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FIRE NOTE

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FIRE INTERVALS AND BIODIVERSITY RESPONSES IN THE SOUTH-WEST OF WA

SUMMARY

Prescribed fire is widely used in forest landscapes in south-west Western Australia (SWA) for a range of land management objectives including conservation of biodiversity, fuel reduction for mitigation of bushfires, and regeneration of areas after timber harvesting. Managers require knowledge of the ecological effects of fire in order to apply fire regimes that are consistent with these management objectives. However, there is limited information about how the biota responds to long-term fire management practices, especially at whole-of-community level.

Project B1.1 used accurate fire history information to determine the impact of different fire interval sequences over the last 35 years on the composition and abundance of vascular plants, ground-dwelling invertebrates, vertebrates and macrofungi in the forests and shrublands of SWA. The aim of Project B1.1 was to guide the management of fire intervals for biodiversity conservation in forests and shrublands of the Warren bioregion, a species-rich area experiencing a Mediterranean-type climate.

Comparisons between sites using ordinations revealed no patterns in species composition and abundance due to different fire interval sequences. This finding indicates that forest and shrubland ecosystems in SWA are resilient to a range of fire regimes and that occasional short intervals between fires will not adversely affect biodiversity. The methodology used for this study could be applied to other fire prone landscapes in Australia for which fire history information is available.

Photo courtesy of Grant Phelan

ABOUT THIS FIRE NOTE

This research was conducted as part of Project B1.1: Managing fires in forested landscapes in southern Western Australia.

The authors: Dr Roy Wittkuhn (pictured right) is a Research Scientist with the WA Department of Environment and Conservation (DEC). Dr Lachie McCaw (left) is a Principle Research Scientist with the DEC and Project Leader for B1.1.

A DVD on the research in this Fire Note, *Fire in the Landscape*, is available from the Bushfire CRC through the AFAC Shop. Go to www.bushfirecrc.com/publications/ then to Products.

BACKGROUND

South-west Western Australia (SWA) is one of the most fire-prone regions in the world due to the combination of a Mediterranean-type climate with hot dry summers and the presence of large areas of flammable native vegetation. Prescribed fire has been used extensively in forest landscapes since the 1960s to mitigate the impacts of bushfires on the community and on environmental values including biodiversity. The ecological implications of prescribed burning, however, remain contentious.

The sequence of time intervals between successive fires (see 'Fire interval sequences' on page 2) forms part of the fire regime that can influence the composition and abundance of biodiversity. Inappropriate fire intervals can lead to localised extinction or changes to the abundance or habitat quality of a range of species in the community (Burrows 2008). However, long-term impacts of fire regimes are difficult to study due to the time required for longitudinal studies or the lack of accurate fire history information for retrospective studies.

The Department of Environment and Conservation and its predecessors have maintained a record of fire occurrence in forested areas of SWA since 1953 (Hamilton *et al.* 2009).

Figure 1: The study area consisted of a mosaic of jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) forest on uplands (top left), interspersed with seasonally-inundated shrubland/sedgeland in valleys (bottom left) north-east of Walpole, south-west Western Australia.

This historical data source provided the basis for investigating the impacts of different fire interval sequences on the biota of open eucalypt forests and shrublands in the Warren bioregion in the far south of SWA. The aim of this study was to evaluate the resilience of plants, vertebrates, invertebrates and fungi to different fire interval sequences over the last 35 years in order to guide the management of fire interval regimes for biodiversity conservation. This Fire Note summarises a paper currently in review (Wittkuhn *et al.* in review).

BUSHFIRE CRC RESEARCH

This project investigated historical fire intervals in a landscape mosaic of open jarrah (*Eucalyptus marginata*) forest and seasonally-inundated shrublands in the Warren bioregion (Fig. 1). The study area of ~50 000 ha was burnt in wildfires or prescribed burns of the 2002/03 fire season, such that the time-since-last-fire was the same at all sites. This variable is a strong determinant of community composition, and controlling for it represents an important part of the study design.

Fire history data obtained from Departmental records was used to determine the sequence of short (≤ 5 years), moderate (6–9 years) and long (≥ 10 years) fire intervals between 1972/73 and 2004/05 (Wittkuhn *et al.* 2009).

Thirty sites were selected in jarrah forest (16) and shrubland (14). Sites were selected based on the following fire interval sequences which were experienced at some stage in the history of these sites:

1. short-short (SS): two fire intervals of ≤ 5 years in succession;
2. long-long (LL): two fire intervals of ≥ 10 years in succession;
3. mixed/moderate (M): a mixture of fire interval lengths, or predominantly moderate (6–9 year) intervals;
4. very long (VL): a 30 year interval prior to the most recent fire (only available for forest sites).

Species composition and abundance of ants, beetles and vascular plants were surveyed on all sites. In addition, forest sites were surveyed for macrofungi and vertebrate fauna.

FIRE INTERVAL SEQUENCES

Fire interval sequences (sensu Wittkuhn *et al.* 2009; Wittkuhn & Hamilton in press) are a classification of actual fire intervals (in years) into a number of specified temporal groups, such as 'short', 'moderate' and 'long', joined together in geographic information system (GIS). An example is presented here, showing two polygons with different fire histories.

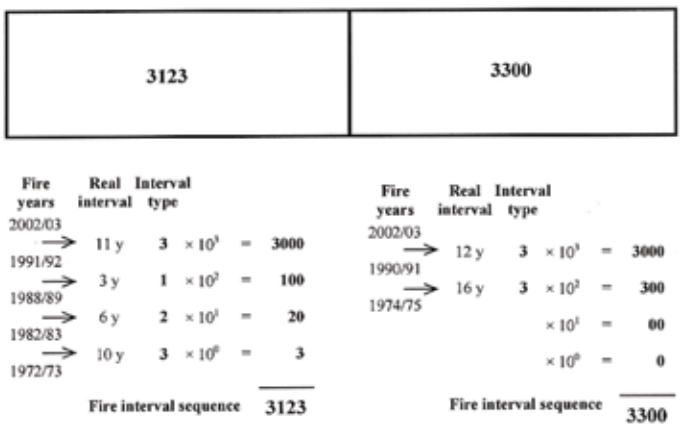
The following integers were used to classify actual fire intervals:

1 = short fire intervals (≤ 5 years)

2 = moderate fire intervals (6–9 years)

3 = long fire intervals (≥ 10 years).

By joining the classifications into a sequence and mapping in GIS, contrasting and similar fire interval sequences can be identified and displayed with other GIS layers.



END USER STATEMENT

"This study represents the most advanced analysis on the potential effects that long-term fire treatments and fire intervals have on the composition and abundance of our flora and fauna in the forest and shrubland ecosystems of southern Western Australia. The key finding of this study, that these ecosystems are resilient to a range of fire regimes including consecutive short fire intervals, is reassuring to fire and land managers who have responsibility for planning and implementing a variety of fire regimes to achieve a wide range of land management objectives. The findings are likely to be applicable to other fire-prone forested lands throughout Australia, and will be of great value for those fire and land managers who have responsibility for protection and conservation of dry forest and shrubland ecosystems."

– Rick Sneeuwjagt
Principal Fire Projects Officer
Department of Environment and Conservation (DEC)

Surveys for most groups were conducted over two years, and often twice in a single year to account for seasonal variation in species composition.

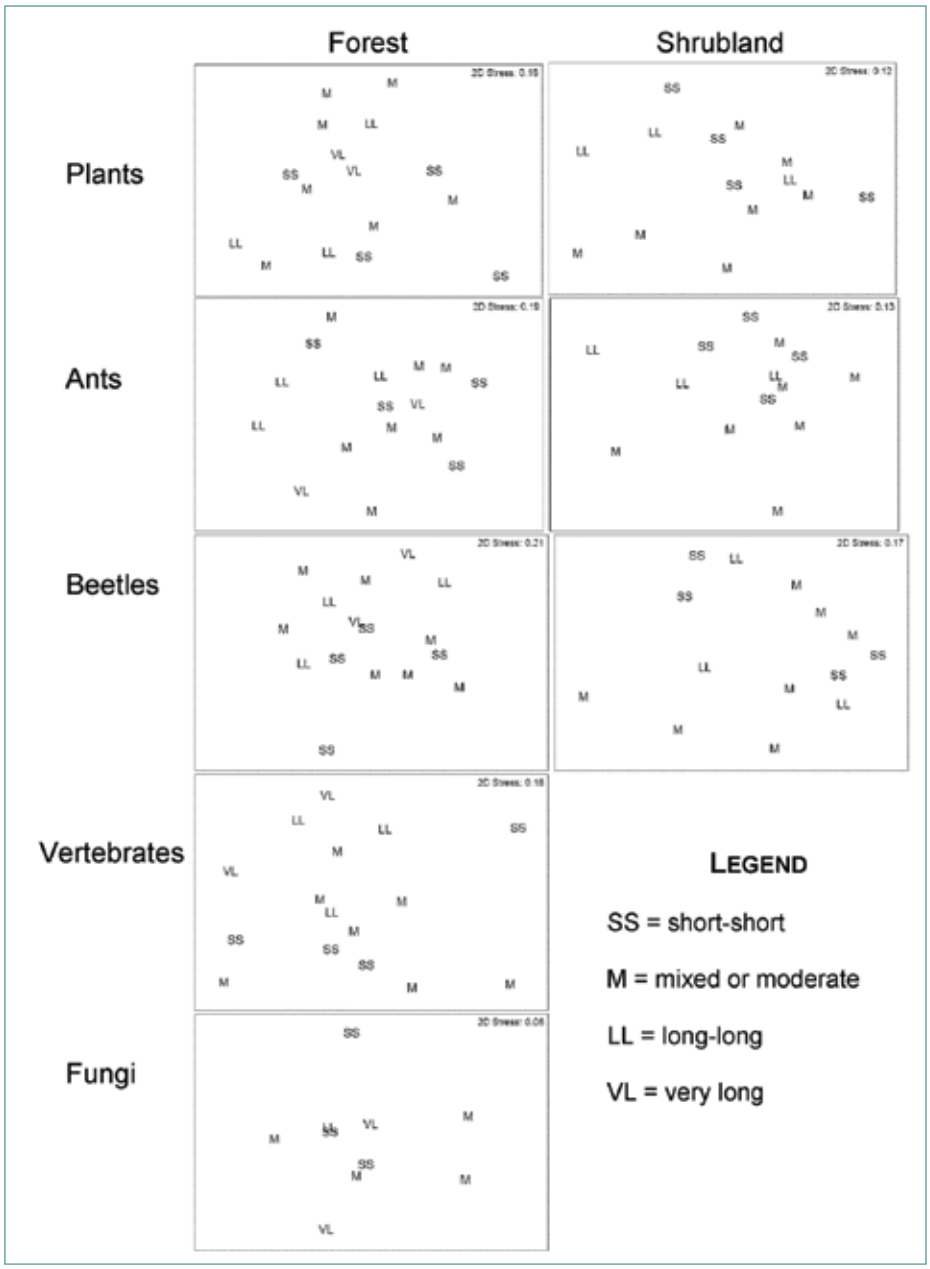
Data collected over the two years of sampling were combined and then analysed using ordination techniques to examine similarity in species composition and abundance between sites.

RESEARCH OUTCOMES

None of the taxonomic groups displayed significant differences in species composition as a result of contrasting fire interval sequences in either forest or shrubland (Fig. 2). Our data show that varying fire intervals had no persistent effect on the richness and composition of biota associated with open forests and shrublands of the Warren bioregion, and demonstrate that these ecosystems are highly resilient to fire. The periodic occurrence of fire in these ecosystems from pre-human to more recent times is likely to have pre-conditioned the biota to persist across a range of fire intervals varying from long (at least 30 years) to short (≤ 5 years) fire intervals. We suggest that the variability that has occurred at our sites makes an important contribution to observed resilience, whereas repeated short intervals over the longer term would likely lead to substantial ecological change.

Our findings contrast with those from other environments dominated by fire-sensitive shrubs where consecutive short fire intervals have been shown to have deleterious effects on fire-sensitive plant species (Cary and Morrison 1995; Bradstock *et al.* 1997). Similarly, differences in invertebrate (York 1999; Andersen *et al.* 2006) and fungi (Anderson *et al.* 2007) composition have been observed on frequently- and un-burnt forest, though time-since-last-fire may be a confounding variable in these studies which cannot be distinguished from fire interval effects.

A key research question arising from this work is whether time-since-fire is a stronger driver of species composition than is previous fire history. This has critically important implications for conservation management, which could focus on the maintenance of an appropriate mosaic of time-since-last-fire across the landscape (Wittkuhn & McCaw 2010).



▲ **Figure 2:** Ordinations of research sites based on the composition and abundance of species in each biotic group for forest and shrubland sites (non-metric multidimensional scaling ordinations). Each site is represented by its fire regime label as shown in the legend. Fungi and vertebrates were not sampled in the shrubland. Sites plotted closer together have a more similar species composition and abundance than those plotted further apart.

HOW THE RESEARCH COULD BE USED

The fact that two consecutive fire intervals < 6 years did not lead to persistent changes in community composition has important implications for resolving trade-offs between using prescribed fire to reduce fuels on one hand, and managing for biodiversity on the other. A 50-year study of fire history in the Warren region by Boer *et al.* (2009) showed that the incidence of large unplanned fires (wildfires) was significantly less than the long term average when the annual extent of prescribed fire was at a maximum. The effects of prescribed burning on the incidence

and extent of unplanned fires persisted for up to 6 years (Boer *et al.* 2009). Our findings suggest that it is possible to maintain the age of vegetation and fuel at < 6 years across parts of the landscape and limit the potential spread of wildfire, without deleterious impacts on a range of biota.

Importantly, Boer *et al.* (2009) showed that the percentage area with young (≤ 6 years) fuels was less important than the connectedness of old (> 6 years) fuel patches as a significant determinant of the annual extent of area burnt by wildfire. A strategic prescribed burning program that breaks up the connectedness of older fuels in the landscape will be effective in limiting the potential spread of unplanned fires and may provide a feedback loop whereby the spatial scale of wildfires is mitigated by the mosaic of shifting young (≤ 6 years) fuel ages through time in the landscape. This type of fire management should also aim to include some decadal-scale fire intervals as part of the variation in fire interval sequences. Our results did not demonstrate any significant beneficial or detrimental ecological effects from the long or very long fire intervals. This suggests that the organisms in these ecosystems are well adapted to tolerate significant variation in fire intervals, and this variation may be important for their persistence at the landscape scale.

▲ Examples of the biodiversity in south-west Western Australia.

Additionally, the resilience demonstrated by all taxonomic groups to a range of fire interval sequences means that occasional shorter intervals that may result from unplanned fires affecting recently-burnt sites are unlikely to have serious adverse consequences for biodiversity.

FUTURE DIRECTIONS

Further research should focus on quantifying the range of spatial scales at which mosaics of young and old fuels should be implemented for effective species conservation and wildfire mitigation. This understanding will become critical if predictions of increased fire danger and more extreme fire events due to climate change become a reality.

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