Fire management – what has changed?

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Abstract

Disastrous fires across temperate Australia in the early to mid 20th Century precipitated a revolution in forest fire management. Broad area fuel reduction burning, often by aerial ignition, made it possible to minimise the occurrence of very large high intensity wildfires. From the 1980s demographic and political changes brought a counter revolution. Managers concerned about theoretical, ecological impacts of burning allowed fuels to accumulate, suppression again became the major fire management activity, and disastrous fires returned. In many forest areas roads and fire trails were blocked or no longer maintained, making access for fire suppression more difficult.

In the last decade there have been a number of developments which are pulling Australian bushfire management in opposing directions. These include: publication of several Australian compendia on ecology and management of fires, transfer of large areas of multiple use forests into national parks and the declaration of roadless wilderness areas, listing of frequent fire as a threatening process under environmental legislation, many very large and damaging fires and subsequent government enquiries, a number of international conferences on fire management, establishment of the Bushfire Cooperative Research Centre (CRC), a current trend of global warming, declining rainfall or droughts in parts of Australia, declining forest health in long unburnt areas and the ever-increasing numbers of Australians living at the urban/rural interface. Some of these developments are tempering the counter revolution, but the overall imbalance remains.

The tensions in bushfire policy could be reduced by correcting the perception that there is a conflict between the socioeconomic and the ecological objectives of fire management. There is a notable absence of intellectual leadership from the Australian academic community on this issue and land managers have been unable to adapt as they did fifty years ago. Northern Australia has escaped the socioeconomically disastrous fires of temperate Australia, but there are fears of environmental damage by frequent extensive burning and there are moves to reduce its extent. Some moves appear to be based on traditional use of fire to maximise its benefits whilst some appear to follow the southern model of artificial exclusion based on a flawed and failing system. Fire managers in the north should learn from the mistakes made in temperate Australia rather than repeating them.

Introduction

Fire management in Australia began with Aboriginal occupation. European occupation caused major changes when Aboriginal people were displaced, and domestic stock and feral animals replaced fire as a major factor controlling grass and regeneration of woody plants (Noble 1997). Australia's early foresters brought with them a European attitude to fire and caused major changes when they attempted to suppress fire in the landscape. After they realised their folly, they reintroduced fire with broad area burning and aerial ignition. Prescribed burning in Australian forests has been continually challenged by environmentalists and many academics. As they became more politically influential, frequent low intensity fires were again removed from a large part of the landscape, especially in eastern Australia, and replaced by extensive high intensity fires. The concept of fire management has been overshadowed by one

of disaster management. Huge resources are being allocated to emergency response where more modest investments in land management could provide better protection (e.g. Scherl 2006).

Australian foresters became world leaders in forest fire management when they adapted their management in the 1960s. North American fire managers coveted Australia's success in keeping a reasonable rhythm of fire on the ground (Pyne 2003), but they have now taken the lead (e.g. Scherl 2005) while Australia has mostly slipped behind. Australia's revolution in the 1960s was pragmatic, based on empirical research and field experience. By comparison the counter revolution was supported mostly by theory, ideology and philosophy. The situation is reversed in North America where pragmatism is now in the ascendancy. The theoretical, ideological approach to fire management is based on ecological concepts of disturbance and succession that are not appropriate to fire dependent ecosystems such as eucalypt forests (Pyne 2003, Jurskis 2005a). The pragmatic approach recognises fire as a fundamental feature of living landscapes and encourages reintroduction of managed fire to restore ecological functionality and human safety (Pyne 2003, Hessburg *et al.* 2005, Jurskis 2005).

The tension between pragmatism and theoretical fire ecology in Australia remains unabated. A Bushfire Cooperative Research Centre has been set up following recent government enquiries, to improve the scientific basis for fire management to achieve social and ecological objectives. More progress could be made if some influential fire ecologists discarded false perceptions and assumptions, and were prepared to examine the ecological impacts of large high intensity fires as well as those of mild patchy prescribed burns. Examination of some recent literature points to the major issues and suggests some avenues for reducing tension and integrating social and ecological objectives to encourage positive changes in Australian fire management.

What were the pre-European fire regimes?

There is a view that pre-European fire regimes are unknown or cannot be precisely determined and are, in any case, not relevant to the current environment (Gill *et al.* 2002, Keith *et al.* 2002, Keith and Henderson 2002). The concept of precisely defining low intensity fire regimes is not valid because they are inherently very variable (Jurskis 2005a). However an understanding of Aboriginal fire regimes can help to develop sustainable landscapes (Bowman 2003, Burrows and Abbott 2003, Hessburg *et al.* 2005, Burrows *et al.* 2006). Regional Forest Agreements assess the adequacy of reserve systems in the context of their pre-European distribution, therefore the adequacy of their fire management should be assessed in the context of their pre-European functionality (Jurskis 2005, Jurskis and Turner 2007). A considerable body of evidence has accumulated that Aboriginal burning was frequent, patchy and extensive (Abbott 2003, Burrows and Abbott 2003, Bowman 2003, Hassell and Dodson 2003, Ward *et al.* 2001, Fensham 1997, Jurskis *et al.* 2003, 2006). This evidence supports frequent low intensity burning as an integral part of fire management, and therefore continues to be denied by those that are philosophically opposed to burning. According to theoretical ecology some extant ecosystems could not have survived their historical and Aboriginal fire regimes because some obligate seeding shrubs should have been extinguished. Rather than discarding the theories some ecologists continue to challenge the historical and physical evidence (Enright *et al* . 2006).

What are the ecological impacts of burning or grazing to reduce fire hazards?

Theoretical fire ecology often doesn't consider Aboriginal fire regimes (eg Jurskis 2002) and is therefore based on a false premise that the frequency of fire in the Australian landscape increased following European settlement and is maintained at a high level by prescribed burning (e.g. Whelan 1995). However suggestions of more frequent fire since European settlement rely on studies that can not reliably detect low intensity fires (Jurskis *et al.* 2003). Another false premise is that ecosystems remain stable and unchanged in the absence of burning and/or grazing (Jurskis 2002, Jurskis and Turner 2007). As a result of this flawed perspective, differences between managed and unmanaged areas are typically reported as impacts of management even though it is more appropriate to report the differences as changes resulting from lack

of maintenance of functional ecosystems (e.g. Jurskis 2003, Jurskis and Turner 2007, Hessburg *et al.* 2005). The false perspective continues to drive some research and is apparent in the new Bushfire CRC (e.g. York *et al.* 2006), unnecessarily complicating the consideration of appropriate fire regimes to maintain or enhance biodiversity. It has been claimed that to be effective, hazard reduction burning must be so frequent and extensive that it threatens biodiversity (e.g. Bradstock *et al*. 1998, Whelan 2003). However there is no objective evidence from Australian forests to support this view (e.g. Jurskis 2003).

How to design fire regimes?

The rise of theoretical fire ecology in the last few decades has reportedly seen an exponential growth in scientific literature and a significant growth in knowledge (Gill *et al.* 2002). Still, theoretical fire ecologists claim that the design of appropriate fire regimes is complex and bedevilled by a lack of knowledge, and they call for more research (e.g. Bradstock et. al. 1998, Bradstock *et al.* 2002, Gill *et al.* 2002, Whelan *et al.* 2002). However, scientifically based fire management is fundamental to conserving biodiversity and protecting human life and property so there is an immediate need to apply existing knowledge (Burrows and Abbott 2003). For example, Christensen and Abbott (1989) suggested a pragmatic approach using a diverse range of prescribed fire regimes, with a selection of unburnt reference areas, and monitoring of sample areas under various regimes.

Instead there is a trend to examine life histories and vital attributes of flora and fauna, consider the biotic composition and structure associated with various 'seral states' and to develop ideal fire age class distributions or fire frequencies or intervals between fire for particular ecosystems (e.g. Burrows and Abbott 2003). The complexity is increasing because of a perceived need to account for variability and stochasticity in planned fire regimes (Bradstock *et al.* 2002, Gill *et al.* 2002, Keith *et al.* 2002). However designing fire regimes around life histories and age classes assumes that prescribed fires are homogenous, kill all the target plants within the fire perimeter and reset the vegetation structure to ground level. These unrealistic assumptions underpin theoretical fire ecology but results from experimental burning studies and everyday observation of the outcomes of prescribed burns lit under mild conditions do not support the theories (Jurskis *et al.* 2003 Penman Burrows and WJ?). Frequent fires will not extinguish obligate seeding plants, because the fires will be patchy and populations of adult plants will always surivive within the burn perimeter. This is apparently not understood by many ecologists (e.g. Enright *et al* 2006, Dixon and Barrett 2003).

The drive from ecologists for ever-more complexity in designing prescribed burning programs makes the planning and execution so difficult, costly and time consuming that even some scheduled burning simply does not get done. This adds to the increasing quantities and continuities of fuel in the landscape and leads to large high intensity fires which totally consume ecosystems. Thus lack of will in some cases and lack of resources in others have set up forests for extensive severe fires and outbreaks of pests (Hessburg *et al.* 2006).

It is ironic that landscapes have been simplified and homogenised by long term absence of fire and by consequent extensive, high intensity fires while ecologists have been grappling with complexity and variability. High intensity wildfires are relatively uniform, kill most plants and animals and reset vegetation back to ground level over large areas. Homogenisation through lack of prescribed burning in Victoria threatens biodiversity whilst in many parts of Australia recent fires have overwhelmed fine grained mosaics created by interactions between the physical environment, fire and biota and replaced them with expanses of relatively uniform age and structure (VFEWG, Burrows 2005, Burrows *et al.* 2006, Jurskis *et al.* 2006). Woody thickening, extensive severe wildfires and declining forest health are apparent in long unburnt forests and woodlands in Australia and North America (Dyer *et al.* 2001, Jurskis 2005, Hessburg *et al.* 2006). A return to more pragmatic fire management would use physical variability and more frequent burning to restore biotic variability (i.e. biodiversity) and functional landscapes (e.g. Jurskis 2005a,b, Hessburg *et al.* 2006).

The concept of succession is not applicable to eucalypt ecosystems because eucalypts remain the dominant life form irrespective of time since disturbance (Jurskis 2005a), whilst the concept of seral vegetation structure is applicable only to ecosystems such as wet forests and heaths that are confined to physically protected environments (e.g. sheltered gullies, rock outcrops, swamps) and attuned to infrequent fires. Reintroducing more frequent low intensity burning into a landscape with a mosaic of exposed and protected sites will maintain or restore broad scale structural stability and fine scale floristic variability in more exposed parts of the landscape, and at the same time maintain or restore variability in age class and structure amongst the sheltered sites because discontinuous fuels in the more exposed matrix will reinforce their protection. Fire management can cope with variability and stochasticity only by reinforcing variability and minimising the extent of stochastic events within the landscape.

Effectiveness of fuel reduction in achieving socioeconomic objectives

Despite the overwhelming historical and experimental evidence in Australia (e.g. McCaw *et al.* 2003) and North America, the effectiveness of broadscale reduction of fuel in assisting to control wildfires and minimise damage continues to be challenged. The challenges may arise from theoretical and philosophical objections to burning and grazing or they may be intended to encourage the application of resources to disaster response in preference to land management. For example, in late 2007, the Commissioner of New South Wales' Rural Fire Service repeatedly stated in the media that wildfires recurring in areas that had previously been burnt by wildfires in 2003 indicated that more extensive fuel reduction burning would not assist firefighting operations. These statements ignored the different fuel accumulation processes that may occur after wildfires compared to prescribed burns, and did not allow that fuel reduction is intended to moderate fire behaviour rather than prevent ignition (e.g. Jurskis 2003).

A study following the 2003 alpine fires in Victoria (Williams *et al.* 2006) purported to show that grazing had not reduced fire intensities or fire occurrence compared to ungrazed areas. However fire intensities were estimated only in heath where limited grazing has little impact on vegetation (Williams *et al.* 2006), whilst fire occurrence in grassland was generally low (15 out of 113 points). In any case, ignition depends on the presence of fuel not the quantity. Thus the design of the study did not allow a robust test of the hypothesis, and the conclusion that grazing to reduce fuel was not justified on scientific grounds (Williams *et al.* 2006) is questionable.

Recent modelling within the Bushfires CRC has supported the well known facts that wildfire control is easier and safer where fuels have been reduced by prescribed burning. Obviously the area and location of burning are important, but burning a small proportion of the landscape can have a significant impact on wildfire control (King *et al.* 2007). There is a wealth of evidence that burning and/or grazing can prevent accumulation of fuels, and affect their arrangement and their seasonal flammability. It is a well established principle of physical science that these factors affect fire behaviour and intensity. The moderating effects of fuel reduction on fire behaviour have been repeatedly demonstrated (e.g. Underwood *et al* 1985, McCaw *et al.* 2003,) therefore it is unproductive to continue to divert resources to research and modelling that tests these established facts.

Tropical savannas and grasslands

Northern Australia has a much more frequent and extensive fire regime than the rest of the continent. Knowledge of traditional Aboriginal cultural burning has not been entirely lost although extensive higher intensity fire has displaced the traditional patchy, low intensity regimes (Dyer *et al* 2001, Bowman 2003, Burrows *et al.* 2006). Andersen *et al* (2005) drew parallels between prescribed burning in the tropics and in temperate forests but considered that the ecological implications of high frequency fire have received little attention in the tropics. They reported a "serious conservation concern" arising from the Kapalga burning experiment, that riparian vegetation and small mammals were not resilient to fire, irrespective of fire intensity.

Although Andersen *et al* (2005) intended to test a patchy low intensity fire regime using progressive ignition during the drying cycle, this was not achieved. The 'early', 'late' and 'progressive' fires were all lit using a single line head fire, 2 to 5 km long on the windward side of each block, and the early fires were lit at the same time of year as the initial 'progressive' fires. With continuous grass fuels it is possibly not surprising that the early and progressive fires weren't more patchy and that all the fires had similar impacts on some flora and fauna despite having different intensities as a result of different fuel moisture and weather conditions. Andersen *et al* (2005) proposed that it was necessary to increase the proportion of landscape remaining long unburnt. This could supposedly be achieved by burning less each year or by not burning long unburnt areas (Andersen *et al* 2005). Thus they failed to heed the lessons from repeated failures of fire management in temperate Australia.

Burrows *et al.* (2006) had a different response to the homogenisation of age classes in spinifex grasslands, and declining populations of small mammals following disruption of traditional Aboriginal culture. They initiated a program to reintroduce traditional patchy fire regimes, and research into the physical aspects of fire behaviour in spinifex will support this ecological burning (Burrows *et al.* 2006b). Concerns about prescribed burning (Andersen *et al* 2005) can be addressed by burning in a different way, such as spot ignition against the wind, and 'very early season' burning. If the ecological importance of long unburnt habitat is common to tropical savannas and temperate forests (Andersen *et al* 2005), so too is the need for frequent burning in the landscape to reinforce physical protection and prevent homogenisation. Early burning can protect less flammable sites from late season fires whereas not burning around them must inevitably result in many or all fire refuges being burnt across extensive areas at the same time (e.g. Burrows *et al.* 2006, Jurskis *et al.* 2006).

Political developments

In the 1960s Australian foresters recognised the folly of attempting to exclude fire from most of the environment. Research was then primarily directed at understanding fire behaviour, developing prescriptions for burning and improving safety and socioeconomic protection. The rise of the conservation movement and theoretical ecology in recent decades has seen a strong focus on the potential impacts of prescribed burning on biodiversity (Gill *et al.* 2002, Abbott and Burrows 2003) and substantial transfers of land from multiple use management to conservation reserves. As a result there has been a substantial reduction in prescribed burning (e.g. Scherl 2006**)**, although public perceptions to the contrary (Jurskis *et al.* 2003) have been cultivated by academia (e.g. Whelan 1995, 2003).

Public reactions to woody thickening, environmental homogenisation and disastrous fires appear to be divided demographically. Rural communities generally see woody thickening and environmental homogenisation as undesirable developments that need to be managed by clearing, burning and grazing, and they view disastrous fires as a consequence of mismanagement (Jurskis and Turner 2007). Urban communities generally see woody thickening and environmental homogenisation as positive developments because they confuse biomass with biodiversity (J et al 2003). They view disastrous fires as a consequence of severe weather and climate change. This urban view is well supported amongst the generally urban living academic community (e.g. Flannigan *et al.* 2005).

The divergent reactions to these major environmental changes were apparent in the government inquiries following the disastrous 2003 fires. The House of Representatives (2003) Inquiry sat in many regional centres and rural communities were well represented in evidence and in the report's recommendations. These began by addressing land management factors which were clearly indentified as contributing to the severity of bushfires. A dissenting report by a city based member relied heavily on a submission from an academic fire ecologist (Whelan 2003) who stated that "broad scale hazard reduction is threatening biodiversity conservation and must therefore be avoided by land managers and resisted at a political level". This academic had good opportunity for further political influence as a member of the COAG Inquiry together with another academic and a professional consultant.

The primary issue addressed in the COAG Inquiry report was education - learning to live with bushfire - and the report claimed that appropriate land management was constrained by poor knowledge about landscape scale impacts of fire regimes on biodiversity It also questioned the effectiveness of fuel reduction in reducing risk to assets. The COAG Inquiry articulated a vision for fire management in Australia that begins with further research (Kanowski *et al* 2005).

Conclusions

When foresters pioneered adaptive management of fire during the 1960s, they were responding to the consequences of a management regime which had clearly failed. Management has now regressed to the same point. Theory has replaced pragmatism as the driving force for management and our forests are being ravaged by fire. Research has been confused with adaptive management. Academic ecologists have failed to take responsibility for the problems caused by their influence on political processes. They have hidden behind supposed complexities and continue to resist a return to pragmatic management. As a result community resources have been directed to disaster response and unproductive research rather than adaptive management and restoration such as is being developed in North America.

The proliferation of large high intensity bushfires clearly indicates that management is failing (Williams, 2007). Untenable theories should be discarded. Empirical evidence shows that biodiversity and socioeconomic values are best served by pragmatic management based on simple physical principles. 'Conservative' fire management based on ecological theories has created relatively homogenous, unhealthy and dysfunctional ecosystems. Burning should follow prescriptions to control fire behaviour, not theoretical fire intervals. Fire should be generally excluded from 'refugia' by good management because it cannot be excluded by regulations. Frequent patchy burning will protect both human society and biodiversity.

References

Abbott, I. (2003). Aboriginal fire regimes in south-west Western Australia: evidence from historical documents. In Abbott, I. and Burrows, N. (eds.) *Fire in ecosystems of south-west Western Australia: Impacts and management.* Backhuys Publishers. Leiden, pp 119-146.

Abbott, I. and Burrows, N. (2003) Foreward – The genesis of this book. In: I. Abbott and N. Burrows (eds.) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, Leiden pp vii-xiii.

Andersen, A.N., Cook, G.D., Corbett, L.K., Douglas M.M., Eager, R.W., Russell-Smith, J., Setterfield, S.A., Williams, R.J., Woinarski, J.C.Z. (2005) Fire frequency and biodiversity conservation in Australian tropical savannas: implications from the Kapalga fire experiment. *Austral Ecology* **30**, 155-167

Bowman, D.M.J.S. (2003) Australian landscape burning: a continental and evolutionary perspective. In: I. Abbott and N. Burrows (eds.) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, Leiden pp 107-118

Bradstock, R.A.; Bedward, M.; Kenny, B.J.; Scott, J. (1998). Spatially-explicit simulation of the effect of prescribed burning on fire regimes and plant extinctions in shrublands typical of south-eastern Australia. Biological Conservation 86: 83-95.

Bradstock, R.A., Williams, J.E. and Gill, A.M. (2002) Preface In: R.A. Bradstock, J.E. Williams and A. M. Gill. (eds) *Flammable Australia. The Fire Regimes and Biodiversity of a Continent.* Cambridge University Press. United Kingdom. pp ix

Burrows, N. (2005). Burning rocks. *Landscope* **20** (4), 55-61.

Burrows, N. and Abbott, I. (2003) Fire in south-west Western Australia: synthesis of current knowledge, management implications and new research directions. In: I. Abbott and N. Burrows (eds.) *Fire in*

ecosystems of south-west Western Australia: impacts and management. Backhuys Publishers, Leiden pp 437-452

Burrows, N.D., Burbidge, A.A., Fuller, P.J. and Behn, G. (2006a) Evidence of altered fire regimes in the Western Desert region of Australia. *Conservation Science Western Australia* 5 (3), 272-284.

Burrows, N.D., Ward, B., Robinson, A.D., and Behn, G. (2006b) Fuel dynamics and fire behaviour in spinifex grasslands of the western desert. In: Cuong Tran (ed.) *Bushfire 2006. Life in a fire prone environment: translating science into practice.* Griffith University. CD

Burrows and WJ

Christensen, P. and Abbott, I. 1989. Impact of fire in the the eucalypt forest ecosystem of southern Western Australia: a critical review. *Australian Forestry* **52** (2), 103 – 121.

Dixon, K. and Barrett, R. (2003) Defining the role of fire in south-west Western Australian plants. In: I. Abbott and N. Burrows (eds.) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, Leiden pp 205-223

Dyer, R., Jacklyn, P., Russell-Smith, J., Williams, D. (2001) Introduction. In: *Savanna Burning* (eds. R. Dyer, P. Jacklyn, J Russell-Smith, D. Williams) Tropical Savannas CRC Darwin pp1-2

Ellis, S., Kanowski, P. and Whelan, R. (2004) *National Inquiry on Bushfire Mitigation and Management.* Council of Australian Governments, Canberra.

Enright, N.J., Lamont, B.B. and Miller, B.P. (2005) Anomalies in grasstree fire history reconstructions for south – western Australian vegetation. *Austral Ecology* **30,** 668-673.

Fire Ecology Working Group (2002). *Analysis of disturbance by fire on public land in Victoria.* Department of Natural Resources and Environment. Melbourne

Fensham, R.J. (1997) Aboriginal fire regimes in Queensland, Australia: analysis of the explorers record. Journal of Biogeography **24** (1), 11-22.

Flannigan, M.D., Logan, K.A., Stocks, B.J. Wotton, B.M., Todd, J.B. (2005) Fire and climate change in boreal forests. *The international Forestry Review* & (5), p77.

Gill, A.M., R.A. Bradstock & J.E. Williams 2002. Fire regimes and biodiversity: legacy and vision. In: In: R.A. Bradstock, J.E. Williams and A. M. Gill. (eds) *Flammable Australia. The Fire Regimes and Biodiversity of a Continent.* Cambridge University Press. United Kingdom. pp 429-447

Hassell, C.W. and Dodson, J.R. (2003) The fire history of south-west Western Australia prior to European settlement in 1826-1829. In: I. Abbott and N. Burrows (eds.) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, Leiden pp 71-86

Hessburg, P.F., Agee, J.K., and Franklin, J.F. (2005). Dry forests and wildland fires of the inland northwest USA: Contrasting the landscape ecology of the pre-settlement and modern eras. *Forest Ecology and Management* 211, pp117-139

House of Representatives Select Committee (2003) *A Nation Charred: Inquiry into theRrecent Australian Bushfires.* Parliament of the Commonwealth of Australia, Canberra.

Jurskis, V., (2001). Fire management for conservation: reconciling theory and practice. In *Bushfire 2001*. Proceedings of Australasian Bushfire Conference. New Zealand Forest Research Institute Ltd. Rotorua. pp. 190-194.

Jurskis, V. (2002) Restoring the prepastoral condition. *Austral Ecology* **27,** 689-690.

Jurskis, V. (2003) Assessing the ecological implications of prescribed burning: where do you start? In *Conference Proceedings 3rd International Wildland Fire Conference and Exhibition. Sydney*

Jurskis, V. (2005a) Decline of eucalypt forests as consequence of unnatural fire regimes. *Australian Forestry* **68** (4), 257-262.

Jurskis, V. (2005b) Eucalypt decline in Australia, and a general concept of tree decline and dieback. *Forest Ecology and Management* **215**, 1 -20.

Jurskis, V., Bridges, B. and de Mar, P. (2003) Fire Management in Australia: the lessons of 200 years. In *Joint Australia and New Zealand Institute of Forestry Conference Proceedings 27 April – 1 May 2003 Queenstown, New Zealand.* Ministry of Agriculture and Forestry. Wellington. pp 353 – 368.

Jurskis, V., de Mar, P. & Aitchison, B. (2006) Fire management in the alpine region. In *Bushfire 2006. Life in a fire prone environment: translating science into practice.* (ed. Cuong Tran) Griffith University. CD

Jurskis, V. and Turner, J. (2002). Eucalypt dieback in eastern Australia: a simple model. *Australian Forestry* **65** (2), 81-92.

Jurskis, V. and Turner, J. (2007) In conservation's name. In: These proceedings.

Kanowski, P.J., Whelan, R. and Ellis, S. (2005) Inquiries following the 2002-2003 Australian bushfires: common themes and future directions for Australian bushfire mitigation and management. *Australian Forestry* 68 (2), pp 76-86

Keith, D.A. and Henderson, M.K. (2002) Restoring the prepastoral condition: Response to Jurskis. *Austral Ecology* **27**, 691-693.

Keith, D.A., J.E. Williams and J.C.Z. Woinarski 2002. Fire management and biodiversity conservation: key approaches and principles. In *"Flammable Australia. The Fire Regimes and Biodiversity of a Continent."* Editors R.A. Bradstock, J.E. Williams & A. M. Gill. Cambridge University Press. United Kingdom. pp 401-428.

King, K.J., Cary, G.J., Bradstock, R.A., Chapman, J., Pyrke, A. and Marsden-Smedley, J.B. (2006) Simulation of prescribed burning strategies in south-west Tasmania, Australia: effects on unplanned fires, fire regimes, and ecological management values. *International Journal of Wildland Fire* 15, 527-540.

McCaw, W.L., Cheney, P. and Sneeuwjagt, R. (2003) Development of a scientific understanding of fire behaviour and use in south-west Western Australia. In: I. Abbott and N. Burrows (eds.) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, Leiden pp 171-188

Noble, J.C. (1997) *The delicate and noxious scrub.* CSIRO, Lyneham.

Penman

Pyne, S.J. (2003) Introduction – Fire's lucky country. In: I. Abbott and N. Burrows (eds.) *Fire in ecosystems of south-west Western Australia: impacts and management.* Backhuys Publishers, Leiden pp 1-8.

Scherl, T. (2005) *At the crossroads: A comparison of current social, scientific and political influences on fire management in Australia and the USA.* World Forest Institute, Portland, Oregon.

Underwood, RJ, Sneeuwjagt RJ and Styles, HG (1985). The contribution of prescribed burning to fire control in Western Australia: case studies. In: Ford, JR (Ed) Fire Ecology and Management in Western Australian ecosystems, pp 153-170. WA Institute of Technology Environmental Studies Group Report, 14. WA Institute of Technology, Perth.

Williams, J (2007). The megafire reality. Paper presented to a national forum organised by the Bushfire CRC in Canberra, February 27th, 2007 (unpublished).

Ward, D.J., Lamont, B.B. and Burrows, C.L. (2001). Grasstrees reveal contrasting fire regimes in eucalypt forest before and after European settlement of southwestern Australia. *Forest Ecology and Management* **150**, 323 – 329.

Whelan, R.J. (1995). *The Ecology of Fire.* Cambridge University Press.

Whelan, R. (2003). Submission No. 351 to House of Representatives Select Committee on the recent Australian Bushfires.

Whelan, R.J., Rodgerson, L., Dickman, C.R. and Sutherland, E.F. (2002). Critical life cycles of plants and animals: developing a process-based understanding of population changes in fire-prone landscapes. In Bradstock, R.A., Williams, J.E. and Gill, A. M. (eds.) *Flammable Australia. The Fire Regimes and Biodiversity of a Continent.* Cambridge University Press. United Kingdom. pp 94 – 124.

Williams, R.J., Wahren, C., Bradstock, R.A. and Muller, W.J. (2006) Does alpine grazing reduce blazing? A landscape test of a widely held hypothesis. *Austral Ecology* 31, 925-936.

York, A.K., Bell, T.L., Christie, F.J. and Brennan, K.E.C. (2006) Forests, fire and ecological processes – more than just good in theory. In: Cuong Tran (ed.) *Bushfire 2006. Life in a fire prone environment: translating science into practice.* Griffith University. CD