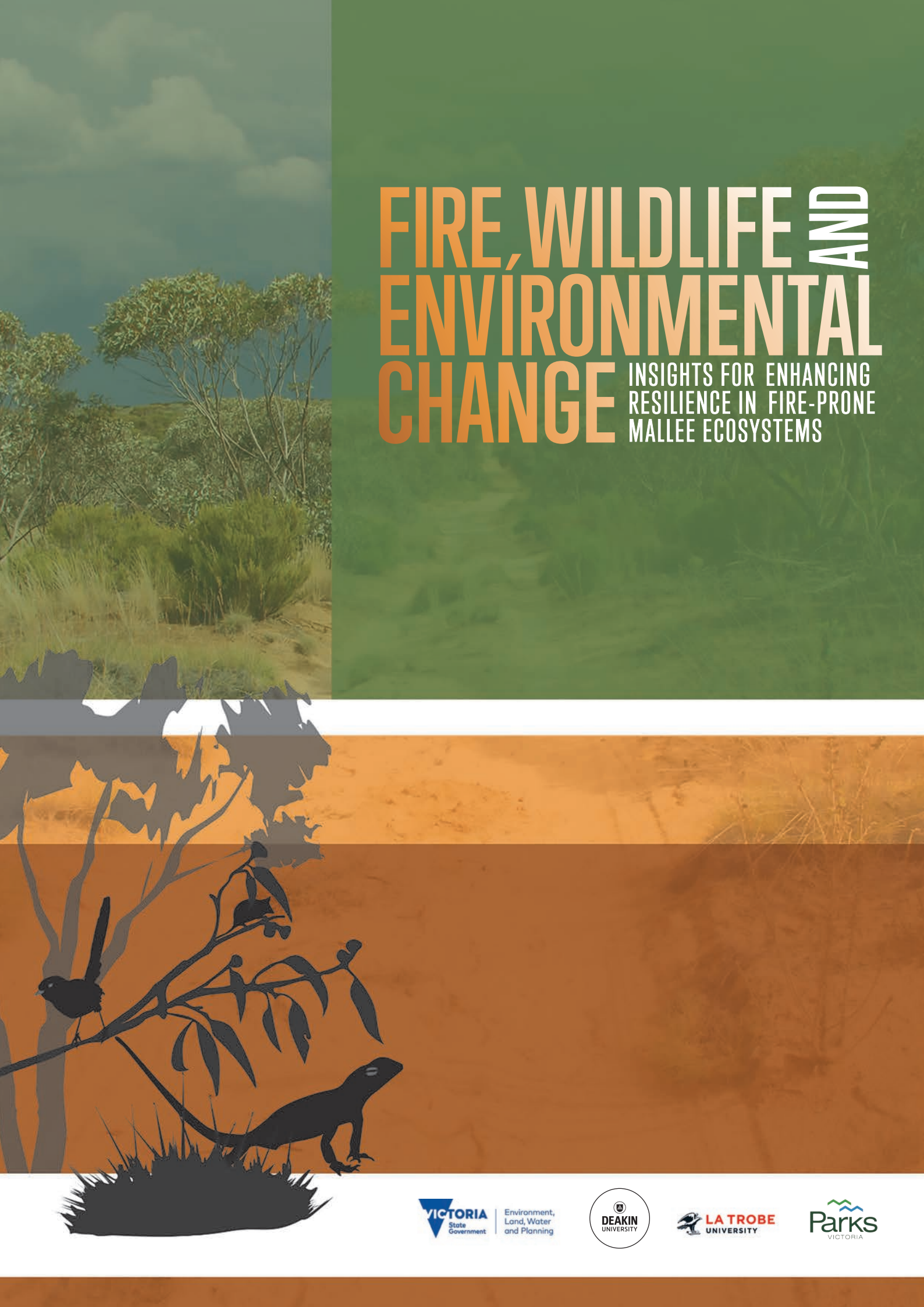


FIRE, WILDLIFE AND ENVIRONMENTAL CHANGE

INSIGHTS FOR ENHANCING RESILIENCE IN FIRE-PRONE MALLEE ECOSYSTEMS

VICTORIA State Government | Environment, Land, Water and Planning
DEAKIN UNIVERSITY
LA TROBE UNIVERSITY
Parks VICTORIA

UNDERSTANDING THE LONG-TERM EFFECTS OF FIRE ON THE WILDLIFE OF THE MURRAY MALLEE REGION

Long-term monitoring leads to greater understanding of how ecosystems respond to disturbance. Scientists at La Trobe and Deakin Universities, together with staff of the Department of Environment, Land, Water and Planning have continued monitoring sites established by the Mallee Fire and Biodiversity Project; maintaining data collection for eight years to 2014 across 180 sites surveyed for birds and 18 sites surveyed for small mammals and reptiles. Data on habitat resources and fuel hazard were collected at 25 sites. This work addressed three main questions:

- **Can we identify particular kinds of plants and animals or habitat features that are good indicators of the diversity of wildlife we will find there?**
- **What are the impacts of fire frequency in the mallee on threatened species?**
- **Can we predict what kinds of animals will be in an area of mallee by knowing what stage in the recovery process the vegetation is up to?**

This brochure presents a summary of how mallee flora, fauna and habitat elements respond to fire and suggests ways to manage fire within mallee systems such that the viability and resilience of faunal communities are enhanced.

THE EFFECT OF FIRE ON HUMMOCK-GRASS MALLEE

Mallee ecosystems occur in regions with low rainfall and high summer temperatures, on sandy soils with low nutrient status. They are rich in wildlife; particularly reptiles, birds, ants and plants. Following fire, plants resprout from living rootstocks or regenerate from soil or canopy seed stores. Animals respond to changes in habitat elements through time, such as increasing cover of leaf litter (in which invertebrate prey can be found) and spinifex (for protection from predators), and development of tree hollows (for shelter and breeding).

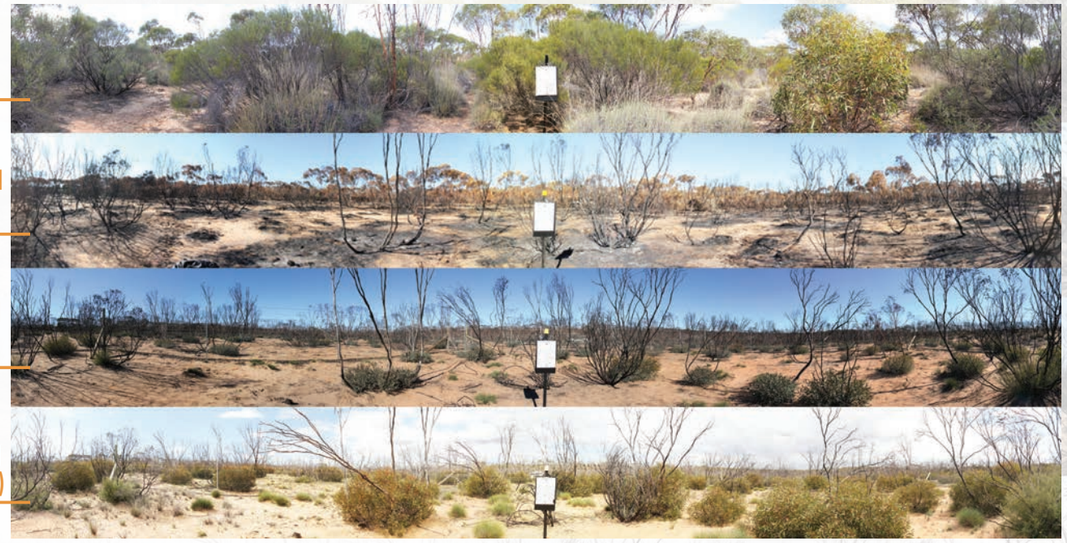
A fire at any time will reset the ecosystem back to the initial stage

Initial 0-5 yrs
Immediately after fire, most above ground vegetation is burnt, the area is open and the soil exposed. Few tree hollows remain. Early colonisers thrive, including Painted Dragon and the feral House Mouse.

Juvenile 5-20 yrs
As time-since-fire increases (5-20 years), low and mid-storey vegetation cover reaches its maximum (in the form of resprouting plants and coppicing eucalypts) and the dead mallee stems fall and accumulate in large numbers. The cover of spinifex increases rapidly during this period. Many species start to recolonise previously burnt areas as available habitat niches increase.

Mature 20-50 yrs
At 20-50 years-since-fire, spinifex cover peaks, litter cover increases and the height of the canopy increases as the coppicing eucalypts continue to regenerate. Small hollows begin to appear in mallee stems. Species richness of reptiles peaks and the threatened Mallee Ningaui and Mallee Emu-wren reach their highest density.

Stasis (>50 yrs)
In longer unburnt vegetation (>50 years since fire), spinifex cover declines as the species senesces, whilst the stems of the mallee eucalypts in the canopy vegetation begin to steadily accumulate greater amounts of decorticating bark and hollows. Bird populations, especially those of Malleefowl and Black-eared Miners, peak in diversity and abundance in mature vegetation.



A TALE OF TWO HABITATS

As you travel over sandy dunes, down through the swales of the tree mallee landscape, two distinctive vegetation types are apparent. On the tops and slopes of dunes, Hummock-grass Mallee predominates. This vegetation is more fire prone due to its characteristic ground layer of spinifex (and interspersed shrubs). Many kinds of animals in this vegetation are highly responsive to time-since-fire, and at least seven plant species require long intervals (>50 years) between fires to thrive.

On the heavier soils of the swales, Saltbush Mallee prevails. This vegetation is inherently less fire prone, with a sparse understorey of semi-succulent plants (chenopods, including various salt bushes). Old mallee eucalypts (>40-50 years since fire) typically offer hollows for shelter and nest sites. In Saltbush Mallee vegetation, populations of fewer kinds of animals are affected by time since fire than in Hummock-grass Mallee.

ARE THE CURRENT KEY FIRE RESPONSE SPECIES GOOD INDICATORS?

How fire is managed in the landscape is partly guided by monitoring a group of 13 indicator species (Key Fire Response species) - all of which are plants. These plants are thought to be the most vulnerable to extreme fire regimes, such as too frequent or too infrequent fire. Ten of these species were recorded during an extensive survey effort, but sufficient data to produce time since fire models were obtained for only four of them, none of which showed a significant response to time-since-fire. When planning for fire management it is also important to consider how structural habitat components, used by animal species, respond to fire.

10 of the 13 species currently used in tree mallee to guide fire management proved to be unsuitable due to their rarity or lack of clear response to fire

PLANTS CAN'T FLEE FIRE

Some animals can flee from the direct impacts of fire, but fire has an immediate impact on plant species. Fire results in changes in the mix of different kind of plants in tree mallee vegetation. Twenty plant species changed significantly in their abundance depending on how long since the site had been burnt. Species that were most common in early post-fire ages (<10 years since fire) included Tar Bush *Eremophila glabra*, Rough Halgania *Halgania cyanea* and Sugarwood *Myoporum platycarpum*. The occurrence of Dark Turpentine Bush *Beyeria opaca* and Nealie *Acacia rigens* peaked at 30 years since fire; while chenopod species such as Ruby Saltbush *Enchyleana tomentosa* and Common Twinleaf *Zygophyllum apiculatum* steadily increased in occurrence with increasing time since fire.

<10 YEARS SINCE FIRE

SUGARWOOD

TAR BUSH

APPROX 30 YEARS SINCE FIRE

DARK TURPENTINE BUSH

NEALIE ACACIA

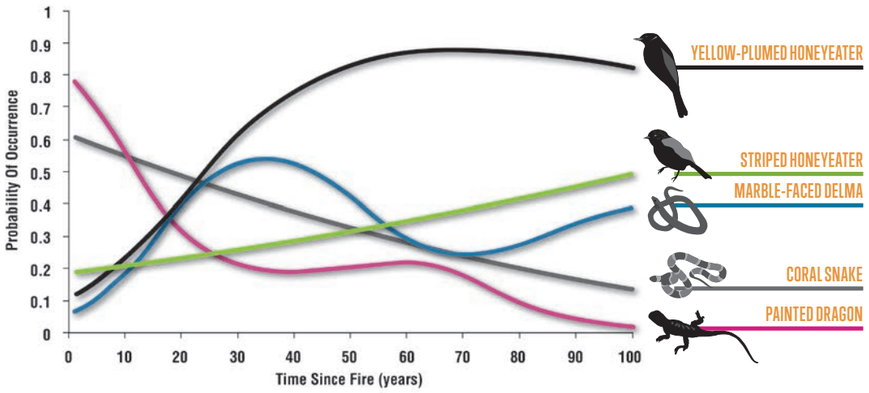
LATER IN TIME SINCE FIRE

RUBY SALTBUSH

COMMON TWINLEAF

FIRE TRIGGERS DIFFERENT RESPONSES BY DIFFERENT ANIMALS

Fire changes the structure of mallee ecosystems. Most above-ground vegetation is removed and takes decades to recover. Five common, but different, patterns of fauna response were detected after fire. Some species, like the Painted Dragon, are most common in the first decade after fire; whereas others, like the Yellow-plumed Honeyeater, become most common at least 40-50 years after fire. While a range of post-fire age-classes is needed to cater for all species, areas of older time-since-fire require particular attention as they take the longest time to re-create if lost to planned burning or bushfires.



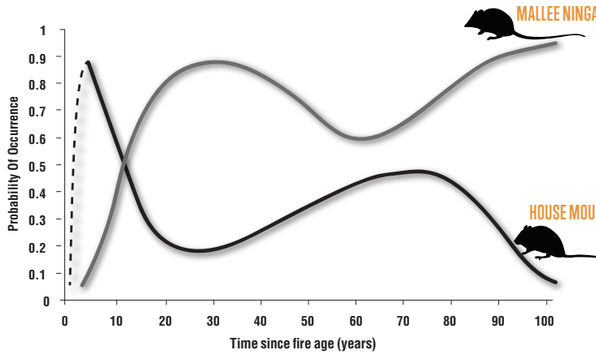

PAINTED DRAGON


YELLOW-PLUMED HONEYEATER


MALLEE NINGAUI

SMALL MAMMALS- INVADERS IRRUPT WHILST NATIVES TAKE COVER

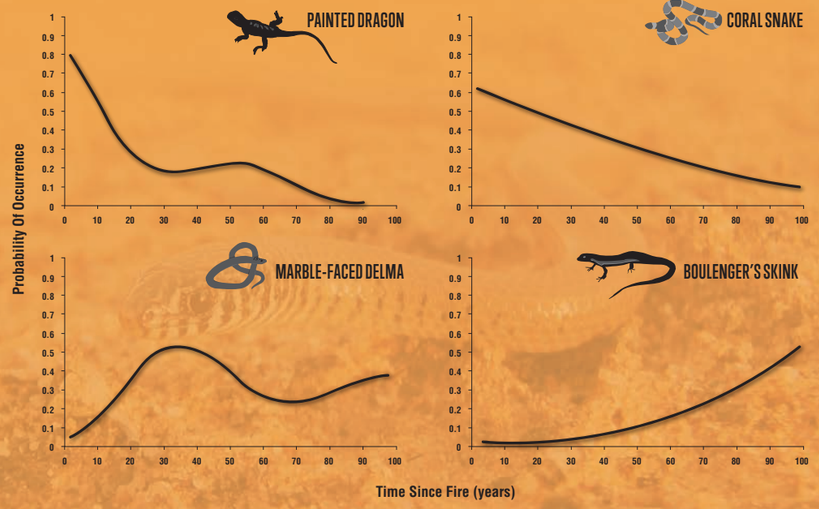
Two species of small mammal showed contrasting responses to time-since-fire. The feral House Mouse was most likely to occur in more open vegetation during the first 5 years after fire (an irruptive response), whilst the native Mallee Ningaui showed a preference for vegetation of intermediate fire ages (20-40 years post-fire) where the cover of spinifex is greatest.



Small mammals showed contrasting responses to time-since-fire in tree mallee

SOME REPTILES CAN TAKE THE HEAT

The Victorian Mallee is home to an impressive array of reptiles. Many burrow-dwelling species appear resilient to fire and their occurrence did not vary consistently with time-since-fire. However, the responses of six species appear to be linked to the availability of shelter and foraging habitat. Four species (two dragons, one snake and one skink) were most likely to occur immediately post-fire (irruptive and declining). The Marble-faced Delma showed a preference for intermediate fire ages (20-50 yrs) with good coverage of spinifex, whilst Boulenger's Skink preferred longer unburnt sites (>50 years since fire) with greater litter accumulation.



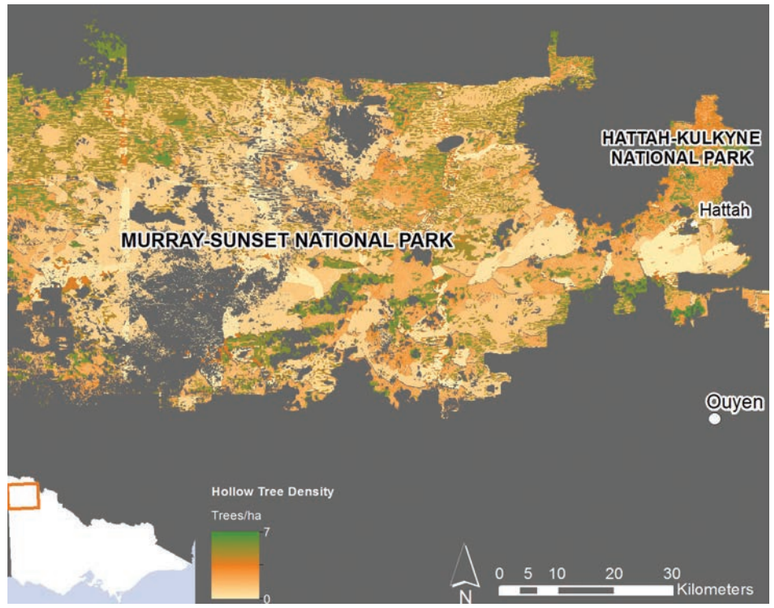
A variety of fire response shapes highlights the importance of maintaining a diversity of fire ages within the region.

FINDING A HOLLOW THAT'S JUST RIGHT

Where are the hollows needed by wildlife? Up to 45 species of birds, mammals and reptiles depend on hollows for breeding and shelter. Large hollows (>10 cm diameter) are preferred as nest sites by birds like the Pink Cockatoo; medium-sized hollows (4-10 cm) by species such as the Regent Parrot; whilst reptiles and bats often occupy small (1-4 cm) hollows. Maps of hollow density help locate this long-forming habitat resource in the landscape. Creation of these maps is dependent on known fire history and models that retrospectively predict past fires.

Tree hollows in mallee eucalypts are slow to form, only beginning to develop at more than 35 years post-fire. Surveys found that 5% of hollows showed signs of use by fauna. Large hollows are predicted to be extremely rare in the tree mallee landscape.

BELOW: MAP OF THE DENSITY OF TREES WITH MEDIUM-SIZED HOLLOWS IN MURRAY SUNSET N.P.



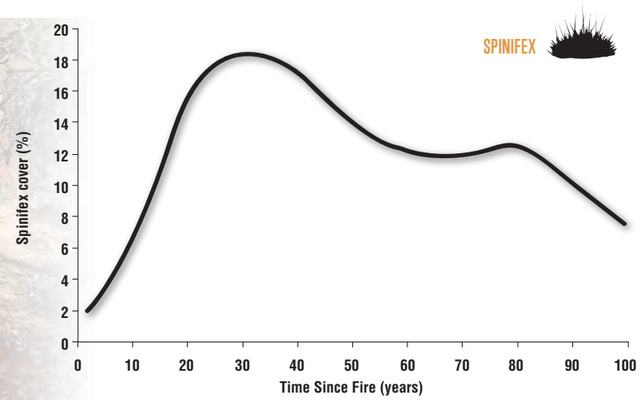

OWLET NIGHTJAR IN TREE HOLLOW

New maps of tree hollow density will enable planners to protect this key resource for wildlife


MALLEE EMU-WREN

SPINIFEX: A VALUABLE BUT FLAMMABLE FORTRESS FOR FAUNA

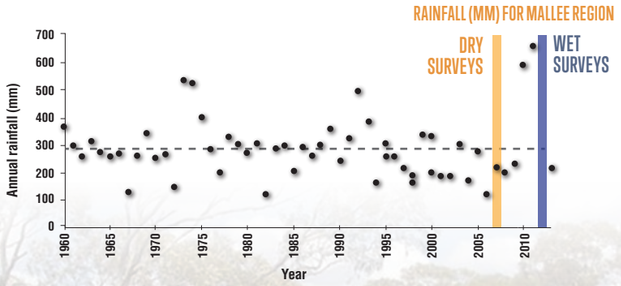
Spinifex (Triodia) is an iconic feature of the tree mallee landscape. The 'fortress-like' nature of spinifex, created by its spiky leaves, provides many animal species with protection from weather, shelter from predators, and a rich supply of insects as food. The occurrence of many species – skinks, geckos, small mammals and even birds, like the endangered Mallee Emu-wren - is intricately linked to the growth and availability of spinifex hummocks. But spinifex also creates a highly flammable fuel source that helps the spread of fires. After fire, spinifex regrows and reaches peak levels of cover around 30 years post-fire. Cover decreases as the hummocks senesce.



The greatest cover of spinifex occurs in intermediate age-classes (20-40 years) after fire

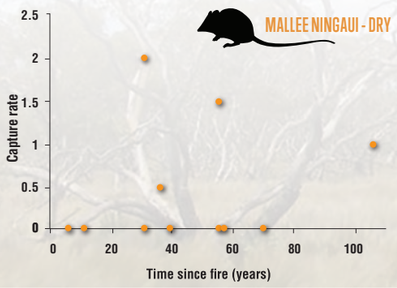
LAND OF DROUGHT AND FLOODING RAINS

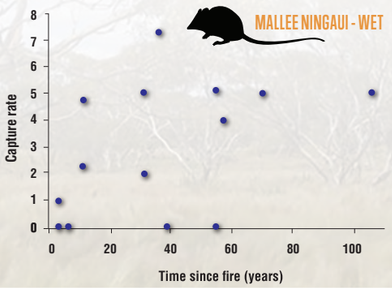
Above-average rainfall interacts with regeneration of mallee vegetation after fire to alter the fire responses of wildlife. The abundance of four mammal species was much higher during years of above-average rainfall. The Mallee Ningaui occurred in earlier post-fire age-classes, compared with drier years. Whilst rainfall had little effect on the fire-response of reptile species, the abundance of birds increased substantially in all fire age-classes during wetter years. Bird species exhibited a greater range of responses to fire in wetter years, with some showing a different response to fire in wet than dry years.



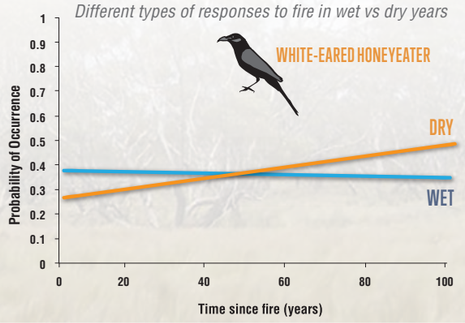
Rainfall and fire interact to alter species responses to fire

Rainfall increases the habitat breadth of the Mallee Ningaui





Different types of responses to fire in wet vs dry years



HERBIVORY AND FUTURE FIRES IN TREE MALLEE VEGETATION

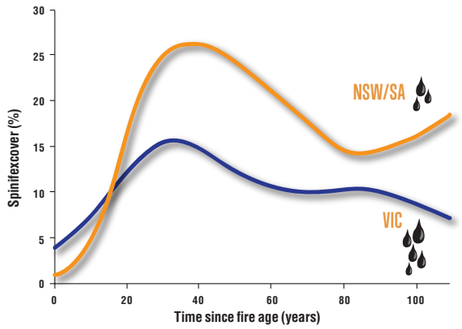
Foraging by herbivores such as the Western Grey Kangaroo, feral goats and rabbits may affect the post-fire regeneration of native plants, in turn altering the distribution of fine fuels. Fencing exclusion experiments indicated that these herbivores had little direct effect on the post-fire regeneration of spinifex. Instead, they appeared to target more palatable (and less flammable) plant species. Herbivory was dispersed throughout the fire area, rather than concentrated around fire edges.

WESTERN GREY KANGAROO

Foraging by native and introduced herbivores had little direct effect on the post-fire regeneration of spinifex.

RAINFALL OBSCURES THE RESPONSE OF SPINIFEX TO FIRE

Above-average rainfall commonly results in greater plant growth in mallee vegetation. However, there was no region-wide increase in spinifex cover between 2007 (drought) and 2012 (following rainfall). During drought, one third of the variation in cover of spinifex between sites was attributed to time-since-fire. After above-average rainfall, the differences in cover of spinifex between sites of different time-since-fire were less obvious. Time-since-fire had a stronger influence on spinifex cover in lower rainfall regions to the north (NSW, SA) compared with higher rainfall regions to the south (Vic).

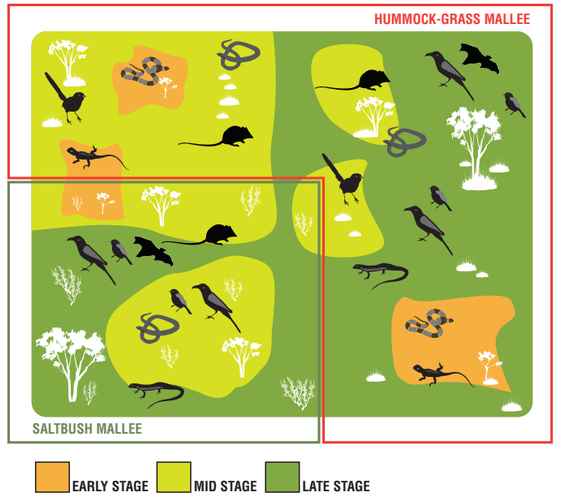


Time-since-fire explained more variation in spinifex cover in higher rainfall regions than in lower rainfall regions

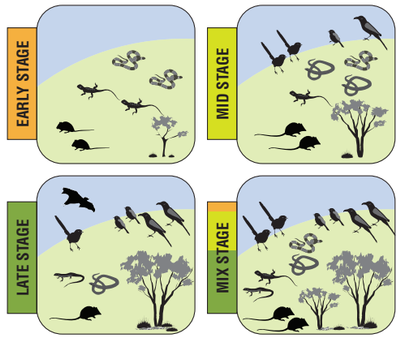
ARE THE STAGES OF VEGETATION RECOVERY AFTER FIRE DISTINCT ENOUGH TO BE RELIABLE PREDICTORS OF THE WILDLIFE PRESENT?

Animal species do not follow the same successional stages described for plant communities in Hummock-grass Mallee and Saltbush Mallee. There are no distinct successional stages in the recovery process, instead there is a continuum. Different species of wildlife peak in abundance at various points along that continuum.

To cope with this complexity of species responses, we propose three very broad 'management' stages for fire management in Hummock-grass Mallee. Each represents a range in fire ages within which fire sensitive species (or attributes) reach their peak occurrence. The early stage (0-15 years) is when "irruptive" and "declining" species show peak occurrence. The mid stage (15-50 years) is when spinifex cover is greatest and the associated fauna reach peak occurrence. The late stage (>50 years) meets the requirements of "plateau" and "inclining" species/attributes, with vegetation >100 years old being the most favourable habitat for many "inclining" fauna species. In Saltbush Mallee, we propose two management stages. From 0-30 years allows for the "declining" species whose peak occurrence is 0-10 years; and from 30-150+ years caters for the requirements of bell-shaped and inclining species (or their habitats).



The viability and resilience of vertebrate faunal communities will be favoured by maintaining landscapes with large proportions of the mid (15-50 years) and late (>50 years, including >100 year old) management stages in tree mallee vegetation.

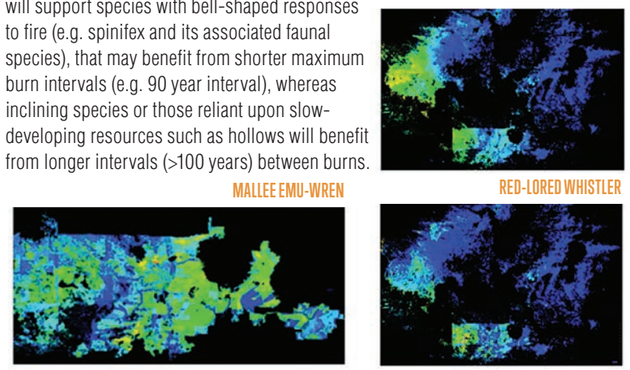


WHAT'S THE BEST MIX OF EACH AGE CLASS TO CONSERVE WILDLIFE?

A key challenge for land managers is to maintain a landscape in which the requirements of all species are met. Identifying desirable mixes of age classes across the Mallee that will support the greatest diversity of wildlife in the greatest numbers requires some complex mathematical modelling and some challenging choices. For example, the mix of age classes that would maximize bird community viability consisted of entirely late successional vegetation, whilst that for the reptile community included more mid-successional vegetation. If we aim to manage the mallee vegetation to maximize the viability of the entire vertebrate community, this requires an area comprised of mostly middle and late successional vegetation. Having parks comprised of large proportions of early successional vegetation would be detrimental to a wide range of wildlife.

HOW LONG BETWEEN FIRES?

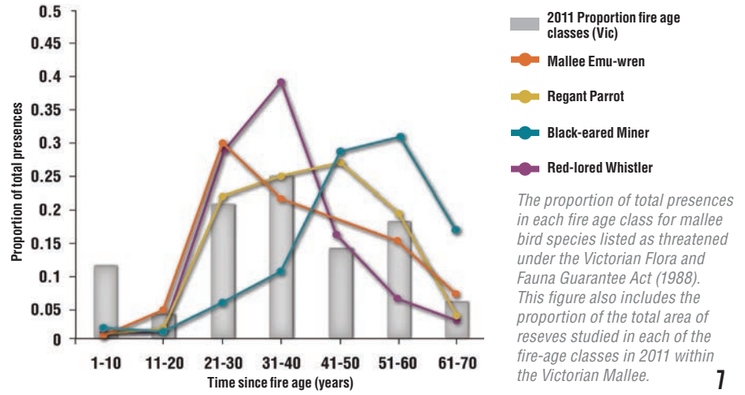
The Mallee Hawkeye Project has used the time-since-fire responses of a suite of plants, animals and habitat attributes to review the minimum tolerable fire interval for tree mallee vegetation. Based on this data, it is recommended that the minimum time between fires within Hummock-grass Mallee and Saltbush Mallee be at least 40 years. The appropriate maximum amount of time between fires will depend upon the species or resources that managers aim to protect. The data suggest the current maximum recommended amount of time between fires for Hummock-grass Mallee (90 years) and Saltbush Mallee (200 years) will support species with bell-shaped responses to fire (e.g. spinifex and its associated faunal species), that may benefit from shorter maximum burn intervals (e.g. 90 year interval), whereas inclining species or those reliant upon slow-developing resources such as hollows will benefit from longer intervals (>100 years) between burns.



Data from fire responses suggest the minimum time between fires in tree mallee be at least 40 years

SHARING DATA INFORMS FIRE MANAGEMENT FOR THREATENED BIRDS

The Mallee Hawkeye Project combined the results of new surveys with previous sightings of 12 species of rare and threatened mallee birds from historic data sets collected by government agencies, universities and volunteer organisations. Analysis of this combined data set revealed that eight threatened species were most common in mature (20-50 years) or stasis (50-70 years) post-fire vegetation classes. Maps of the distribution of suitable habitat for each species in the Murray Mallee showed that habitat presently is most restricted for the Mallee Emu-Wren and the Red-lored Whistler.



The proportion of total presences in each fire age class for mallee bird species listed as threatened under the Victorian Flora and Fauna Guarantee Act (1988). This figure also includes the proportion of the total area of reseves studied in each of the fire-age classes in 2011 within the Victorian Mallee.

KEY MESSAGES:

- Plant and animal species show a range of response types to fire – irruptive, declining, bell-shaped, plateau and inclining – indicating the importance of maintaining a variety of fire ages at a regional scale to cater for all species.
- Animal species respond positively to the re-establishment of favoured foraging, breeding and shelter resources after fire.
- Spinifex, a key shelter and foraging resource for many species, typically peaks in cover at around 30 years after fire. As a result, mid-aged (15-50 years) mallee vegetation is favoured by numerous reptile, bird and mammal species.
- Tree hollows, a key habitat requirement, take many years to form in mallee eucalypts (typically not until >35 years since fire) and are often destroyed by fire. The availability of larger hollows (>10 cm diameter) is at risk from too frequent fires.
- Species time-since-fire response curves highlight the importance of vegetation that is maturing (20-50 yrs) and moving into stasis (>50 yrs) particularly for threatened bird species.
- Weather (rainfall or drought) and herbivory may interact with fire to alter the ways plant and animal species respond to fire in mallee vegetation.
- Plant species currently listed as Key Fire Response Species generally are too rare or too resilient to fire to be useful for determining Tolerable Fire Intervals in Hummock-grass Mallee and Saltbush Mallee vegetation.
- Based on the fire responses of plants, animals and habitat attributes, it is recommended that the Minimum Tolerable Fire Interval for Hummock-grass Mallee be increased to at least 40 years.
- Faunal responses to fire do not closely align with currently recognised vegetation growth (successional) stages and instead can be simplified into 'management' stages.
- Findings from this project favour strategic and targeted burning to reduce risk to rare ecological assets (e.g. tree hollows in Saltbush Mallee) that could take a century or more to replace if lost.
- The overall viability and resilience of faunal communities will be favoured by landscapes with large proportions of mature (20-50 years) and stasis (>50 years, including >100 year old) mallee vegetation.

ISBN: 978-0-646-94948-2

VICTORIA State Government | Environment, Land, Water and Planning

DEAKIN UNIVERSITY

LA TROBE UNIVERSITY

Parks VICTORIA

ACKNOWLEDGEMENTS

This brochure was funded by DELWP through the Mallee HawkEye project. The project team was: Project Leaders Professor Michael Clarke (*LaTrobe University*) and Professor Andrew Bennett (*LaTrobe/DELWP*), Project Coordinator Sarah Avitabile (*La Trobe*), Hawkeye Project Officer Natasha Schedvin (*DELWP Mildura*) and Key Researchers Kate Callister (*La Trobe*), Jemima Connell (*La Trobe*), Lisa Farnsworth (*La Trobe*), Angie Haslem (*La Trobe*), Luke Kelly (*University of Melbourne*), Steve Leonard (*La Trobe*), Simon Watson (*La Trobe*), Sally Kenny (*DELWP*) and Rick Taylor (*La Trobe*).

Many thanks to the broader group of agency staff, students and workshop attendees who contributed to the project including Kathryn Schneider (*Parks Victoria*), Rowan Mott (*La Trobe*), Catherine Payne (*Deakin*), Connie Warren (*Deakin*), Joe Benshemesh (*La Trobe Unit*), Ross Bradstock (*University of Wollongong*), Don Driscoll (*ANU*), Peter Ewin (*DECCW, NSW*), Kate Giljohann (*University of Melbourne*), Malcolm Gill (*ANU*), Jose Lahoz-Monfort (*University of Melbourne*), Dale Nimmo (*Deakin*), Steve Platt (*DELWP*), Euan Richie (*Deakin*), Martin Westbrooke (*University of Ballarat*), Matt White (*DELWP*) and Mike Wouters (*DENR, SA*).

Layout, design & illustration of the brochure by: EOID | Clare Kelly *(www.expressionsofinterestdesign.com.au)*