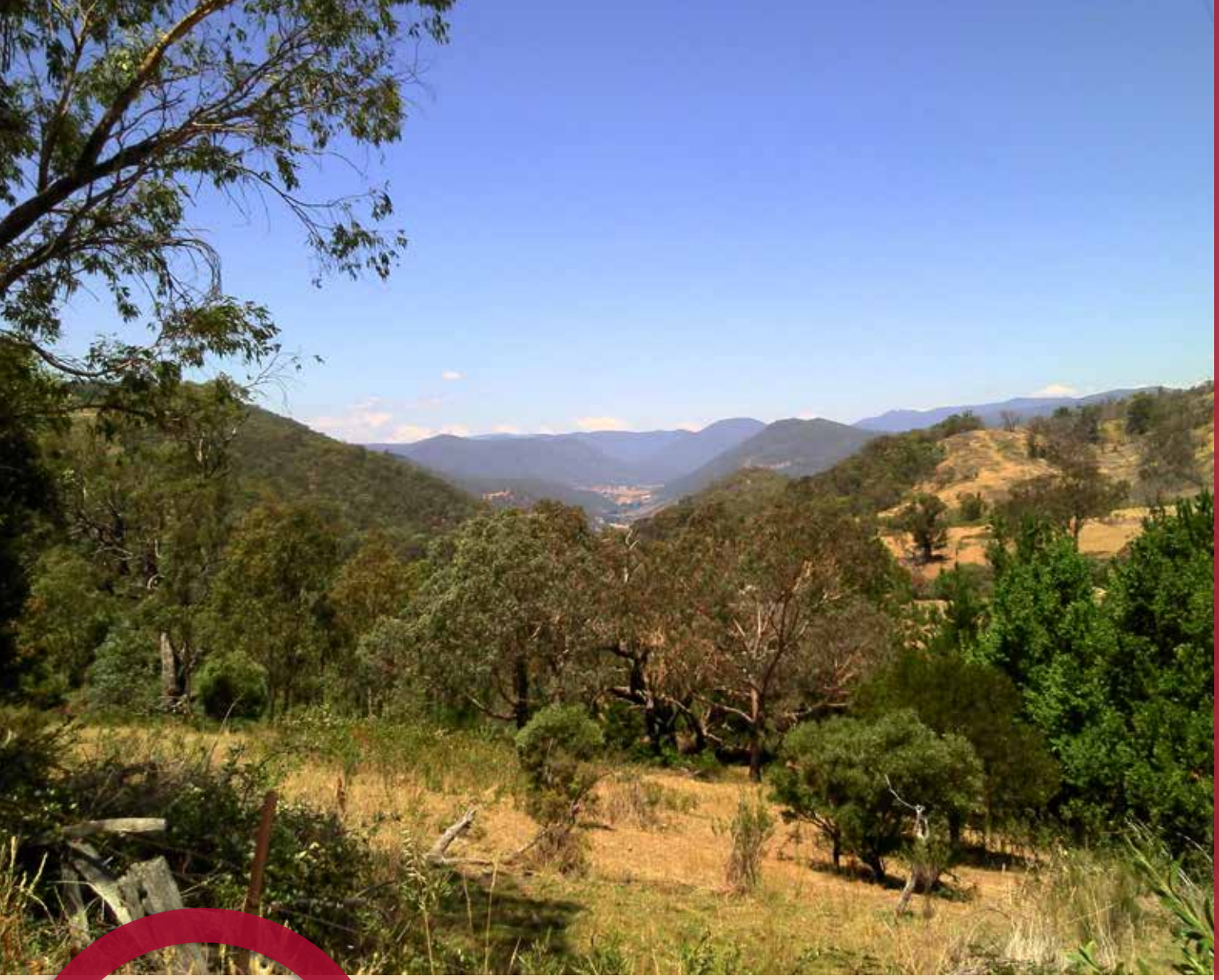


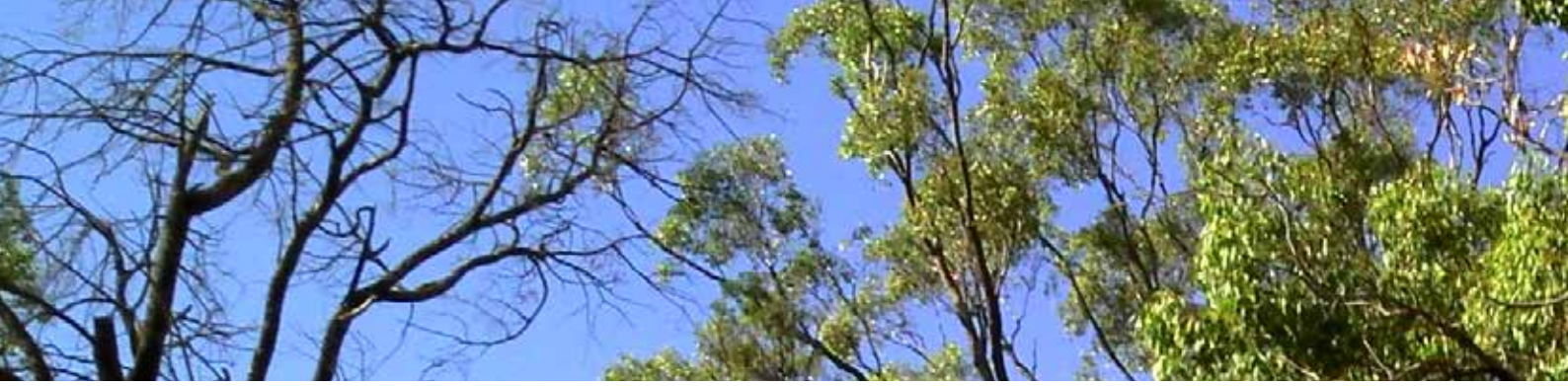
HOTSPOTS FIRE PROJECT

MANAGING FIRE ON YOUR PROPERTY

A booklet for landholders in the Murrumbidgee

NSW Rural Fire Service

Nature Conservation Council of NSW

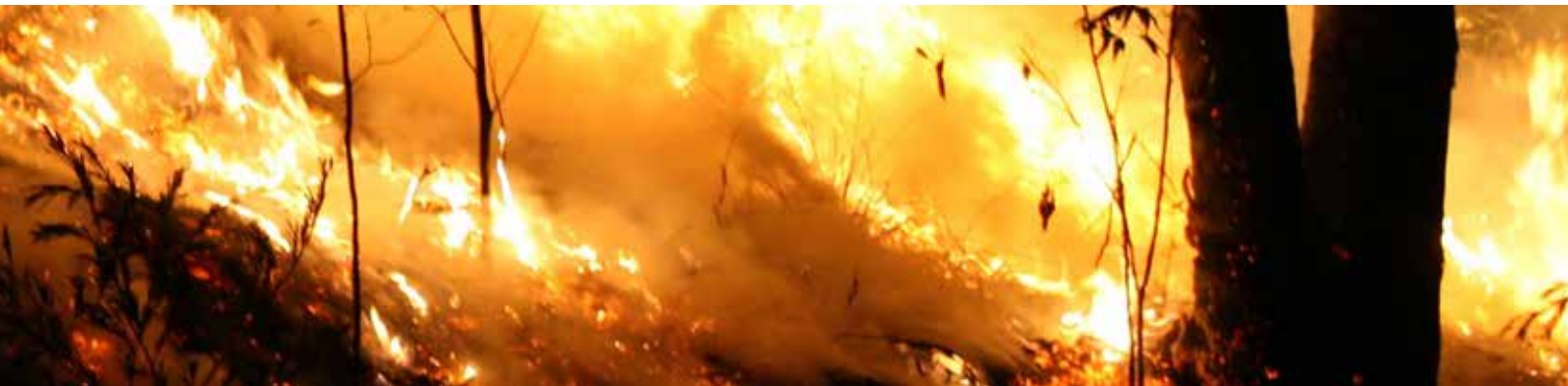


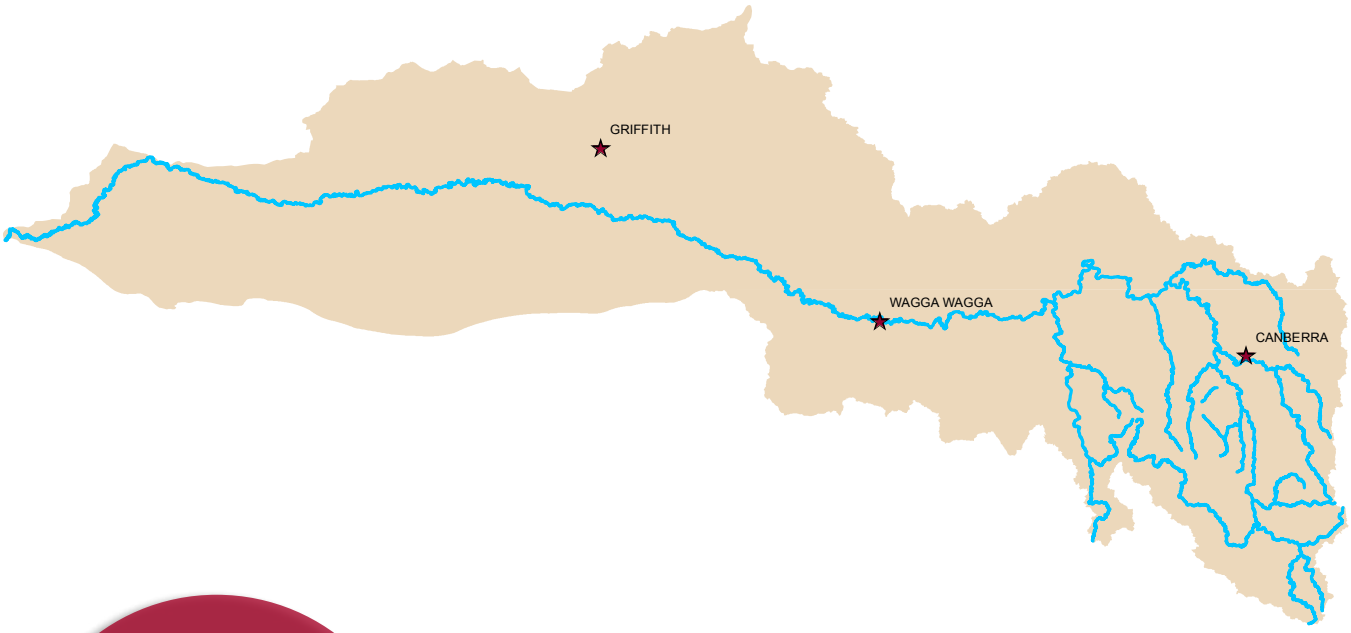
HOTSPOTS FIRE PROJECT

MANAGING FIRE ON YOUR PROPERTY

A booklet for landholders in the Murrumbidgee

WHAT DOES THIS BOOKLET COVER?





HOTSPOTS FIRE PROJECT

MANAGING FIRE ON YOUR PROPERTY

A booklet for landholders in the Murrumbidgee

1 INTRODUCTION TO THE MURRUMBIDGEE

The Murrumbidgee is a diverse catchment composed of many distinctive landscapes including the peaks of the Great Dividing Range, Monaro Tableland and Australian Alps in the east, Canberra and Wagga Wagga in the central reaches and the Lower Murrumbidgee Wetlands and the Hay Plain in the far west. Due to its high productivity the Murrumbidgee is an agriculturally developed catchment. It is a central component of the wheat belt that extends from Victoria through the western slopes and plains of NSW to southern QLD and provides a large proportion of the states irrigated fruit and rice production output.

The remaining tracts of native vegetation provide important habitat and contain a rich diversity of native flora and fauna, with numerous species endemic to the Murrumbidgee. Some of these intact areas of vegetation include important corridors linking the south coast with the Alps as well as corridors linking the northern slopes of the Alps with the ACT.

The substantial decline in rainfall across an east-west gradient and substantial variation in elevation (from approximately 55m above sea level in the west to over 1500m on the peaks of the Alps) contributes to a high diversity of vegetation types. Vegetation range from the Alpine Complexes of the Snowy Mountains to the Temperate Montane Grasslands of the Monaro Plains and Grassy Wet Sclerophyll Forests on the high rainfall tablelands in the upper parts of the catchment, to Grassy Woodlands, Dry Sclerophyll Forests and Forested Wetlands in the mid-reaches, and the Shrublands and Grasslands of the semi-arid western Riverina, and chenopods Shrublands in the far west of the catchment.

The Murrumbidgee is mostly contained within the Wiradjuri Nation, but shares its land with other Aboriginal nations including Walgalu, Ngunawal, Ngarigo, Ngambri, Muthi Muthi, and Nari Nari, whose members have lived in the region for thousands of years. Wiradjuri country is the largest in NSW, stretching from the eastern boundary of the Great Dividing Range, to Gunnedah and Albury in the north and south, and the line between Hay and Nyngan approximates the western boundary.

Aboriginal people have a strong connection with the Murrumbidgee region through the rivers, creeks and abundant wetlands. As traditionally important routes, the rivers provide water, food and shelter. There are many heritage sites along the Murrumbidgee River including scarred and carved trees, camp and burial sites and there are several wetlands within the region that are also important.

2 LIVING WITH FIRE

Fire in the Murrumbidgee

Fire is part of life on the land in the Murrumbidgee region of New South Wales. Some landholders use fire as a land management tool. Others are concerned about the impact of wildfire on their properties, particularly during drought conditions.

Developed specifically for the Murrumbidgee, this booklet provides an introduction on how fire can be managed for healthy, productive landscapes and also presents a framework for incorporating fire into property management planning activities.

Knowledge about the nature of fire and its effects on the landscape will help provide greater confidence in managing fire, both for the protection of life and property, and as a land management tool.

For some landholders, this information will stimulate a new understanding of the role of fire in shaping and sustaining local landscapes and the plant and animal species they contain. For those already in the know, this information will add to existing knowledge and hopefully prompt some important new insights into fire management.

Fire and the Australian continent

Triggered by lightning strikes and traditionally used by Aboriginal Australians, fire has shaped the character of Australian landscapes for millions of years. Many plant and animal species have evolved strategies to deal with fire, and some species have developed ways to take advantage of the opportunities it creates.

Aboriginal Australians actively used fire as a management tool. In some parts of the landscape, we know Aboriginal fire management practices involved smaller and more frequent fires than would have occurred naturally by lightning strike.

There is much debate though, about the nature and extent of Aboriginal burning across the Australian continent.

Even if we knew the whole story about Aboriginal fire management, this knowledge may not give us all the answers we need for the future conservation of native plant and animal communities.

The changes to our landscapes since European colonisation have been profound. In particular we are faced with fragmented vegetation, the spread of introduced species, and changes in the abundance of native plants and animals.

We need to draw on both old and new knowledge about fire in order to protect our bush and so manage for healthy productive landscapes. Much of our new knowledge and our current understanding of how fire might best be managed comes from looking at the way plant and animal species in different communities respond to fire. This topic is the focus of the next section.

> “For me fire is part of a bigger narrative about learning to live like an Australian, as if we intend to stay on this continent forever, for good.” [1]

1 Andrew Campbell - farmer, first national landcare facilitator, and Executive Director of Land and Water Australia speaking at the Australia Burning forum held just after the 2003 fires in Canberra. Quote taken from: Campbell, A. (2003) “Learning to live with fire” pp 243-247 in Cary, G., Lindenmayer, D., and Dovers, S. *Australia Burning: Fire Ecology, Policy and Management Issues,* CSIRO Publishing, Collingwood, Victoria.

3 MANAGING FIRE FOR BIODIVERSITY CONSERVATION

Science based management

Scientists and land managers have long recognised the relationship between biodiversity (the variety of different plant and animal species) and healthy land systems.

It wasn't until the late 70's that scientists gained a much better understanding of the significant role that fire plays in shaping these land systems and the biodiversity within them. Fire ecology is now an important area of scientific study.

For landholders, the most useful information to come out of this research relates to how different aspects of fire affect vegetation and wildlife, and how different plant and animal species respond to fire.

Plant responses to fire

Many Australian plant species have developed reproductive strategies in close association with fire. Since fire is such a powerful disturbance force, changes in fire patterns can quickly influence which species (and reproductive strategies) will persist in an area and which won't.

Different plant species respond differently to fire: some do not tolerate fire; some tolerate it but don't rely on it for reproduction; and in many Australian plant species, one or more aspect of reproduction – flowering, seed release or germination – occur exclusively, or most abundantly, in the months or years after a fire.

Scientists describe two broad post-fire regeneration strategies that occur in areas with a long history of fire which are of particular relevance to fire managers: *obligate seeding* and *resprouting*.

Obligate Seeders

When *obligate seeder* species are exposed to a fire, all, or almost all, plants are killed. These species can persist, however, by regenerating from seed (they're *obliged* to regenerate from seed if they are to survive in an area). This seed may be stored in the soil, on the plant (e.g. in cones), or brought in from nearby unburnt patches of vegetation by wind, water, birds or other animals.

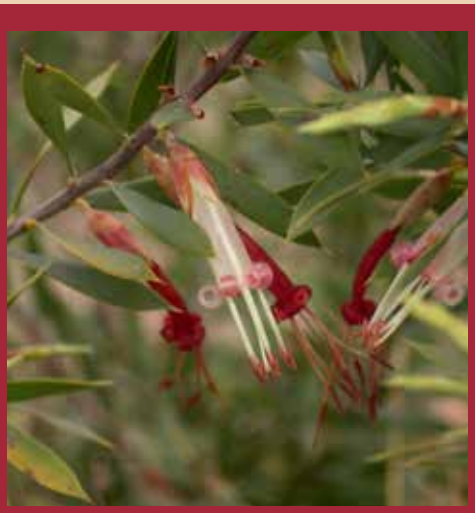
Land managers implementing fire management strategies need to consider the frequency of burning if they wish to ensure the survival of these obligate seeder species.

Obligate seeders reliant on seed dispersal from other areas may also be threatened by extensive fires. This is because no or few seed supply areas escape being burnt and the likelihood of animals (or other dispersers) bringing in new seed is reduced.

Fire *intensity* can also affect obligate seeders because specific temperatures may be necessary to trigger seed release and/or germination.

Fire frequency needs to take account of the life span of obligate seeders; including the amount of time it takes for these plants to experience their first flowering and to produce seeds. If the interval between two fires is too short, the second fire may wipe out an entire generation of young obligate seeders before they have reached reproductive maturity (i.e. before they have started producing seed).

On the other hand, if fire is excluded from an area for too long, a whole generation of obligate seeders may move beyond reproductive age and die off before a fire has had a chance to trigger germination. While some seeds can survive in the soil for very long periods, seeds of some species are relatively short lived.



Obligate seeder pink five-corners (*Styphelia triflora*) © P. Watson, Hotspots Fire Project.

Resprouters

Resprouters are able to resprout after fire from woody underground *lignotubers* or from buds protected underneath their bark. Many landholders may be familiar with the behaviour of these plants.

Some resprouters can tolerate frequent fire, and some can live for a long time without fire. However, it is important to note that even resprouter populations may be affected by very frequent fire or by fire exclusion, and may rely on seed to ensure healthy, diverse gene pools.

Not surprisingly, in the absence of fire, those plants which come to dominate the landscape include long lived species and those which are able to regenerate without fire. These plants may competitively exclude other species from available light and space. A fire can help to open up the bush so light can reach ground level triggering resprouting, germination, and plant growth.

Fire regimes

Fire regime is the term used to describe aspects of fire that are important for managing vegetation and wildlife.

A fire regime includes the following factors:

- **Fire Frequency:** the number of fires in a given time
- **Fire Season:** what time of year the fire occurs
- **Fire Extent:** the area covered by the fire
- **Fire Intensity:** how hot the fire is

More on fire frequency:

It is important to consider the sequence of fire events. Long term effects on landscape and biodiversity are generally the result of a pattern of fires over time, rather than of just a single fire. (Although this is not to say that a single fire doesn't have the potential to significantly impact on a given area, like in a rainforest for example).

The amount of time between fires (fire interval) and the frequency with which fires occur in a given area are important in the conservation of our plant and animal species.

Frequent burning tends to reduce shrub cover and increase grassiness in some vegetation types resulting in more open landscapes. Infrequently burnt areas may naturally be shrubbier. These differences in vegetation structure affect the animals and birds that live in the bush. Some animals need shrub cover to shelter and breed, while others need open, grassy areas to find their food.

Different vegetation types are adapted to different fire frequencies.

Variability in the interval between fires is important for maintaining species diversity. Repeated fire intervals of similar length are not always good news for plants or animals.

Eucalypt resprouting from base three months after fire. © P. Watson, Hotspots Fire Project.

More about fire season:

Climate and weather will influence fire season more than any other factor. In the Murrumbidgee, wildfires generally occur in the summer but the danger period can begin as early as October and extend through to March. Depending on the seasonal weather, areas in the west have been known to experience wildfires as early as September through until April.

Planned burns are, of course, constrained by the bush fire danger period and total fire bans, as well as by weather. The window of opportunity for planned burns is usually limited to autumn or spring, but burns can sometimes occur throughout winter. Spring and autumn provide the most ideal weather conditions for planned burns; however this is dependent on suitable weather conditions.

From an ecological point of view, some variability in the season in which a fire occurs is likely to be the best way to go. While the season appears to affect some individual species, scientific findings do not point to a particular season being 'better' for a whole community of plant and animal species. Where possible, it is probably better to avoid always burning at the same time of year.

More on fire extent:

The area covered by any particular fire can vary. Some wildfires can be very extensive, for example in 2003 several hundred thousand hectares of the Australian Alps and adjoining ranges burnt over several months. Planned burns may range from small burns of a hectare or less, to block burns of several hundred hectares.

Within a fire perimeter, patches will often remain unburnt. Extensive fires that leave few unburnt patches may limit the ability of animals to find refuge during the fire, and food and shelter after it has passed. Unburnt patches provide a base from which animals can slowly move back into burnt areas as these recover. Those undertaking planned burns aim to leave unburnt patches.

However, small burns may also have a down side. Animals can easily move into small burnt patches from surrounding unburnt country and may place too much grazing pressure on the recovering vegetation in these small patches. This problem may be particularly prevalent where animals such as kangaroos are abundant. If a greater area is burnt, grazing pressure is more likely to be spread, reducing impacts on regenerating vegetation.

Landholders wanting to burn with biodiversity in mind may therefore want to aim for burns of varying size, while still ensuring unburnt bushland patches remain for fauna. Burning a number of different patches at around the same time is another way to spread grazing pressure over a larger area. Previously burnt patches can provide boundaries for later patch burns.

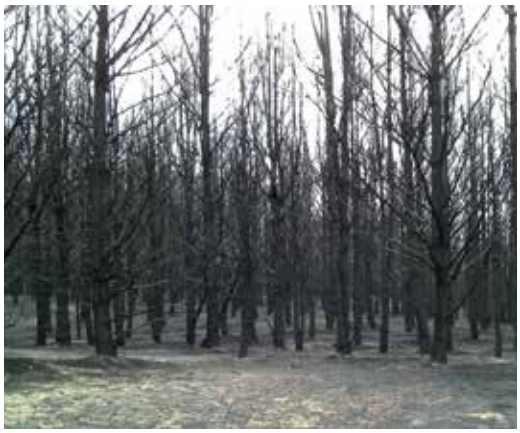
More on fire intensity:

A fire varies in intensity depending on factors such as wind speed, temperature, humidity, slope, fuel load and the structure of the vegetation. The most intense fires tend to occur during times of high temperatures, low humidity and strong winds.

Generally:

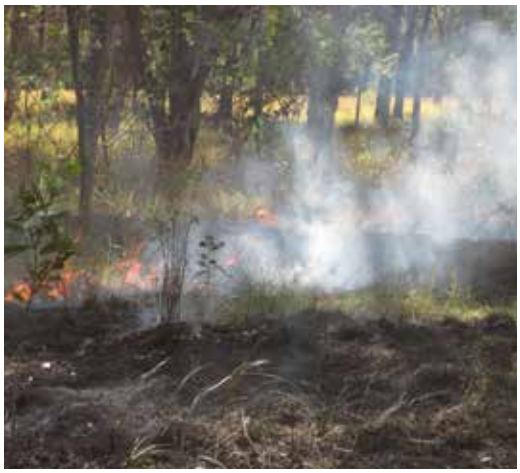
- Fires tend to be more intense when there is more available dry fine fuel. 'Fine fuel' is material less than a pencil width.
- High intensity fires are more destructive and will kill more plant and animal species, but they are also naturally occurring and important in some plant communities.
- After a high intensity fire, lots of seed germination may occur. Areas opened up by a high intensity fire will provide increased areas of sunlight and space for young plants to develop.
- Variation in fire intensity plays a role in keeping a greater number of species in the community (i.e. maintaining biodiversity).

Fire frequency, extent, and intensity are naturally patterned across a landscape, particularly in mountainous and hilly country. This is determined largely by weather, aspect, slope and vegetation type. Fire management should therefore both respond to and make use of these patterns. For example, gullies often contain more moisture loving plant species than upper slopes and ridges. Unplanned fires are less likely to burn into gullies, since the gullies are naturally wetter; and species in gullies are more likely to be adapted to less frequent fire than species growing on higher ground. A fire management plan should account for this.



Extensively burnt areas can affect the ability of plants and animals to recover after fire. © M.Graham, Hotspots Fire Project.

Unburnt patches will provide animals with a refuge during and after the fire. © M. Graham.



Low intensity fire. © W. Parker.

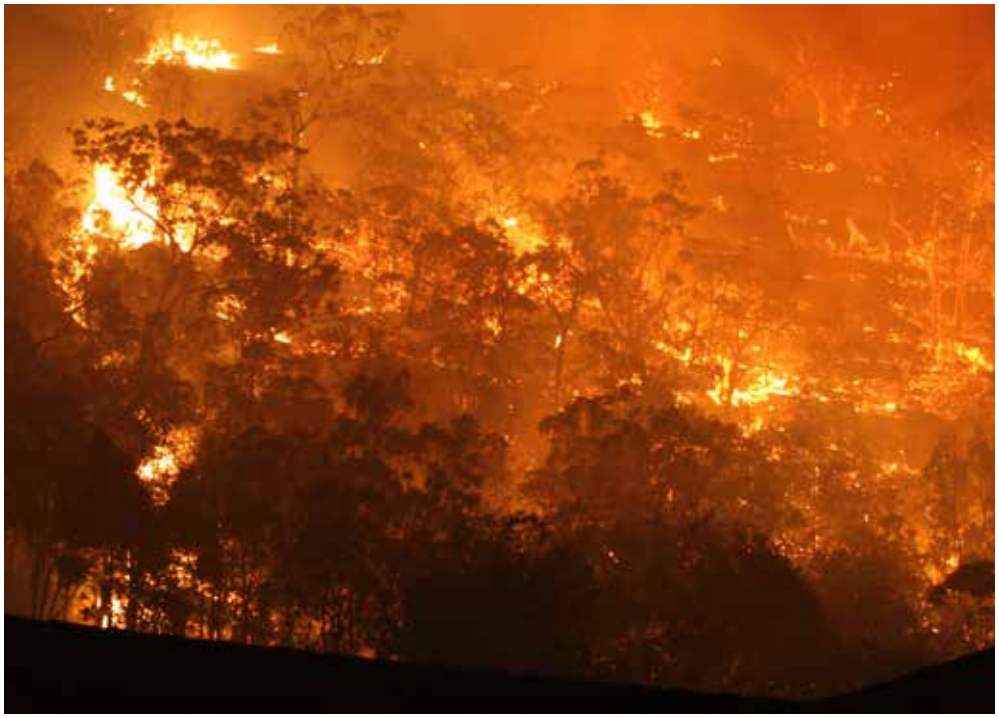
Fire regimes: implications for management

At best, fire management planning is a blunt tool and in some parts of the landscape, unplanned fire is inevitable. Prevailing weather conditions and natural landscape patterns will often influence fire season, intensity and extent. Management planning needs to be flexible enough to accommodate unplanned fire, variability in landscape and weather patterns.

Over thousands of years, much of the Australian bush has evolved ways to live successfully with fire and use it to reproductive advantage. Many vegetation types have also developed an ability to 'bounce back' from different fire regimes. This bouncing back is often termed 'resilience'.

The best approach is to vary your fire management actions over time. Talk to people with knowledge in your region, and try different things based on your own observations of vegetation responses to fire on your property.

Biodiversity is more likely to be sustained when fire management extremes are avoided. Excluding all fire from your property, or burning as soon as vegetation has sufficient fuel to support a fire, will eventually see the loss of species adapted to a more moderate or variable regime.



High intensity fire. © G. Walker, NSW Rural Fire Service.

4 FIRE IN THE LANDSCAPE: PUTTING THE SCIENCE INTO CONTEXT

Like many natural processes, the relationship between vegetation and fire regime is complex. However, there are some simple principles that emerge in the following stories about fire in particular plant and animal communities.


© A. Miehs

FIRE FREQUENCY IN GRASSY WOODLANDS

Grassy Woodlands in the Murrumbidgee, like other regions, have been extensively cleared for agriculture. Patches of good quality Grassy Woodland where native species still dominate are therefore very valuable from a conservation point of view.

A great diversity of Grassy Woodland communities occupy the Murrumbidgee, driven by varying annual rainfall and the complex interactions of elevation, fire, topography, geology and soil formation processes. The climatic variation across the east-west gradient in the Murrumbidgee allows for the existence of four distinct Grassy Woodland classes; Subalpine, Southern Tablelands (eastern parts of the Murrumbidgee), Western Slopes (south western slopes of NSW) and the Floodplain Transition Woodlands on the western alluvial plains.

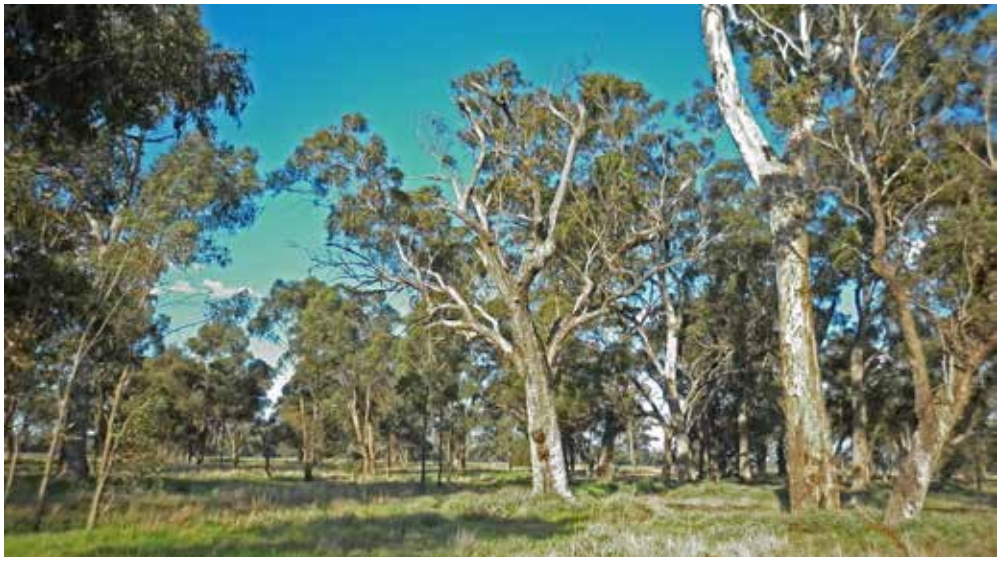
Remnants with White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*), and/or Blakely's Red Gum (*E. blakelyi*) with a grassy understorey are part of the Critically Endangered Ecological Community Box-Gum Grassy Woodland. Another Grassy Woodland that is recognised as an Endangered Ecological Community is Fuzzy Box (*E. conica*) Woodland on Alluvial Soils. Conservation of these remnants is essential for retaining habitat for many declining native plants and animals.

Within Grassy Woodland communities, fire frequency can affect the balance between woody species and grasses. Frequent burning tends to produce open, grassy landscapes, whereas in places where fire has been excluded or is rare, shrubs and young trees may increase in number.

In Grassy Woodlands, tussock grasses such as kangaroo grass (*Themeda australis*); snowgrass (*Poa sieberiana*) and wallaby grasses (*Austrodanthonia sp*) dominate the ground layer. Smaller grasses and herbs grow in the spaces between these tussocks. Fire increases diversity by burning the dense tussocks, making space for the smaller species. Many of these grasses and herbs flower rapidly after fire, producing seeds which germinate while gaps between resprouting grass tussocks are still available. Some of the native tussock grasses, particularly kangaroo grass, are also encouraged by fire. Thus fire provides a way for large native grasses, small grasses and herbs to co-exist.

Where fire has been excluded from Grassy Woodlands, shrubs may increase or decrease depending on whether or not they rely on fire for regeneration. Shrubs and trees that are not reliant on fire and can regenerate between fires will likely increase in density in the absence of fire. If environmental conditions are favourable, these species may then progressively come to dominate the landscape shading out the grasses and herbs. Heavy litter which accumulates over time may also leave little room for small ground layer species. However, there are also shrubs that depend on fire to regenerate. These shrubs may appear in large numbers after a fire as seed stored in the soil is stimulated to germinate. These types of shrubs will tend to die off after a long time without fire, producing a more open understorey.

Both ground layer plants and shrubs form part of the rich diversity of Grassy Woodlands in the Murrumbidgee region and fire plays an important role in regulating these woodlands. The extent of loss, fragmentation and change to Grassy Woodlands, means fire needs to be carefully managed and varying fire over time and space is likely to be important for maintaining diversity.



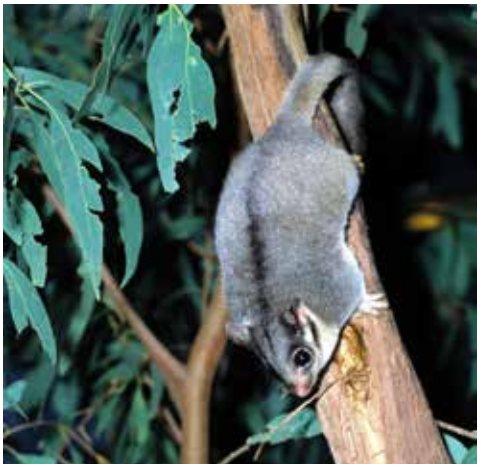
FIRE AND ANIMAL HABITAT

Variability in fire frequency over time and across the landscape plays an important role in providing the habitat that bushland animals need. Fire alters the structure and density of vegetation layers and can change the species composition of bushland areas. Some birds, mammals and invertebrates may even disappear if fires occur too often or are excluded completely. Landscapes in the Murrumbidgee provide a significant refuge for several nationally vulnerable fauna species.

Hollows as Habitat

There are significant areas of mature and old growth eucalypt forest in the mountainous landscapes of the Murrumbidgee catchment. These magnificent forests have numerous hollows and provide habitat for an abundance of fauna. Many fauna species are dependent upon hollows for key parts of their life-cycle. Specifically, hollows provide places for animals to feed, shelter and breed. Hollows can take many centuries to develop or be replaced when lost from a landscape. Fires can burn through significant hollow-bearing trees and cause them to fall. This leads to a loss of valuable habitat and causes increased competition for remaining hollows. Maintenance of hollow-bearing trees and enhancement of these valuable habitats wherever possible, is needed to ensure the survival of many native species.

Barking Owl © K. Stepnell, Office of Environment and Heritage



Squirrel Glider ©K. Stepnell, Office of Environment and Heritage

Mammals and Birds

Many iconic threatened fauna species are known to use hollows in the Murrumbidgee catchment. The vulnerable listed yellow-bellied glider (*Petaurus australis*), inhabits fertile and productive forests in the eastern and upper parts of the catchment. These forests also support the large and distinctive greater glider (*Petauroides volans*). The vulnerable squirrel glider (*Petaurus norfolcensis*), inhabits drier forests and woodlands in the eastern and central parts of the Murrumbidgee. These gliders are favoured prey of the vulnerable powerful owl (*Ninox strenua*), Australia's largest owl at 60cm in height. Other vulnerable large owls known from the Murrumbidgee Valley include the masked owl (*Tyto novaehollandiae*), and the barking owl (*N. connivens*). To ensure the survival of these sensitive species, large hollows must be maintained in the landscape. This will ensure that breeding pairs can successfully maintain their large home ranges and reproduce.

Other threatened species that are known to inhabit hollows in the Murrumbidgee Valley include the gang-gang cockatoo (*Callocephalon fimbriatum*) in the east, and the superb parrot (*Polystelis swainsonii*), which has a limited range in the central parts of the Murrumbidgee valley. Maintenance of isolated large hollow-bearing trees across this primarily agricultural landscape is needed for their survival.

The broad-toothed rat (*Mastacomys fuscus*), is a large native rat that lives in restricted parts of the Murrumbidgee catchment over 1200m elevation. These vulnerable rotund rodents live in

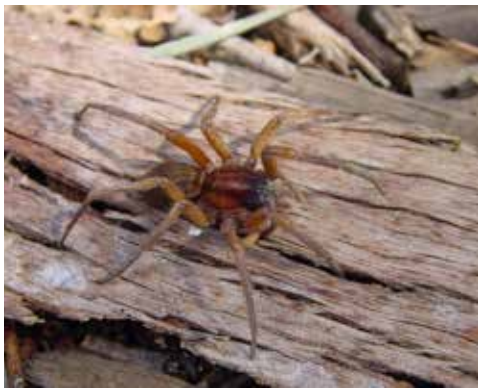
limited areas of native Grassland, Heathland and Sedgeland within broader areas of Subalpine Woodland across the headwaters of the Murrumbidgee. Their diet is composed almost entirely of native grasses, herbs and sedges that they forage upon via a complex network of runways through the dense understorey of this vegetation.

Activities such as clearing, grazing and wildfire which remove or substantially alter the dense understory of areas occupied by broad-toothed rats can adversely impact upon the species. In the short term this can deprive them of food sources and leave them vulnerable to predation by feral predators such as cats and foxes. In cases of burning and grazing it is important that areas of refuge habitat are protected so these populations can recolonise if and when habitat becomes suitable again.

Much of the habitat of the broad-toothed rat was burned in the 2003 wildfires across the Australian Alps. In areas where the wildfire was intense and dense understorey was lost, broad-toothed rats suffered substantial population declines. In many places recovery has been slow because of the low birth rate and small populations of this iconic native rodent. Patchiness of fire across the landscape and staggering burns over longer timeframes is likely to be needed to ensure that viable populations of the broad-toothed rat remain in the Murrumbidgee Valley.

Time since fire, the extent and intensity of fire affects the diversity of insects and plants and therefore the birds which rely on them for food, shelter and nesting. Nectarivorous birds may need to find food outside of recently burnt areas, but as fire is often followed by major flowering, food can become abundant. Some warblers and wrens have been known to increase out of season breeding activity in response to a post-fire increase in insect numbers.

Broad-toothed rat © K. Green



Wolf spider © G.Gowing

Invertebrates

Different fire regimes will also affect invertebrates like ants, beetles and spiders. Numbers of these invertebrates can be reduced immediately post-fire, but can quickly recover. Although overall diversity can be the same between areas, the frequency of fires will affect the features of the habitat and therefore which species live there. Excess nutrients from bushfire debris can reduce aquatic macro-invertebrate (e.g. insect, crustacean and mollusc) populations post fire, however they can also be quick to recover.

Some plant-eating beetles, flies and spiders can take advantage of recent fires, while ants which feed in the litter layer can be more common in longer unburnt areas. Wolf spiders (Family *Lycosidae*) for example are ground hunters, preferring more open habitats to hunt while jumping spiders (Family *Salticidae*) hunt for food in understory vegetation, trees and logs provided by more complex habitats.

Wildfire, Mosaics and Variability

In some places, fire needs to happen often enough to maintain open, grassy forest environments rich in grasses and herbs, where early-successional animal species can thrive. Other places need to support good-sized patches of thicker vegetation where broadleaf shrubs and late-successional fauna can flourish. It is also important to remember some animals need access to both open areas and denser cover and a mosaic of patches can fulfil that requirement.

Where native vegetation covers large areas it is likely that wildfire will fulfil this prescription. Where remnants have been isolated by clearing and urbanisation, or where fire suppression has been unusually effective, some ecological burning may need to occur. Hot fires have their place, as well as cool winter burns. A further point is the importance of topography in providing refuge areas from which re-colonisation of the post-fire environment can occur. Not only do unburnt areas serve this function, places where fire is less severe also play this role. When thinking about the effects of fire and how best to manage it, it is instructive to consider landscape patterns: how does vegetation change with topography? How does topography affect fire behaviour and how does this enable plant and animal species to survive and thrive together in a fire-prone environment?

THE STORY OF WHITE CYPRESS PINE

White cypress pine (*Callitris glaucophylla*) is a prominent feature of the landscape across central western New South Wales and is a component of many vegetation classes in the Murrumbidgee. Unlike most trees in Australia, *Callitris* species are not flowering plants; they are conifers and produce seed on the surface of cone scales.

The recruitment of white cypress pine isn't triggered by fire, but rather is an occasional event associated with particularly good rainfall. The density of young pines can be quite high. Unlike eucalypts, pine seedlings can take many decades to reduce in density and thick stands of small spindly trees can remain for many years. Whilst these stands can provide good habitat for native species including terrestrial orchids and woodland birds, dense regrowth is not suitable habitat for other species. Because of this, changes in habitat structure from open woodlands to dense cypress regrowth can lead to changes in native animal populations.

The last two hundred years have seen many changes in the cypress pine woodlands. Some have been cleared for cropping, while elsewhere the density of pine has increased. The balance between eucalypts and pines, and between large and small trees, has also changed. Early 19th century leases often required landholders to remove eucalypts, shrubs and young pines. Mature pines provided excellent wood. As foresters know, pine regeneration happens readily in 'understocked' stands: where once mature eucalypts and pines left few resources for new plants, logging created gaps for young pines to come in.

The regeneration and thickening of woody native species, such as white cypress pine, in previously cleared or agricultural landscapes is regarded as a problem for agricultural productivity. On the other hand dense regeneration of white cypress pine can provide a more sheltered and cooler microclimate than surrounding open habitats. This is particularly the case during extremely hot summer days when native animals such as the koala (*Phascolarctos cinereus*) take refuge within cooler cypress stands.

Fire regimes have also changed. Historians and scientists who have studied cypress pine forests generally agree that fires started by Aboriginal Australians and lightning probably once helped maintain a mosaic of woodland patches. In many places the understorey was open and grassy under a canopy of eucalypts and mature pines, while in other places shrubs and young cypress

grew thickly or in clumps. Although challenging to know for sure, it appears with European settlement, fire became increasingly less common in the slopes and plains of NSW.

White cypress pine is much more sensitive to fire than the eucalypts that grow with it. Not all cypress plants are killed in every fire: even in hot wildfires a proportion are generally tall enough to escape most of the flames. Seedlings, however, are readily killed in a burn. Thus fire has the potential to kill very young regrowth, and to thin dense cypress stands.

Landholders who may wish to limit the density of pine stands may find fire a useful tool for managing white cypress pine seedlings. Fire and other management techniques that encourage the growth of eucalypts, native shrubs and deep-rooted perennial native grasses will in turn produce more ground fuel for fires, may discourage pine regeneration and provide habitat for those native animals that require the nectar, seeds and insects that are available from these native plants.

While fire may open up cypress pine stands, managing the intensity and spread of fire can be challenging. The trick will be to find fire regimes that balance all the different needs of plants, animals and us – a job for landholders, people familiar with fire and scientists to tackle together.

White cypress pine. © W. Parker

5 MANAGING FIRE FOR DIFFERENT VEGETATION TYPES

If different vegetation types are adapted to different fire frequencies, how do landholders know whether their fire management actions are good for biodiversity?

To help make these decisions, the Office of Environment and Heritage (OEH) has developed *fire frequency guidelines* for broad vegetation types around NSW. These guidelines are periods of time (in years) bounded by 'thresholds'. Thresholds refer to the upper and lower limitations to survival for species that are particularly sensitive to very short or very long, intervals between fires. The fire frequency guidelines aim to ensure fire intervals are long enough to let vulnerable obligate seeders grow to maturity, while also ensuring fire happens often enough to keep short lived species around.

Hotspots is working with OEH and local ecologists to further support these guidelines to take into account the considerable differences between regions within NSW. The 84,000 square kilometres covered by the Murrumbidgee catchment includes a wide range of environments, from tablelands to the slopes and down onto the plains. Elevation in the catchment varies from over 1500m above sea level on the eastern ranges of the Great Dividing Range to approximately 50m above sea level on the western plains. Across the east to west gradient, annual rainfall varies from an average >1700mm in the east to <350mm in the west of the catchment

Summers are relatively hot, with temperatures averaging 30-35ºC in the west compared to averages of 27ºC in the higher elevated areas to the east. Winter is mild to cold, with average temperatures of 12-16ºC in the west but averaging as low as 4ºC in the Alps.

All these factors affect which plants grow where, and how fast they grow. They also affect the way fire behaves. Fire frequency guidelines aim to reflect these differences.

The recommended fire frequency intervals are based on what scientists currently know about fire ecology, and will continue to be refined as more information comes to hand. Upper thresholds in particular are currently based on very limited data.

Fire frequency intervals for broad vegetation types found in the Murrumbidgee are listed on the following pages.

For further information or to find out any recent developments please refer to the NSW Rural Fire Service website at: www.rfs.nsw.gov.au.

The vegetation types are classified according to a statewide assessment made in 2004 by Dr David Keith. The groupings can be recognised by specific combinations of plant species, in some cases, these include plant species found nowhere else. The vegetation types are also based on factors such as the height and spacing of the dominant plants as well as geographic indicators of rainfall and soil type.

Vegetation types of the Murrumbidgee

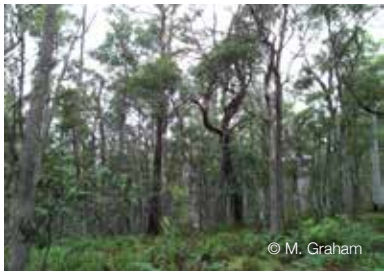
Wet Sclerophyll Forest (shrubby subformation)

The term sclerophyll refers to the hard, leathery leaves of many distinctly Australian trees and shrubs.

Wet Sclerophyll Forests (shrubby subformation) are tall eucalypt forests with a dense understorey of ferns, herbs, and shrubs with broad soft leaves. These forests grow on relatively fertile soils and in the Murrumbidgee region is restricted to the high rainfall escarpments in the east of the catchment. Although it is understood that fire is important in these forests, the fire intervals needed to preserve the dominant eucalypts and safeguard other biodiversity values are still unclear. Shrubby subformation Wet Sclerophyll Forests are likely to experience occasional intense wild fires, perhaps every 50 to 100 years. Intense fire may be needed for eucalypts to regenerate. Less intense but more frequent understorey fires may have a role in maintaining shrubs, ferns and herbs.

Currently, variable fire intervals in the range 25 to 60 years are recommended for shrubby subformation Wet Sclerophyll Forests across the state. However these recommendations may be reviewed and refined as we learn more.

Wet Sclerophyll Forest (grassy subformation)

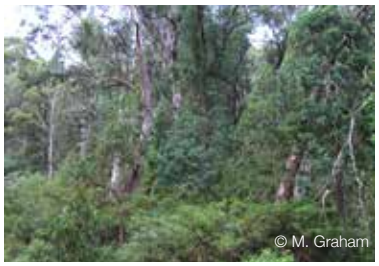


Grassy subformation Wet Sclerophyll Forests are dominated by straight trunked eucalypts, with a grassy understorey and sparse shrubs which may have hard or soft leaves. This tall forest type also grows on fertile soils in high rainfall areas. It is similar to Wet Sclerophyll Forest (shrubby subformation) but has a more open canopy, less shrubs and a greater grassy or herbaceous groundcover. In the Murrumbidgee, this vegetation community occurs in the far east of the catchment in the South Eastern Highland Bioregion.

Several NSW studies have found that fire frequency has a profound effect on vegetation structure in wet grassy forests. Frequently burnt areas are open and grassy, with a diverse herbaceous ground layer, while infrequent burning is associated with an increased abundance of shrubs and small trees. Each environment provides habitat for a distinct suite of plants, insects and small mammals. To provide for the full range, it is important to keep some parts of the landscape open with relatively frequent fire, while other places are burnt less often to allow thicker habitat to develop.

Appropriate fire frequencies for this forest type are still being debated. The present state-wide recommendation is for fires every 10 to 50 years although occasional low intensity fire on a more frequent basis may be necessary for the maintenance of understorey diversity.

Dry Sclerophyll Forest (shrubby subformation)



This vegetation type includes forests and woodlands dominated by eucalypts such as scribbly gum (*Eucalyptus rossii*) and brittle gum (*E. mannifera*) but may also support white cypress pine (*Callitris glaucophylla*), black cypress (*C. endlicheri*) bulloak (*Allocasuarina leuhmannii*) and belah (*Casuarina cristata*). The shrubby understorey of these forests contains many obligate seeders and resprouting shrubs whose flowers colour the bush in spring. The cover of grasses and sedges is sparse. Dry Sclerophyll Forests grow on poor soils in moderate rainfall areas.

Variable fire intervals between 7 to 30 years are recommended to maintain diversity in this vegetation type.

Dry Sclerophyll Forest (shrub/grass subformation)

Dry Sclerophyll Forests (shrub/grass subformation) consist of open eucalypt forest with a sparse hard leaved shrub layer with a grassy groundcover. These forests occur on moderately fertile soils in areas of moderate rainfall. In the Murrumbidgee there are several different forms of shrub/grass Dry Sclerophyll, many intergrade with shrubby forests and the distinction among them is likely to be arbitrary in many instances. The structural differences however can affect fire behaviour. Dry Sclerophyll (shrub/grass subformation) Forests include the red stringybark (*Eucalyptus macrorhyncha*), scribbly gums, red box and tussock grass open forest of the NSW South Western Slopes Bioregion and the white cypress pine woodland on the plains of central NSW.

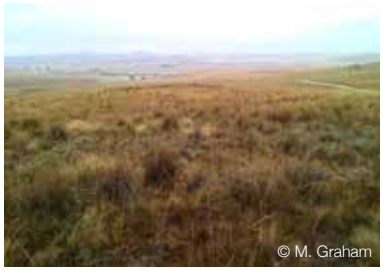
Across the state, intervals in the 5 to 25 year range, with occasional intervals up to 50 years in some areas, have been recommended for these forests. The grass component is likely to be best maintained by short intervals, while the shrub component is predicted to increase with longer intervals.

Grassy Woodland

This is open eucalypt woodland of trees that are widely spaced with crowns that rarely touch. The understorey is usually quite grassy with herbs and scattered shrubs. Grassy Woodlands grow on rolling terrain with fertile soils and moderate rainfall, and have been extensively used for grazing. In the Murrumbidgee these are amongst the most productive of ecosystems. They mostly occupy fertile landscapes and flatter terrain. The Murrumbidgee supports a high diversity of Grassy Woodlands that includes Grassy Woodlands of the Western Slopes, Southern Tablelands, Subalpine and Floodplain Transition woodlands.

Across the state, a variable fire frequency of between 5 to 40 years has been recommended. In places where plants grow relatively quickly because of higher rainfall and warmer temperatures, intervals are likely to lie towards the lower end of this range.

Grassland



Grasslands are notable for their lack of woody plants, although a few low shrubs can sometimes be found in these communities. A wide variety of herbs grow in the spaces between tussocks of perennial native grasses such as kangaroo grass (*Themeda australis*), snowgrass (*Poa sieberiana*) and wallaby grasses (*Austrodanthonia spp.*). Many plants in native Grasslands are often missed; some may not be visible through autumn or winter, but re-emerge to flower in spring.

Extensive natural Grasslands were a prominent feature of the pre-European vegetation of the Murrumbidgee including well-known areas of Grassland such as the Monaro Tableland and the Hay Plain. Grazing and pasture improvement have extensively modified natural Grasslands, so remnants where native species continue to thrive are places to be cherished.

The structural and floristic composition of these natural Grasslands varies widely as a result of the interplay between climate, fire, altitude and landscape productivity. Classes of Grassland in the Murrumbidgee catchment include Temperate Montane and Riverine Plain Grasslands.

Across the state, fires at intervals between 2 to 10 years are recommended to keep dominant grasses from overwhelming smaller herbs and to open up gaps for seedlings to germinate and grow. A slightly longer interval might be more appropriate in sites with slower growth (high altitude Grasslands). As rainfall decreases the spaces between grass clumps may close up more slowly. Knowledge of the fire responses of Grasslands is still developing.

Semi-arid Woodland (shrubby subformation)

Trees in the Semi-arid shrubby Woodlands subformation are generally shorter in stature than those in the grassy subformation, there is less grass cover but frequently drought-resistant shrubs are dominant. Sclerophyll trees such as eucalypts, wattles, cypress pines and she-oaks dominate these areas with drought-resistant shrubs and grasses making up the understorey. Soils vary from sandy outwash soils to red-brown loams on adjacent floodplains. The sandy soils naturally favour shrubs while the heavier floodplain soils will more likely support higher grass cover.

As with other vegetation classes, disturbance affects the density of trees, shrubs and grasses within Semi-arid Woodlands. Drought plays a major role in shaping the vegetation and also influences fire regimes. In some places where the shrubby areas have thickened up considerably since European settlement, lack of fire is thought to be one of several factors involved in this change.

Fire frequency guidelines for Semi-arid Woodlands are particularly tentative due to lack of data; however intervals between 10 and 40 years have been proposed.

Semi-arid Woodland (grassy subformation)

Semi-arid Woodlands cover most of the western plains and the drier half of the western slopes of NSW. The woodlands of the semi-arid zone are dominated by sclerophyll trees (eucalyptus, she-oaks, wattles, cypress pines), contain drought-resistant shrubs and are home to many ephemeral (short-term or transitory) grasses and herbs.

Grassy subformation Woodlands occur on the floodplains in areas subject to occasional flooding. These woodlands intergrade with Grasslands and Arid Shrublands. To the east these woodlands become Grassy Woodlands. Inland Floodplain Woodlands and Riverine Plain Woodlands are the main vegetation classes found in the Murrumbidgee.

Drought plays a major role in shaping the vegetation and also influences fire regimes. In many places fires will only burn when the grasses which flourish after good rains dry off. Fire frequency guidelines for Semi-arid Woodlands are particularly tentative due to lack of data; however intervals between 6 and 40 years have been proposed.

Heathland

Heathland is dominated by short hard-leaved shrubs, many of which are obligate seeders. Heath grows in moderate to higher rainfall areas, shallow and infertile soils, often in exposed positions. In the Murrumbidgee catchment, Heathland is restricted to the limited areas in the far east of the catchment (Southern Montane Heathlands), and at upper elevations.

Fires at a range of intervals between 7 to 30 years are recommended for maintaining biodiversity in Heathlands. Within this range, variability is important as this creates the space and opportunity for large and small species with a range of responses to fire, to live together.

Arid Shrublands (chenopod subformation)

Arid Shrublands dominated by chenopods such as saltbush (*Atriplex spp.*), roly-poly (*Sclerolaena muricata*) and bluebush (*Maireana spp.*) are common on the riverine plains in the west of the Murrumbidgee. These vegetation communities are part of the chenopod subformation of Arid Shrublands.

Chenopod shrublands have low flammability, and are considered extremely fire-sensitive. Chenopod species are mostly obligate seeders with only local seed dispersal and no effective post-fire seedbank. Fire should be avoided in chenopod shrublands.

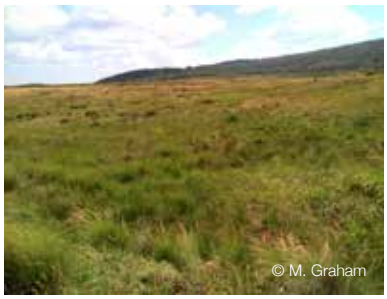
Arid Shrublands (acacia subformation)

Mulga (*Acacia aneura*) dominated shrublands are common in the western parts of the Murrumbidgee, particularly on the rocky landscapes of the Cobar Peneplain. Mulga shrublands are part of the acacia subformation of the Arid Shrublands.

Mulga and other plants that comprise the acacia shrublands have the capacity to regenerate after the infrequent (30-50 years) unplanned fires that mostly occur following fuel build-up during favourable climatic conditions such as significant La Niña events.

The minimum interval for fire in mulga communities should be at least 5-6 years, and the maximum approximately 40 years, although there is a recognised lack of knowledge of the best fire regimes for this vegetation subformation.

Alpine Complex



Australia's Alpine Complex encompasses heathlands, herbfields, freshwater bogs and alpine fjaeldmarks. Small-leaved shrubs, herbs and tussock grasses dominate the vegetation, while altitudinal climatic conditions inhibit tree growth. Site conditions, such as exposure, duration of snow cover and degree of waterlogging, determine formation of vegetation communities.

Fire should be avoided in this vegetation community.

Forested Wetlands

These forests typically feature hard leaved trees (casuarinas and eucalypts), scattered shrubs and patchy groundcover of water loving sedges and herbs. They occur on flood plains or along riparian zones. Two classes of Forested Wetland occur within the Murrumbidgee, the Eastern Riverine Forests and the Inland Riverine Forests. The relative abundance of either river oak, *Casuarina cunninghamiana* (Eastern Riverine) or river red gum, *E. camaldulensis* (Inland Riverine forest) defines these two types of Forested Wetland.

Scientists have not yet studied the role of fire in this vegetation type in any detail; however variable intervals between 7 and 35 years have been suggested.

Freshwater Wetlands

Two main types of Freshwater Wetlands are found in the Murrumbidgee catchment. Those along inland rivers in areas that are periodically or permanently flooded with fresh water and the Montane Lakes and Lagoons such as Lake George, found in the east of the catchment. In floodplain areas, forests of river red gums form a mosaic with lignum shrublands and reed-beds. In their natural state these wetlands usually have a dense groundcover of water loving sedges and herbs, and provide wonderful habitat for water birds.

Drought, river regulation and grazing have all impacted inland wetlands. Wet-dry cycles play a vital role in maintaining their diversity, and ensuring these continue is the major issue for their survival. Fire intervals of between 6 to 35 years have been suggested for Freshwater Wetlands and variable fire regimes may play a role in the recruitment of some shrubs in drier healthy wetlands. However, for most other wetland types, fires rarely occur, if at all, and have little ecological function. The use of fire therefore is not considered to be a practical management tool and should be avoided if possible. In some cases, these wetlands can occur on peat and peat fires can have a devastating effect on these systems and should be avoided. Freshwater Wetlands are areas of great environmental sensitivity, and need to be treated with care.

Saline Wetlands

There are small Inland Saline Lakes in the far west of the Murrumbidgee. These lakes contain many plant species such as the slender glasswort (*Sclerostegia tenuis*) that are sensitive to fire.

Saline Wetlands are not fire-prone communities and fire exclusion from this class of vegetation is recommended.

Saline Wetlands Inland Saline Lakes: classification from Benson, J.S., Allen, C., Togher, C. & Lemmon, J. (2006) New South Wales Vegetation Classification and Assessment: Part 1 Plant communities of the NSW Western Plains. Cunninghamia 9(3): 383-451. Photo ID018 Sclerostegia tenuis - Atriplex vesicaria chenopod shrubland near Nitchie Lake, [AGD66 33°27'27.6"S 141°49'45.0"E], 14/4/02, Jaime Plaza. From Benson, J.S. (2006) New South Wales Vegetation Classification and Assessment: Introduction - the classification, database, assessment of protected areas and threat status of plant communities. Cunninghamia 9(3): 331-382.

6 FIRE MANAGEMENT PLANNING

Introduction

If you live in a fire prone landscape, eliminating fire from your property is not a practical solution. Managing fire is an important part of living with fire, both to protect life and property and to respond to the needs of the bush.

Traditionally many landholders see their assets as being their house and property as well as the productivity of their land. In addition to this, a growing number of landholders consider the different plant and animal species on their property to be assets of real value. Aboriginal symbols of cultural importance are also considered to be assets.

If you consider native vegetation and wildlife as assets, effective planning will be essential to meeting the challenges associated with fire in the Murrumbidgee.

This planning needs to address two goals: (1) protection of life and property and (2) protection of environmental and cultural values.

Each goal requires its own particular management strategies which can be developed and implemented at the property level. However, in particular areas of your property, these two goals may come into conflict. In these instances, the relative advantages and disadvantages need to be weighed up and tradeoffs are often inevitable.

> “Hotspots is a way of returning the community back to the land, with a new range of training programs and education that can provide the community with the skills and knowledge to be in the drivers seat for managing their own land. They can now set their own direction.”
>
> – Claude McDermott, Aboriginal Heritage Officer, Office of Environment and Heritage.

Protecting *all* your assets

The *Rural Fires Act* (1997) recognises ecologically sustainable development and endorses the Bush Fire Risk Management Planning Process which is designed to protect life, property and the environment.

A zoning approach to fire management planning

The Bush Fire Risk Management Planning Process uses a zoning approach to fire management planning.

Asset Protection Zones are fuel reduced areas around assets or groups of assets which are adjacent to bush fire hazards. These areas contain highly modified vegetation to prevent fire from having a pathway to the assets. Asset Protection Zones provide a safe *defendable space* for fire fighters and home owners to use if there is a fire.

Strategic Fire Advantage Zones are strategic fuel reduced areas designed to slow a fire and reduce its intensity. These areas may need to be maintained using slashing or fuel reduction burning to provide strategically located fuel reduced areas to reduce vulnerability of assets. The NSW Rural Fire Service recommends reducing fuel in these zones by 50-80%.

Land Management Zones are areas that are managed to maintain or enhance land management objectives, including biodiversity. Fire history, vegetation type and fire frequency are important considerations in these areas. The NSW Rural Fire Service recommends burning in these zones to maintain a mosaic of areas with varying fuel loads.

Fire Exclusion Zones are areas where fire is actively excluded. These areas may include rainforest and other fire sensitive vegetation and some cultural or historic heritage sites and production areas.

When planning for a prescribed burn it is important to define your objectives. The fire frequency intervals in a Strategic Fire Advantage Zone (i.e. where your objective is to protect life and property) may be shorter than those needed to protect biodiversity.

Burning native vegetation on your property requires environmental assessment and consent. Landholders need to apply to the NSW Rural Fire Service (RFS) for a *Bush Fire Hazard Reduction Certificate* before planning and implementing a burn. Applications for a Bush Fire Hazard Reduction Certificate are assessed under the Bush Fire Environmental Assessment Code for NSW. In processing an application to carry out a burn in a Strategic Fire Advantage or Land Management Zone, the RFS will consider the vegetation type in which the burn is to be carried out, the fire history and the recommended fire frequency intervals for that vegetation type.

A range of RFS brochures and standards are available that provide detailed information about how to undertake a low intensity burn safely and how to maintain Asset Protection Zones. Most of these are available on the NSW RFS website, or from your local district office. For details on how to safely conduct a low intensity prescribed burn, refer to *Standards for Low Intensity Bush fire Hazard Reduction Burning*, and for details on how to maintain a suitable Asset Protection Zone, refer to *Standards for Asset Protection Zones*.

Some key messages in planning for biodiversity conservation

The relationship between fire and biodiversity is complex, and there is still much for scientists and fire managers to learn.

However fire management planning for biodiversity conservation need not be a complex or difficult process. You can take the information in this book away with you, think about it and decide for yourself how you might be able to apply it on your own property.

Based on existing knowledge, and on the information contained in this book, the following key messages provide simple guidelines for fire planning to protect biodiversity on your property.

When making decisions on issues such as fire frequency it helps to be very clear about what your land management objectives are in different areas of your property.

You should anticipate the need for flexibility with regards to your management actions. For many landholders, this forms part of an overall adaptive management approach to biodiversity on their property.

When your objective is biodiversity protection:

- Think about the key messages listed here; and
- Use the recommended fire frequency intervals for the different vegetation types on your property as a guide.

THE KEY MESSAGES

Simple principles for management

- Both too frequent and too infrequent fire can trigger negative impacts that throw systems 'out of balance' e.g. loss of species, weed invasion.
- Even within a single vegetation type, different species have different needs in relation to fire. To address this, vary fire frequency over time and space to allow for the full range of species.
- The bush at each stage of growth after fire looks different. Each stage provides different habitat, each has value.
- Don't burn entire vegetation types at once. Patchiness provides refuges for animals and a seed source for plants to recolonise burnt areas.
- Fires occur in a landscape context. It's useful to think about how the different vegetation types in a landscape are related in terms of fire.
- Coordinate fire activities with neighbours to provide a mosaic of vegetation in different stages of post-fire development, as different animals use different stages. Remember that fire management is a shared responsibility.
- When planning how often to burn, think about unplanned as well as planned fire. Unplanned fires may happen often enough to fulfil the needs of the bush.
- Understanding how fire behaves in different vegetation types, and the influence of weather and topography will help you to better prepare for fire.

"Before Hotspots we were an isolated community, we felt we had to fight fire by ourselves, we were alone. But since the training, we feel part of a larger community now that we manage for fire as a community."

– Hotspots workshop participant.

7 PREPARING A PROPERTY FIRE MANAGEMENT PLAN

The following steps can help you prepare a property fire management plan:

1. Identify your property and productivity assets and map them.

- Talk to the NSW Rural Fire Service about setting up and maintaining Asset Protection Zones and Strategic Fire Advantage Zones.

2. Identify and map the vegetation types in your Land Management Zones.

- Make a note of the fire frequency intervals recommended for the vegetation types on your property.
- How often have these vegetation types burned in the past? Note when and where fires have occurred.
- Are past fire regimes consistent with recommended regimes? Make a note of vegetation areas on your property that don't meet recommended fire regimes.
- Think about actions you could take to bring fire frequency into line with the recommendations.

3. Develop and maintain a mosaic of different stages of post-fire development.

- Do you have the resources to maintain parts of your property at different stages of development after fire?
- Could you work with your neighbours to make this happen?

4. Monitor and review.

- Keep a record of when fires occur and what areas they cover.
- Observe what happens to the vegetation, and to different species. Like all land management planning, fire planning is partly a matter of observation and responding to the needs of the land.
- Review your plan as you learn more.

8 Fire and Climate Change

It is now generally accepted that the world is undergoing a significant change in climate.

The impacts of climate change in Australia are not yet clear although an increase in extreme weather conditions including drought, storms, floods as well as changes in rainfall (increase or decrease in different places) are anticipated.

It is possible that the frequency and intensity of fire may increase as conditions for fire (such as hot, dry conditions) increase. By 2020 in south-east Australia, days of high or extreme fire danger are forecast to increase by 5 to 25 per cent if the effects of climate change are low and by 15 to 65 per cent if they are high[1].

Climate change in the Murrumbidgee

> "A warming of 1.5°C and a 8% decrease in rainfall (a moderate scenario for 2030) would make the climate of Wagga Wagga similar to the current climate of Forbes" [2]

Since 1950, the region has experienced warming of around 0.8°C. This is likely to be partly due to human activities. Rainfall has declined by around 20–30 mm per decade. The contribution of human activities to this rainfall decline is hard to distinguish from natural variability. The future climate of the Murrumbidgee Catchment is likely to be warmer and drier. Such trends would also increase evaporation, heatwaves, extreme winds and fire risk. Nevertheless, despite this trend toward drier conditions, there is also potential for increases in extreme rainfall events. These projections account for a broad range of assumptions about future global greenhouse gas emissions, as well as differences in how various climate models represent the climate system[2].

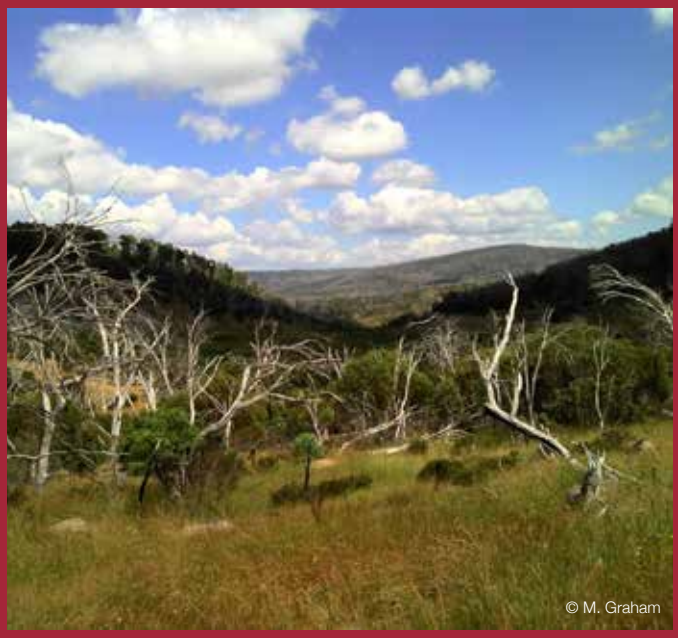
Climate change is likely to affect the amount of snow in the east of the Murrumbidgee Catchment and projections for the area experiencing 60 or more days of snow cover per year would decline by 18–60% by 2020, and 38–96% by 2050[3]. Such a scenario would have significant impacts on the native flora and fauna.

If warming occurs at the higher end of the predicted change, some alpine species are projected to completely disappear by 2070. For example, a modest level of warming may lead to the extinction of the mountain pygmy possum within 70 years as well as the extinction of 15–40 of the region's 200 alpine plant species[4].

The 2003 fires in the Australian Alps resulted in a significant reduction in forest cover across the headwaters of the Murrumbidgee River, in many of these areas forest cover has not re-established. The long-term trend of declining area and depth of snow cover across the Alps have resulted in a reduction in inflows into the Murrumbidgee River and caused a general drying trend across the catchment. Global warming is likely to have been a significant factor contributing to these changes.

However, it is not just climate change that will influence future fire regimes and subsequent fire management planning. Human development, settlement patterns, fragmentation and the landscape shifts will also play important roles.

> “Altered fire regimes are expected over the coming decades, and may be one of the major ecological challenges for Australia.” [5]



1. CSIRO (2007) report *Bushfire Weather in South-East Australia: Recent Trends and Projected Climate Change Impacts*.

2. CSIRO (2006) report *Climate Change in the Murrumbidgee Catchment*. Prepared for the New South Wales Government by the CSIRO.

3. Hennessy, K.J., Whetton, P.H., Bathols, J., Hutchinson, M. and Sharples, J. 2003. *The Impact of Climate Change on Snow Conditions in Australia*. CSIRO Atmospheric Research. Consultancy report for the Victorian Dept of Sustainability and Environment, NSW National Parks and Wildlife Service, Australian Greenhouse Office and the Australian Ski Areas Association, 47 pp.

4. Pickering, C.M., Good, R., and Green, K. 2004. *Potential Effects of Global Warming on the Biota of the Australian Alps*. A report for the Australia Greenhouse Office.

5. Morton SR, Hoegh-Guldberg O, Lindenmayer DB, Harriss Olson M, Hughes L, McCulloch MT, McIntyre S, Nix HA, Prober SM, Saunders DA, Anderson AN, Burgman MA, Lefroy EC, Lonsdale WM, Lowe I, McMichael AJ, Parslow JS, Steffen W, Williams JE & Woinarski JCZ (2009) *The big ecological questions inhibiting effective environmental management in Australia*. Austral Ecology 34: 1-9.

9 WORKING TOGETHER TO MANAGE FIRE ACROSS THE LANDSCAPE

Cooperation in the Murrumbidgee region

Fire management planning to protect life, property and the environment requires collaboration within communities, between agencies and across tenures.

In the Murrumbidgee, this is already happening. Fire management planning, using a risk management approach, is being undertaken across the wider landscape in national parks, state forests and on public lands.

By working together, individual landholders can be part of a much broader process of fire management, whilst being able to make independent choices about fire management on their own land.

This process has a number of individual and potentially far reaching benefits. Among other things, it encourages landholders to:

- Plan and talk together about assets and how best to protect them;
- Listen to others with knowledge and ask them challenging questions; and
- Protect all of the aspects of the landscape most valued by landholders.

© L. Andrews

Partners and collaborators

This booklet has been compiled for the Hotspots Fire Project, with input from and in consultation with a wide range of stakeholders. The information contained herein reflects our understanding at the time of publication. We are learning more about fire and the environment every day and anticipate that some recommendations may change as new information comes to hand.

This booklet was written by Nicole Conroy and Penny Watson, with assistance from Julie Hinchliffe, Christine Pfitzner, Mark Graham, Kate McShea, Waminda Parker, and Blessing Uwagboe for the Hotspots Fire Project.

The Hotspots Fire Project is jointly managed by the Nature Conservation Council of NSW and the NSW Rural Fire Service.

For further information on the Hotspots Fire Project contact:

The NSW Rural Fire Service
(02) 8741 5555
Email: hotspots@rfs.nsw.gov.au

The Nature Conservation Council of NSW
(02) 9516 0359 or
Email: info@hotspotsfireproject.org.au

Thank you to Dr. John Benson (Royal Botanic Gardens), Greg Gowing (the Australian Museum) and Kenneth Green for providing photographs to the booklet.

Thank you to our project partners for their technical input, photographs and continuing support to the project:

The NSW Office of Environment and Heritage, NSW Catchment Management Authorities, NSW Farmers, The Southeast Queensland Fire and Biodiversity Consortium, Forestry Corporation of NSW, Local Government NSW, National Parks and Wildlife Service, and the University of Wollongong's Centre for Environmental Risk Management of Bushfires.

The following agencies have useful websites and may be of assistance:

Hotspots Fire Project
www.hotspotsfireproject.org.au

NSW Rural Fire Service
www.rfs.nsw.gov.au

Murrumbidgee Catchment Management Authority
www.murrumbidgee.cma.nsw.gov.au

Nature Conservation Council of NSW Bushfire Program
www.nccnsw.org.au/bushfires

Forestry Corporation of NSW
http://www.forestrycorporation.com.au

NSW National Parks & Wildlife Service
www.nationalparks.nsw.gov.au

Southeast Queensland Fire and Biodiversity Consortium
www.fireandbiodiversity.org.au

NSW State Emergency Services
www.ses.nsw.gov.au

HOTSPOTS FIRE PROJECT

© L. Andrews

NSW Rural Fire Service

Nature Conservation Council of NSW