EFFECTS OF FIRE ON SOME PLANTS AND ANIMALS

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Introduction

This session will be in 2 parts. Firstly, I will discuss some general principles of fire effects on plants and animals in the south-west using a number of case studies. I will then examine how these principles can be and are applied in land management.

Vegetation and Fire

Vegetation is a logical place to start when discussing fire effects. It becomes the fuel, is the food and shelter for animals, is the cover for the soil and is important in its own right. In fire prone environments such as ours, the bush has remarkable powers of recovery after fire due to the evolution of many adaptive traits. These adaptations include thick protective bark, seeds protected in woody fruits or capsules, epicormic buds buried beneath the bark, rootstocks, lignotubers, fire induced flowering, fire induced synchronized seed fall, hard seeds buried in the soil and which require heating to germinate en masse and other traits. One or more of these adaptive traits can be found in our local plant communities.

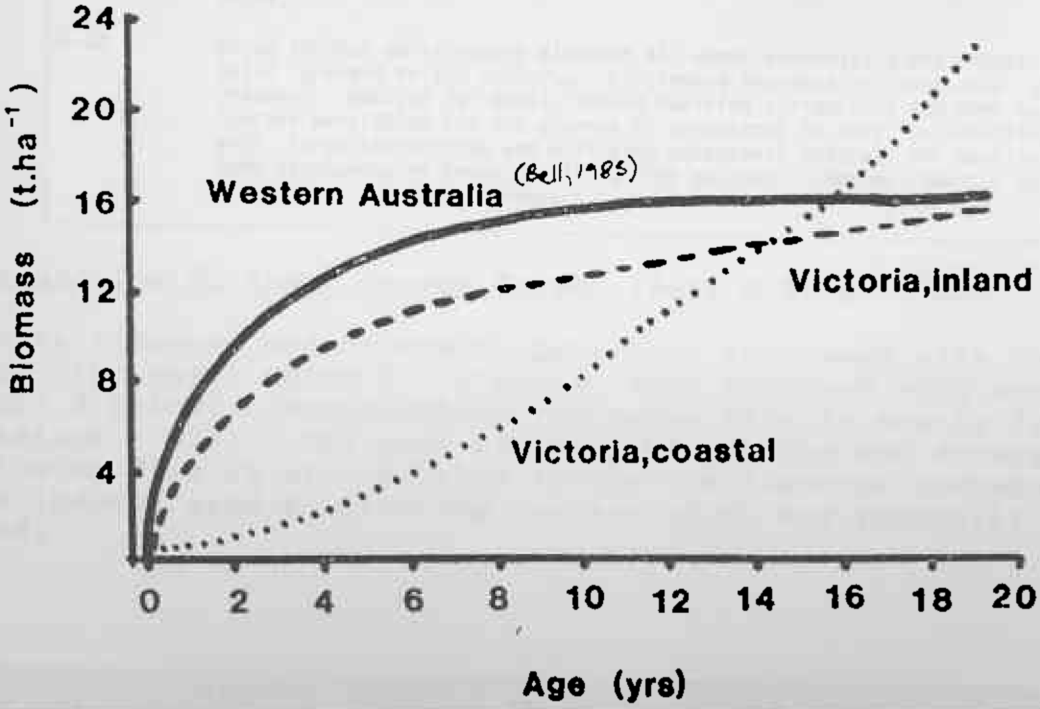
It is not correct to say that our plant communities are adapted to fire. They are in fact, adapted to survive the fire regime in which they have evolved. A fire regime is the frequency and season of fire, the fire intensity, the cumulative number of fires within the life cycle of each plant species and the area which the fire burns. When discussing fire effects, it must be in these terms. Discussing the effects of a one-off fire without reference to what came before and what is to come after in terms of fire, can be misleading. However, we do not have the benefit of long term studies so must make judgements on the likely effects of various fire regimes from our short term studies. Together with a knowledge of plant life cycles, adaptive traits and climate, we can deduce what some of the long term consequences of various fire regimes might be. Lets now look at a number of such studies.

Fire in Heaths (Bell, 1985)

A high proportion of species in northern sandplain heaths re-sprout from rootstock or lignotuber (85%) following fire and most of the remainder have seed present in the soil or carry seed in protective woody fruits. The proportion of plants capable of re-sprouting following fire provides a clue to the expected fire frequency in these plant communities. For example, in vegetation to the north of Esperance, workers (van de Moezel and Bell 1984) found that less than 30% of the species were re-sprouters. They concluded that in order to maintain the status quo of plant communities in this region, then fires should not be more frequent than about 50 - 100 years. They also noted that species richness was greatest soon after fire. The longer time intervals are necessary to allow seed species to build up adequate stocks of soil stored seed which will germinate following fire. Generally, the lower the proportion of re-sprouters, the longer the interval between fires. Estimates of the minimum sustainable fire frequency in northern sandplains near Badgingarra range from 25 - 50 years. Repeated firing at shorter intervals is likely to cause changes to the floristic composition (Bell 1984). Notably, seed species will disappear and re-sprouters will dominate.

The rate of plant re-growth following fire on the northern sandplain is rapid as most species are re-sprouters. Within 12 months, the plant biomass is around 4t/ha and by 2 years, is more than 11t/ha. By 8 years, the quantity of above ground vegetation levels off at around 14 - 16t/ha. Again, it is due to the stores of nutrients and energy in below ground organs which enables rapid post fire response. Communities dominated by seed species, respond much slower.

Figure 1. Biomass accumulation curves from the Northern Sandplain kwongan and reported curves from inland and coastal Victorian heaths (after Jones et al. 1969).



Fire in Woodlands and Semi-Arid Zones of the South-west
(Hopkins, 1985)

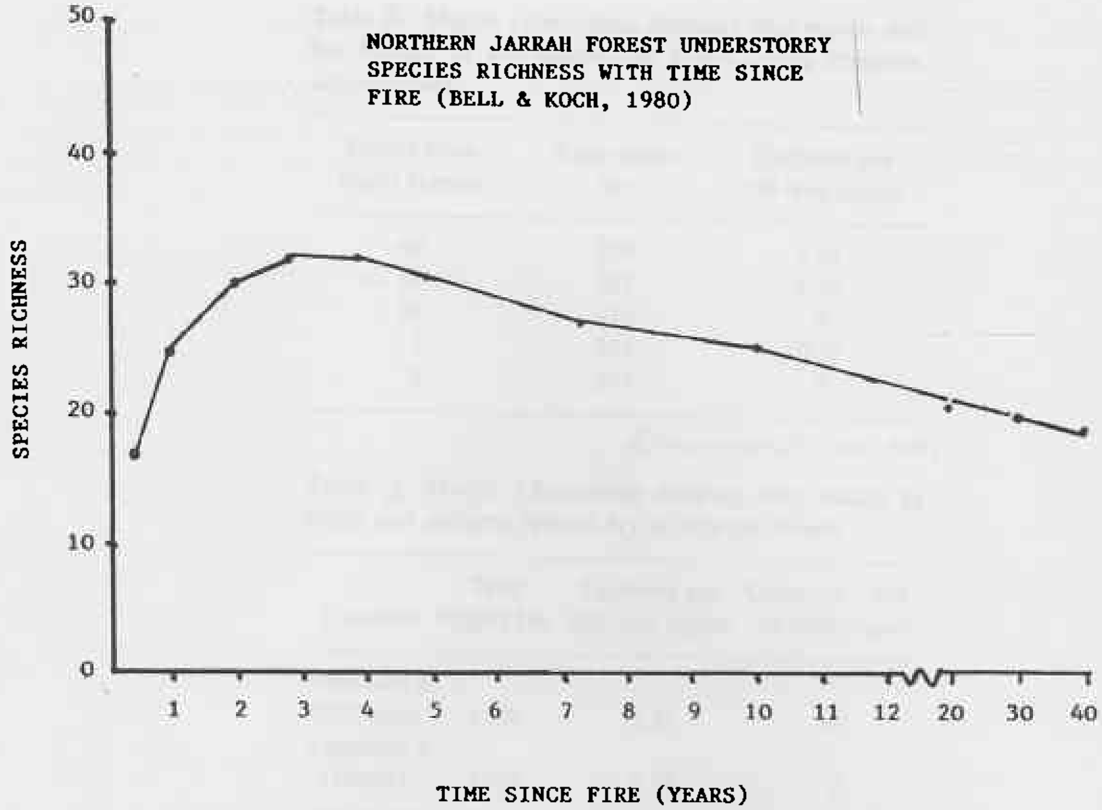
Table 1 below summarises the fire effects sequence likely in south western Australia receiving a 300 - 450mm annual rainfall.

Table 1. A generalised fire effects sequence for a hypothetical site in south-western Australia receiving 300-450 mm annual rainfall and supporting trees, shrubs, herbs and grasses. (Hopkins, 1985)

TIME (years)	STAGE
-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 resources. 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 dwelling vertebrates. Minor litter build-up. Vegetation vulnerable: severe perturbation (i.e. 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 ground dwelling 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 emphemerals, now present only as seeds in soil). Gradual increase in litter load and commensurate increase 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 sparse 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 utilising occasional thickets for nesting. Some senescence of trees providing tree hollows. Optimal habitat for decomposers and their predators.

Fire and the Northern Jarrah Forest (Bell & Koch, 1980)

Species richness and diversity generally increased with time since fire until about 3 - 5 years, then declined with age (see Figure 2 below). Regeneration following fire is mostly from rootstock (~69%). The peak richness of species and diversity following fire is attributable to the simultaneous presence of fire induced seed-germinating species which are generally short lived.



Fire and the Karri Forest (Christensen and Kimber, 1975)

Again, species richness increases after burning. This is due to the high proportion of herbs and seed species in these communities. Apart from the very early seral stages (soon after fire) the karri forest understorey is dominated by fire sensitive woody species which regenerate from seed. There are about 10 or so such species, but on any one site, only one or two are present. All are prolific seeders and large seed reserves are stored in the soil. After fire many of these seeds germinate (but not all) along with seeds of herb species. With time after fire, many of the short lived herbs and woody seed species die out or are suppressed out. There are few long term studies of repeated fire in the karri forest, but one such study being conducted near Manjimup has revealed that even after 15 years of repeated burning every 2 - 3 years, there has been little or no change in understorey species composition.

The Effect of Fire on Some Animals (Christensen & Kimber, 1975)

1. Mardo (*Antechinus flavipes*)

The mardo occurs throughout the forests of the south west. It favours swamps in the northern jarrah forest and is found throughout the karri forest. Population levels are generally low in frequently burnt forest (see Tables 2 & 3 below).

Table 2. Mardo *(Antechinus flavipes)* trap results and fire history in wet sclerophyll forest (After Pentony, unpublished).

Period since burnt (years)	Trap nights No.	Captures per 100 trap nights
40	324	7.41
ca. 30	312	1.28
20	312	0
5	312	0.32
2	264	0

(Christensen & Kimber, 1975)

Table 3 Mardo *(Antechinus flavipes)* trap results in burnt and unburnt upland dry sclerophyll forest.

Location	Trap Nights No.	Captures per 100 trap nights	Captures—No. of individuals
Amphion 6 (Unburnt)	1200	11.83	36
Amphion 9 (Burnt)	1200	0.17	2

The rate of re-colonization by mardos increases steadily with time after fire and in accordance with the vegetation recovery (see Figure 3).

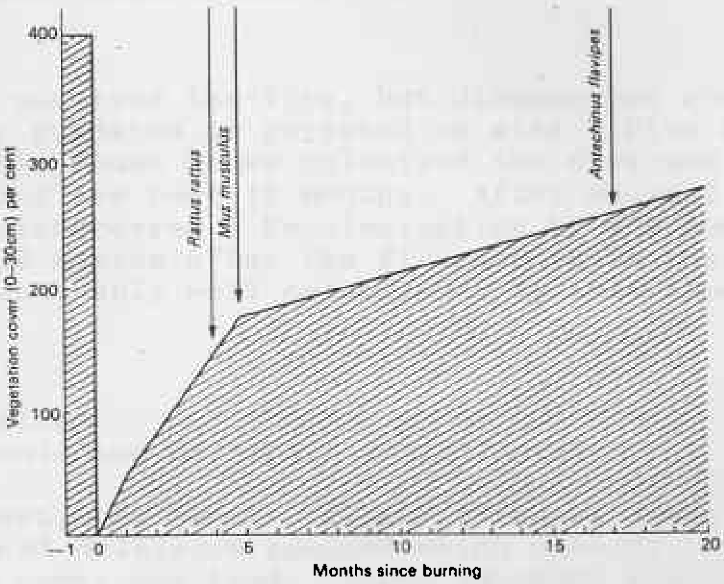


Figure 3 Vegetation recovery and recolonisation by small mammals following fire (Moore's Swamp).
(Christensen & Kimber, 1975)

2. Southern Bushrat (*Rattus fuscipes*)

An experimental site in karri forest which had not been burnt for 20 years was burnt at wildfire intensity. The numbers of bushrats in the area was monitored by trapping before and after the fire (see Figure 4).

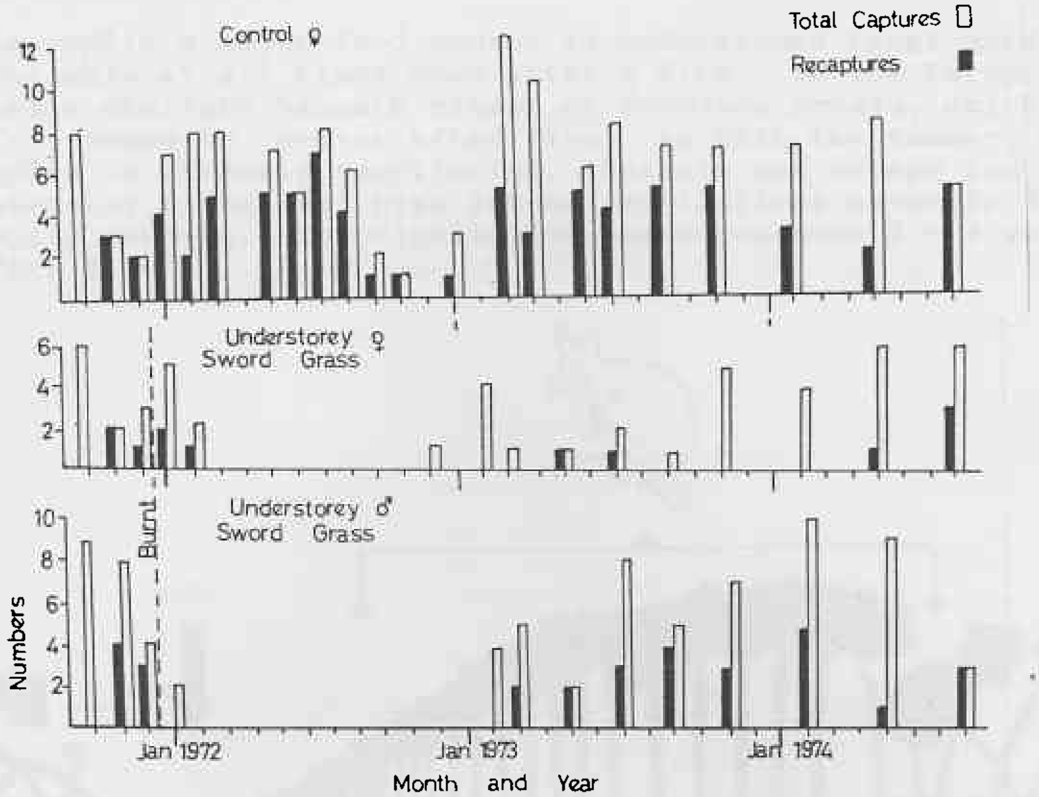


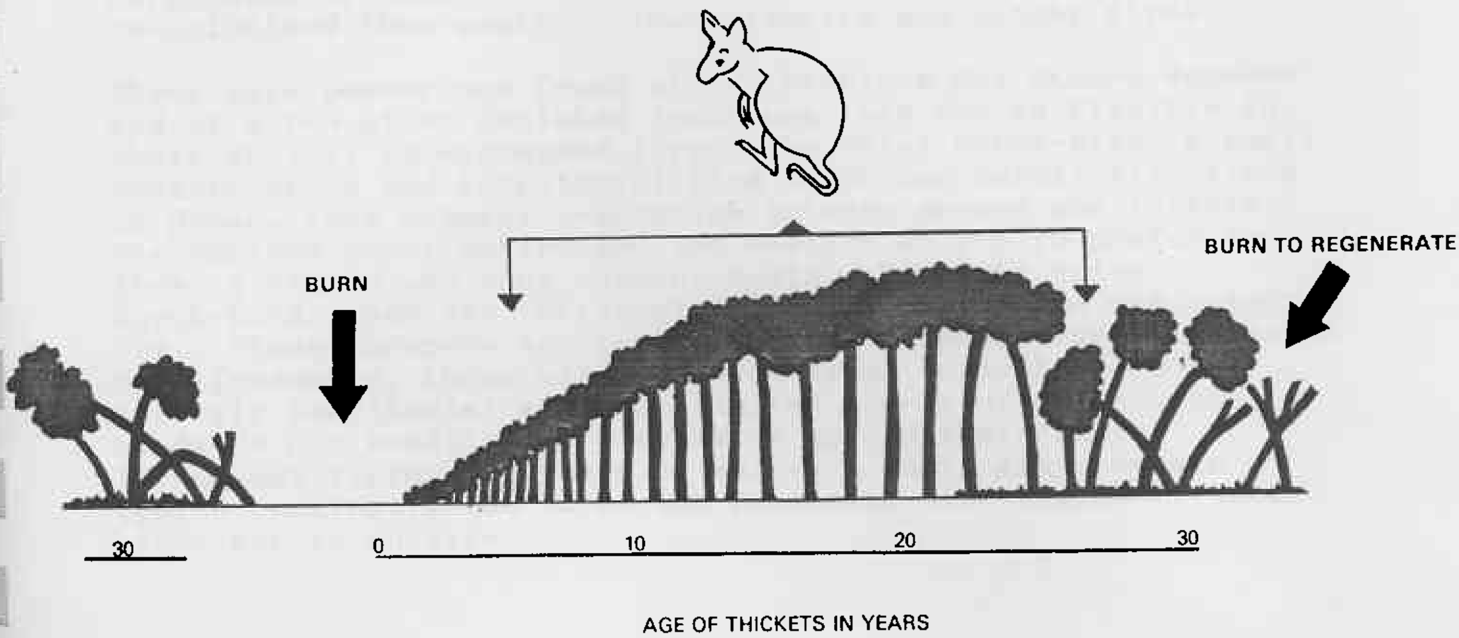
Figure 4 Fire and bush rat trapping. (Christensen & Kimber, 1975)

Some of the rats survived the fire, but disappeared soon after and were probably predated or perished on site. Five months after the fire, the house mouse colonized the area and reached high numbers during the next 12 months. After about 2 years, the house mouse disappeared. Recolonization by the bushrat commenced about 12 months after the fire and again vegetation cover was also reasonably well established by this time (see Figure 3).

3. Tammar and Woylie
(*Macropus eugenii* and *Bettongia penicillata*)

In the Perup forest, the Tammar wallaby lives in dense thickets of *Gastrolobium* and *Melaleuca* species which provide the animal with good cover and food. These thickets degenerate and collapse after about 20 - 30 years and are unsuitable as habitat for the animal. It requires an intense summer or early autumn fire (dry fuels and soils) to regenerate the thickets. About 6 years after the fire, the animals recolonize the thickets. Tammars are relatively slow breeders, one young per year, and live for about 6 years. They occupy group territories in different sections of the thicket, are strongly territorial even when confronted by fire.

The woylie's major food source is underground fungi which is available at all times even after a fire. In the Perup, the woylie shelters beneath clumps of *Bossiaea ornata*, which takes 3 - 4 years to recover after fire. As with the tammar, the woylie is strongly territorial. Animals may escape low intensity fires, but high intensity wildfires severely deplete woylie numbers. Re-colonization commences some 3 - 4 years after fire.



▲ Fig. 5—Tammar thickets in the Perup develop after intense autumn or summer fires. For the first five to six years the thickets are too dense for the tammars. Competition between the plants thins them out and the tammar may live in the thickets till the plants die and the thickets collapse after 25-30 years. (Christensen, 1982)

Fire and Birds (Christensen and Kimber, 1975; Smith, 1985)

Birds in the jarrah forest tend to be habitat specific. While there are exceptions, birds prefer to nest and to feed at a specific level in the forest profile. For example, thornbills prefer to nest and feed in the low scrub layer (up to 2m), but the striated pardalote favours the upper tree canopy. Measurements of bird numbers and species before and after various intensity fires revealed that the level of disturbance caused to bird populations was determined by fire intensity and the resultant change in the forest profile. Low intensity burns which consumed or scorched all vegetation up to 2m effectively removed the habitat of birds such as thornbills, so thornbill numbers were reduced until the vegetation recovered. High intensity fires which defoliated the overstorey trees caused the greatest loss in bird numbers. However, within 2 - 3 years after a fire, bird numbers and species were equal or greater than the pre-burn situation.

Most birds in the jarrah and karri forest regions are highly mobile and enjoy a long breeding season. Hence, they are not normally disrupted for long following a fire of any intensity. Fire size as well as intensity is important. Large areas defoliated by wildfire take considerably longer to be re-colonized than smaller, low intensity and patchy fires.

Three rare passerines found at Two People's Bay Nature Reserve and at a few other isolated locations, are not as flexible in their ability to withstand fire. The Noisy Scrub-bird, a small insectivorous and territorial bird which can barely fly, lives in dense, long unburnt vegetation between swamps and forests. The Western Bristle-bird and the Western Whip-bird prefer to live in closed and long unburnt heath. Like the Noisy Scrub-bird, they are territorial, insectivorous and can barely fly. Since European settlement and the accompanying increase in fire frequency, these birds have declined in number. Being strongly territorial and with limited powers of flight, the birds do not readily re-colonize or spread their range. Infrequent firing (50 years or so) on a small grain mosaic (patch burning) seems to be the preferred fire regime if these birds are to survive.

Further reading;

Fire and the Australian Biota. Eds. Gill, A.M.; Groves, R.H. and Noble, I.R. (1981).

Fire Ecology and Management in Western Australia. Proceedings of May 1985 Symposium. Ed. Julian Ford (1985).