 90 % of area surveyed fire penetrates no further than one metre into the edge. **Not Achieved:** Fire penetrates further than one metre into the edge in > 10 % of area surveyed.

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

Fire parameters

What fire characteristics will help address this issue?

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

Fire severity

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

Mosaic (area burnt within an individual planned burn)

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

Landscape mosaic

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

What weather conditions should I consider?

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

FFDI: Refer to relevant fire vegetation group

DI (KBDI): Refer to relevant fire vegetation group

Wind speed: < 15 km/hr

Soil moisture: Refer to relevant fire vegetation group.

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

What burn tactics should I consider?

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

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

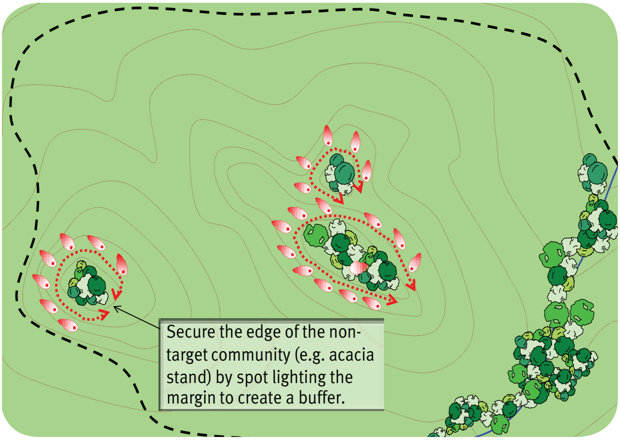
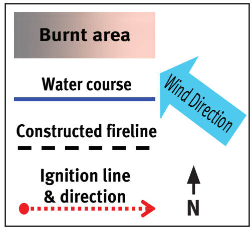


Figure 1: Example of initial lighting pattern to limit fire encroachment into non-target fire vegetation group.



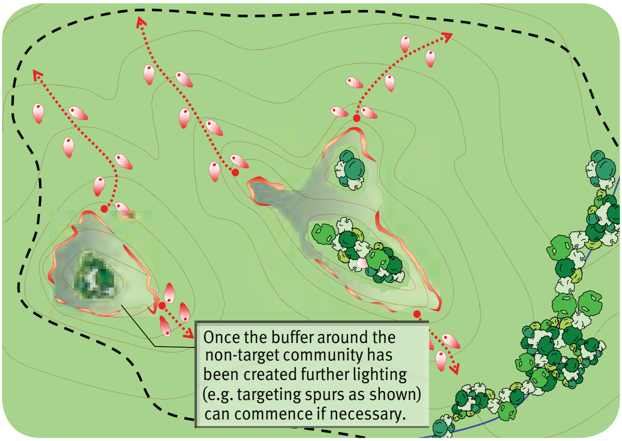


Figure 2: Example of strategic ignition adjacent to non-target community and along spurs.

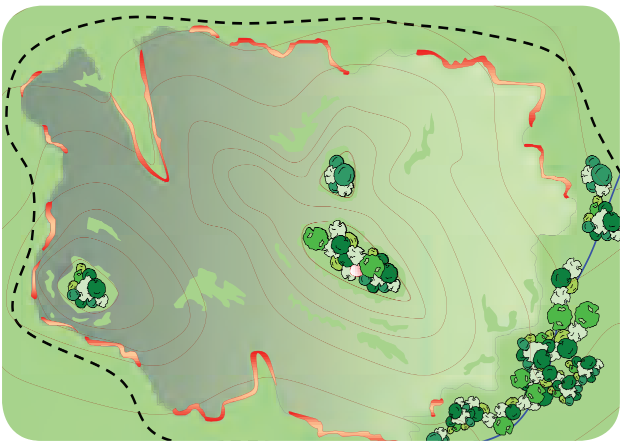


Figure 3: It was not necessary to burn back from the non-target community at the bottom of the slope, as the backing fire naturally extinguished against its edge due to greater moisture in the low lying area.