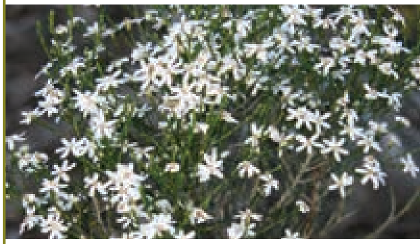
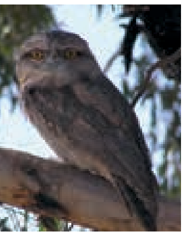
Planned burning in Box-Ironbark forests

Investigating the ecological outcomes

Planned burning is commonly used to reduce the likelihood of wildfire. In box-ironbark forests and woodlands of central Victoria, little is known of the ecological effects of planned burns. How do plants and animals respond? How are habitat resources such as logs and litter affected by burning? Do patchy mosaic burns produce different ecological outcomes to extensive burns across the landscape?



Box-ironbark forests and woodlands



***From top**: Grey Box flowers; Tree Goanna; Tawny Frogmouth; Pobblebonk Frog; Eastern Grey Kangaroo.*

Box-ironbark forests and woodlands occur on slopes and hills inland of the Great Dividing Range in south-eastern Australia. These dry forests with a shrubby understorey derive their name from the dominant eucalypts: 'box barked' species, including Grey Box and Red Box, as well 'ironbarks', both Red and Mugga Ironbark.

Aboriginal people lived in the box-ironbark country for thousands of years before European settlement. More recently, these forests and woodlands have had a distinctive role in Australia's history and identity: they were at the centre of the 1850's gold rushes, they inspired numerous works from bush poets such as Henry Lawson and 'Banjo' Paterson, and they are the home of Australia's floral emblem, the Golden Wattle.

In Victoria, the box-ironbark region has a distinctive flora and fauna. Around 1,500 species of flowering plants occur, comprising 17 ecological vegetation classes. Colourful wildflowers are a characteristic feature in the spring. The region is also home to at least 38 species of native mammals, 186 species of land birds, 41 species of reptiles, and 15 species of frogs. A distinctive feature of the bird community is the large number of species that move to and from the region to take advantage of seasonal resources, such as nectar from flowering eucalypts.

Box-ironbark forests and woodlands also provide critical habitat for rare and threatened species, including several species of orchids, the Brush-tailed Phascogale (above), Swift Parrot, Regent Honeyeater and Woodland Blind Snake.

There has been much change to the forests and woodlands of the box-ironbark ecosystem in Victoria since European settlement. More than 70% of the original forest cover has been cleared, with remaining forests typically occurring on areas less suitable for agriculture where the soils have low nutrient levels and poor water-holding capacity. The remaining forest blocks are fragmented and have been greatly modified by historic gold mining activities, timber harvesting, stock grazing and other land uses.

Dry, shrubby box-ironbark forests are dominated by box-barked and ironbark eucalypt species
(pictured here are Grey Box and Red Ironbark)

***Box-ironbark forests have experienced a wide range of land-uses since European settlement** (above top: timber cutting; above bottom: apiculture and honey production from flowering trees.*

Fire in box-ironbark forests

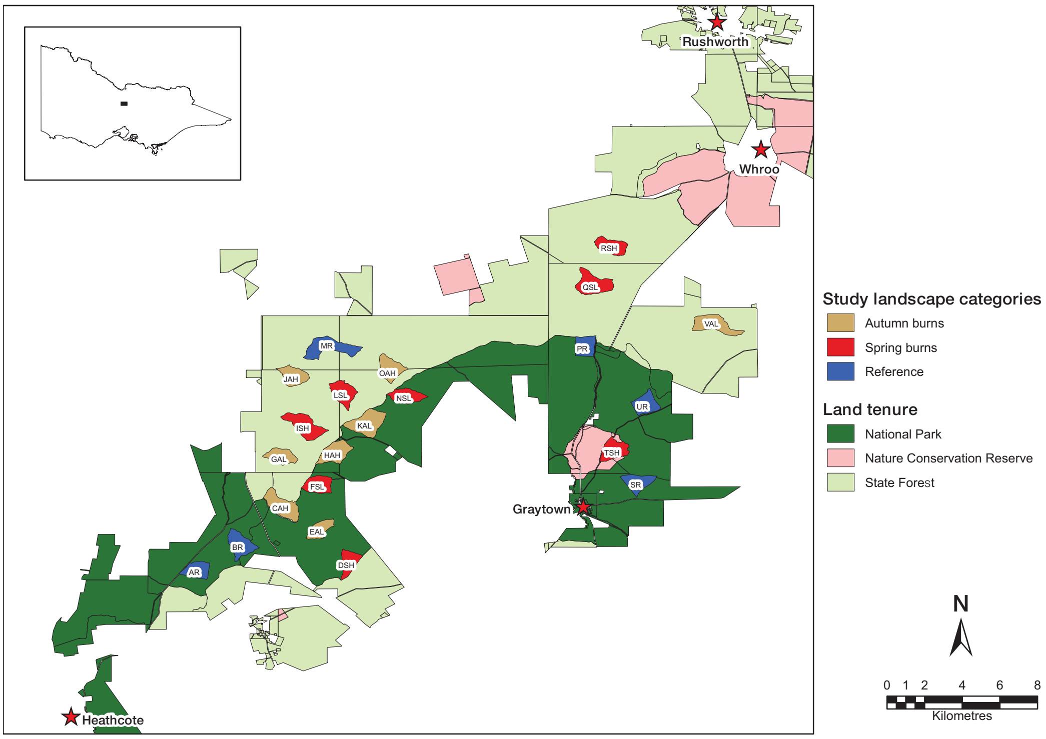
Little is known of the fire regime in box-ironbark forests before European settlement. Aboriginal people certainly inhabited the area, but there are no records of the way in which they may have used fire in these dry shrubby forests.

Today, fire management agencies use planned fire to reduce fuels and therefore reduce the likelihood of wildfire. Fuels such as leaf litter and logs are slow to accumulate in these dry forests, and the hazard risk is relatively low.

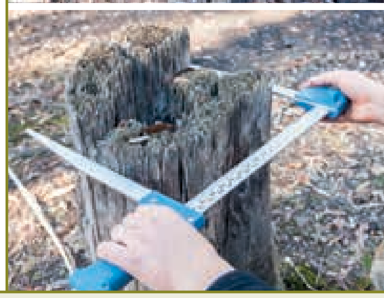
Studying fire in box-ironbark forests

The 'Box-Ironbark Experimental Mosaic Burning Project' is a collaborative project between La Trobe and Deakin Universities, the Department of Environment, Land, Water and Planning and Parks Victoria. It is investigating the short-term ecological effects of planned burns in box-ironbark forest. The study is being conducted in the Heathcote-Graytown-Rushworth forest, the largest block of box-ironbark forest remaining in Victoria (~40,000 ha). The project is based on a series of experimental burns. Twenty-two 'landscapes', each ~100 ha in size, were selected. Six were randomly chosen as 'Reference' areas, where ecological monitoring would occur but experimental burns would not take place. The remaining 16 landscapes were planned to be burnt according to two criteria:

1. **Season of burn**: autumn or spring
2. **Extent of burn**: lower cover, patchy mosaic burn (30–50% burn cover) or more continuous burn (70–90% burn cover)



Location of 22 study landscapes in the Heathcote-Graytown-Rushworth forest



Type	**~30–50%**		**~ 70–90%**		**Reference**
Season	autumn	spring	autumn	spring	not burnt
Replicates	4	4	4	4	6

Total : 16 burns + 6 reference = 22 study areas

Study design (above): three treatment groups were established—low-cover burns (30–50%), high cover burns (70–90%), and unburnt reference landscapes. In each burn treatment, four landscapes were to burn in autumn and four in spring.

This design allows a comparison of 'before vs after' burning, and of landscapes which varied in burn extent (i.e. amount of the landscape burnt). It also allows comparison of burned vs reference landscapes, to identify changes that may be associated with other processes independent of burning (e.g. rainfall).

In each study landscape, 12 plots (each 20 x 20 m) were randomly located to monitor ecological attributes before and after burning. Attributes investigated include:

- logs, stumps and litter
- plant species composition
- the bird community

Studies were also undertaken of the effects of fire on individual species (Scarlet Robin, Yellow-footed Antechinus, Brush-tailed Phascogale).

Results reported here relate to short-term effects, within the first two years after burns. Longer-term monitoring is required to determine further outcomes through time.

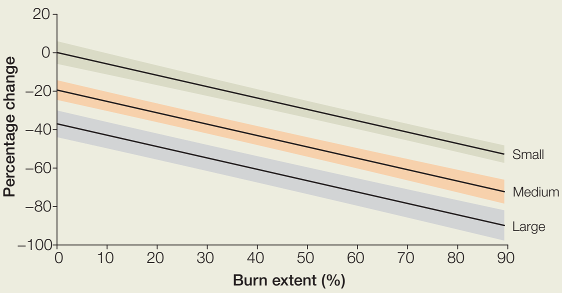
Experimental planned burns

Experimental planned burns were carried out in autumn and spring 2011. Burn cover ranged from 22% to 89% across the 16 treatment landscapes. Autumn burns ranged from 22% to 51%; spring burns 52% to 89%. Thus, burn extent was lower in all autumn burns than for spring burns. Above-average rainfall in summer, prior to autumn 2011, created difficult conditions for planned burning. The differences between seasons (all autumn burns ≤51%, all spring burns >51%) limits the ability to make comparisons of ecological outcomes between seasons.

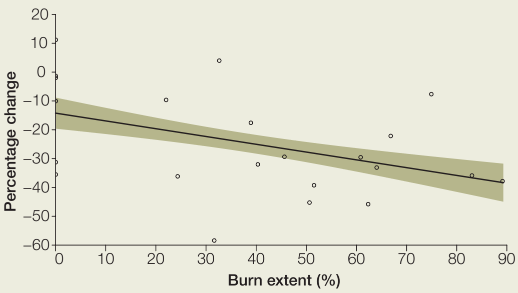
Measuring burn cover

To measure burn cover, the length of burnt ground was determined on a series of transect lines across each landscape. By averaging across transects, an estimate of burn cover for the entire landscape was obtained. Across the 16 burn landscapes a total of 132 transects was walked, more than 68 kms!

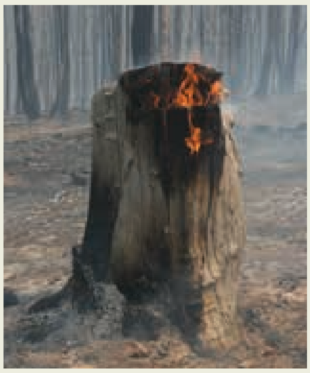
Logs, stumps and litter

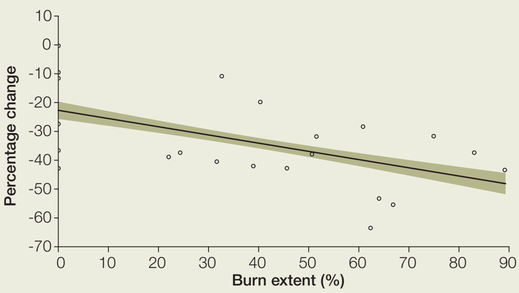


Planned burns reduced the number of logs. The loss of logs in a landscape (expressed as the percentage of pre-fire logs that were lost) increased as the burn extent in the landscape increased, for small ≤10 cm, medium 10–20 cm, and large >20 cm diameter logs. Large logs were more vulnerable. For a given burn extent, a greater percentage of large logs were consumed than small logs.



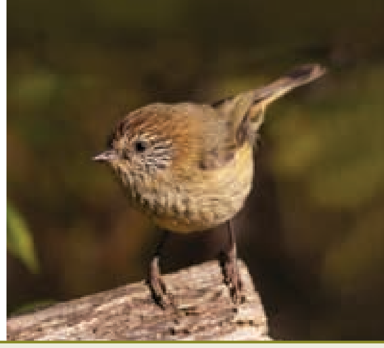
Reduction in the number of stumps from pre- to post-fire was also influenced by the extent of the landscape burnt; but it did not differ in relation to the size of stumps. The percentage reduction of stumps increased as the burn extent increased.





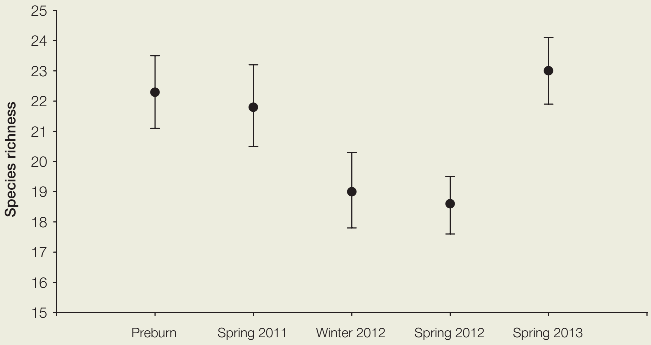
Leaf litter was also reduced by burning. The percentage reduction in depth of leaf litter increased with increasing burn extent. A similar pattern of loss was observed for both fine (≤1 cm diameter) and coarse (>1 cm) litter.

Structural attributes, like logs, stumps and litter, provide foraging areas and shelter for some wildlife species. They also reduce water run-off and help trap and retain nutrients in an otherwise dry and infertile forest system. Planned burns reduced the occurrence of these structural attributes, with higher burn coverage resulting in greater declines.



Birds and planned burning

Point surveys of birds were carried out at the 12 plots in each of the 22 study landscapes. A total of 93 terrestrial species was recorded from five survey rounds (one pre-fire and four post-fire). The extent to which a landscape was burnt was not an important influence on the total number of species per landscape. However, species richness did vary through time (see below). Fewer species were recorded in surveys in 2012 (winter and spring) compared with the pre-fire survey. This was not related to burning since the same trends were observed in both reference and burnt landscapes. Instead, differences likely relate to environmental factors such as rainfall.

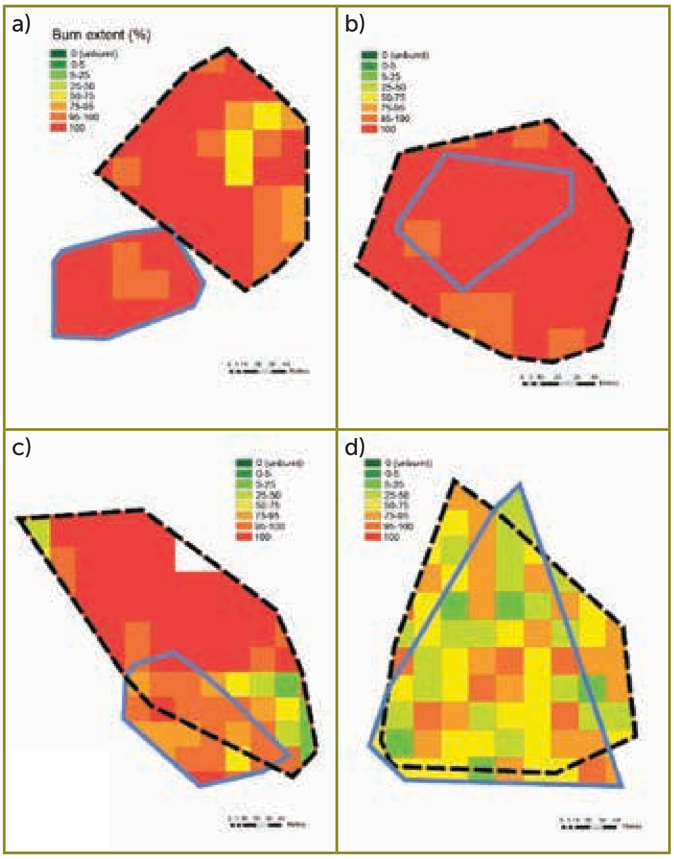


Average number of bird species per landscape in each survey round.

The extent to which a landscape was burnt was not an important influence on the composition of the bird community either. However, the composition did change with survey period: the bird community present in winter 2012 was different to all other surveys (conducted in spring). This represents seasonal movements of birds into and out of the forest. The Golden Whistler, for example, was common in winter but rare in spring, while the Rufous Whistler displayed the opposite pattern.

Golden (top) and Rufous (left) Whistlers contributed to differences in community composition across time

Scarlet Robins: survival and home range



Before (blue outline) and after (dashed black outline) home range areas and burn extent for four Scarlet Robins. Home ranges increased post-fire, but incorporated equally burnt habitat. Just one individual (a) displayed a complete shift in home range position.

The Scarlet Robin forages on the ground, making it potentially susceptible to planned burns. Radio-tracking was used to investigate both the responses of robins during burning, and post-fire changes in home range. Of 12 individuals tracked during burns, all were alive and in or near their original territory two days post-fire. Individuals tracked during a low-cover burn remained within the landscape and moved into the upper canopy. Robins tracked during a high cover burn retreated to adjacent unburnt forest.

Scarlet Robins displayed strong site fidelity despite their home range being burnt. Even where burn cover was high, robins did not shift their range into nearby unburnt forest. However, there was a significant increase in the area used post-fire (increase in territory size from 50 to 300%). Only one robin shifted from its pre-burn area (i.e. <1% overlap), but the new home range was immediately adjacent to the old. Fine-scale burn mapping within territories (see Figure) revealed that the post-burn expansion of range was into equally burnt habitat—birds did not expand their home range to incorporate nearby unburnt forest.

Scarlet Robin (left), and tracking robins during an experimental planned burn (right)

Yellow-footed Antechinus

Effects of planned burns on small marsupials

What happens to dens during fire?

Of 52 unique den sites used by Yellow-footed Antechinus individuals before autumn burns, 31% were completely burned. This included 17% of dens in trees (4/23), 48% in logs (10/21) and 20% in stumps (1/5). This loss occurred in two landscapes in which just 41% and 51% of the area was burned.

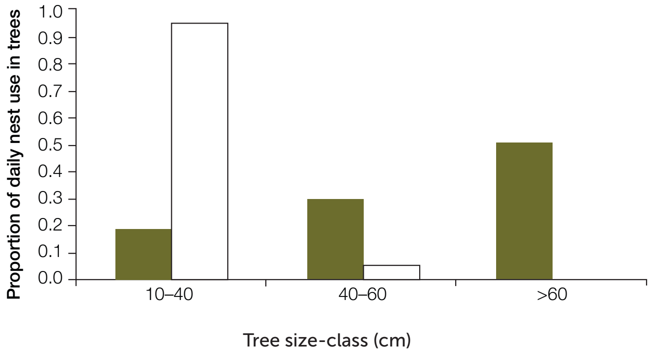
In spring, females selected large old trees as nest sites for their young. Both of the nest sites identified were still present post-fire.

This large old tree was used as a den site by Yellow-footed Antechinus

Yellow-footed Antechinus: survival and den sites

The Yellow-footed Antechinus, a small (~30-60 g) marsupial, is active mainly at night. During the day it occupies a den or nest site. In the breeding season (late winter and spring), young are cared for in a nest. We used radio-tracking to investigate the survival of animals post-fire and their use of den sites. Of 12 individuals tracked during burns (autumn = 10; spring = 2), all survived the immediate effect of the planned burns. One individual died from predation shortly after a spring burn.

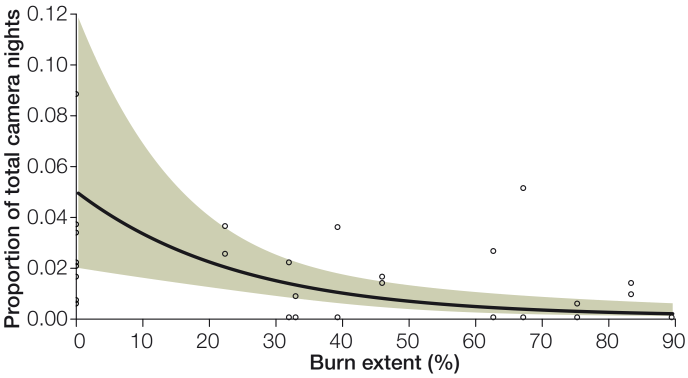
In autumn, individuals commonly used trees as den sites (45% of daily nest site use), followed by logs (38%), stumps (11%) and grass trees (6%). Trees included both living (78% of daily nest site use) and dead (22%) trees. Yellow-footed Antechinus were highly selective in their choice of den sites: they favoured larger trees (>40 cm diameter) and logs (>20 cm diameter).



The use of trees as den sites (shaded) compared with their availability (open) across the landscape. Large trees (>40 cm diameter) are preferentially selected as den sites, yet are extremely scarce.

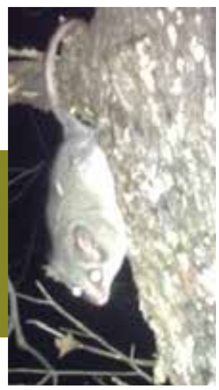
Brush-tailed Phascogale: post-fire occurrence

The Brush-tailed Phascogale, a small carnivorous marsupial, is a threatened species in Victoria. Females occupy a home range of about 50 ha, whilst male home ranges are larger (~100 ha). We used remote infrared cameras to study the distribution of phascogales in 14 landscapes (five autumn and five spring burns, four reference). They were detected in 13 of the 14 landscapes surveyed. The relative occurrence of phascogales (number of nights detected as a proportion of total camera nights) was most strongly influenced by the extent of burning in the landscape: activity declined as an increasing amount of the landscape was burnt. Generally, phascogales were not detected in highly burnt areas, but did occur in areas only slightly burnt or unburnt.



A noteworthy record: Eastern Pygmy-possum

While conducting nocturnal radio-tracking, a noise in the bush turned out to be an Eastern Pygmy-possum. This is the first record of this species in the district for at least 30 years!



Planned burning and plant species

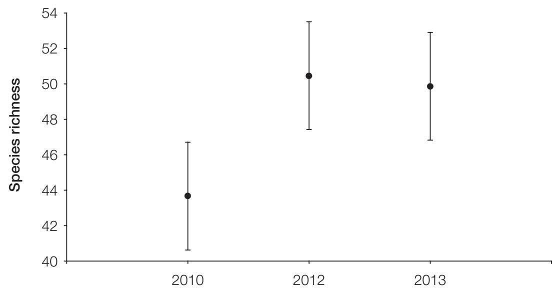
Spreading Wattle

Daphne Heath

Surveys of plant species were conducted at eight survey plots in each of 15 study landscapes (six autumn burn, six spring burn, three reference). At each survey plot, all vascular plant species occurring in five 1 x 1 m quadrats were recorded. Surveys were carried out pre-fire (2010) and on two occasions post-fire (2012 and 2013). Across the three surveys a total of 244 plant species was detected.

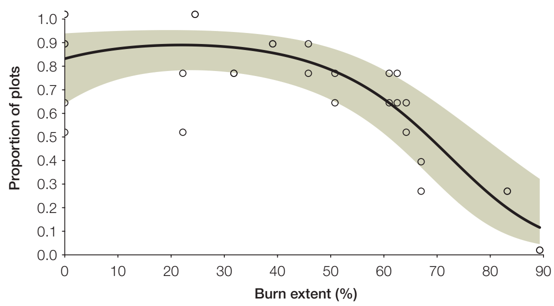
Species richness

The number (richness) of perennial plant species (i.e. excluding grasses and annuals) per landscape differed across survey periods: species richness was higher in the two post-fire surveys compared with pre-fire (see figure at right). This increase was observed in all landscapes (including unburnt reference landscapes): the extent to which a landscape was burnt was not influential. There were drought-breaking rains in 2010 and 2011, after a decade of drought (2000–2009). The increase in species richness in 2012 and 2013, regardless of fire treatment, is consistent with there being a marked response by plants to rainfall.



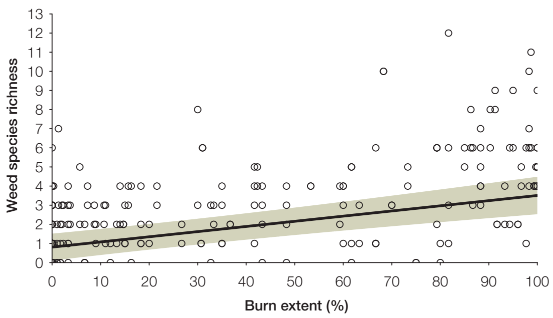
Occurrence of individual species

The occurrence of several species, considered 'key fire response species' for box-Ironbark forests, was assessed. Two species (Gold-dust Wattle and Daphne Heath) showed no change in occurrence at the landscape scale throughout the study. Four species (Spreading Wattle, Drooping Cassinia, Gorse Bitter-pea, Twiggy Bush-pea) were encountered more often in post-fire surveys (including in reference landscapes), suggesting a positive response to rainfall. Just one species (Cranberry Heath) displayed a strong response to burning: its occurrence was largely unchanged by burns of up to 45% of the landscape, but declined quickly as burn extent increased beyond 45% (see figure at right).



Introduced plants

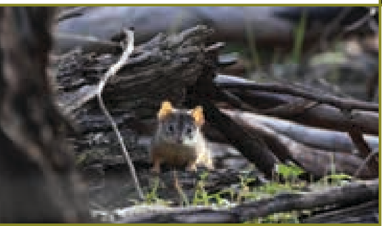
The most frequently occurring weed species were grasses, daisies and thistles, including Hair Grass, Flatweed, Smooth Cat's Ear, Fescue and Common Sow-thistle. At the level of individual plots (20 x 20 m), the number of weed species detected increased as the burn extent per plot also increased (see figure at right).



Is flowering of Red Ironbark affected by fire?

Red Ironbark trees flower in winter and are an important nectar source for many animals. Flowering was assessed in 16 landscapes in the second winter after burning (2013). Flowering was recorded in all 16 landscapes, but just 13% of Red Ironbark trees had flowers. The extent of burning did not influence flowering rates. Instead, flowering was more likely to occur in the north of the study area (compared to the south), and larger trees were more likely to flower than smaller trees.

Planned burning in box-ironbark forests



Understanding the ecological outcomes of planned burning is essential to ensure a balance between fuel reduction to protect from wildfire and maintaining nature conservation values. This study has documented short-term responses (two years post-fire) to burning. Post-fire changes can continue for decades.

Box-ironbark forests have low productivity. The sparse shrubby understory and low rate of leaf litter accumulation mean that these forests have relatively low fuel levels. Wildfires of natural origin can and do occur, but are infrequent.

Planned burns result in a loss of structural features (e.g. logs, stumps, litter). There is a disproportionate effect on some resources—for example, for a given burn extent, a greater proportion of large logs were lost compared with small logs. These large logs will take a long time (>100 years) to be replaced. Loss of structural features means a loss of habitat (e.g. for shelter, nesting and foraging) for animal species.

The ecological impacts of burning are related to the extent of the landscape that is burned. Lower-cover patchy burns (e.g. <50%) have less impact than extensive burns.

Individual animals may survive patchy burns but ongoing effects depend on how individuals and species respond to habitat changes. Examples include:

- *change in size of home range*: Scarlet Robins expanded their home range post-fire, likely in response to reduced habitat quality after burning.
- *loss of shelter and refuge*: for the Yellow-footed Antechinus, 31% of dens identified pre-fire were lost. This may negatively affect survival and reproductive success.
- *change in distribution*: the Brush-tailed Phascogale was less likely to occur in landscapes with high burn extent. Burning reduces the area of suitable habitat for this species, at least in the short term.

Climatic conditions after fire influence the response of plants and animals. Increased richness of perennial plant species in all landscapes during post-fire surveys were driven by rainfall patterns rather than burning. However, burning increased the number of introduced plants.

Frequency of burning is a key issue for fire management in box-ironbark forests. If the interval between fires is not sufficient for species and habitat resources to be replenished, successive fires will result in cumulative loss of natural values. A spread of fire intervals across the full range of the proposed 'tolerable fire interval' (from 12–150 years) is required; as is a regional strategy to maintain a mix of growth stages sufficient to ensure a resilient ecosystem.

The Department of Environment, Land, Water and Planning is developing a Risk Landscape Strategic Bushfire Management Plan to manage long-term fire regimes and risk to people, property and the environment. Research, such as that presented here, will help guide the development of this plan, and ongoing monitoring will be used to assess the impact of the plan and where further research is required. Such monitoring is critical given that the effects of planned burning extend over decades.

Further information

Holland, G.J. 2015. *Box-Ironbark Experimental Mosaic Burning Project*. Report for the Dept Environment, Land, Water and Planning; and Parks Victoria.

Environment Conservation Council 1997. *Box-Ironbark Forests and Woodlands Investigation: Resources and Issues Report.* Environment Conservation Council, Melbourne

Muir, A.M., Edwards, S.A. and Dickins, M.J. 1995. Description and conservation status of the vegetation of the Box-Ironbark ecosystem in Victoria. *Flora and Fauna Technical Report 136.* Department of Conservation and Natural Resources, Victoria.

Tolsma, A., Cheal, D. and Brown, G. 2007. *Ecological Burning in Box-Ironbark Forests.* Phase 1 - Literature Review. Department of Sustainability and Environment, Victoria.

Bennett, A.F., Holland, G.J., Flanagan, A., Kelly, S. and Clarke, M.F. 2012. Fire and its interaction with ecological processes in Box-Ironbark forests. *Proceedings of the Royal Society of Victoria* 124: 72–78.

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