The Use of Fire for Ecological Purposes: Animal Habitat Management.

by Angas J.M. Hopkins

Western Australian Wildlife Research Centre

P.O. Box 51

WANNEROO W.A. 6065.

Abstract

Fire is an important tool in the management of semi-arid lands in Australia for maintenance and enhancement of European property values. Fire also has a role in management of areas for nature conservation. However, effects on natural ecosystems, particularly the faunal component, are poorly understood. Thus fire regimes for maintaining biological values are not well developed. This paper briefly outlines some features of a fire -- post-fire sequence relevant to the development of these fire regimes.

Introduction

In the management of land in the semi-arid region of Australia, fire is an important tool. The region has highly flammable vegetation and experiences a climatic regime which engenders fire. Activities and property values of European man are dispersed throughout the semi-arid region; these require protection which, in practice, is often achieved through the use of fuel reduction burning. But fire has also been a feature of the evolutionary environment of our indigenous biota and thus effective conservation, which necessarily involves maintenance of process, also involves the use of fire. At this stage however, our technological capacity to use fire as a management tool exceeds our understanding of its effects (particularly long-term effects) on biological systems. The purpose of this brief paper is to highlight some of these effects as they relate to animals and their management.

The Management Objective

The practice of deliberate or prescribed burning should always be towards a clear objective. A number of examples spring to mind: protection of timber values in a productive forested area; enhancing sheep grazing on a pastoral lease; or maintenance of an assemblage of plants and animals in a nature conservation area. Each objective has an appropriate fire regime (_sens._ Gill 1975). For example frequent, low-intensity burns in early Spring facilitate fuel reduction; moderate-intensity burns in Autumn-Winter remove rank grass and may reduce mallee eucalypt populations, while infrequent, moderate-to high-intensity burns may trigger a post-fire regeneration sequence. Each regime will affect the indigenous fauna to some extent. Each may also affect populations of introduced animal species. Indeed one of the above regimes is actually designed to promote a land-use based on introduced animals. However, it is appropriate at this workshop to focus attention on the indigenous fauna - fire interaction, particularly in relation to areas for which nature conservation is the principal management objective.

The process of developing an appropriate fire regime for a nature conservation area usually involves an assessment of the response of the system to a single fire. That assessment may be based on results from either consecutive samples of a single site over a long period of time or contemporaneous observations at a number of ecologically equivalent sites with different fire histories. These studies provide the time framework of the post-fire succession, where succession is defined as an ecocline in time. Animal species usually exhibit Gausian-like abundance responses in time, with each species having an abundance peak at the time when the environment is most favourable for it. An example of this was demonstrated in an earlier paper by Noble using data from Fox and McKay (1981). If desired, the abstract management objective (maintenance of maximum diversity) can be redefined in terms of one or more indicator species. The between-fire interval or return time is then related to the time from fire to maximum abundance of the indicator species. However, it should be noted that, as a burning rotation is implemented, the average age of the vegetation will increasingly approximate half the return time. Thus consideration should be given to developing a fire regime in which return time is about twice the time from fire to maximum abundance of the indicator species. Once the chosen regime is implemented, the affects of repeated fires can be assessed and the prescription modified on the bases of later monitoring results.

Fire and Fauna

It is clear from the foregoing that the deliberate use of fire to achieve an objective related to the ecology of a particular faunal species is dependant on knowledge of the post-fire succession. Unfortunately, for most nature conservation areas in semi-arid Australia, this knowledge is lacking. I propose, therefore, to outline a simplified fire -- post-fire succession to provide a basis for discussion. The succession described is for a hypothetical site in southern Australia which experiences a Mediterranean-type climate with annual rainfall of 300-450 mm. The nature vegetation consists of a mixture of trees and shrubs with a minor herb and grass component in the understorey (Figure 1a).

It may be possible to extrapolate the idealised succession beyond the limits of the hypothetical area described by varying the time scale inversely with rainfall but extreme caution should be used when a) the understorey changes from predominantly shrubs to predominantly grasses and b) when the pattern of rainfall changes from being predominantly in winter to predominantly in summer.

The site suffers an unplanned fire resulting from lightning strike ingition nearby. The fire is fanned by hot, dry summer winds and moves rapidly through the vegetation, affecting an extensive area which includes the site of interest. The litter layer is removed and much of the living foliage, (including tree crowns to ca. 6 m high) and woody material up to ca. 1 cm diameter is consumed (Figure 1b). For the animals, most escape direct incineration but the environment has suddenly become inhospitable; they have been deprived of food resources (there may be a time lag for higher order consumers) and habitat. Non-mobile species may persist throughout the burnt area in low abundances by utilizing unburnt, refugial areas, while mobile species may either move out altogether (where territories are available) or may merely move to feed. Then as the food and habitat resources regenerate, the animal species gradually re-invade the burnt site giving rise to the faunal succession to which I previously referred.

This post-fire succession must be related to some rather subtle and often difficult to measure features in the vegetation such as structure (habitat) and relative importance and phenology of individual plant species (food resources). This is because there is little floristic change at a site during the regeneration period. Post-fire succession in most Australian sclerophyllous vegetation types accords with the Initial Composition Model, whereby most of plant species ever to be found at a site will be present within 1-2 years after the fire (Purdie and Slatyer 1976). Thus the remainder of the idealised succession (Table 1) deals with the plants only as they affect the animals.

Three further points are pertinent to the discussion of fire and animals. Firstly, any fire regime incorporating a rotation of fires, particularly with a short return time, is likely to have a more profound impact on the ecosystem than any single fire. Thus regimes prescribed for conservation reserves should be conservative from the point of view of the biota.

Secondly, the affects of animal grazing on the regenerating vegetation may have significant effects on both structure and floristics of the mature vegetation. Some of these effects have been noted for feral animals (Cheal et al. 1979) and native vertebrates (Leigh and Holgate 1979) and invertebrates (Wheelan and Main 1979). Grazing by the native animals may be mitigated by burning large patches (eg. greater than 500 ha). For feral animals, less frequent burning, some fencing and some eradication measures may be appropriate.

Up to this point I have been discussing within-habitat effects of fire and subsequent management strategies. However, ecotones (boundaries between habitats) are of considerable significance to animals (eg. Readers Digest 1976, p.11) and, in recognizing this, a number of field workers have incorporated measures of ecotones in their observations (eg. Muir 1977). Fire boundaries exhibit many ecotone-like properties: they may provide short-term floristic discontinuities of importance to animals (eg. Bolton and Latz 1978) or long-term, possibly permanent, structural discontinuities (Hopkins and Robinson 1981). At this stage the importance of these fire boundaries for most animal species in semi-arid Australia is not known. Procedures for translting such knowledge into management practice is a further problem.

References

B.L. Bolton and P.K. Latz (1978). The western hare wallaby, Lagorchestes hirsutus (Gould) (Macropodidae), in the Tanami Desert. Aust. Wildl. Res. **5** : 285-293.

B. Cheal, J. Day and C. Meredith (1979). Fire in the National Parks of North-West Victoria. (National Parks Service of Victoria; Melbourne).

B.J. Fox and G.M. McKay (1981). Small mammal responses to pyric successional changes in eucalypt forest. Aust. J. Ecol. **6** : 29-41.

A.M. Gill (1975). Fire and the Australian flora : a review Aust. For. **38** : 4-25.

A.J.M. Hopkins and C.J. Robinson (1981). Fire induced structural change in a Western Australian woodland. Aust. J. Ecol. 6(2) in press.

J.H. Leigh and M.D. Holgate (1979). The responses of the understorey of forests and woodlands of the Southern Tablelands to grazing and burning. Aust. J. Ecol. **4** : 25-45.

B.G. Muir (1977). Biological Survey of The Western Australian Wheatbelt. Part 2 : Vegetation and habitat of Bendering Reserve. Rec. West. Aust. Mus. Suppl. No. 3 : 1-142.

R.W. Purdie and R.D. Slatyer (1976). Vegetation succession after fire in sclerophyll woodland communities in south-eastern Australia. Aust. J. Ecol. 1 : 223-236.

Reader's Digest (1976). Complete Book of Australian Birds. First Edition. (Reader's Digest Services Pty. Ltd. : Sydney).

R.J. Wheelan and A.R. Main (1979). Insect grazing and post-fire plant succession in south-west Australian woodland. Aust. J. Ecol. 4 : 387-398.

Table 1. Idealised Fire - Post-fire Succession at a Southern Australian Site Receiving 300-450 mm Rainfall p.a., predominantly in winter and with Typical Sclerophyllous Vegetation.

Time (Years)	
-1	Mature vegetation with ample stores of seed on plants and in soil, relatively high fuel loading.
0	Hot fire. Death of large proportion of above-ground parts of plants, release of bradysporous seed, scarification of soil stored seed. Destruction of habitat and food resources and consequent death of fauna, particularly non-mobile and territorial species.
+1	Regeneration of vegetation by resprouting from below-ground parts (lignotubers etc.) and from seedlings. In general, all species ever present at a site are present at this early stage (Initial Floristic Composition Model). Increasing herbivore food resource. Poor habitat, low litter load and decomposer communities.

+2-5	Dense low shrub and herb layer, first flowers of some shrub species. Some seedling mortality through grazing pressures. Habitat slowly improving for ground and near-ground welling vertebrates. Minor litter build-up. Vegetation vulnerable: severe perterbation (ie. another fire) may cause extinctions.
+5-10	Shrubs form closed canopy at ca. 1 m but becoming more open beneath - provides good cover for small mammals and other gorund welling vertebrates. Good flowering and fruiting of shrub spp. Tree species emergent from shrub stratum but flowers rare. Mortality of short lived perennial shrub spp. (fire ephemerals, now present only as seeds in soil). Gradual increase in litter load and commensurate in decomposer invertebrates and their predators.
10-25	Shrub stratum beginning to thin out, gradual mortality of shrub spp., and canopy opening. Slow increase in herbs and grasses. Less flowering and fruiting of shrub species but good seed store present. Small mammal habitat becoming sub-optimal but species persisting. Tree stratum maturing with some deaths. Litter

standing crop reaches maximum (plateau) level as decomposers keep pace with litter-fall rates.

25-50 Shrub stratum quite sparce although all woody perennial plant species still present in low numbers. Continuing increase in importance of grasses. Habitat for small, ground dwelling vertebrates now poor and species persisting (in the absence of predators) at very low densities with large territories and utilizing occasional thickets for nesting. Some senescence of trees providing tree hollows. Optimal habitat for decomposers and their predators.

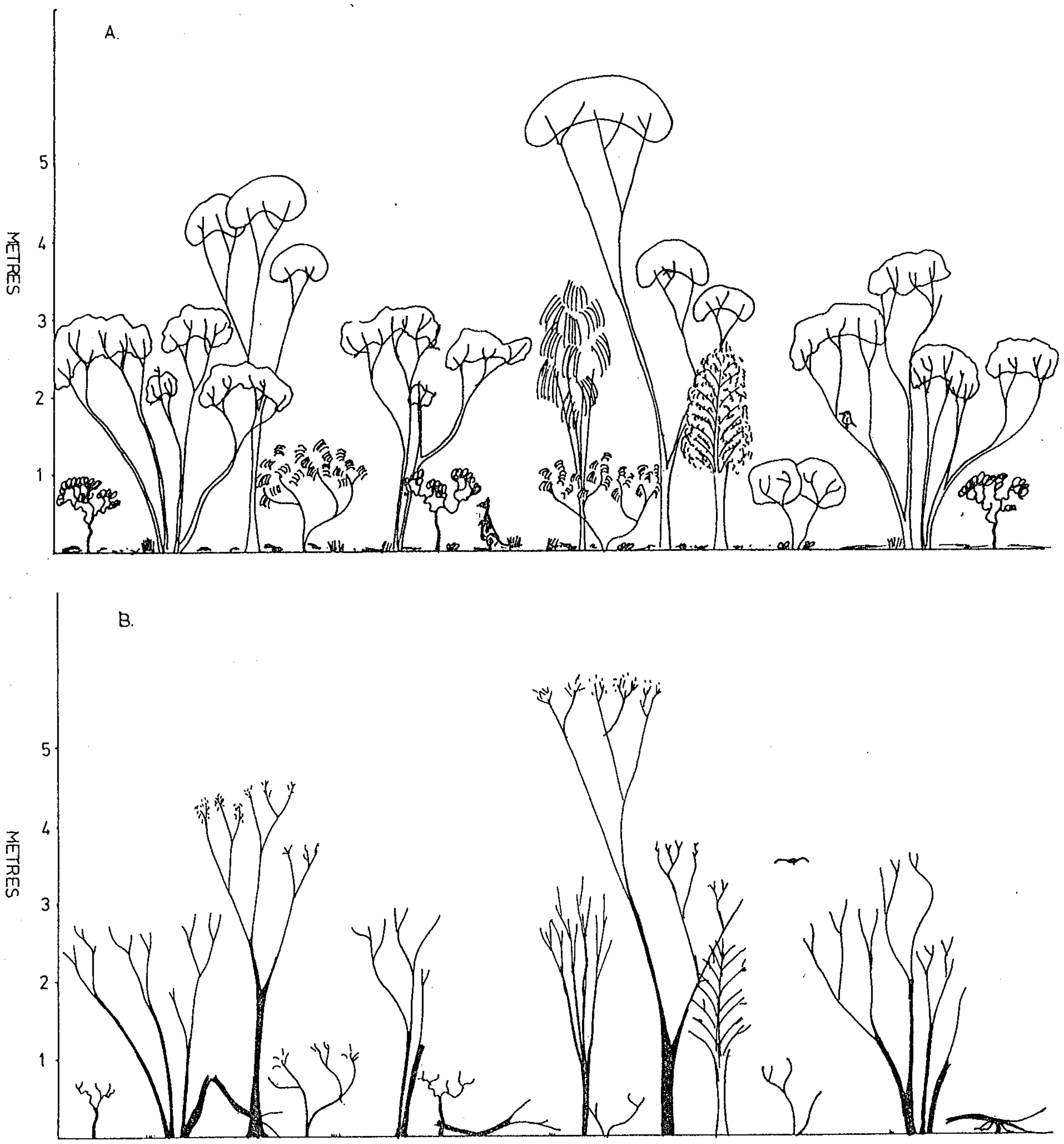

Figure 1. Profile diagram of vegetation at the hypothetical site in semi-arid southern Australia. A represents the mature vegetation before the fire, B is the same site soon after a hot, Summer wildfire.