Fire parameters

What fire characteristics will help address this issue?

Key factors

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

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

- In some cases, applying the recommended fire frequency for the fire vegetation group in which woody weeds occur may be sufficient enough to control the issue. Increasing the fire frequency for a period of time may further assist in their control.
- Apply a follow-up burn if observations indicate that the issue is not under control (e.g. mature plants have re-sprouted or seedlings have emerged from the seed bank). In some cases a third fire may be required to completely remove the infestation. Once resolved, re-instate the recommended fire regime for the fire vegetation group. Continue Monitoring the issue over time.
- Due to the low fuel loads in many communities of the Desert Uplands, it may be necessary to implement burns following high rainfall events to ensure sufficient fuels exist to carry a fire.

Fire severity

- **Low** to **moderate**. Best results have been achieved utilising a slow-moving backing fire with good residence time with high soil moisture. Fire severity should generally remain within the recommendations for the fire vegetation group in which the woody weed occurs.

What weather conditions should I consider?

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

Season: Early to mid dry and occasionally late dry

GFDI: < 11

DI (KBDI): 120 ideally ‹ 100

Wind speed: < 23 km/hr. Variable, depending on the objective and the density of the infestation (denser infestation may require some fanning by wind in order for the fire to carry).

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

What burn tactics should I consider?

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

- A **running fire** of a higher-severity may be required to carry fire through areas of low fuel or dense thickets.
- **As part of a control program**. In areas where dense woody weeds shade-out grasses and limit the fuel available for fire, initial herbicide treatment or mechanical methods can be used. Care should be taken when applying fire to dead rubber vine plants which remain hanging in the canopy as they may act as elevated fuels.
- **A low to moderate-severity backing fire.** Where woody weeds are scattered in the understorey, a slow-moving, low to moderate-severity backing fire with good soil moisture (and sufficient surface fuels), ensures a greater residence time at ground level. This has proven to be successful in killing seeds, seedlings, young and some mature plants.
- **Aerial incendiary using a 'heli-torch'**. Applying fire using a heli-torch may help control woody weeds that have invaded communities where fire is either not required or desired (such as those which are fire sensitive) (refer to Figures 1 and 2 below). This tactic involves an aerial incendiary drop using gelled-gasoline to directly ignite the base of the plants. The surrounding vegetation needs to be moist to wet to ensure the fire doesn't spread. Aim to strike a balance between ensuring the surrounding vegetation is moist enough that it will not ignite and ensuring the woody weeds are dry enough that it will.

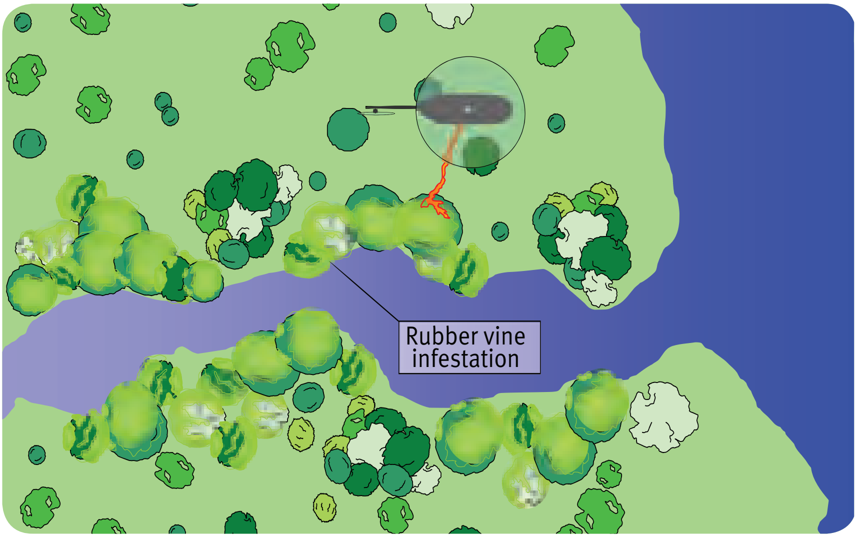


Figure 1: Aerial incendiary using a 'heli-torch': Fire should be applied to the base of the plants allowing sufficient time for the latex to boil.

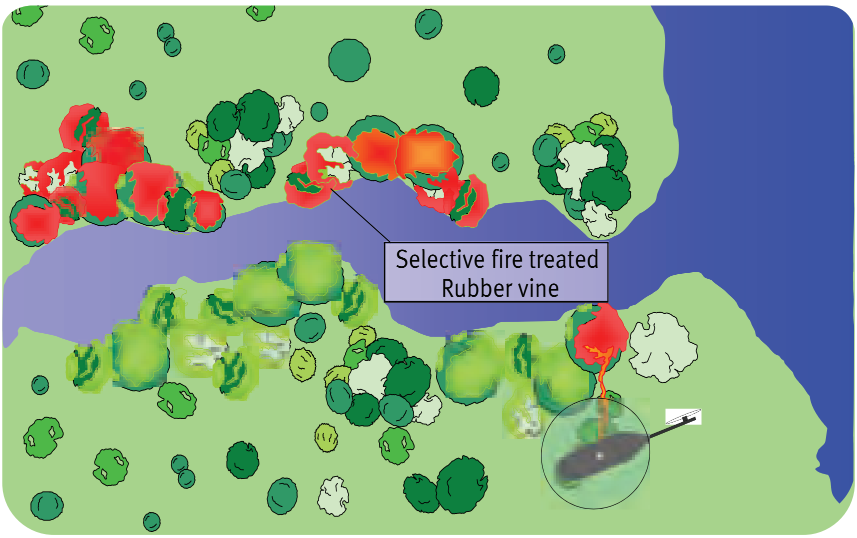


Figure 2: Aerial incendiary using a 'heli-torch'—selective rubber vine fire treatment.

Issue 5: Manage invasive grasses

Exotic grasses are capable of outcompeting native species to form dominant stands. High-biomass grasses of concern in the desert uplands are buffel grass *Pennisetum ciliaris* and the emerging weeds thatch *Hyparrhenia rufa* and grader grass *Themeda quadrivalvis*. They have the ability to increase fuel loads, fire intensity, spotting and flame height which leads to increased fire severity and spread. This results in greater tree death and loss of habitat features with flow-on effects to species. Exotic grasses can carry fire into fire-sensitive vegetation resulting in considerable damage. Fire can be used as part of a control program for some exotic grasses. At the same time, high-biomass grasses both promote fire and many are promoted by fire. They tend to occur as a result of disturbance and spread along firelines and utility easements. It is important to be aware of the presence of high-biomass grasses during planned burn operations.

Awareness of the environment

Key indicators:

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

- The presence of high-biomass grasses, usually occurring in a dense infestation.
- High-biomass grasses are generally forming single-species dominated stands.
- The grasses are generally taller than the native species.
- They have a lot of mass and/or dead material.

A close-up of the flowering head and clump mass of buffel grass.
Paul Williams, Vegetation Management Science Pty Ltd, Bald Rock (2005).

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

Discussion

- Be on the lookout for newly-forming stands and be especially vigilant in disturbed areas (particularly those where disturbance is ongoing, e.g. roadsides) and areas adjacent to or down stream from existing high-biomass grass infestations (Melzer and Porter 2002). Control is often easier if their presence is detected and addressed early—before it has become established.
- Prior to undertaking planned burns in areas where high-biomass grasses occur, become familiar with the response of this grass to fire (e.g. if it is promoted or killed) and other factors such as fire severity type and weather conditions which may favour and further its spread.
- The closed canopy of healthy, mature acacia stands will often suppress the encroachment and establishment of invasive grasses.
- Invasive grasses cause the progressive loss of fire sensitive communities and also increase the risk of wildfires (particularly during dry conditions) carrying into the canopy of the community and causing the loss of mature trees. This contributes to the gradual decline and fragmentation of the extent, and/or loss of a population, of fire sensitive communities.
- There is a relationship between fire timing, frequency and severity and the ability of these grasses to invade which is still poorly understood. Aim 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, it is desirable to avoid burning high-biomass invasive grasses due to the likely increase in fire severity and the potential to promote them. However the risk of wildfire later producing an even higher-severity fire must be considered. In some situations, burning high-biomass grasses under mild conditions with planned fire is more desirable than allowing them to burn with wildfire.
- Once an area has been impacted by invasive grasses (in particular within fire-sensitive communities) the aim often becomes one of fuel management. This may involve implementing mild or cool fires (both within the site and the surrounding areas) by implementing appropriate tactics that burn away from the non-target community (and therefore limit edge-effects on the margin). Other techniques which may be effective include slashing, spraying with herbicide and in some instances grazing (Melzer and Porter 2002; Butler and Fairfax 2003).

Buffel grass *Cenchrus ciliaris*

- Fire is not known to be an effective tool to manage buffel grass. A “positive feedback” loop has been described for the relationship between buffel grass and hot fires (Butler and Fairfax 2003)—buffel grass increases fuel loads and thus damages remnant vegetation. This also creates a disturbance which favours its spread. The same phenomenon has been observed to occur with increased grazing pressure (Eyre et al. 2009). Buffel grass is further promoted by fire, as seeds germinate more quickly when sown on burnt ground. Under normal (non-fire) grass establishment, it can take up to two years for seeds to germinate.
- Buffel grass is of particular concern to fire-sensitive communities. This species can penetrate and establish a dense sward up to several hundred metres into open acacia woodland across a front several kilometres long, greatly increasing fuel loads and future impacts upon open acacia communities (Butler and Fairfax 2003).
- The use of fire to control buffel grass is often debated. While not a direct control measure, fire may assist in facilitating other control methods such as spraying or grazing. Be aware that follow-up spraying of the affected site will need to be continued for some time—buffel grass will usually germinate en masse after fire and rain. Any fire applied to buffel should be of a **low**-severity. Using night-time burns (where moisture is high) may assist in achieving a low-severity burn.
- At the end of the growing season, buffel grass is more susceptible to fire as it stores reserves at this time. Late summer fires may reduce its ability to compete with native species over time (Chamberlain 2003).
- The curing rate for buffel grass differs from that of some native grasses and tends to remain greener for longer periods of time (note: blue grass *Dichanthium* spp. stays green longer than buffel). In some instances, creating a buffer by mechanical or chemical means adjacent to an area of buffel grass may be useful in limiting its further spread. Creating a buffer between the buffel infestation and the margin of neighbouring communities of between 50–100 m may also be an option. Care should be taken to ensure the buffel infestation does not spread into the buffer.

Grader grass *Themeda quadrivalvis*

- Grader grass is an emerging weed in the Desert Uplands bioregion. Be aware of new infestations which can quickly take hold and ensure they are dealt with as a matter of priority.
- Grader grass is a weed of disturbance. Soil disturbance (e.g. road grading) can expose seed allowing favourable conditions for its establishment and spread.
- 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 of grader grass, the fire frequency should be limited to > 5 years.

Thatch grass *Hyparrhenia rufa*

- Fire is not known to be an effective tool to manage thatch grass. However, frequent fire (every one to two years) promotes their spread through disturbance mechanisms and possibly through reducing canopy cover.
- The distribution of thatch grass within the Desert Uplands is unknown, however it is considered to be an emerging weed.
- Post-fire herbicide control has been effective but needs to be ongoing.
- If 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 encroachment into riparian zones.

What is the priority for this issue?

Priority	Priority assessment
High	It is important to be aware of the presence of invasive grasses (particularly where it is a new infestation) so that their negative effects can be managed and the potential for effective control can be considered.

Buffel grass is fire-promoted and drought-tolerant. Following a disturbance (such as fire) buffel grass is able to rapidly invade and form dense swards within a vegetation community.

Bronwyn Terry, QPWS, Moorrinya National Park (2012).

Thatch grass is easily identifiable by its striped appearance which is particularly prominent when young. Be on the look out for new infestations.

John Clarkson, QPWS (2007).

Assessing outcomes

Formulating objectives

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

Choose from below as appropriate:

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

Reduction of fuels adjacent to non-target communities to low.	**Post fire:** use the Overall Fuel Hazard Assessment Guide (Hines et al. 2010b), or Step 5 of the QPWS Planned Burn Guidelines: How to Assess if Your Burn is Ready to Go, to visually assess the remaining fuel in at least three locations.	**Achieved:** Fuel hazard has been reduced to low. **Not Achieved:** Fuel hazard has not been reduced to low.

If the above objectives are not suitable refer to the 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

Varies depending on species, see discussion above.

Dense buffel grass can significantly increase fire severity.

Justine Douglas QPWS, Boodjamulla (Lawn Hill) National Park (2012).

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.

- **As part of a control program**. An initial fire to reduce the biomass of invasive grasses, followed by chemical control of the new shoots has been an effective method of control. Similarly, grazing can also reduce fuel loads.
- **Spot ignition** can be used to effectively alter the desired intensity of a fire, particularly where there is a high-biomass grass infestation. 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 (against the wind or down slope) will generally result in the more complete coverage of an area and a better consumption of available fuels. This tactic ensures the fire has a greater amount of residence time, reduction of available fuels (particularly fine fuels) and ensures the fire intensity and rate of spread are kept to a minimum. Lighting fires at night can assist in decreasing fire intensity.
- **Limit fire encroachment into non-target communities.** Use appropriate lighting patterns (e.g. spot lighting with matches) along the margin of the community in combination with favourable weather conditions to promote a low-intensity backing fire that burns away from the non-target community. Undertaking burning in areas adjacent to invasive grass infestations while the grass is green, under mild conditions, early morning on the dew, late afternoon or at night will assist in creating a low-severity fire that burns away from the non-target community. Where the non-target community is present in low-lying areas (e.g. drainage lines) use the surrounding topography to create a low-intensity backing fire that travels down slope towards the non-target community. In both instances, ensure good soil moisture is present within the non-target community.
- **Fire exclusion.** Excluding fire from buffel grass infestations may provide the opportunity for species such as brigalow or other acacias to out-compete the buffel grass. Ideally the acacia community will remain unburnt long enough to form a closed canopy that shades out and disadvantages the buffel grass. This requires active fire management in the surrounding fire-adapted communities to prevent unplanned fire.

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

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

Awareness of the environment

Indicators of fire encroachment risk:

- Conditions are not mild enough or fuels sufficiently sparse to ensure fire extinguishes on the edge of fire vegetation group.
- Where invasive grasses or woody weeds are invading fire-sensitive communities.
- The non-target community is upslope of a planned burn area.
- Where the riparian community or other fire-sensitive community is adjacent to a planned burn area.

Discussion

- Because wildfire often occurs under dry or otherwise unsuitable conditions (and high fuel loads from successive high rainfall years) 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. Sometimes where a fire-sensitive community occurs at the top of a slope, it is necessary to avoid running fires upslope (even in ideal conditions).
- The presence of invasive grasses increases the severity of fire and may contribute to the contraction of fire-sensitive communities such as acacia. If high-biomass grasses are present, use fire with caution (refer to Issue 5).
- 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, and may open up the canopy. This in turn may increase the risk of weed invasion and soil erosion and lead to greater production of fine fuel (mainly grass) and hence an increase in the fire hazard. It is highly desirable to exclude fire or at least minimise the frequency and intensity of fire in many riparian communities in order to promote structurally complex ground and mid-strata while retaining mature habitat.

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 100m long section of the margin in three locations) and estimate the percentage of margin scorched.	**Achieved:** No scorch. **Partially Achieved:** < 25 % scorched. **Not Achieved:** > 25 % scorched.
Fire penetrates no further than 10 m 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 100m 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 10 m into the edge. **Not Achieved:** Fire penetrates further than 10 m 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 the adjacent fire-adapted community will help achieve the objective of limited fire encroachment. A backing fire will help ensure good coverage. If there are overabundant saplings in the area being burnt, a higher-severity fire may be required (in which case appropriate tactics and moisture conditions will help to limit scorch of 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 fire into fire-sensitive communities.

Landscape mosaic

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

What weather conditions should I consider?

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

FFDI: Refer to relevant fire vegetation group

DI (KBDI): Refer to relevant fire vegetation group

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

Soil moisture: Good soil moisture will assist in avoiding non-target communities.

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.

- **Test burn** the site to ensure the non-target communities will not be affected.
- **Do not create a running-fire**. When burning in adjacent sclerophyll forest during dry conditions use a low-intensity perimeter burn from the edge of low-lying communities to protect its margins.
- **Commence lighting on the leeward (smoky) edge** to establish the fire and promote a low-intensity backing fire. Depending on available fuels and the prevailing wind on the day, this may require either spot or strip lighting or a combination of both.
- **Afternoon ignition.** Planned burning in areas adjacent to non-target communities can be undertaken late in the afternoon. The milder conditions during this time will assist in promoting a low-severity fire that trickles along the edge and generally self-extinguishes, (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 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.

Issue 7: Manage severe storm or flood disturbance

In the event of a severe storm, the canopy of trees and shrubs may be stripped with debris accumulating on the ground or left suspended. Snapped limbs and trees can cross fire breaks and accumulate in flooded riparian areas increasing the extent or severity of a fire. In addition, high rainfall events can increase grass fuels and present an increased risk of wildfire.

Major flood events can have a significant impact on riparian communities. These events can remove ground and mid-stratum vegetation and in some cases canopy trees. Invasion of exotic grasses and other weeds may often follow, increasing fuel loads and creating a fire-prone community which can inhibit the recovery of riparian vegetation.

Changed fuel conditions from severe storm or flood disturbance may lead to:

- the potential for high-severity wildfires
- an increased fuel hazard close to assets and infrastructure
- altered fire behaviour during planned burning operations in the months and years following a severe storm or flood event. These can include increased fire severity or ignition problems due to silt suspended in flood waters coating grasses)
- fire-sensitive communities (e.g. riparian) becoming vulnerable to fire encroachment during drought periods that follow.
- an increased risk of fire crossing control lines through fallen trees and debris
- access issues caused by damage to infrastructure such as causeways.
- an opportunity to re-introduce fire into areas with overabundant saplings at an advanced stage.

An initial assessment and review of strategic fire control lines and the fire management zoning plan will usually be required. Possible strategies to manage changed fuel conditions include: strategic planned burning with high soil moisture and avoiding dry conditions, encouraging neighbouring landholders to mechanically reduce fuel, avoiding ignition sources during risk periods and reviewing scheduled planned burns to make use of moister seasonal conditions.

Severe storm events can dramatically alter the forest structure. Reassessment of zoning plans may be required in response to greatly increased fuel loads.

Peter Cavendish, QPWS, D'Aguilar National Park (2008).

Riparian vegetation has been completely removed during a severe flood event and replaced by flammable exotic grasses. Although previously used as a fireline, flood impacts have instead created a potential fire corridor.

Dave Kington, QPWS, Lockyer National Park (2011).

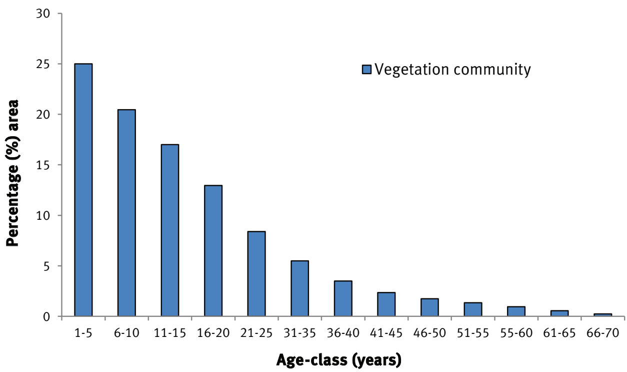
Flood events can create concentrated areas of high fuel hazard. Large debris deposits adjacent to or within fire-sensitive communities can increase the risk of fire encroachment.

Dave Kington, QPWS, Lockyer National Park (2011).

Glossary of fire terminology

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

<table>
<tr><th>Terminology</th><th>Definition</th></tr>
<tr><td>Aerial ignition</td><td>The lighting of fine fuels for planned burning by dropping incendiary devices or materials from aircraft.</td></tr>
<tr><td>Available fuel</td><td>The portion of the total fuel that would actually burn under current or specified conditions.</td></tr>
<tr><td>Age-class distribution</td><td>The distribution of groups of similar aged vegetation (age-class) of a particular vegetation community after fire. In fire ecology this is used to indicate the success of mosaic burning in achieving varied habitat conditions. This is usually represented as a plot of areas (y-axis) versus age-class (x-axis) (e.g. 25 per cent of a fire vegetation group burnt between one and five years ago) (refer to Figure 1).

Figure 1: Idealised age-class distribution (concept only)

</td></tr>
<tr><td>Burn severity</td><td>Relates to the amount of time necessary to return to pre-fire levels of biomass or ecological function.</td></tr>
<tr><td>Backing-fire</td><td>The part of a fire which is burning back against the wind or down slope, where the flame height and rate of spread is minimal.</td></tr>
</table>

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

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

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

Fire management zone	Fire management sub-zone or Fire vegetation group
Conservation	FVG1
	FVG2
Protection	P1
	P2
Wildfire mitigation, etc	W1
	W2

Terminology	Definition
Fire perimeter	The outer containment boundary in which fire is being applied.
Fire regime	The recommended use of fire for a particular vegetation type or area including the frequency, intensity, extent, severity, type and season of burning.
Fire regime group (FRG)	A group of related ecosystems that share a common fire management regime including season, severity, recommended mosaic etc. These are a sub-grouping of the fire vegetation groups to provide more detail about specific fire management requirements. Fire regime groups are provided as a more detailed alternative for use with fire strategies or in mapping.

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

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

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

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

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Appendix 1: List of regional ecosystems

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

Fire vegetation group	Hectares within Desert Uplands bioregion	Percentage
Eucalypt communities	4 409 473	63
Grasslands	141 524	2
Acacia communities	786 416	11
Riparian spring and fringing communities	318 038	5
Non-remnant	1 276 942	18
Other bioregion	49 798	1
TOTAL	**6 982 408**	**100**

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
1	1	**Eucalypt communities**	Eucalypt communities (spinifex or heath dominant)		10.10.3, 10.10.4, 10.10.4a, 10.10.4b, 10.10.4c, 10.10.4d, 10.10.5, 10.10.5a, 10.10.5b, 10.10.5c, 10.10.5d, 10.10.5e, 10.10.7, 10.3.10, 10.3.10x1, 10.3.10x2, 10.3.20, 10.3.29b, 10.5.1, 10.5.1a, 10.5.1b, 10.5.1c, 10.5.1d, 10.5.1e, 10.5.1i, 10.5.10, 10.5.11, 10.5.11a, 10.5.11b, 10.5.11c, 10.5.12, 10.5.5, 10.5.5a, 10.5.5b, 10.5.5c, 10.5.8, 10.5.8a, 10.5.8b, 10.7.10, 10.7.10a, 10.7.10b, 10.7.10c, 10.7.11, 10.7.11a, 10.7.12, 10.7.12a, 10.7.12b, 10.7.2, 10.7.2a, 10.7.2b, 10.7.2e, 10.7.4, 10.7.5, 10.7.7, 10.7.7a, 10.7.7b, 10.7.7c, 10.7.7d, 10.7.8, 10.7.8b, 10.7.9, 10.7.1, 10.7.1a, 10.7.1b, 10.7.1bx1, 10.7.1c, 10.7.1d, 10.7.1e, 10.7.1f.
1	2	**Eucalypt communities**	Eucalypt communities (tussock grass dominant)		10.3.11, 10.3.11a, 10.3.11b, 10.3.11c, 10.3.11d, 10.3.15, 10.3.15a, 10.3.15ax1, 10.3.15b, 10.3.15c, 10.3.15d, 10.3.15dx1, 10.3.15e, 10.3.15f, 10.3.15g, 10.3.15h, 10.3.15hx1, 10.3.15i, 10.3.15j, 10.3.15k, 10.3.15l, 10.3.15m, 10.3.15n, 10.3.15o, 10.3.27, 10.3.27a, 10.3.28, 10.3.28a, 10.3.28b, 10.3.5, 10.3.6, 10.3.6a, 10.3.6ax1, 10.3.6ax2, 10.3.6ax3, 10.3.6ax4, 10.3.9, 10.3.9x1, 10.3.9x2, 10.4.9, 10.5.2, 10.5.2a, 10.5.2ax1, 10.5.2b, 10.5.4, 10.5.4a, 10.5.4b, 10.5.4c, 10.5.9, 10.5.9a, 10.7.2c, 10.7.2d, 10.7.11b, 10.5.9b, 10.9.5, 10.9.5a, 10.9.5ax1, 10.9.5b.
2	1	**Grasslands**	Grasslands		10.3.7, 10.3.7a, 10.3.7b, 10.3.8, 10.3.8a, 10.3.8b, 10.4.8, 10.4.8x1, 10.4.8x2, 10.4.8x3.

Chapter	Issues	Fire vegetation group	Fire regime group	Map label (if required)	**Regional ecosystems** (Sattler and Williams 1999; Queensland Herbarium 2011a; 2011b).
3	1	**Acacia communities**	Acacia		10.10.1, 10.10.1a, 10.10.1b, 10.10.2, 10.10.2a, 10.10.2b, 10.10.2c, 10.10.2d, 10.3.17, 10.3.17a, 10.3.17b, 10.3.19, 10.3.21, 10.3.4, 10.3.4a, 10.3.4b, 10.3.4c, 10.3.4dx1, 10.4.4, 10.4.5, 10.4.5x1, 10.4.5x2, 10.5.7, 10.5.7a, 10.5.7ax1, 10.5.7b, 10.5.7c, 10.7.3, 10.7.3a, 10.7.3b, 10.7.3c, 10.7.3d, 10.7.3e, 10.7.3ex1, 10.7.3f, 10.7.6, 10.7.6x1, 10.7.6x2, 10.9.1, 10.9.1a, 10.9.1b, 10.9.1c, 10.9.1d, 10.9.1e, 10.9.1f, 10.9.2, 10.9.2a, 10.9.2b, 10.9.2c, 10.9.2d, 10.9.2dx1, 10.9.2dx2, 10.9.6, 10.9.6x1, 10.3.25, 10.3.25x1, 10.3.25x2, 10.3.25x5, 10.3.26, 10.4.6, 10.4.6a, 10.4.6b, 10.9.8, 10.9.8x1, 10.3.29, 10.3.29a, 10.3.30, 10.4.7.
	2		Brigalow and blackwood		10.4.2, 10.4.3, 10.4.3a, 10.4.3b, 10.9.3, 10.9.3a, 10.9.3b, 10.9.3c, 10.4.1, 10.4.1x1, 10.4.1x2, 10.4.1x3, 10.3.3, 10.3.3a, 10.3.3b, 10.3.2, 10.3.2a, 10.3.2b, 10.3.2bx1, 10.3.1.
4	1	**Riparian spring and fringing communities**	Riparian spring and fringing communities		10.10.6, 10.3.12, 10.3.12a, 10.3.12b, 10.3.13, 10.3.13a, 10.3.13b, 10.3.14, 10.3.14a, 10.3.14ax1, 10.3.14b, 10.3.14c, 10.3.14d, 10.3.14e, 10.3.14f, 10.3.14g, 10.3.14h, 10.3.14i, 10.3.14j, 10.3.31, 10.3.31a, 10.3.22, 10.3.22a, 10.3.22b, 10.3.22c, 10.3.22d, 10.3.22f, 10.3.23, 10.3.23a, 10.3.23b, 10.3.23c, 10.3.23d, 10.3.24, 10.3.16, 10.3.16a, 10.3.16b, 10.3.16c, 10.3.16d, 10.3.16e, 10.3.16f, 10.9.7, 10.7.13, 10.7.13x1.

The spatial data is based on version 6.1 of the "Queensland Remnant Vegetation Cover 2006" layer (16 September 2011) data (refer to Figure 1).

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

The RE's listed below are those RE's from the classifications listed above that do not have any matching records in version 6.1 of the Survey and Mapping of 2006 Remnant Vegetation Communities and Regional ecosystems of Queensland spatial layer (16 September 2011).

Unmatched regional ecosystems	10.10.6, 10.10.3, 10.10.7.

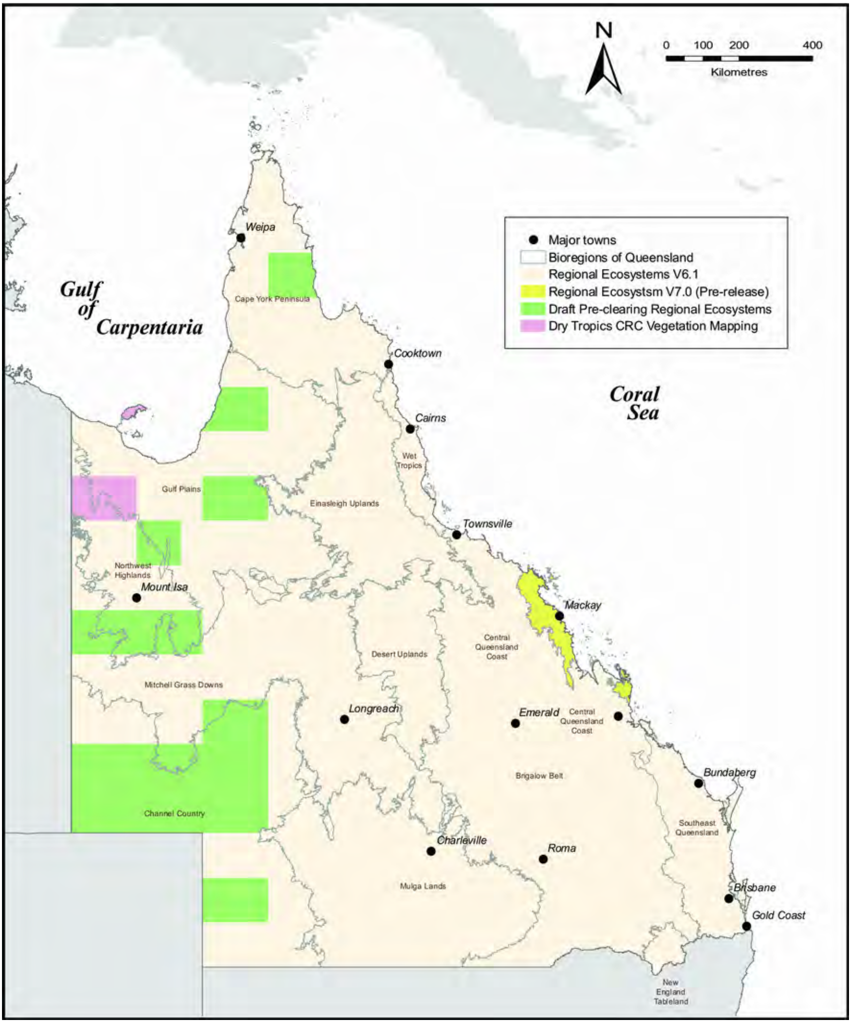

Figure 1: Map of Queensland indicating the different GIS data sources used to produce the spatial fire vegetation group mapping product.

Appendix 2: Mosaic burning

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

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

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

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

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

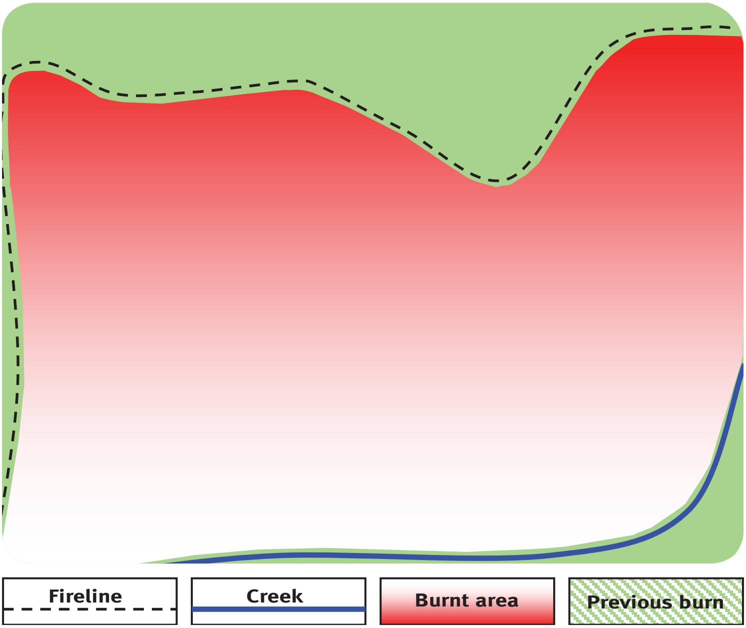

Figure 1: Example area between fireline and creek burnt in a wildfire—year 0. (Recommended fire interval for fire vegetation group is eight–12 years).

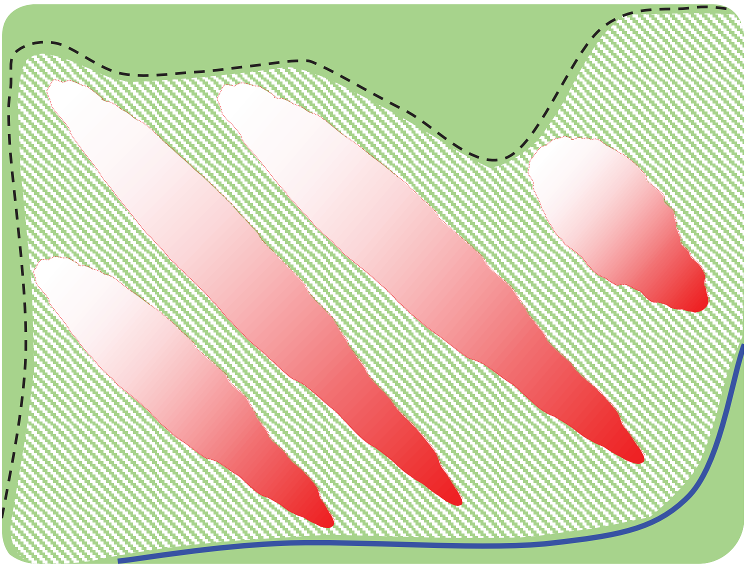

Figure 2: Planned mosaic burn—year 8.

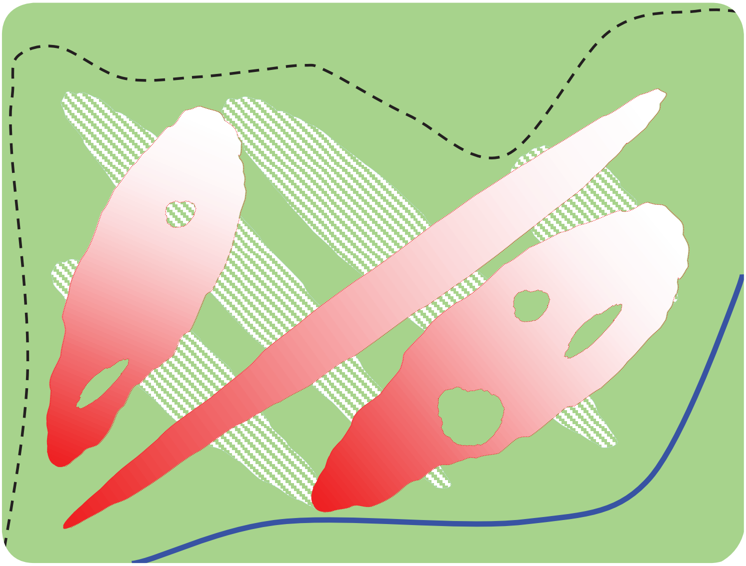

Figure 3: Planned mosaic burn—year 20.

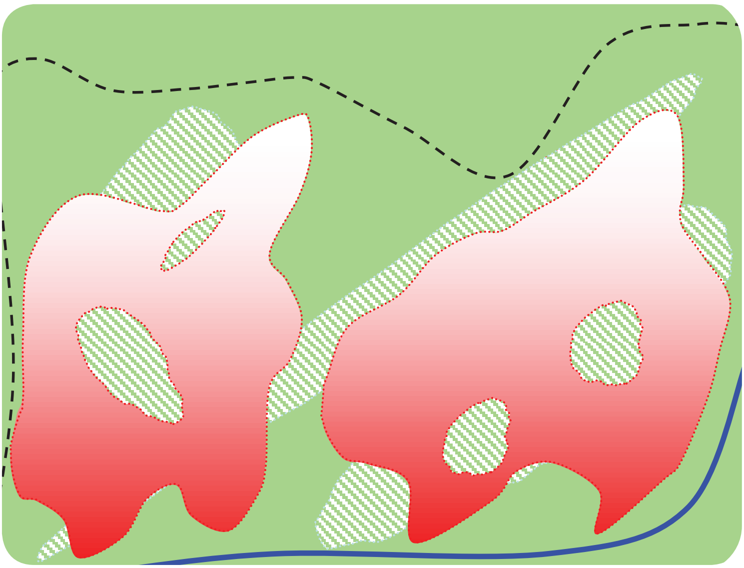

Figure 4: Planned mosaic burn—year 28.

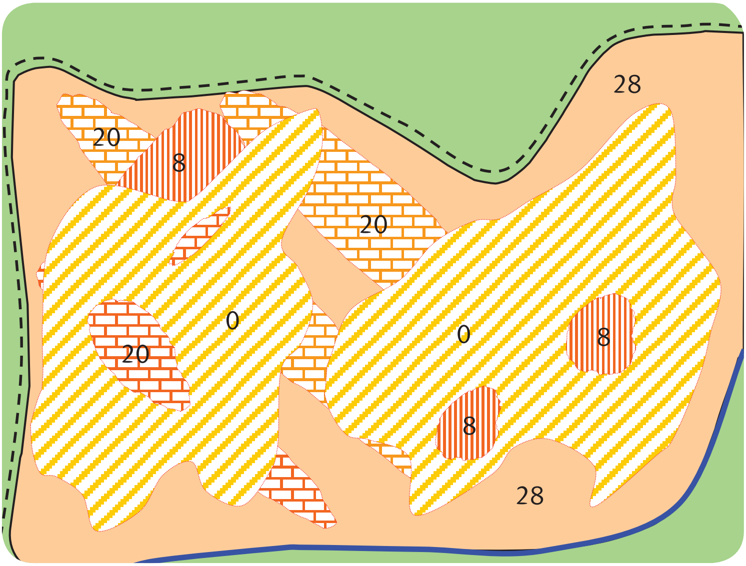

Figure 5: Fire history summary—year 28.
Wildfire and mosaic burn patterns overlaid (with years since last burnt).

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