Department of
Sustainability and
Environment

About fire ecology

an overview

State Government
Victoria

Healthy Parks Healthy People

Further information: DSE Customer Service 136 186

Published by the Victorian Government Department of Sustainability and Environment
Melbourne, January 2011

Authorised by the Victorian Government, 8 Nicholson Street, East Melbourne.

Printed by Stream Solutions

ISBN 978-1-74242-931-1 (print)
ISBN 978-1-74242-932-8 (online)

Accessibility

If you would like to receive this publication in an accessible format, such as large print or audio, please telephone 136 186, 1800 122 969 (TTY), or email customer.service@dse.vic.gov.au

This document is also available in PDF format on the internet at www.dse.vic.gov.au/fireecology

COVER PHOTO: RESPROUTING EUCALYPT, WALHALLA, STEPHEN PLATT

This booklet explains:

- How fire shapes Victoria's natural environment
- How patterns of fire (fire regimes) influence plants and animals
- How Victoria's fire program plans to achieve ecologically appropriate fire regimes on public land

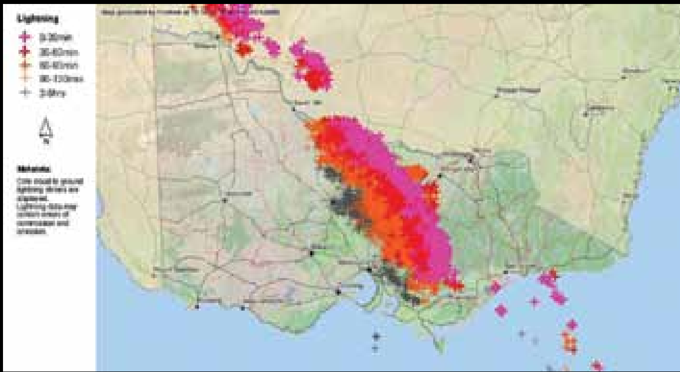
Part 1:
How fire shapes Victoria's natural environment

PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

PHOTO: DON PRATT

Victoria's wet winters, which promote plant growth, and hot dry summers **create the ideal conditions for bushfire**.

Fire is a **natural** part of the Australian environment and has been so for **thousands of years.**



Radar captures lightning strikes in real time during a storm front.

SOURCE: TODD GRETTON

PHOTO COURTESY OF CHRIS ARNDT

Natural fires are ignited by lightning.

Between 1979 and 1998 (20 yrs), 3314 fires were caused by lightning, an average of 166/yr.

Immediately after a fire, it may seem like the environment has been destroyed or devastated.

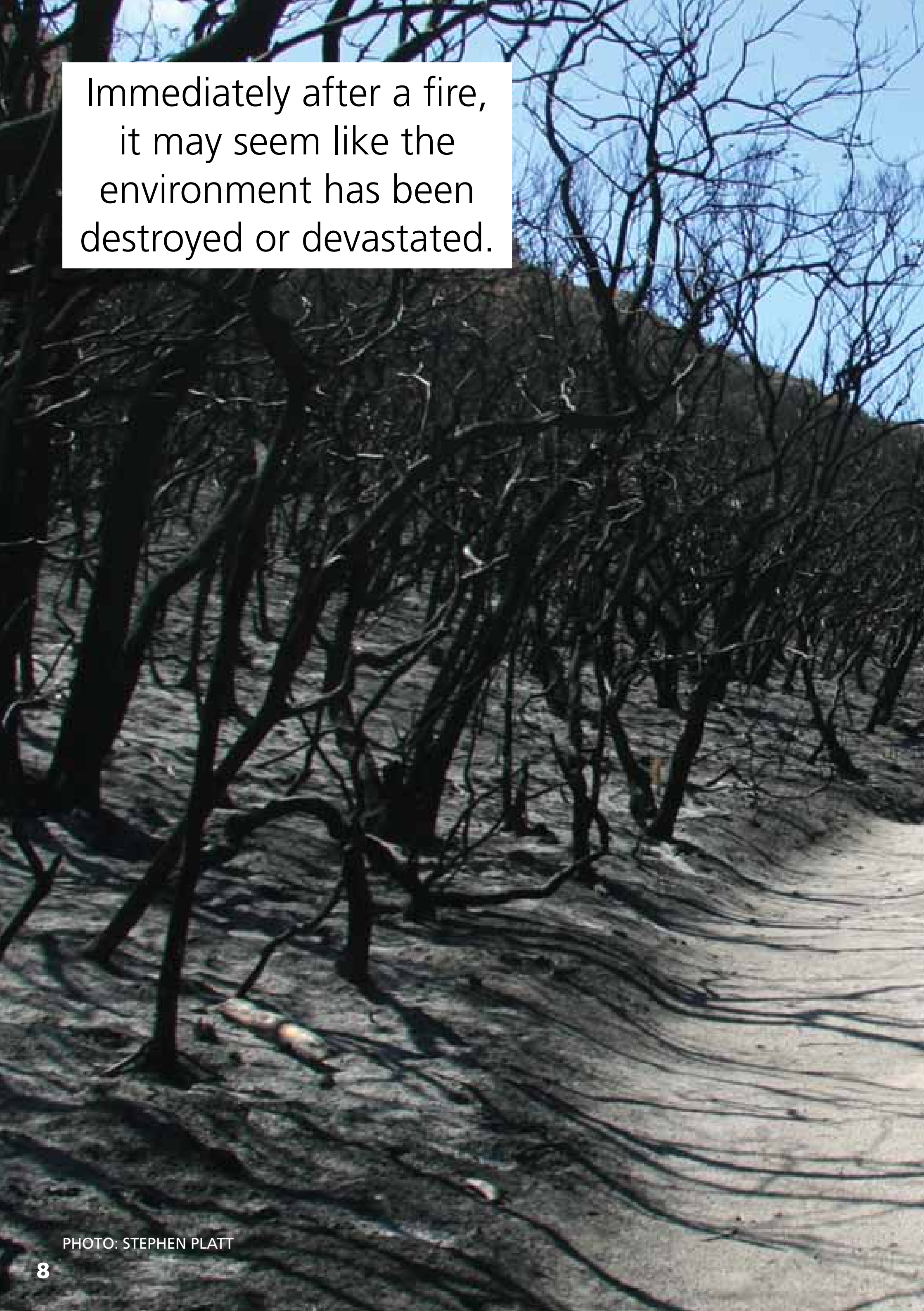


PHOTO: STEPHEN PLATT

Wilsons Promontory National Park, **March 2009**

But most plant and animal populations will survive a fire event.

Fire is necessary for the health of many ecosystems.

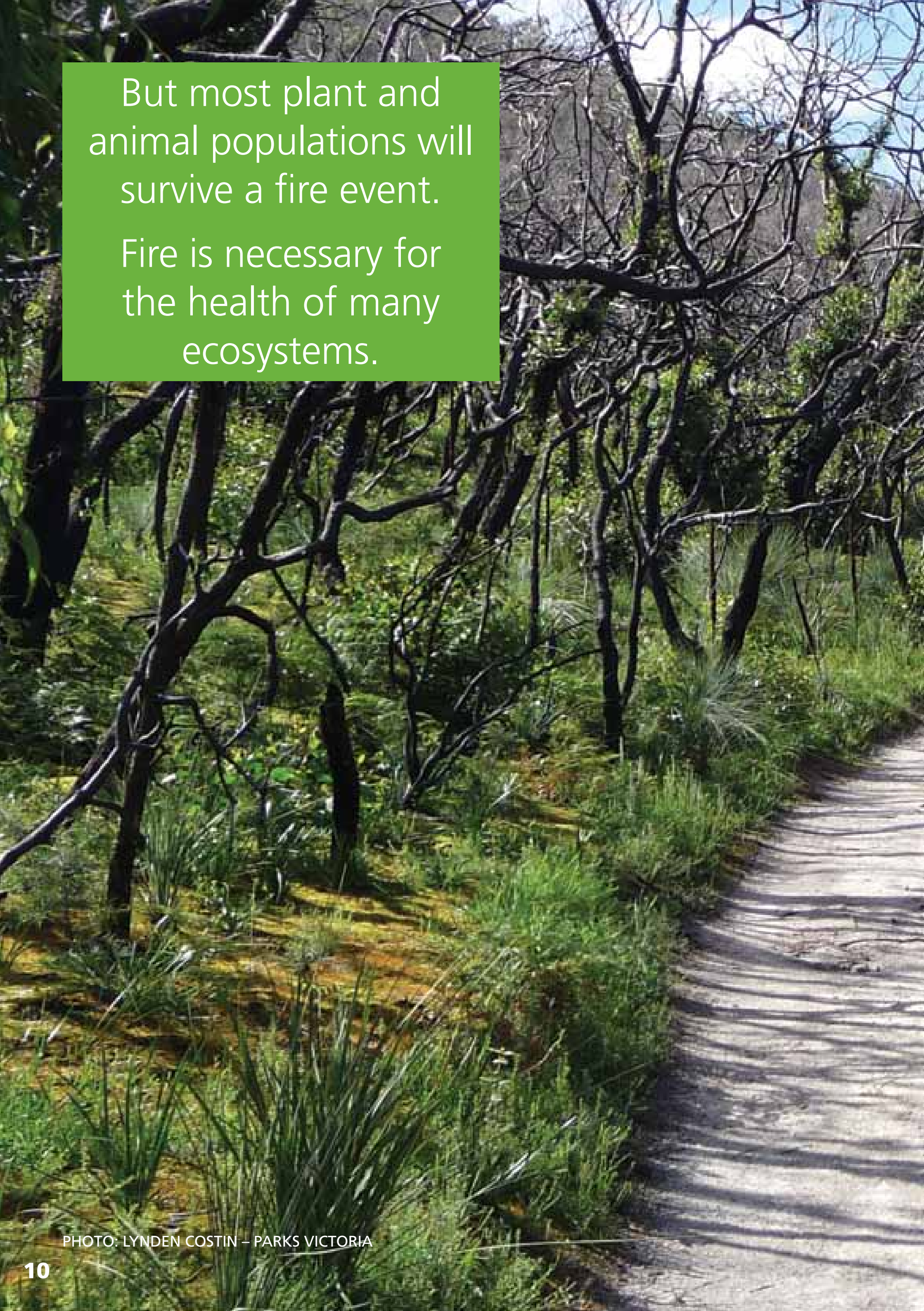


PHOTO: LYNDEN COSTIN – PARKS VICTORIA

Wilsons Promontory National Park,
March 2010 (12 months later)

Over many centuries, plants and animals have evolved ways to survive fire.

PHOTO: STEPHEN SMITH AND ROWHAN MARSHALL

This Swamp Wallaby has survived the 2009 fires in the Big River catchment.

Different plant species have different methods of regenerating after fire

Seeders

Flowering plants produce seed, which may be protected from fire in woody fruits (e.g. eucalypts, hakeas), by thick seed coats (e.g. wattles) or survive fire underground. The release of seed is stimulated by the heat of a fire and germination can be stimulated by smoke.

Some species such as the Ash eucalypts ONLY reproduce by seed. They are most at risk from frequent fire. These species are known as obligate re-seeders.

Banksia cone after seed release'

PHOTO: STEPHEN SMITH

Mountain Ash seedlings

PHOTO: OWEN GOODING

PHOTO: STEPHEN PLATT

Re-sprouters

Some species regenerate from below-ground parts of plants that are protected from fire by soil and remain alive.

Bark can also protect the living inner stems of plants. Following fire the plant shoots from buds under bark, or beneath soil.

Resprouting is a very common method of survival in native plants.

PHOTO: GORDON FRIEND

PHOTO: OWEN GOODING

Many species use a combination of methods.

Non-flowering species

Non-flowering species, such as fungi, survive fire vegetatively, using spores etc.

PHOTO: STEPHEN PLATT

The timing and process of recovery and site conditions


PHOTO: MARIA GIBSON

Mt. Bishop, Wilsons Promontory April 2005


PHOTO: MARIA GIBSON

Mt. Bishop, Wilsons Promontory September 2005

Mosses are the first to appear in this tea tree (*Leptospermum*) thicket.

depends on the vegetation type

PHOTO: THOMAS CHAMBERS

Jehosophat Creek September 2009 (February 2009 fire)

PHOTO: THOMAS CHAMBERS

Jehosophat Creek June 2010

Regeneration in fertile, wet gullies can be quicker than on infertile, dry ridgetops.

Different animal species have different methods of surviving fire

Invertebrates

Survive in water bodies, under damp leaf litter, underground or by flying away.

Scorpion
(Urodacus armatus)

PHOTO: MALLEE FIRE AND BIODIVERSITY PROJECT

Fish

Survive in water bodies and in mud.

Murray Cod

PHOTO: GÜNTHER SCHMIDA

Amphibians

Survive in burrows, under damp leaf litter and underground.

Mallee Spadefoot Toad

PHOTO: NICK CLEMANN

Reptiles

Survive in burrows, rock shelters, under bark, in unburnt hollows.

Gecko in Grasstree foliage

PHOTO: RICHARD LOVETT

Birds

Survive by fleeing the fire, and in unburnt patches.

Superb Fairy-wren

PHOTO: DSE/McCANN COLLECTION

Mammals

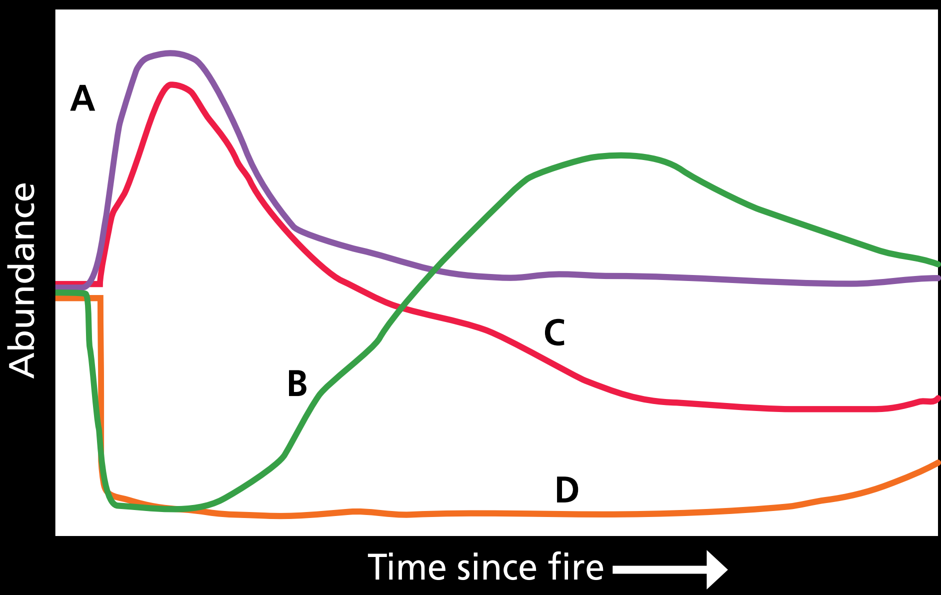
Survive in unburnt patches, underground burrows, under rocks and other shelters and by fleeing.

Common Ringtail Possum

PHOTO: RICK TINKER

Wildlife species return to burnt areas at different rates and times

This will depend on the availability of habitat requirements (e.g. food, shelter, breeding) and is not specifically linked to 'time since fire'.



Changes in vegetation density and structure with time

A – some species quickly benefit such as New Holland Mouse and Scarlet Robin.

B – some species show an initial decline then increase to levels above or below pre-fire abundance such as Southern Brown Bandicoot and Golden Whistler.

C – some show a long term decline after fire such as Spotted Quail Thrush and Red-necked Wallaby.

D – some decline immediately post fire and do not recover for very long periods such as Greater Glider and Red-browed Treecreeper.

McHunter *et al*. 2009

Growth stages of vegetation provide a range of habitats that suit different species at different times

Swamp Scrub

Nine months

Broombush Whipstick

Immediately post fire

PHOTOS: DAVID CHEAL

After a major disturbance such as intense fire, a sequence of growth stages of vegetation can be recognised. These provide habitats that suit different plant and animal species at different times (e.g. old growth may contain hollows used by wildlife).

Three years

Long unburnt (56 years)

17 Years

Long unburnt

Foliage changes colour seasonally.

Over time, different fauna habitat elements appear, or disappear, that meet the foraging, shelter, dispersal and reproduction needs of fauna

Hollows form in older vegetation and provide habitat to animals.

Leaf litter provides cover for young birds.

Coarse woody debris provides basking sites and shelter for reptiles.

PHOTOS: STEPHEN PLATT

Long unburnt growth stages are difficult to recreate but important for some species

Fire may play a role in both the loss and protection of old growth areas.

Tea Tree Fingers (*Hypocreopsis amplectans)* is a rare fungus that appears to be restricted to long unburnt patches of Tea Tree *Leptospermum* spp. (Nyora).

PHOTO: TOM MAY

Fire can place some species and ecosystems at risk

PHOTO: STEPHEN SMITH

Species that are **threatened prior to the fire**, such as Leadbeater's Possum.

Species that are more **vulnerable to predation after fire**, such a many small ground-dwelling mammals. Also, species affected by weed invasion or herbivore browsing.

PHOTO: STEPHEN PLATT

Ecosystems that are **fire sensitive** such as rainforests.

PHOTO: STEPHEN PLATT

Aquatic species that are **unable to avoid the direct and indirect impacts of fire**, such as sediment produced by erosion.

PHOTO: JUSTIN O'CONNOR

Lack of fire has consequences for species and ecosystems

As species are adapted to a particular fire regime, a lack of fire can change the species mix at a site.

Reduced fire in some vegetation types can lead to invasion by native species, e.g. Coast Wattle and Sweet Pittosporum.

This in turn can change the fire risk of an area.

Sweet Pittosporum invading long unburnt native vegetation.

PHOTO: GARY SUMMERS

Part 2:
How patterns of fire (fire regimes) influence plants and animals

PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

Fire regimes are made up of:

- fire **frequency** (interval between successive fires)
- fire **intensity** (how hot)
- fire **season** (time of year)
- fire **extent** (area affected)

At any one place in the landscape there is a different combination of these factors.

Appropriate fire regimes help maintain species and ecosystems at a location

Fire regimes influence what vegetation and wildlife can live in Victoria. Individual fire events are less influential.

It is the cumulative effect of different types of fires (i.e. fire regimes) over time that can create long term change.

Too much or **too little** fire can harm native plants and animal populations and over time alter the species mix at a site.

PHOTO: OWEN GOODING

Fire frequency

Different species prefer different intervals between fires

Some species are more sensitive to short or long intervals between fire than others. The most sensitive are called Key Fire Response Species because they indicate the limits of tolerance to fire.

Frequent repetition of fires can deplete nutrient reserves, cause erosion and otherwise alter the environment that species rely upon.

Basalt Grasslands require fire every 2–7 years.

PHOTO: STEPHEN PLATT

Heathy Dry Forests require fire every 15–45 years.

PHOTO: DAN BROWN

Closed Forests require 80 years minimum between fires.

PHOTO: DAN BROWN

Fire frequency case study

In the Mallee, *Callitris verrucosa* is a long-lived plant that is killed by, and regrows from seed, after severe fire.

Thus, the oldest *C. verrucosa* at a site indicates that there hasn't been a severe fire there for at least the age of the tree.

The age of *C. verrusoca* can be estimated by looking at the tree rings in its trunk.

This information is being used to estimate the time since the last severe fire in areas without other records.

Mallee Dendrochronology Study, DSE.


PHOTO: *CALLITRIS VERRUCOSA* IN THE MALLEE, HEIDI ZIMMER

Fire intensity

Intense fires increase the risk to species and ecosystems

The intensity of a fire affects which plants and animals survive and the resulting species mix that returns.

Fire intensity relates to the rate that energy is released by fuel (vegetation).

Underground parts of plants remain alive, as heat from fire does not penetrate far into the soil.

This intense fire has consumed nearly all above-ground vegetation. Brightly coloured leaf shoots indicate life persists in tree trunks

PHOTO: STEPHEN PLATT

Severe fire intensity case study

In 2009, bushfires burnt large areas of tall wet forest south of Marysville. Here, Mountain Ash (*Eucalyptus regnans)* trees have been killed by the severe fire intensity – indicated by canopy leaf loss and lack of leaf shoots. They will regenerate from seed.

Among the dead Ash are live specimens of Shining Gum (*E. nitens)*. They have survived the same fire intensities and will live on as mature individuals.

If another intense fire occurs before the Mountain Ash seedlings mature to produce seed, Shining Gum may become more prolific as the living adult plants will drop seed onto uncontested soil.

PHOTO: STEPHEN PLATT

Fire season

Species' life cycles are adapted to seasonal changes such as changing temperature, water and food availability.

As natural fires occur in the warmer months, species are more likely to have adapted to survive fire during this period.

Fires outside this period can pose a higher risk to plants and animals.

Fire planning considers species that may be at risk due to seasonal factors

Birds can be **vulnerable in spring** when nesting occurs. However, wet conditions in this season can provide natural protection.

Grey Fantail

PHOTO: IAN McCANN/DSE

Plants can be **vulnerable prior to seed** maturity, especially if that is the main method of reproduction.

Silver Wattle

PHOTO: STEPHEN PLATT

Invertebrate pollinators can be **vulnerable in some life stages**.

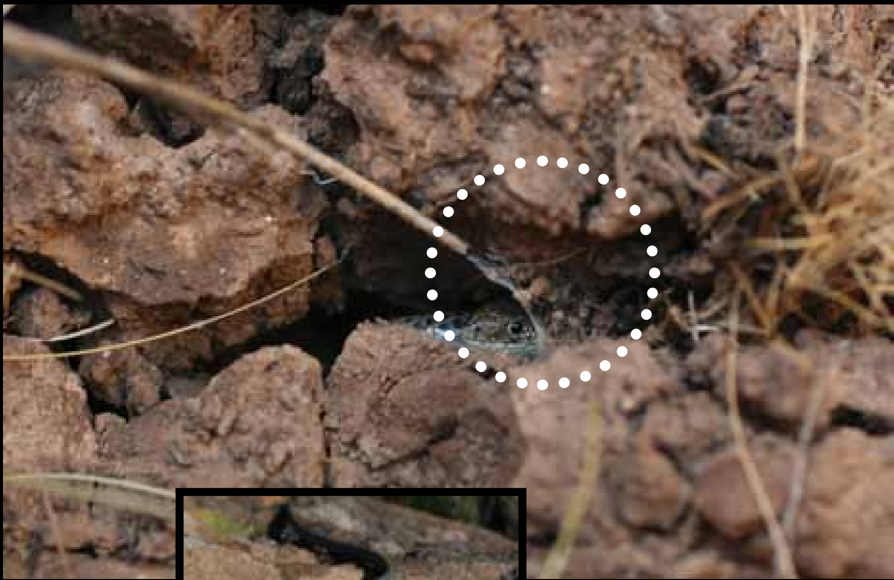
Macleay's Swallowtail

PHOTO: STEPHEN PLATT


PHOTO: DAVID HUNTER

The endangered alpine Corroboree Frog *Pseudophryne corroboree* – is **vulnerable to fire in autumn**.

Any planned burns should avoid the autumn months. They should not occur within 300m of frog breeding sites as frogs move into surrounding vegetation during these months.



PHOTOS: MELISSA DOHERTY

Striped Legless Lizards are vulnerable in the winter and autumn. They escape summer fire by slithering into soil cracks. If fire occurs when these cracks are not available (i.e. during wetter periods), the lizards have fewer places to hide and are much more likely to die.

Fire extent

Large uniform fires generally have greater impacts on plant and animal species than smaller patchy fires. This is because habitat resources are affected across wide areas.

PHOTO: OWEN GOODING


PHOTO: OWEN GOODING

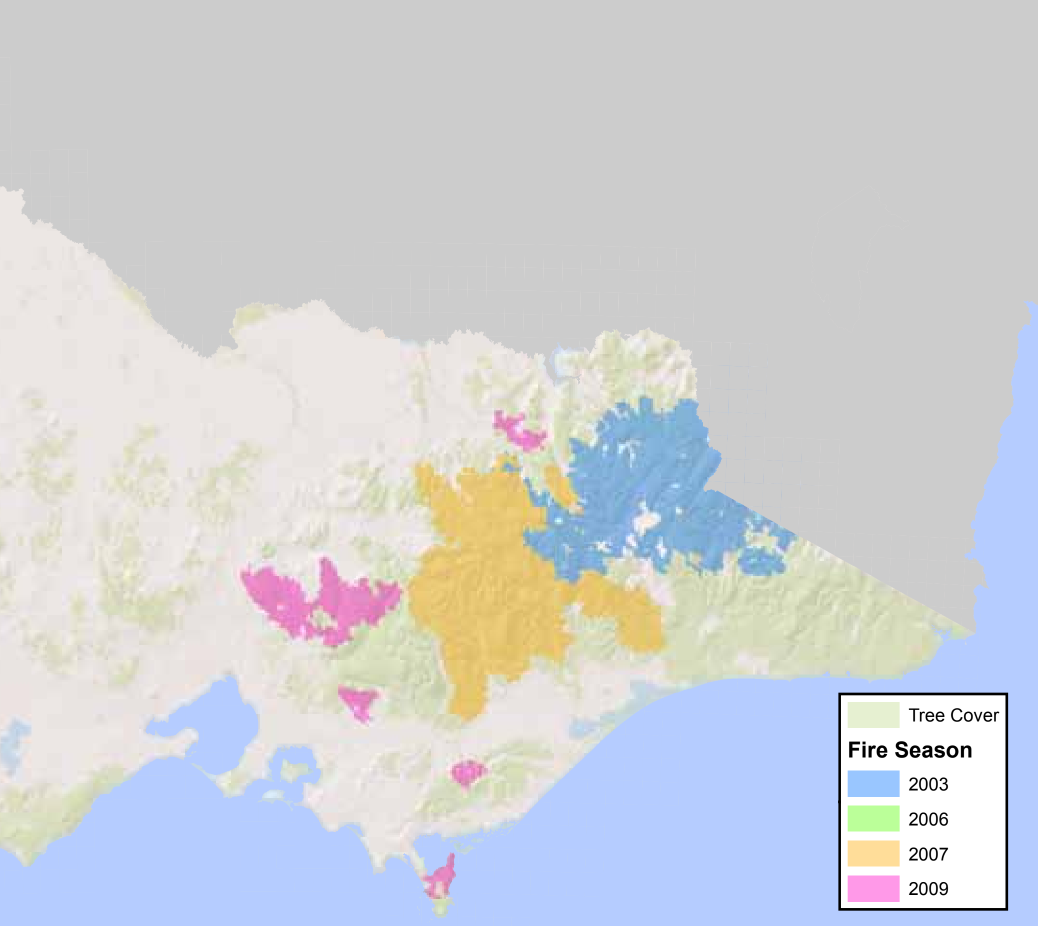
Fire extent case study

In recent times, large fires have affected much of Victoria's landscape.

- 2003 – Alpine fires burnt 1.0 million hectares.
- 2007 – Great Divide fires burnt 1.1 million hectares.
- 2009 – 'Black Saturday' fires burnt 430 000 hectares.

Large scale fires tend to occur during periods of drought.

ire Areas (>20,000ha) Since 2003



Fire mosaics

The ‘fire mosaic’ is the pattern that successive fires make across the landscape over time.

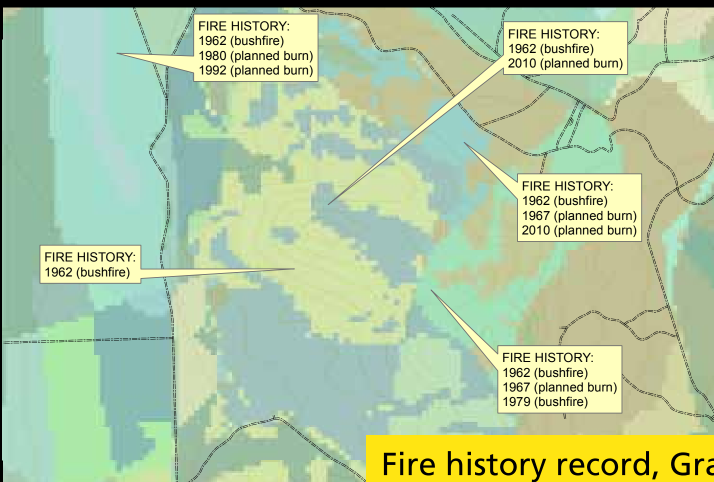
The patchiness of each individual fire and the varying intensity of fire across the landscape contribute to the pattern.

Though largely hidden from view, the mosaic’s long-term influence on the vegetation and fauna of an area can be profound.

PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

Grampians National Park, 2010.

This individual fire has produced a patchy burn of burnt (brown colours) and unburnt (green colours) vegetation of various extent. The unburnt patches may act as refuges for fauna species.



SOURCE: FireHAT ANALYSIS TOOL, ANDREW BLACKETT

Fire history record, Grampians National Park, 2010.

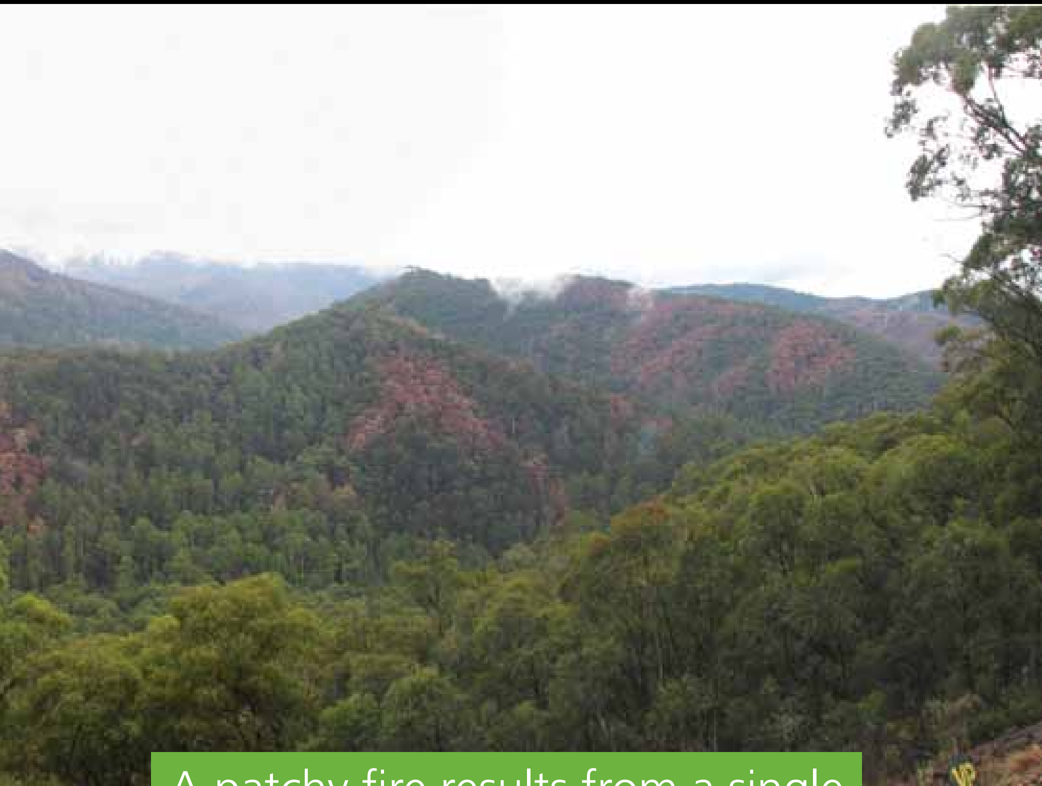
The underlying pattern of fires is partially revealed by fire history mapping which shows repeated burns in some sites.

Patchy fires

PHOTO: DAVID CHEAL

Patchiness is particularly important for species that cannot flee quickly e.g. Koala.

PHOTO: DSE



A patchy fire results from a single fire event where areas remain unburnt. This means that habitat is continuously available within the local area and that wildlife **populations** can persist, though some **individuals** may have died in the fire.

Fire type

Different types of fire occur in different environments

Peat fires (ground fires) permanently remove peat habitat that have taken decades to accumulate.

Surface fires leave the canopy unburnt and so some food and shelter may remain for some species.

PHOTO: NICK CLEMANN

The interplay between fire frequency, intensity, season and extent creates the risk for species

Frequent fires of high intensity at the wrong season and of large extent have a higher risk. The reverse is true for lower risk.

It’s not all about fire regimes

PHOTO: NICK CLEMANN

The combination of fire intensity, frequency, season and extent, plus time, are important factors that influence the vegetation and wildlife at a location.

There are many other factors including climate, soils, geology and topography, disease, human impact, historical legacy, introduced species and chance.

Land managers develop plans that account for all the factors affecting the values they aim to protect.

South West Fire Project case study

Studies to date have revealed:

- Abundance and composition of animal communities did not change predictably with time after a fire.
- Small mammals, such as the Silky Mouse and Heath Rat, responded more strongly to the availability of shelter and food resources than fire.
- Most ant species appeared to be resilient to fire, however multiple fires over a short period had a negative impact.
- Browsing animals (e.g. kangaroos, wallabies) preferred to graze around the edges of freshly burnt areas, potentially having a negative impact on recovery after small burns.

This indicates the complex relationship between fire regime, habitat and species.

http://www.forestscience.unimelb.edu.au/research/bushfire/index.html

FOREST AND FIRE ECOLOGY RESEARCH GROUP, DEPARTMENT OF FOREST AND ECOSYSTEM SCIENCE, UNIVERSITY OF MELBOURNE.

THE UNIVERSITY OF MELBOURNE

POST FIRE ENCLOSURE MONITORING PLOT. PHOTO: FIONA CHRISTIE

Part 3:
How Victoria's fire program plans to achieve ecologically appropriate fire regimes

PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

Fire planning integrates human and environmental protection

Fire planning aims to achieve **multiple aims**: protecting human life and property and sustainably managing the environment.

Fire ecology assessments are one of numerous inputs to fire planning.

The following pages consider how fire ecology assessments **inform** ecologically appropriate fire regimes.

Planned burning generally results in low intensity fires

Bushfires vary in their intensity depending on the prevailing conditions.

Low intensity fires are less likely to burn all the vegetation in an area and less likely to kill vulnerable species.

PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

The fire regime appropriate to a species is reflected in its life history

By understanding species' life histories we can plan for appropriate fire regimes for an area. If we protect the most sensitive species, it is assumed that other species will also persist.

A knowledge of indigenous people's burning practices is valuable but not a prerequisite.

Fire suppression reduces the effect of bushfires **in maintaining ecosystems**. Planned burning can replace this by adding fire.

There will **always be some uncertainty** in the amount of fire that should be applied to the landscape through planned burning due to the unpredictable nature of bushfires and limited extent of our knowledge of ecosystems.

PHOTO: IAN TEMBY

In rural landscapes, habitat fragmentation adds another level of complexity to determining the appropriate fire regime.

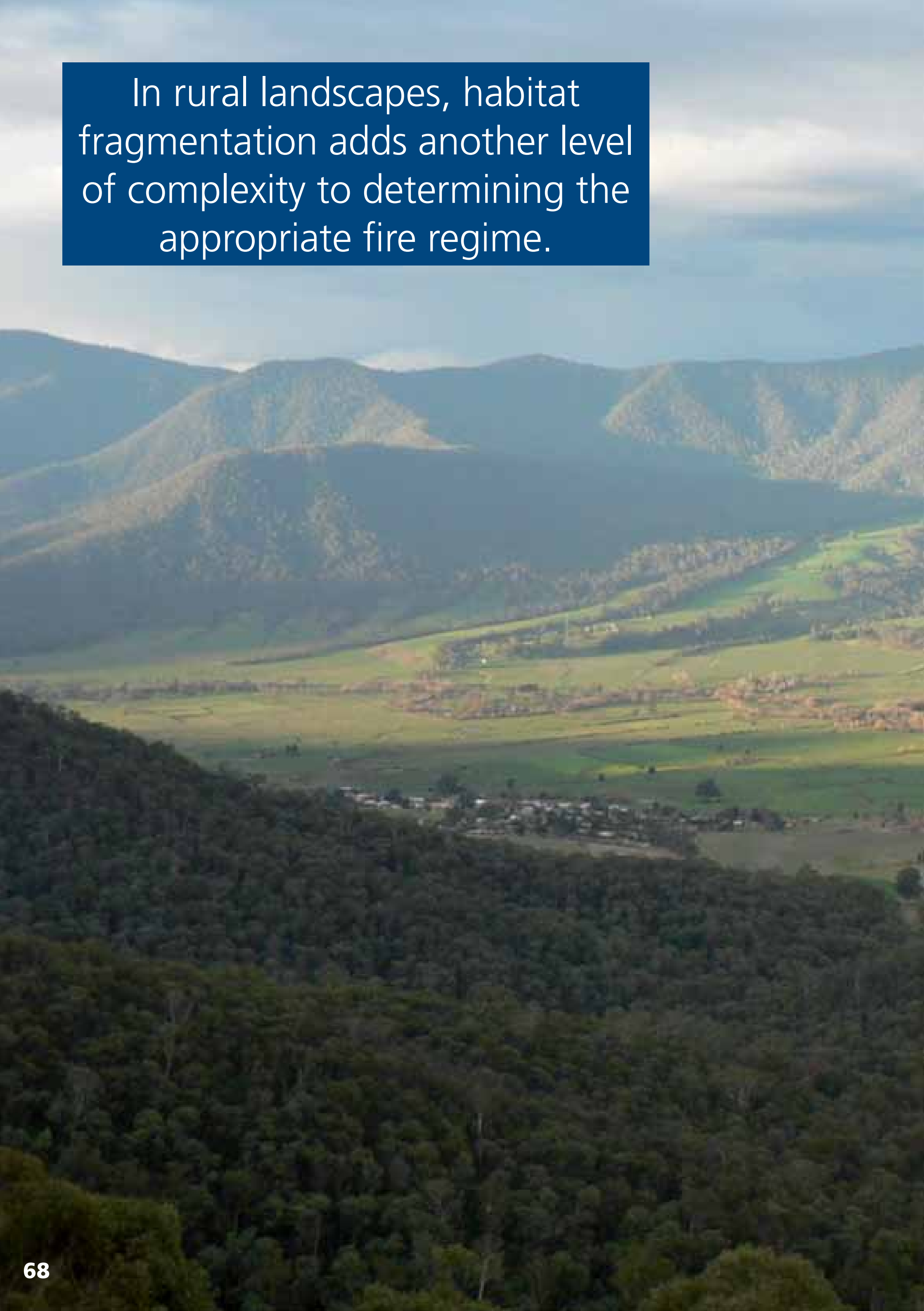
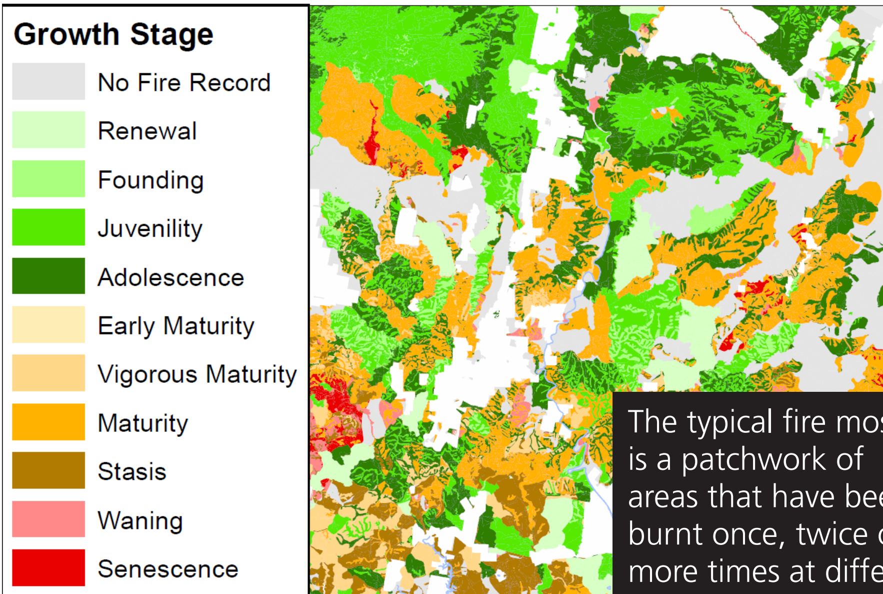



PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

Planning for ecologically appropriate fire regimes starts at the landscape level

The primary goal is to retain a **mosaic of growth stages** of vegetation, **across the landscape**, in a **suitable spatial arrangement** that meets species' needs. This appropriate mix of growth stages need **to be maintained over time**. In addition, specific measures need to be in place to protect some 'at risk' species and ecosystems. Fire is not appropriate in some areas.



The typical fire mosaic is a patchwork of areas that have been burnt once, twice or more times at different intensities and seasons.

SOURCE: FireHAT ANALYSIS TOOL, ANDREW BLACKETT

Life history characteristics indicate how species survive fire

A species' biology reflects the environment in which it lives.

Characteristics of species that relate to fire (vital attributes) can be used to assess the likely fire regime at a location.

In particular, they can be used to determine the minimum and maximum interval between fires that is tolerable.

Desert Banksia (*Banksia ornata*) takes eight years to produce enough seed to reproduce. It lives for 50–60 years and seed is not stored in the soil. Thus, for this species to survive and flourish the minimum time between fires should be no less than eight years and the maximum no more than 60 years.

If all species in the vegetation are assessed then the most sensitive species to fire can be used to set the minimum and maximum fire interval.

A database of species vital attributes has been developed by DSE.

PHOTO: MIKE WOUTERS

Key Fire Response Species have been determined for all major vegetation groups in Victoria

Key Fire Response Species are those species that are most sensitive to the effect of fire. They can be used to set the required maximum and minimum interval between fire for different vegetation groups.

These species have been identified using the life history characteristics of plants and animals.

Examples of Key Fire Response Species:

Sticky Boronia *(Boronia anemonifolia)*

Silver Banksia *(Banksia marginata)*

Sweet Wattle *(Acacia suaveolens)*

PHOTOS: DAVID CHEAL

Animals as Key Fire Response Species

Animals can also be used as Key Fire Response Species. These are species whose habitat requirements can be clearly or logically linked to habitat changes associated with vegetation succession after fire and species that use the area for breeding.

For example, the near threatened Silky Mouse (*Pseudomys apodemoides*) lives in diverse dry heathland and Brown Stringybark vegetation in north west Victoria. It requires a diverse shrub cover that provides a year round food supply. This typically occurs between three and ten years after fire.

PHOTO: IAN McCANN/DSE

The Mallee Fire and Biodiversity Research Project case study

The Mallee Fire and Biodiversity research project found that animals differ in their sensitivity to fire due to both the frequency and scale of the fire.

A collaborative project by:

www.latrobe.edu.au/zoology/research/mallee-fire/index.html


PHOTO: PINK-NOSED WORM LIZARD, LISA SPENCE-BAILEY

Some mallee animals are resilient to fire, e.g. scorpions, lizards, termites.

Some mallee animals are profoundly affected by fire for decades, e.g. Black-eared Miner, Mallee Ningaui.


PHOTO: MALLEE NINGAUI, LAUREN BROWN

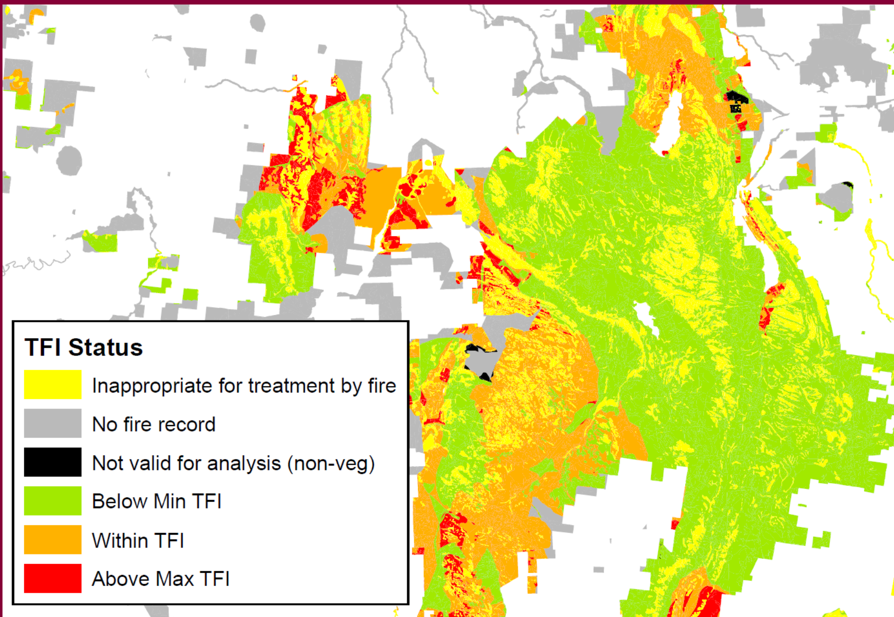
Tolerable Fire Intervals are used as a broad guide to identify how often to burn

The Tolerable Fire Interval (TFI) is the time after the species reaches reproductive maturity and before the time of senescence (old age) when reproduction stops.

The **minimum TFI** for an ecosystem is set by the slowest plants to reach reproductive age and produce seed.

The **maximum TFI** is set by the earliest time when plants start to senesce (pass reproductive age including seed store).

If the objective is to maintain the vegetation type, then burning within these limits is unlikely to have long term effects on the range of plant species present.



SOURCE: ANDREW BLACKETT

Fire history and Tolerable Fire Intervals of the vegetation allow areas above and below minimum and maximum TFI to be mapped.

Extra care needs to be taken if burning below the TFI for a vegetation type

While maps may indicate an area is below its tolerable fire interval, the actual situation can be more complex as fire rarely burns evenly.

When fire is thought appropriate for such areas, then extra care needs to be taken to ensure all species will survive over time.

This grass tree was burnt during a planned burn and then again in the February 2009 bushfires. It subsequently died. The flower spike followed the earlier burn and was charred by the latter one (Mt Everard, 2009).

PHOTO: STEPHEN PLATT

In some instances, fire may be used to protect species and ecosystems that are sensitive to fire

Planned burning can be used to create a mosaic of burnt areas that limit the spread of fires and prevent fires of high intensity over extensive areas.

Burns can also be planned to reduce the likelihood of an unplanned fire burning a sensitive area.

The objectives for land management are set out in a Fire Management Plan.

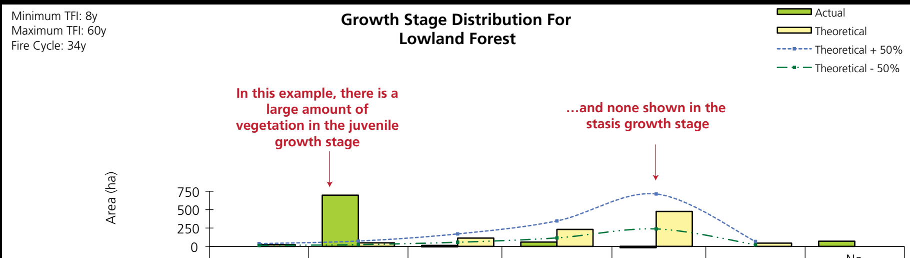
PHOTO: JULIA STANLEY

Analysis of growth stages indicates how much of each vegetation type is in each growth stage in an area

Fire history and vegetation mapping is combined to show how much of each vegetation type is in each growth stage at the current time.

Growth stages within the Tolerable Fire Interval that are 'over represented' can be considered as potentially available to burn.

The aim is to maintain a continuous supply of growth stages over time.



	Renewal (0–1y)	Juvenile (1–3y)	Adolescence (3–8y)	Vigorous Maturity (8–20y)	Stasis (20–60y)	Waning (60+y)	No Disturbance History
Actual	0.00	696.68	13.27	59.20	1.43	0.00	70.61
Theoretical	24.98	48.53	113.40	231.17	475.81	44.69	
Theoretical + 50%	37.47	72.80	170.09	346.76	713.72	67.04	
Theoretical - 50%	12.49	24.27	56.70	115.59	237.91	22.35	

Growth Stage

In this example, much of the vegetation is in early growth stages. Leaving areas unburnt will allow for older growth stages to be represented.

A challenge is how to 'optimize' growth stages for the long-term benefit of species

The amount of different growth stages, their arrangement across the landscape and over time will benefit different species.

Land managers aim to create an optimum mix that meets management objectives.

PHOTO: GROWTH STAGES IN MALLEE, KATHRYN SCHNEIDER

Other issues need to be considered

- The need to protect life and property
- Legislative and policy requirements (e.g. Old growth policy)
- The fire management zone that the proposed burn is located in
- Specific requirements of threatened flora and fauna species
- Other stressors such as drought that might make species more sensitive to further disturbance
- Interactions with invasive species (e.g. weeds, foxes) and other disturbances (e.g. timber harvesting)
- Activities that could be affected by fire (e.g. research sites)
- Water production in catchments

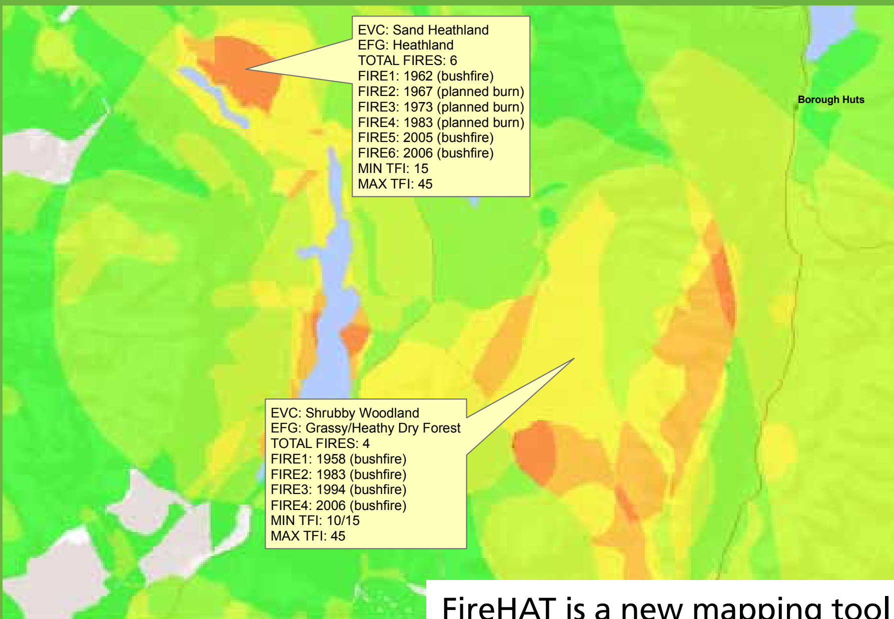
Planned burns are applied to achieve protection and ecological outcomes

Once assessed, an area to be burnt may be nominated to be part of the three year Fire Operations Plan. These proposed burn plans are made available by DSE for public comment prior to burns occurring.

PHOTO: DEPARTMENT OF SUSTAINABILITY AND ENVIRONMENT

Monitoring fire effects helps inform the ongoing fire program

To ensure fire regimes are not having negative effects on the environment, a range of monitoring systems are in place and will be further developed.



FireHAT is a new mapping tool that helps analyse fire history across the landscape. It can assist with selecting monitoring sites that aim to understand the effects of particular fire regimes.

The Fire Ecology Program will continue to evolve…

There are knowledge gaps in our understanding of how fire interacts with the environment and how to apply this understanding to create ecologically appropriate fire regimes. The Fire Ecology Program aims to address these gaps through ongoing research, monitoring and policy application.

Summary

Fire is a natural part of the environment and important for ecosystem health.

Fire regimes influence what species can live in an area.

Too much or too little fire can be detrimental to plants and animals.

DSE and its partners are continuously improving methods to achieve ecologically appropriate fire regimes as part of an integrated approach to fire management.

Selected references

Living with Fire – Victoria's Bushfire Strategy, Victorian Government (2008).

Fire Ecology Program Strategic Directions 2009–11 (DSE 2009).

Guidelines and Procedures for Ecological Burning on Public Land in Victoria 2004 (DSE 2004).

Towards a Process for Integrating Vertebrate Fauna into Fire Management Planning (2009), J. MacHunter, P. Menkhorst and R. Loyn, DSE – ARIER Technical Report Series No. 192.

Flora Monitoring Protocols for Planned Burning: a rationale report, DSE 2008.

Growth Stages and Tolerable Fire Intervals for Victoria's Native Vegetation Datasets (2010) D. Cheal, DSE.

Analysis of Fire Causes on or Threatening Public Land in Victoria 1978/79–1997/98, NRE (1999).

To learn more:

www.dse.vic.gov.au/fireecology

DSE Customer Service Centre 136 186