Fire and Biodiversity: The Effects and Effectiveness of Fire Management

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17 ASSET PROTECTION IN A FIRE PRONE ENVIRONMENT

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17.1 Abstract

Fire, a factor of the natural environment, has greatly influenced the formation of ecosystems. Fire protection, the protection of community assets from wildfire, is a local mechanism which interrupts the natural fire cycle. Fire protection consists of fire suppression, and fire prevention. Fire suppression effectiveness is limited to fires below about 3500kW/m intensity. This compares unfavourably with wildfire intensities which exceed 100,000 kW/m on 'blow up' days. Once such fires have developed, nothing can be done to suppress them until weather or fuel conditions change.

A major component of fire prevention is fuel management. Provision of broad area fuel reduction in strategically placed zones has been demonstrated to counteract high intensity fires on public land in Victoria. The effectiveness of fuel reduction burning can be shown by modelling, by the case study approach, or the economic efficiency approach.

The Department of Conservation and Natural Resources has statutory responsibility for 'proper and sufficient works for the prevention and suppression of fire' on public lands in Victoria; and also has responsibility for land management. Whilst fire protection is a statutory obligation, there is a developing awareness of the need to understand natural fire regimes, and use fire as a management tool.
The alternative, fire exclusion, usually assists neither management nor protection. Where the requirements of natural fire regimes and fire protection overlap, mutual benefits are possible. Several examples demonstrate that this approach is becoming established in managing public land in Victoria.

Key words

asset protection, fire prone environments, fire suppression, fire prevention, natural fire regimes,
fuel management, Victoria.

17.2 Introduction

Fossil evidence indicates that fires accelerated the transition from rainforest to more open woodland from about twenty million years ago (Kemp 1978). As the climate became drier, the natural fire frequency increased and eucalypts became more widespread. Birds, mammals and other fauna evolved in, and adapted to, habitat in which naturally caused wildfires were relatively common (Catling & Newsome 1978). Thus fire, a factor of the natural environment, has greatly influenced the formation of Australian ecosystems.

Use of fire was an essential part of the conversion of the natural landscape to agricultural land following European settlement. Periodically these small-scale, deliberate fires became uncontrollable and developed into large-scale wildfires (unplanned grass, scrub or forest fires) under severe conditions (weather conducive to high-intensity burns). In the summers of 1898, 1917, and 1926, widespread fires resulted in loss of life and property in many areas of Victoria.

17.2.1 Black Friday, 1939

In early January 1939, many uncontrolled fires were burning throughout the state. During the week of 'Black Friday', 13 January, 1939, 76 Victorians perished and large scale losses were incurred, including virtually all of the old growth mountain ash forests in Victoria, a resource of inestimable value.

Justice L E B Stretton led a Royal Commission into the causes of these fires. His recommendations (1939) laid the basis for new legislation and upgraded fire protection for public lands. Ultimately the Country Fire Authority was established in 1944, following extensive grass fires and a further Stretton Royal Commission in that year.

The Stretton recommendations heralded a more rigorous approach to fire protection in Victoria. 'Fire protection' includes both fire prevention and fire suppression measures, and a range of programs were progressively implemented. Prevention measures included improved access into forest areas and mechanical fuel reduction programs, including extensive firebreak construction. Uncontrolled burning off was prohibited. The systematic use of low intensity prescribed burning commenced on public lands during the 1970's with the introduction of the Forests Commission's fire protection planning system.

Fire suppression practices improved, particularly the early detection of fires and prompt despatch of suppression equipment to the fire scene, with the objective of limiting fire development. While serious fires occurred in the summers of 1952, 1962, 1969, and 1977, losses were localised and not of the scale of the 1939 fires. Official reviews followed these fires, and prevention and suppression measures were further refined. It was thought in some quarters that losses on the scale of the Black Friday disaster could not happen again.

17.2.2 Ash Wednesday, 1983

Just when the Black Friday fires were fading into the mists of mythology, the 'Ash Wednesday' fires occurred. On 14 February, 1983, 46 Victorians perished in ten hours; insured property losses exceeded $133 million (Hickman & Tarrant 1986).

The Bushfires Review Committee (1984) made 21 recommendations. These ranged from: adjustments to DISPLAN, the state emergency management arrangements; to measures for bushfire mitigation and preparedness; to systems for evacuation and interagency liaison. The Hon John Cain, Premier of Victoria, in announcing the Governments response to the recommendations, referred to previous fire tragedies and the subsequent enquiries as follows:

'I have already expressed the view that we were far better protected on Ash Wednesday than in 1939. I think it fair to say that we were also better protected than was the case in January and February of 1977...in other words, lessons have been learnt on each occasion and steps have been taken to improve fire-prevention techniques, fire fighting methods and relief procedures'

The recommendations of the enquiry were progressively implemented.

In the ten years since Ash Wednesday, further improvements have been made to inter-agency co-operation, fire organisation and fire fighting techniques. Refinements have occurred in aerial fire bombing, fire fighting equipment design, and the adaptation of technology to a range of fire fighting applications, including weather forecasting, radio communications, and real time fire mapping.

17.3 Review and Discussion

17.3.1 Victoria - high wildfire risk area

Table 1 shows the level of insurance payouts for wildfire damage to property between Australian states for the 20 years 1970-1989.

Table 1. Details of Insurance payouts for "bushfire" loss 1970-1989, Insurance Council of Australia

State	Payout $M (1989 values)	%
Victoria	269.4	69
Tasmania	84.8	22
SA	19.4	5
NSW	10.4	3
ACT	5.3	1
QLD	0.1	-
WA	0.1	-

TOTAL	384.5	100

These data confirm Victoria's unenviable reputation as one of the world's leading wildfire hotspots, along with southern California, and the Mediterranean coast of France.These recurring wildfire losses are an outcome of a combination of extremes of summer climate, vast expanses of dry fuel, and a recurring pattern of ignition events.

While campaigns directed at reducing fire causation can reduce fires caused by the responsible community, ignitions from lightning, arson, carelessness and accidents rule out the elimination of wildfire.

The fundamental issue faced by the Department of Conservation and Natural Resources, in discharging its responsibility for wildfire suppression on public lands in Victoria, is that the capability of suppression forces is quickly exceeded by fire intensity levels under severe weather conditions.

Table 2 (Cheney, 1994) illustrates the capability of a range of suppression techniques.

Table 2. Head fire intensity at which suppression is likely to fail on a 10 hectare fire burning in dry stringybark forest

Suppression method	Fire intensity (kW/m)
hand tools (crew of 7)	800
bulldozers (2xD6)	2000
air tanker (D6B)	2500
ground tankers on a 40m fire break	3500

These data show that the capability of suppression action has an upper limit of about 3500kW/m in forest fuels. This sits comfortably with the use of fire in resource management, where the intensity of fuel reduction fires is usually below 500 kW/m.

However the intensity of wildfires can quickly rise above the threshold of suppression capability. The approximate levels of forest fuel and forest fire danger index (McArthur, 1967) at which a fire intensity of 3500 kW/m is reached is shown in Table 3.

Table 3. The Forest Fire Danger Index at which a Fire Intensity of 3500 kW/m arises for five different fuel levels

Fuel QTY (t/ha)	Forest fire danger index (FFDI)

5	100
10	55
15	25
20	14
25	9

Since FFDI is based partly on fine fuel availability (among other factors, including humidity), "spotting" in the more hazardous bark fuel types may prevent suppression of the head of the fire at lower levels than indicated in Table 3.

McArthur (1967) described the 'acceleration effect' in which a forest fire develops as a series of steps through successive layers of fuel, until a convection column develops and the spotting process commences. He commented that 'at a fire danger index of 100, probably the only chance of controlling a fire occurs in the first 30 minutes of its life. Beyond this period, the fire must be considered uncontrollable despite a maximum suppression effort'.

The intensity of the destructive high intensity fires referred to earlier in this paper vastly exceeds the capability of suppression forces. For instance, the intensity of the Otways fire of Ash Wednesday in which the forward rate of spread was 10.8 km/hr, was some 110 000 kW/m. This is equivalent to 110000 one kilowatt electric radiator bars per metre of fire edge and is some thirty times the capability of suppression forces. Spotting of 8-10 km was recorded during the north-south run of this fire (Rawson et al. 1983).

Hence the emphasis placed by suppression forces on early detection and fast, determined first attack on wildfires, based on a level of preparedness which rises as the fire danger develops. However, fire ignition cannot be eliminated, and early suppression of all incidents that start under high FFDI conditions cannot be guaranteed.

The other variable in the fire intensity equation is fuel quantity, as demonstrated in Table 3.

17.3.2 Fuel management programs

Fuel management programs are an important adjunct to the reduction of wildfire losses in fire prone environments. In eucalypt forest, there are three typical sites for fuel accumulation. The continual shedding of leaves, branchlets and bark contributes to the buildup of fuels on the forest floor. Bark flakes, responsible for much of the notorious 'spotting' behaviour of eucalypts, accumulate on trunks and branches; and leaves and other material form suspended fuel banks on wire grass and scrub in some forest types.

Periodic low intensity prescribed fire can be effectively employed to reduce this fuel material. Fuel reduction on public land in Victoria is prioritised to protect townships, settled areas, public assets, and recreation areas as described in fire protection plans. These plans include input from departmental specialists and the community, and have been progressively developed since the 1970's.

Fires are lit on a grid pattern under mild weather conditions, usually in the autumn or spring when the weather is relatively stable. The result is a mosaic of burnt and unburnt patches with the unburnt areas comprising 20-70 per cent depending on fuel moisture conditions and the objective of the burn (Hodgson & Heislers 1972). In general, burning to protect townships and assets is more frequent and more intensive than broad area fuel reduction, and the areas involved are smaller. Burning is carried out to create a reinforcing mosaic of different age classes of fuel reduction wherever possible.

During the period 1989/90 to 1993/94, a mean area of 140,000 ha was fuel reduced. The effectiveness of fuel reduction burning as a strategy to reduce the impact of high intensity fires can be demonstrated by the modelling approach, by the case study approach, or the cost-damage approach.

Gill et al. (1987) processed 28 years of meteorological data for Melbourne, Victoria; they then estimated the maximum FFDI and they then potential number of days for the failure of fire suppression for given quantities of fuel using a suppression threshold of 4000 kW/m. They found that, potentially, bushfires near Melbourne would be uncontrollable on an average of about 100 days per year at fuel quantities of 30 t/ha. However, if fuel levels were reduced to about 8 t/ha, the potential number of uncontrollable fires would be around zero.

When a high intensity fire enters a fuel reduced area, fire intensity is reduced, thus facilitating control or reducing damage to assets. Many examples of case studies are on record including Billing (1981), Rawson et al (1985), Buckley (1990), and Grant & Wouters (1993).

In a conclusion typical of other studies, Grant and Wouters (1993) concluded that fuel reduction burns up to ten years old can assist in the suppression of wildfires. A key part of this effectiveness is the reduction of bark fuels; other benefits included the reduction in the suppression resources required at each fire, especially when concurrent wildfires occurred in remote country.

Mills and Bratten (1988), approached the evaluation of fuel management programs from the perspective of economic efficiency and risk. In 1990, MIRA Consultants Limited were engaged by CNR to carry out a preliminary study of the economic efficiency of fire prevention programs. The study has not yet been concluded nor extended to the field management unit.

To date, a stochastic simulation model has been developed to investigate the relationship between different prevention and suppression strategies. The model calculates the probability of fire losses of different magnitudes and estimates direct fire suppression costs and the resultant damage.

Assumptions about the outcome of different strategies are entered into the model which then simulates the number and size of fires and calculates the expected damage and cost for each strategy. These can then be compared to consider the benefits of different strategies.

The model is based on 70 years of aggregate fire history data for CNR managed land. The statewide cumulative relationship between prevention and suppression costs, and damage cost is included as Appendix 1.

Whilst fire protection works are a statutory obligation, there is a developing awareness of the need to understand natural fire regimes, and use fire as a tool to achieve management objectives.

17.3.3 Ecological management

Since fire has a role in the development of ecosystems, it follows that fire has a place in maintaining them. Good (1978) indicated that because fire is the major and only environmental factor over which some control can be exercised, and many native species depend on fire for their continued existence, the use of fire will always have a place in conservation management. Hodgson and Heislers (1972) indicated that the role of fire in determining habitat requirements for Leadbeater's possum, kangaroos, scrub wallabies, and bronzewing pigeons is well known.

Prescribed fire is regularly used in the management of the Kangaroo Grass plains north of Melbourne, and has recently been used to maintain heathland in Wilson's Promontory National Park where fire exclusion for twenty five years had resulted in encroachment on heath sites by coast
tea-tree.

A fire management plan has been drawn up for the Management of the Coastal Heathlands in Far East Gippsland. The objectives of this plan, which covers 410 separate coastal heathlands totalling 12500 ha, aim at the establishment of a comprehensive fire regime which maintains and promotes all the ecological values of the coastal heathland. A section of the plan details the interface between the fire protection plan, and the fire management plan.

17.4 References

Billing, P. 1981, 'The effectiveness of fuel reduction burning; five case histories.', *Department of Conservation and Environment, Research Report* no 10, pp.1-13.

Buckley, A. 1990, 'Fire behaviour and fuel reduction burning.', *Department of Conservation and Environment, Research Report* no 28, pp. 1-24.

Grant, S. & Wouters M. 1993, 'The effect of fuel reduction burning on the suppression of four wildfires in Western Victoria.', *Department of Conservation and Environment, Research Repor*t no 41, pp. 1-17.

Bushfires Review Committee. 1984, Report on Bushfire Disaster Preparedness and Response in Victoria, Australia, following the Ash Wednesday fires , 16 February 1983. Victorian Government Printer. 174 pp.

Catling, P.C., & Newsome, A.C.E. 1978, 'Responses of the Australian vertebrate fauna to fire; an evolutionary approach.', in *Fire and the Australian Biota,* eds. A.M. Gill, R.H. Groves, & I.R. Noble, Australian Academy of Science, Canberra.

Good, R.B. 1978, 'The role of fire in conservation reserves', in *Fire and the Australian Biota,* eds. A.M. Gill, R.H. Groves, & I.R. Noble, Australian Academy of Science, Canberra.

Cheney N.P. 1994, 'Bushfire fighting and Occupational Health and Safety, a National perspective', *Proceedings of Bushfire Fighting and Occupational Health and Safety, Sydney,* Worksafe Australia, pp. 1-10.

Gill, A.M., Christian, K.R., Moore, P.H.R., & Forrester, R.I. 1987, 'Bushfire incidence, fire hazard, and fuel reduction burning', *Australian Journal of Ecology,* vol. 12, pp. 299-306.

Hickman, J.M. & Tarrant, M.E. 1986, 'Australian bushfires and their real cost', *4th. National Institution of Fire Engineers' Conference, Perth, 21-24 October 1986.*

Hodgson, A., & Heislers, A. 1972, 'Some aspects of the role of forest fire in South Eastern Australia', *World Forestry Congress, Buenos Aires 1972.*

Joy, C.S. 1991, 'The cost of natural disasters in Australia', *Climatic Change Impacts and Adaptation Workshop,* Australian Committee for the International Decade for Natural Disaster Reduction.

Kemp, E.M. 1978, 'Pre-Quaternary fire', in *Fire and the Australian Biota*, eds. A.M. Gill, R.H. Groves, & I.R. Noble, Australian Academy of Science, Canberra.

Mills, T.J., & Bratten, F.W. 1988, *Economic efficiency and risk character of fire management programs, northern Rocky Mountains.* Pacific Southwest Forest and range Experimental Station, USDA.

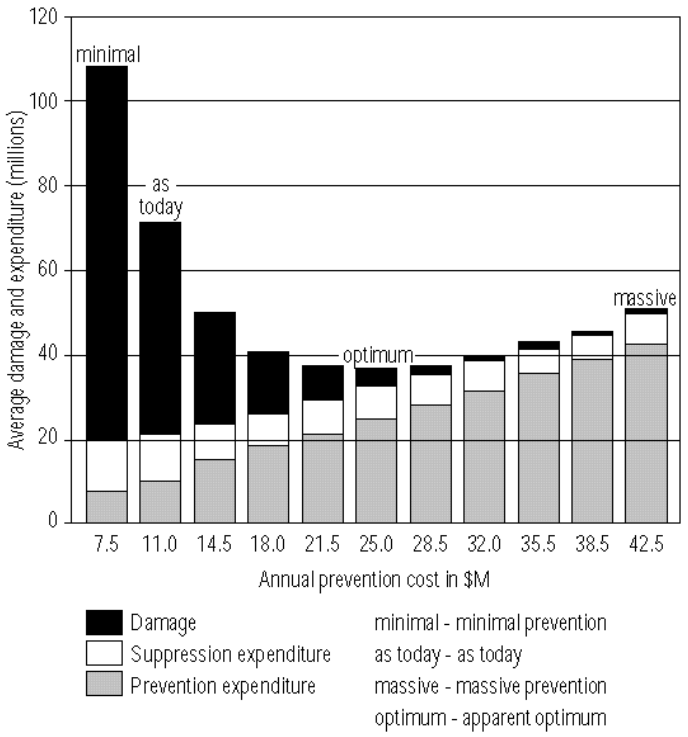
McArthur, A G. 1967, *Fire Behaviour in Eucalypt Forests.* Forestry and Timber Bureau Department of National Development. Canberra. 36pp.

Rawson, R.P., Billing, P.R., & Duncan, S.F. 1983, 'The 1982/83 forest fires in Victoria', *Australian Forestry,* vol. 46, no. 3, pp. 163-172.

Rawson, R., Billing, P., & Rees B. 1985, 'The effectiveness of fuel reduction burning', *Department of Conservation and Environment, Research Report* no 25, pp. 1-48.

Stretton, L.E.B. 1939, *Report of the Royal Commission to Inquire into the Causes of and Measures Taken to Prevent the Bush Fires of January 1939, and to Protect Life and Property,* Melbourne, Government Printer, pp. 1-36.

17.5 Appendix 1:
Effect of Discretionary Prevention - Risk Level all.



120
100
80
60
40
20
0
Average damage and expenditure (millions)
minimal
as
today
optimum
massive
7.5
11.0
14.5
18.0
21.5
25.0
28.5
32.0
35.5
38.5
42.5
Annual prevention cost in $M
Damage
Suppression expenditure
Prevention expenditure
minimal - minimal prevention
as today - as today
massive - massive prevention
optimum - apparent optimum