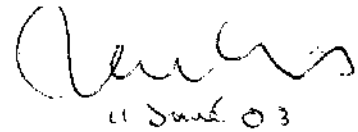


6<sup>th</sup> June 2003

Secretary of the Committee  
Select Committee on the Recent Australian Bushfires  
Parliament House  
Canberra ACT 2600



bushfires.reps@aph.gov.au

Dear Sir/Madam,

The Conservation Council of Western Australia is Western Australia's peak non-government conservation organisation. It is an umbrella organisation for over 60 affiliated groups, all of which are dedicated to the protection of the natural environment.

The Council has long been interested in fire in the natural environment, so we welcome the opportunity to make a submission to the House of Representatives Select Committee on the recent Australian bushfires and thank you for extending the time in which we may make this submission.

As a non-government organisation dedicated to the protection of the natural environment, the Council is not qualified to comment on some of the non-environmental and technical aspects of the inquiry. However, there are many matters that do impinge on the natural environment, in particular native ecosystems, and we will endeavour to address them. We attach the Council's policy on fire in the natural environment, which sets out our position on the subject (Attachment 1).

The Council has many concerns about 'bushfires,' some of which do not fit directly within the Committee's terms of reference. We shall nevertheless include them because they are relevant to the issue and the inquiry.

#### Language

There is a need to standardise the language used in relation to fire in the natural environment for safety as well as environmental reasons. The language generally used tends to associate unwanted fires with native vegetation. This is implicit in the very expression 'bushfire'. Not only does this make 'bush', i.e., native vegetation, seem like a threat; it is misleading in that introduced grasses, crops, plantations and weeds are equally, if not more, flammable and can carry a very fast fire, and people and property need fire protection from them as much as they do from native vegetation.

The Conservation Council therefore strongly recommends that the Committee, along with all government agencies and the general community, adopt the term 'wildfire'. The word is well known and often used, so its general adoption as a replacement for 'bushfire' should not pose a problem.

Similarly, the term 'vegetation', which covers both native and exotic plants, would be more appropriate than the term 'bush land'.

Any discussion of fire in Australia tends to focus on conservation reserves as a land use and forests as a vegetation type. Since crops, pasture and grasslands on private property are as prone to wildfires as the vegetation in conservation reserves, it would be appropriate to include them as land uses now increasingly exposed to the risk of wildfires. There should also be a clear indication that vegetation types other than forest must be taken into consideration. The speed with which a wildfire can race through coastal heath, grassland and pasture (and the difficulties in reducing flammable vegetation in, for example, coastal heath without totally removing it) means that these vegetation types also represent a wildfire risk.

There are also problems with the word 'fuel'. Calling flammable vegetation 'fuel' ignores the importance of this material as a source of nutrients in nutrient-poor ecosystems and as habitat for very large numbers of species, whose importance to the functioning of natural ecosystems is increasingly being recognised. We suggest 'flammable vegetation' as an appropriate substitute.

Various expressions are used for the practice of burning to reduce the likelihood and intensity of wildfires, all of which ('prescribed', 'fuel reduction', 'hazard reduction') are misleading in one way or another.

'Prescribed burning' covers burns intended to reduce the risk of wildfires and also scientific 'conservation' burns and post-logging burns (so-called 'regeneration' burns), which are very intense. And 'prescribed burning' doesn't always follow the prescription.

'Fuel reduction' and 'hazard reduction' are misleading and not appropriate because the burning may actually increase the fuel and the hazard, not reduce them.

'Planned burning' is another expression for this practice, but like 'prescribed burning' it covers a range of practices in addition to pre-emptive burning.

For these reasons we propose to use the expression 'pre-emptive burning' as the most appropriate.

The expression 'back burning' should be restricted to its correct usage, namely the practice of burning back towards (or in front of) an advancing wildfire as a means of controlling and suppressing the fire.

The term 'firebreak' can be dangerous as what are called 'firebreaks' may be little more than access tracks, with no ability to stop a wildfire. We recommend that more accurate alternatives be used, such as 'reduced vegetation buffers' (or 'vegetation free buffers' as the case may be), which may vary in width from a few metres to several hundred metres, and 'access tracks' for narrow tracks through, for example, tall forest, where for the most part they serve no other purpose than to provide access.

We now address the specific terms of reference.

The Select Committee on the recent Australian Bushfires seeks to identify measures that can be implemented by governments, industry and the community to minimise the incidence of, and impact of bushfires on, life, property and the environment with specific regard to the following.

*the extent and impact of the bushfires on the environment, private and public assets and local communities;*

- (a) The extent and impact of fires cannot be limited to wildfires. The cumulative extent and impact of wildfires and pre-emptive and other types of prescribed burning, including back-burning, must be addressed. The total area of country burnt in Australia every year is enormous and, in Western Australia, is increasing.

*the causes of and risk factors contributing to the impact and severity of the bushfires, including land management practices and policies in national parks, state forests, other Crown land and private property;*

Most fires in Western Australia are started by people, whether deliberately or accidentally, legally or illegally. Australians' generally cavalier attitude to fire may be due in part to some of the myths about fire in the Australian environment. These include:

- (b)
- *Australian flora and fauna are adapted to fires.* This is not necessarily so. Adaptations are to major environmental disturbances, of which fire is one.
  - *Fires of almost any intensity and frequency do no real or lasting damage to the natural environment.* There is extensive evidence that in many ecosystems frequent fires cause serious environmental damage. 'Frequent' means occurring at intervals shorter than those required for an ecosystem to recover from one fire before the next occurs. Natural ecosystems take decades, if not centuries, to recover from intense fires, yet there is evidence that since European settlement the frequency of intense fires has increased greatly.
  - *Prior to European settlement, the Aboriginal people frequently burned country and we can and should do the same.* Frequent burning by Aboriginal people is only a hypothesis and it is hotly contested. There is strong disagreement about pre-European Aboriginal burning. And given that in much of Australia, European land management has completely changed the composition and structure of the vegetation, what the Aboriginal people did may no longer be relevant. Indigenous peoples used fire for very different reasons and applied it in a very different manner.

*the adequacy and economic and environmental impact of hazard reduction and other strategies for bushfire prevention, suppression and control;*

Myths have been generated about so-called 'hazard reduction' burning, such as:

- They are mild and controlled. Many pre-emptive burns are very hot, and some get out of control and burn far more than prescribed.
- They do no harm. Frequent, broad-scale fires from whatever cause and for whatever reason, including pre-emptive burns, can completely change the composition and structure of native vegetation. Both flora and fauna species may be lost and even become extinct as a result of too frequent fires.
- They are cost effective. It is difficult to ascertain the cost-effectiveness of pre-emptive burning as opposed to other strategies for wildfire prevention, suppression and control. The full costs and benefits, economic, social and environmental, of all strategies must be spelled out so that the community can decide which strategies are appropriate in which circumstances.
- They are the best (if not the only) way to prevent and suppress wildfires. Frequent pre-emptive burning is effective for only a few years, and fires, whether prescribed burns or wildfires, often make natural ecosystems more, not less, flammable by encouraging the rapid and prolific growth of vegetation, both native and exotic (weeds), that responds well to fire.

(c) Strategies other than frequent, broad-scale pre-emptive burning should be investigated, assessed and, where appropriate, implemented (see (e) below).

In Western Australia, the government agency responsible for land management, the Department of Conservation and Land Management (DCLM), has an annual target for its pre-emptive burning in the South West of the State of approximately 10% of the land it manages. This target is set without regard for biodiversity or amenity values and has nothing to do with ecology. In recent years DCLM has complained that, for various reasons, it has been unable to reach its target. For the period spring 2002 – autumn 2003, it aimed to burn 200,000 ha but to 1 May 2003 had burnt only 110,000 ha. Yet over the same period a further 112,000 ha of DCLM-managed lands were burnt through wildfires. Thus the total area burnt exceeded the target for pre-emptive burning, but in publicising its figures for area burnt each year DCLM appears not to take the area burnt through wildfires into account.

DCLM has set a 'fuel load' (i.e., amount of flammable vegetation) of eight tonnes per hectare for jarrah forest and 17 tonnes per hectare for karri forest. DCLM estimates that these figures are reached in five to seven years in jarrah forest and six to eight years in karri forest. These are the frequencies at which DCLM aims to pre-emptively burn WA's south-west forest ecosystems, in both State 'production' forest and conservation reserves. This is despite the fact that young jarrah and karri trees are fire sensitive until they are 15 to 20 years of age. DCLM's figures represent the amount of flammable vegetation above which DCLM says it is not possible to control a wildfire. The claim that a fire regime based on such calculations has an ecological basis is simply untrue.

*appropriate land management policies and practices to mitigate the damage caused by bushfires to the environment, property, community facilities and infrastructure and the potential environmental impact of such policies and practices;*

(d) The Council is strongly opposed to heavy reliance on pre-emptive burning of native vegetation for wildfire protection. Frequent pre-emptive burning of native vegetation may cause serious and potentially irreparable damage to the environment and degrade and destroy the very things that attract people to build in natural areas.

There is a large and increasing body of scientific literature that shows the environmental damage caused by frequent fires (see Attachment 2 for excerpts from six papers). The community must be made aware of the costs as well as the benefits of pre-emptive burning and encouraged and assisted to adopt other methods of reducing the risk of wildfires (see (e) below).

So-called 'parkland clearing' of native vegetation (selective removal of overstorey trees and almost total removal of understorey vegetation) is an environmentally unacceptable means of reducing the risk of wildfires. It is unsustainable as it requires the elimination of the majority of plant species, and the ecological functionality of an area depends on maintaining the full suite of plant species. 'Parkland clearing' also leads to the growth of exotic grass species. The annual senescence of exotic grasses creates a preponderance of highly flammable dry vegetation, so creating a very artificial 'parkland' ecosystem may actually increase the wildfire risk of an area.

*any alternative or developmental bushfire mitigation and prevention approaches, and the appropriate direction of research into bushfire mitigation;*

To reduce the demand for frequent pre-emptive burning, various steps must be taken. People should be discouraged or prevented from building in very fire-prone areas through, for example, appropriate planning and greatly increased insurance premiums. If, despite the risks, people build in such areas, there must be fire-protective building rules and regulations (requirements for fire resistant designs and building materials; external sprinkler systems; fire shelters, like the tornado shelters built in tornado-prone areas of the USA).

- (e) If people choose to build in very fire-prone areas, they must be made aware that there is a risk of uncontrollable wildfire and that native vegetation will not necessarily be sacrificed to lessen that risk.

The Conservation Council has recommended that the feasibility of using roving patrols for fire prevention and protection be investigated. They would be equipped with the most up-to-date communication and small-scale fire-fighting equipment and during the fire season they would patrol areas of high fire risk.

We have also recommended the trialing of all-terrain fire-fighting equipment developed in Western Australia.

The effectiveness of frequent broadscale pre-emptive burning needs to be thoroughly investigated by independent scientists.

*the appropriateness of existing planning and building codes, particularly with respect to urban design and land use planning, in protecting life and property from bushfires;*

- (f) The Conservation Council is concerned that residential, commercial and industrial construction continues to be targeted to land partially or wholly covered with native vegetation (in Western Australia, residential subdivisions at Gnarabup, near Margaret River; Dalyellup, near Bunbury and Brighton, near Quinns Rocks; proposed industrial park at Bibra Lake). While the general community is concerned about the protection of biodiversity and deplores the accelerating loss of species in Western Australia, government agencies continue to approve and even promote construction in native vegetation in full knowledge that the vegetation will be removed. This still occurs even in places where so much has already been lost that every remaining hectare should be protected.

Residential, commercial and industrial construction in such areas results in the removal of vegetation for actual construction; it also necessitates protection from wildfires, which almost inevitably causes degradation and further loss of native vegetation (reduction or removal of flammable vegetation in adjacent areas; construction of access tracks; introduction of weeds). And because of increased human presence, there are more sources of ignition for wildfires. The solution is to direct residential, commercial and industrial construction to land from which native vegetation has already been removed.

In the follow-up to the Canberra wildfires, there has been considerable research into many aspects of planning, construction and landscaping that can promote or impede damage and destruction by wildfires.

It is not right for people to expect native vegetation to bear the cost of fire protection for inappropriate buildings built in inappropriate places.

All Australians should be, or must be made, aware that no matter what precautions are taken, almost everywhere other than inner urban areas there is a risk of wildfires. Planners and developers should not be allowed to say or imply otherwise.

*the adequacy of current response arrangements for firefighting;*

- (g) As the Canberra wildfires showed, when particular conditions all coincide, nothing will stop a wildfire. To suggest that taking specified measures will assure protection may give people a false sense of security and even discourage them from taking personal responsibility for their safety.

*the adequacy of deployment of firefighting resources, including an examination of the efficiency and effectiveness of resource sharing between agencies and jurisdictions;*

- (h) It is not right for people to expect firefighters, especially volunteers, to risk their lives trying to prevent wildfires from damaging or destroying inappropriate buildings built in inappropriate places.

Given that Australia's fire season occurs in one half of the year while the fire season in North America occurs in the other, the possibility of sharing personnel and expensive firefighting equipment should be investigated.

*liability, insurance coverage and related matters;*

- (i) It is not right for planners and developers to allow and even encourage people to build inappropriate buildings in inappropriate places. If people choose to build in places where there is a high risk of wildfires, insurance premiums should be commensurately high.

*the roles and contributions of volunteers, including current management practices and future trends, taking into account changing social and economic factors.*

The community relies too heavily on 'volunteers' (i.e., unpaid workers) for fire protection as well as for numerous other community services.

- (i) However, problems can arise when people are paid to both fight and light fires (as in pre-emptive burning). In Western Australia, there is considerable anecdotal evidence that far more country is burnt in both wildfires and pre-emptive burning than can be justified on any ground. The explanation is financial. It appears that small fires are sometimes allowed to become big fires and extra pre-emptive burning is carried out because there are people who get paid for the time they spend fighting (or lighting) fires. The Committee should inquire into the feasibility of having full-time country (rural) fire brigades, like urban fire brigades, whose officers are paid whether or not they attend fires.

Another problem is that people with a propensity to light fires illegally are attracted to fire-fighting/lighting organisations such as volunteer fire brigades. Despite the difficulties in catching arsonists, every year there is at least one prosecution of a volunteer fire fighter for arson. The Committee needs to address this issue.

The Conservation Council would be pleased to provide further information and to make an oral submission to your inquiry if requested.

Yours sincerely,

(Dr) Beth Schultz  
Vice-president

# *CONSERVATION COUNCIL OF WESTERN AUSTRALIA*

*POLICY NO : 50 FIRE IN THE NATURAL ENVIRONMENT*

*ADOPTED : JANUARY 1996*

## **BACKGROUND**

Naturally caused fires have always been part of the Australian environment, and Australia's flora, fauna and ecosystems have adaptations that allow them to survive, and in some cases benefit from, natural fire regimes, with frequencies ranging up to several centuries.

The vegetation over most of the continent was also subjected to many thousands of years of burning by Aboriginal people, which, over time, may have altered many ecosystems. However, reliable information about Aboriginal burning is generally scarce.

Judging from the evidence of, for example, fire scars in tree trunks and changes in the composition of plant and animal species, it is apparent that European settlement in Western Australia, begun in 1829, has drastically changed both the natural and Aboriginal fire regimes and in much of the State has greatly increased the frequency and extent of intense fires.

Faced with the destructive impacts of unwanted fires (wildfires) in natural areas, land managers in Western Australia have implemented a program of deliberate pre-emptive burning to reduce the amount of flammable vegetation and thereby the extent and intensity of wildfires. This burning is called 'prescribed', 'controlled', 'hazard reduction' or 'fuel reduction' burning. A more accurate name is 'pre-emptive' burning.\*

For example, the Department of Conservation and Land Management (DCLM) practises pre-emptive burning throughout much of the land it manages. It conducts pre-emptive burns every five to seven years in the jarrah forest and every six to eight years in the karri forest, including the forest in conservation reserves. It also regularly burns heathlands wetlands in both State forest and conservation reserves.

DCLM says that pre-emptive burning is essential to protect life and property and, in the South West, the timber in State forest, especially pine plantations and immature post-logging regrowth.

In the South West, like DCLM, many volunteer bush fire brigades, country shires and other land managers practise frequent regular pre-emptive burning, mainly in Spring. This is the worst possible time for most native flora and fauna.

Many pre-emptive burns become very hot, and some escape and burn larger areas than intended. Escaped pre-emptive burns have destroyed property and burnt out pasture and crops as well as bushland, and pre-emptive burns have even resulted in the death of people.

Most native flora and fauna and natural ecosystems are not adapted to the current fire regime and are rapidly being altered and degraded by it, probably irreversibly.

There is evidence that pre-emptive burns actually increase the amount of flammable material because they promote the growth of weeds and native plants that respond prolifically to fire and interrupt the processes that decompose plant material lying on the ground.

For reasons of economy, in many instances very large areas are lit from aircraft and burnt in a single fire. These burns leave most native fauna no chance to escape. Fauna that does survive may have no food, no shelter from predators and nowhere to live.

Pre-emptive burns release considerable quantities of greenhouse gases into the atmosphere and cause serious air pollution. This makes them a significant health hazard.

There is considerable scientific evidence which shows that under the current fire regime, many natural ecosystems do not have time to recover from one pre-emptive burn before the next occurs. However, while some effort is being made to reduce the size of burns and decrease their frequency in order to protect biodiversity, the public is still being offered no option for fire protection and management other than frequent, regular, extensive pre-emptive burning.

## POLICY

The Conservation Council believes that the environmental, financial and health costs of WA's current fire protection and management in natural areas, which rely almost entirely on frequent, regular, extensive pre-emptive burning, are too high. Instead, the Council believes that fire protection and management in natural areas should rely on:

1. Formulating and enforcing regulations to minimise the human causes of unwanted fires (wildfires) and imposing heavy penalties for breaches. As a matter of urgency, research must be conducted into the reasons for arson and the findings incorporated into fire protection and management policies and practices.
2. Responding to wildfires very rapidly, as soon as they start.
3. Improving wildfire detection, emergency communication systems, firefighting equipment and mobilisation procedures, and providing the funds necessary to fully resource them.
4. Improving liaison between firefighting agencies, including developing a formal code of cooperation between firefighters, to achieve the objective of putting out fires very rapidly, as soon as they start.
5. Having well-trained, well-equipped fire suppression units patrolling high fire-risk areas in the South-West throughout the fire season, to deter arson and detect and put out wildfires as soon as they start.
6. Controlling the expansion of urban development and settlement into fire-prone areas.
7. Encouraging land-occupiers to build and maintain their homes so that they are as fire-proof as feasible, and their surrounds are effective fire-buffers.
8. Placing strategic buffers around vulnerable towns, settlements and property in need of

protection from wildfire. In the buffers, the amount of flammable vegetation must be minimised, preferably by mechanical means (slashing, mowing, raking, pruning, thinning) or, as a last resort, by burning.

9. Educating the whole community, especially land managers and firefighters, about the serious ecological damage now being caused by fire, including pre-emptive burning, in natural areas.
10. Educating the whole community about what to do in case of wildfire.
11. Keeping people out of fire-prone natural areas during periods of high fire hazard.
12. Developing fire protection and management plans for all natural areas and incorporating them into an overall fire management plan for each region. The plans will aim to protect sensitive areas from wildfire and to have a wide range of age for post-fire regeneration
13. Not burning natural areas when they are not adjacent to populated areas or property in need of protection from wildfire except for demonstrated ecological reasons.
14. Conducting research into Aboriginal burning and, where appropriate, incorporating the findings into fire protection and management policies and practices.
15. Investigating and evaluating the effectiveness and impacts of current pre-emptive burning and of ecologically sustainable alternatives to pre-emptive burning, and incorporating the findings into fire protection and management policies and practices.
16. Establishing a large number of sizeable 'no planned burn' control areas in all ecosystem types to investigate the long-term effects of 'no burn' management on natural ecosystems and ground fuel levels, and incorporating the findings into fire protection and management policies and practices.
17. Investigating the use of methods other than burning to assist regeneration in forest after it has been logged.

\*Since the expression 'prescribed burning' covers several types of legal, planned burning (e.g., the burns conducted after logging to reduce logging debris and assist regeneration, the so-called 'regeneration burns'), a better name for burning conducted to reduce the extent and intensity of wildfires is 'pre-emptive burning'.





**CONSERVATION COUNCIL**  
OF WESTERN AUSTRALIA INC.

City West Lotteries House  
2 Delhi St West Perth WA 6005  
Phone: (08) 9420 7266 Fax: (08) 9420 7273  
Email: conswa@inet.net.au

**Some excerpts from the scientific literature on the harmful impacts of current 'prescribed' burning (emphasis added) – April 2003**

**“Historically, many plant species have become locally extinct due to too-frequent fires. Typically, these species have fire-sensitive adults and rely on seed for their re-establishment after fire (“obligate seeder species”). Fire-sensitive species may become rare and become confined to “fire shadows” in the landscape.... Fires are easy to ignite and can spread widely. They can be a cheap management tool and a costly reality.... Examples of fire-induced local extinctions of native plants in Australia span the continent.... Leigh and Briggs (1992) list 19 species as being threatened with extinction at state or federal level due to the inappropriateness of current fire regimes.”**

Gill A.M. and Bradstock R., Extinction of biota by fires, in *Conserving biodiversity: threats and solutions*, Surrey Beatty & Sons, 1995, pp. 309-311

**“Species of fungi that require the conditions associated with a litter layer will not be favoured by a fire regime where the litter layer is frequently removed by burning.”**

Technical Advisory Panel, Environmental Protection Authority, Bulletin 652, 1992, Appendix 2

**“Frequent fires can reduce the native fauna species diversity of an area and the habitat availability.... There is increasing evidence in the [scientific] literature and via personal communications from experts in their fields, that frequent fires have a disastrous effect on many species of flora and fauna and their habitat structure.”**

Botanic Gardens and Parks Authority, Kings Park Bushland Management Plan, 1995-2005, p. 59

**“Detrimental fire regimes contributed to the extinction of two of the three bird species, and three of the four sub-species which have disappeared from Australia since European colonisation. Inappropriate fire management is now a factor in the threatened status of at least 51 nationally recognised threatened bird taxa.... Of the threatened species whose relationships with fire regime has been comparatively well documented, almost all show clear preference for much less frequent fire than that currently prevailing. The long-unburnt vegetation favoured by these species is becoming disappearingly rare, and will require concerted management effort to maintain or increase. Most fire-sensitive threatened birds have low reproductive output and limited dispersal ability. The persistence of these species is further jeopardised by habitat fragmentation, which accentuates the handicap of these traits for recolonisation following fire.... [In temperate eucalypt forests] the most detailed long-term study suggests that such frequent mild fires will lead to the decline and loss of some species which are now perceived as common and little affected by mild fires.”**

**“The endangerment of so many species reliant on relatively old vegetation is a clear indication that land managers are generally burning far more extensively or frequently than prior to European settlement, or that fires now are generally more destructive. The very low fire frequency, or fire exclusion, required by many of these species (e.g. preferred intervals of at least 20 years for most threatened heathland birds, or at least 60 years for Malleefowl) will pose serious management problems....”**

Woinarski, J.C.Z., Fire and Australian birds: A review, in *Australia's Biodiversity – Responses to Fire*; Environment Australia Technical Paper No. 1, 1999, pp. 57, 83

**“Little is known about the effects of repeated hazard-reduction burning over long time scales.... Using ants, beetles, flies, spiders and bugs as representative groups and potential indicators of environmental degradation, this research demonstrated that although overall species richness at specific sites did not change with frequent burning, all groups showed substantial changes in the composition of species assemblages.... These shifts in community composition were substantial and suggested that the extensive and frequent application of fuel-reduction burning could result in a reduction in terrestrial invertebrate biodiversity at a regional scale, with this decrease potentially as high as 50%.... Realistically, the conservation of biodiversity cannot be achieved without consideration of the important role that invertebrates play, both through their involvement in ecological processes, and as a significant component of the overall richness of biotic communities.... [S]ubstantial measured changes in the structure of invertebrate assemblages and the loss of species associated with the decomposer cycle implies frequent burning may be impacting upon nutrient cycling and transfer within these forests. If this is the case, it would have serious implications with regard to the maintenance of ecological sustainability.”**

York, A., Long-term effects of repeated prescribed burning on forest invertebrates: management implications for the conservation of biodiversity, in *Australia's Biodiversity – Responses to Fire*; Environment Australia Technical Paper No. 1, 1999, pp. 183-4

**“Both types of forest [jarrah and karri] are utilized for commercial timber production and both are burned regularly to reduce fuel loads on the forest floor and thus minimize the risk of uncontrolled wildfires.... The development of these ecosystems depends largely on their ability to acquire, conserve and recycle nutrients... The effects of low-intensity prescribed burning on the storage, mineralization and cycling of phosphorus in these ecosystems is a critical area for further research ....Methods for assessing nutrient limitations to growth and for predicting nutrient requirements of intensively managed stands are still largely unknown... the forests may be nutritionally vulnerable in the long term (one or more forest rotations) if the output of nitrogen from prescribed burns at frequencies currently used exceeds more than about half the store of nitrogen in available litter and understorey fuels....There are also no data on the effects of repeated disturbances, such as prescribed burns, on processes such as the rates of mineralization of nitrogen from organic matter in the soil and the consequent availability of nitrogen. Likewise, the effects of disturbance on the phosphorus-status of jarrah and karri forest are uncertain.”**

O'Connell, A.M. and Grove, T.S., Biomass production, nutrient uptake and nutrient cycling in the jarrah (*Eucalyptus marginata*) and karri (*Eucalyptus diversicolor*) forests of south-western Australia, in *Nutrition of eucalypts*, P. M Attiwill and M.A. Adams, eds., CSIRO, 1996, pp. 155-185