Review of the Fire Policies and Management Practices of the Department of Conservation and Land Management

Section 16(e) report and recommendations of the Environmental Protection Authority

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Summary and recommendations

The EPA was requested by the Minister for the Environment to conduct a review of CALM's fire policy and management practices in its Swan, South West and Warren administrative regions in the context of the Department's obligations to manage fire on the lands it manages for the multiple objectives of:

- *protection of human life;*
- *biodiversity conservation and protection;*
- *protection of assets including strategic infrastructure on managed lands;*
- *protection of environmental health; and*
- *the reasonable protection of neighbouring properties and assets.*

The EPA's review of CALM practices has involved the community via information days at various country and metropolitan centres and through a public review of its Discussion paper which generated eighty submissions.

CALM's fire management policy and practices provide its response to wildfires and the use of prescribed burns, in part to assist in wildfire suppression but also for a number of other purposes. CALM's draft Fire Management Policy (February 2004) and the accompanying appendix provide a clear and concise overview of this matter. Protection of human life is the prime objective, but conservation of biodiversity and maintenance of ecosystem health are also important objectives.

The EPA recognises that a fuel reduction programme is a key strategy used by CALM to reduce the extent and damage to biodiversity and other assets, which might otherwise be caused by wildfires. The value of a prescribed burning programme is not in reducing the number of wildfires, but rather their intensity, to assist in their suppression, and to reduce the damage they cause to biodiversity.

The EPA considers that CALM has developed and implemented advanced fire management practices which are rated highly both nationally and internationally. There is, however, room for improvement in some aspects.

Use of a prescribed burning programme to reduce fuel loads and hence the intensity of and damage caused by wildfires is, in our judgment, well validated. There are, however, many gaps in our understanding of the impacts of prescribed burns in a number of areas. Arguably the most important of these is biodiversity; CALM is very conscious of this and is striving to achieve a better understanding and to apply this to its fire management programme through an adaptive management approach. Nevertheless, the EPA believes that there is a need for an increased emphasis on maintenance of biodiversity in both the planning and operation of its prescribed burning programme.

The EPA recommends that, in planning the annual burn programme, assessment of fire requirements for biodiversity outcomes be given first consideration, and that any shortcomings from this approach for the other

objectives be taken into account in a second round process to achieve all priority objectives.

In conducting a prescribed burn, it is important that the objectives of each burn are specified clearly, and that the level of achievement of those objectives can be measured. As a consequence of conducting some sample audits, and after discussion with a number of stakeholders including the Conservation Commission and CALM itself, the EPA considers that improvements can be made in this area.

The EPA recommends that, for each prescribed burn,

- **CALM document the rationale for, and mode of operation to achieve the stated objectives;**
- **CALM report on whether the performance indicators have been met; and**
- **CALM develop and apply indicators to measure burn outcomes against the stated objectives for individual prescribed burn areas, particularly where the objectives are related to biodiversity issues like fire exclusion areas and habitat regeneration burns.**

Indicators must be both meaningful and measurable, a considerable challenge, particularly when resource requirements are taken into account; surrogates may need to be used in some instances. Important measures include: maintenance of species and habitats; vulnerability to dieback, weed infestation, catchment water quality and salinity; and the maintenance of fire exclusion areas and achievement of mosaic patterns.

Audit is one of the prime roles for the Conservation Commission, and it should be actively involved in audit of the burns programme as well as in the development of fire management policy.

The EPA recommends that the Conservation Commission be responsible for auditing the prescribed burning programme, and that this audit forms part of the auditing for the 2004-2013 Forest Management Plan.

In conducting its prescribed burning programme, CALM utilises both spring and autumn burns. The EPA considers this is justified on two grounds. First the different characteristics of spring and autumn burns can be used for specific vegetation/habitat management. Second, it provides the scope to achieve the planned programme without exposing urban communities to unreasonable and unhealthy levels of smoke and emissions. This latter is a contentious issue; CALM incorporates consideration of the forecast weather conditions in determining when to burn, but there are uncertainties and occasional breakdowns. There is scope for study of the balance of risks to human health of smoke from prescribed burns on the one hand, against the increased probability of intense wildfires and the associated risks on the other. There is also scope for improved smoke modelling and smoke trajectory predictions.

Another area in which the EPA received mixed messages was in CALM's public communication and consultation processes. These are sound in

principle, and CALM is keen to achieve good outcomes in practice. It may need to dedicate greater resources to achieve that outcome.

The EPA recommends that CALM further develops and supports appropriate community involvement programmes to provide an effective interface in relation to its prescribed burn programmes, and reports to those communities on the outcomes of any recommendations made, with such reports to be available to the general community.

The EPA also feels that the comprehensive planning and operational processes employed by CALM are not well understood by the community.

The EPA recommends that CALM should document for the public and make readily available its planning and operational processes for prescribed burning.

No matter how good the fire management, wildfires will continue to occur, and it is important that CALM maintains its capability to suppress wildfires; this is particularly relevant in the south-west, where the values are such that the response to a wildfire is always to suppress it as quickly as possible. The training and dedication of CALM staff is first-class, but there is a concern that the human resource base is proving difficult to maintain. Similarly, with the reduced size of the timber industry and the consequent reduction in the availability of heavy equipment with which to fight wildfires, CALM must be more reliant on its own equipment resource.

The EPA recommends that the funding for CALM's fire management operations should be reviewed and adjusted to enable CALM to reach its objectives, as modified from time to time in the light of improved information and understanding, particularly in regard to biodiversity maintenance.

The EPA recommends that CALM undertake periodic forward-planning exercises to ensure readily deployable equipment and a skilled workforce of the appropriate size are available to handle wildfires and hence to contribute into the future to the achievement of its fire management objectives.

CALM is currently undertaking research of quality and relevance, and is a partner in the Bushfire Cooperative Research Centre. It also collaborates with CSIRO and other research teams on fire research. Recognising that there is still very much to learn in this field, it is important that this research activity be at least maintained.

The EPA recommends that CALM's research budget be at least maintained in real terms and that collaborative, peer-reviewed research programmes with universities and other agencies be encouraged.

The research fields to be covered are extensive including, for example, fire ecology, fire behaviour, societal issues, and climate change impacts. With the

inevitable constraints on available resources, priority decisions will have to be made, and it is important that this be done with the highest level of independent expertise. In this regard, while the EPA recognises that CALM seeks advice from specialists, it believes there could be benefits from a more formal process. The Conservation Commission's Research Advisory Committee could provide the basis of such a formal process.

The EPA recommends that the Conservation Commission's Research Advisory Committee be tasked formally to advise on CALM's fire research activities.

In conducting this review the EPA has attempted to respond to, and stay within the bounds of, the terms of reference given to it by the Minister. There were, however, several issues closely related to this review that were considered of sufficient import as to deserve attention being drawn to them. These related to legal and legislative matters on which clarification of responsibilities might be expected to help in fire management. Some of this has been addressed by the Auditor General's Office in its review of fire management. However, the EPA considers there is a need to examine and clarify the responsibilities of planning authorities at state and local government level, and of individual property owners, in regard to fire risk associated with both new and existing peri-urban development.

The EPA also has the view that carbon accounting for CALM's prescribed burning should be carried out preferably through collaboration with the Bushfire and Greenhouse Accounting CRCs.

Finally, the EPA draws attention to other areas in the State which are subject to wildfires. It considers that, in the first instance, CALM should be asked to review its fire management practices for these areas and report its findings and recommendations to the Minister.

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Appendices

1. List of submitters
2. CALM's current (Annual Research Activity Report 2003-04) fire research projects in the CALMScience Division

1. Introduction and background

This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for the Environment on its review of the fire policies and management practices of the Department of Conservation and Land Management.

This advice and recommendations is provided under section 16(e) of the *Environmental Protection Act 1986*, as requested by the Minister for the Environment. The Minister has specifically requested the EPA to provide advice to her in relation to:

> *The Department of Conservation and Land Management's fire management policy and practices, in the Swan, South West and Warren administrative regions of the Department, in the context of the Department's obligations to manage fire on the lands it manages for the multiple objectives of:*
>
> - *protection of human life;*
> - *biodiversity conservation and protection;*
> - *protection of assets including strategic infrastructure on managed lands;*
> - *protection of environmental health; and*
> - *the reasonable protection of neighbouring properties and assets.*

In September 2003 the EPA convened a 'reference group', comprising members across a broad range of interests, to agree on a process for the EPA's review. An outcome of this process was the holding of several Information Days in various south west country locations and the metropolitan area, and in June 2004 the subsequent release by the EPA of a discussion paper for an eight week public review period closing on 20 August 2004. This was called:

> ***Fire, for what purpose? Review of the fire policies and management practices of the Department of Conservation and Land Management. A discussion paper***.

This paper was widely read and gave rise to eighty submissions to the EPA. At the same time an attachment to the Discussion Paper titled ***Consultant reports commissioned as part of the EPA's review of CALM's fire policies and management practices*** was released for comment. It comprised reports from three separate, independent consultants who had been contracted by the EPA to provide expert advice on specific aspects of the review.

Both of the above documents are available on the EPA's website www.epa.wa.gov.au

The purpose of each of the consultant reports was to, respectively:

(1) provide advice to the EPA on best practice fire policy and management practices applicable to the south west corner of Australia and compare them to CALM's;

(2) carry out a literature study on the impacts of fire regimes on biodiversity conservation in the area covered by the review; and

(3) undertake a field audit of and report on three selected areas which had been prescribe-burnt in the recent past by CALM as part of its normal prescribed burning programme in the south west of WA.

The submissions received are listed in ***Appendix 1***, and issues raised in those submissions are summarised in ***Section 2***.

While responding to the Minister's terms of reference the EPA has discussed several matters which fall outside its terms of reference.

Returning to the terms of reference for this review (as specified above) the EPA understands that there is a clear relationship between the intensity of wildfires (and hence the amount of damage that may be caused by them) and the amount of flammable material available to burn once a fire has started. The term 'fuel' will be used in this report to encompass flammable vegetation of all descriptions, leaf litter, twigs, sticks, bark and heavier materials such as shrubs and trees.

The EPA's focus in this review is on fire in general, as required by the terms of reference, and especially on that part of CALM's operations over which CALM has control, that is, its prescribed burning programme and other possible strategies for reducing the severity of unplanned fires. There is limited control over the incidence of wildfires, where lightning or people are the causes, and no control over fire weather.

In the course of its review the EPA noted that the Dwellingup fires were often cited as the disastrous consequences of improper forest management practices and that prescribe burning was introduced directly as a result of the lessons learnt from those fires. There are varying views about how the Royal Commission's report findings led to a change in prescribed burning practices. Certainly, aerial prescribed burning was not introduced until after the fires, According to the Report of the Royal Commission into those fires in 1961,

> "*statements that the Forests department does not carry out controlled burning in the Dwellingup forests are entirely without justification. The Department has control burnt extensive areas each year for the last 40 years and more than ever at the present day. At the present time about 10 per cent of the forest in the district is being controlled burnt annually.*"

Broad scale prescribed burning for fuel reduction had been introduced as a strategy by the then Forests Department decades prior to the destructive fires in 1961 that destroyed Dwellingup and Karridale and damaged thousands of hectares of timber production forest. However, before 1961, prescribed burning tended to be carried out in strips and buffers, rather than the current practice of block burning. It appears that:

> "*when the 1960-61 fire season opened, there were still compartments which had not been burnt over for some 25 to 30 years*" but "*except for these long-protected compartments, most of the forest in the Dwellingup division had been controlled burnt in recent years, and the litter on various parts of the forest represented accumulations generally speaking, of from 0 to 8 years*."

Nevertheless, the report went on to say that

> "*the severity of the Dwellingup fire was, to an appreciable extent, due to the fact that parts of the forest had not been burnt for a number of years and, consequently, could carry a hot fire*."

Also of relevance to the Dwellingup fires was that extreme weather conditions existed at the time; the temperature was 100^0F or more for six days straight, lightning started many fires, and winds were at times very strong and changeable.

The technical appendix to the Report of the Royal Commission presented examples where differences in the age and condition of fuels in the forest had resulted in demonstrable differences in fire behaviour. These examples, which were also published by the Forest and Timber Bureau (McArthur 1962), laid the foundation for the practice of fuel reduction burning over the coming decades (McCaw et al. 2003), including the introduction of broad scale aerial prescribed burning.

The main reason for broad scale burning was, and remains, to reduce the risk of large and destructive high intensity fires by keeping flammable material levels low, but prescribed fire is used for other purposes such as regeneration following harvesting and mining, and vegetation/habitat management. Whilst initially broad scale prescribed burning was largely to reduce the probability of the destruction of property and infrastructure, and to protect harvestable timber from fire damage, increasing emphasis has been placed over time on the management of other natural assets such as water production, the management of flora resources for the flower picking and beekeeping industries and the management of natural vistas and view-sheds (Armstrong, 2004). Importantly, in recent times there has been an increased focus on the maintenance of biodiversity.

Since the advent of European settlement the lands of the south west of WA have become increasingly fragmented as clearing of forested and wooded areas for farms, infrastructure and the expansion of towns and suburbs continues. Whereas, in the past, corridors of undisturbed bush would have connected plants and animals and enabled the movement of species from one area to another, fragmentation due to land clearing results in reduced interaction between many of the more sedentary (plant and animal) species in one patch of bush from other discrete fragments.

The final part of the EPA's review process, as agreed with the abovementioned reference group, after taking into account comments from the community and agency submissions to the Discussion Paper, is for the EPA to prepare its advice and recommendations to the Minister for the Environment, as requested by her. This is the substance of this report.

2. Submissions

A total of 91 submissions were addressed to the EPA, of which eighty were specifically in response to the Discussion paper and/or the concurrently released consultants' reports. Others, triggered by the information days, were submitted prior to the release of the Discussion Paper.

Most people responded to the questions listed in the Discussion paper. There was a range of response styles reflecting the spectrum of backgrounds of the submitters, ranging from yes/no answers to long and detailed replies.

The following discusses issues raised in submissions and concludes with a summary in dot point form which the EPA considers to be the key issues.

An issue raised was that "emotional debate is hindering the development of well-informed solutions for sustainable wildfire risk management that integrate community safety and biodiversity conservation" and that therefore the issues are as much in the social and political arenas as the scientific one. Other submissions called for a much more integrated, multi-disciplinary approach to fire management. Some respondents stated that the questions, rather than informing the issues, fuelled the debate because they were worded so as to require a decision in favour of the protection of life and property OR biodiversity conservation, rather than aiming for integration of community safety and biodiversity conservation.

Some submitters thought that the EPA's Discussion Paper focussed solely on forests and noted that within the three CALM administrative areas covered by this review, ecosystems other than forests cover 16% of the area managed by CALM. The concern was expressed that fire management practices appropriate for forests might be applied to these other ecosystems with an adverse impact on their biodiversity.

A number of respondents were happy to spell out a hierarchy for protection (ie human life, then property, then environment) in the event that a conflict situation should arise during a fire, while at the same time stating that all values are important and it would be the preferred goal to save them all, rather than having to sacrifice one for another. Some submissions also noted that often thousands of other creatures may be sacrificed in the bid to save human property and that they should be taken into account. It was noted that if the strength of the community and economy are largely dependant on the strength of the supporting environment then the conservation of biodiversity is paramount to the economic and social viability of those communities. Another perspective from submitters was that the protection of human life and property should be relegated to the community, and property owners should accept responsibility for their own safety by forward planning before each fire season and ensuring that accepted fire safety practices are in place.

Responding to the question whether private property assets should be protected before public assets, submitters felt that the correct way to assess such a situation is on the relative worth of the asset, and the impacts associated

with its loss, and that this principle should be extended to include biodiversity values. However, it is not necessarily the case that the protection of property and biodiversity are mutually exclusive. High biodiversity values should be protected before low property values for example, and vice versa. So it is vital that the values classification used by CALM accurately reflects the values of the whole community and that both risk and consequence are evaluated when comparing values and threats.

Many submitters reviewed the consultants' reports. Some were critical of aspects of them and even suggested that the EPA, by uncritically accepting and publishing them, had compromised its own professional standards. The EPA wishes to make clear that it did not constrain the consultants, nor influence what they wrote in response to the briefs they were given. Neither is the EPA, by publishing them, necessarily agreeing with those reports. Where it has needed further information, the EPA has sought other expert advice, and has not been constrained by the consultants' reports.

The URS audit report of three of CALM's prescribed burns noted that records were missing from the prescribed burn documentation in the CALM operation centres responsible for the prescribed burns that were the subject of its audit. It was observed that this could hardly be seen as 'best practice', which was how consultant Hodgson described CALM's fire management practices in his review.

Some submissions commented on Hodgson's recommendations for legislative changes to the CALM Act. Some saw no need to give the CALM legislation primacy over all other Acts and noted that a review of legislation was not in the Minister's terms of reference for the EPA's review. On the other hand, other submissions queried the omission in the EPA's and Hodgson's report of legal considerations relating to administration of biodiversity protection and want amendments to legislation giving clear management responsibilities for fire management and operations to CALM on CALM-managed lands. A more explicit statement of the respective responsibilities of CALM and the Conservation Commission seems to be important and submitters want the relationship between CALM and the Conservation Commission to be retained, strengthened and adequately resourced so that the Commission can carry out independent audits of CALM's prescribed burning programmes.

Submitters considered that the URS audit was too restricted to be seen as representative of prescribed burning generally in the south west region. They would also have preferred the scope of the audit to have included the assessment of biodiversity impacts and regional planning so that information on whether biodiversity conservation and community safety objectives were addressed could have been analysed.

Some submissions noted that Muller's 2001 internal review of CALM's fire management practices made 44 recommendations and that the EPA's review could have performed a valuable function in determining what progress has been made in the implementation of those recommendations.

The last two comments introduce a general point the EPA wants to make. Some of the submissions reflected an expectation that the EPA would provide a broader review of fire issues than was encompassed by the Minister's Terms of Reference. The EPA considers that this is neither appropriate nor desirable; in a few instances the EPA reached the view that attention should be drawn to matters which lay outside its brief, but these have been separately identified in 'Other Advice'.

Many respondents expressed concern with the report by the Botanic Gardens and Parks Authority on the effects of fire regimes on biodiversity conservation. The main criticisms were that the refereed papers discussed were chosen selectively, that many (equally valid) others were not mentioned at all, and that results of fire regimes in Kings Park seemed to have been unjustifiably extrapolated to cover the broader area encompassed by the EPA study.

Several respondents indicated that forums should be established by CALM to foster a consultative and cooperative approach between the various stakeholders and suggested the dissemination of unbiased information via field trips, workshops, conferences, the traditional media, the internet, and through schools. Submitters wish to include people within a wider radius than is currently the case, that is not just those immediately adjacent to CALM-managed land where a burn is proposed. (Spot fires at distances over a kilometer ahead of the main front are known)

The frequency of prescribed burns seems to be an area where there are a lot of different opinions. Some submitters have implied that burns have occurred every couple of years in the same places and that this is far too often. Some do not accept that there is any place for prescribed burning, stating that there is no compelling evidence that prescribed burns are advantageous to biodiversity and that there is much evidence to the contrary. Others are of the opinion that, rather than reducing fuel levels the opposite is needed ie to increase these levels. Thus, under the tree canopy, litter should be allowed to accumulate and decompose into organic matter. Its natural moisture content may then make it unlikely to need to carry out prescribed burning. It seems to some respondents that there is a general pattern that the worst wildfires occur in areas which have been clear-felled and are still recovering. The changing (drier) climate regime was noted; and seen as slowing down the rate of collection of flammable vegetation and thus indicating a need for burning on a reduced frequency.

Other respondents are concerned that burning is not carried out often enough and feel exposed to unacceptably high wildfire risk. Yet others stated that, for a range of reasons, some areas need to be burned frequently, others rarely, if at all. [The EPA believes that CALM's current burning regimes are much more complex, occurring at different times of the year and at different frequencies, depending on the objectives to be achieved. CALM needs to address this lack of understanding in the community.]

Several submissions stated that CALM's reporting and auditing of its fire management practices were deficient, one reason given being that the stated objectives did not have measurable outcomes and could not be meaningfully audited. It was therefore not possible to determine whether CALM's fire management practices achieve either effective biodiversity conservation or community safety. One target that is frequently used by CALM is the annual prescribed burn area of around 200,000ha. Many submissions made the point that this is an inappropriate objective, even if it is a measurable parameter. Some in favour of CALM using such a target stated that it should be an average figure, subject to annual variations and should never override the biological objectives of a burn prescription. The claim has frequently been made too that the area burnt by wildfires is not taken into account by CALM when planning its prescribed burns. [In fact CALM does take wildfires into account.]

There were comments on the topic of mosaic burning and its role in the enhancement of biodiversity. CALM usually aims to leave unburnt between 10% and 35% of the block. Even if the percentage target area is achieved, however, there is no guarantee that a particular flora or fauna refuge area and protected species (for example) within the burn block will have been avoided, unless the objectives were explicit about its exclusion from the burn and an appropriate follow up survey has been done. Therefore, it was argued there is a need for more clearly defined (and auditable) objectives. Some submissions argue that the current burn mosaic in blocks is much too coarse. They would prefer to see burnt areas no larger than 10ha separated by unburnt areas of about the same size. Other submissions stated that if prescribed burning has to be done, then small autumn mosaic burns of under $1000m^2$ would do the least amount of damage and that as much as 90% of the block should be left unburnt. Some submitters gave as the justification that many species of fauna are unable to escape from fires and that multiple ignition points aggravate this problem.

Some submitters were keen to list the differences in impacts between spring and autumn prescribed burns because they interpreted the Discussion Paper as being in favour of the latter. It was argued that in spring the surface of the fuel layer is dry, whilst deeper layers are moist and usually do not burn. More unburnt pockets are left, thus achieving a desirable mosaic effect. Spring burns were more likely to expose regeneration and remaining fauna to summer drought and food shortages. Autumn burns are considerably more difficult to carry out because they can easily result in much higher fire intensities. The deeper layers often remain dry and, if ignited, an intense fire can develop. There may be greater short-term impacts on undergrowth and on standing and fallen trees, many of which may have important habitat values. Others stated a preference for autumn burns so as to avoid the visual impacts at a time of the year when public visitations are high and when birds and animals are raising their young. Other submissions stated that burning at the same season each time was not a good strategy; and in any case should occur as infrequently as possible. The view was expressed that a mixture of both is best, that the natural world is a complex system of variations and that one of the desired outcomes is diversity.

On the topic of catchment water quality submissions stated that high intensity wildfires not only cause damage to the vegetation but also to the soil. The resulting post-fire erosion can silt up waterways and reservoirs. Vegetation that is recovering from hot fires can use significantly more water than unburnt vegetation. Low intensity prescribed burns are more beneficial, giving rise to a short term increase in water yields because they take out the forest litter which otherwise would absorb rainwater and prevent it from adding to either runoff or groundwater intake. The submission from the Water Corporation stated that if there were to be a repeat of the 1961 Dwellingup wildfires within the Corporation's integrated water scheme catchment areas, half of those water sources would need to be taken off line for several months due to the ensuing water quality problems, resulting in more severe water restrictions to the metropolitan community.

On the topic of wildfire risk to communities it was noted that the EPA in its Discussion Paper did not identify that alternative wildfire risk management strategies (including community-based strategies) are required to significantly reduce the risk to a community or townsite, especially under severe fire weather conditions. A suggestion was that low fuel buffers could be created around towns and farms by several techniques besides prescribed burning, including hand fuel reduction, slashing or by growing less flammable plants such as fruit trees. [The EPA certainly endorses the strategy of applying several fuel reduction techniques in surrounding buffers, and also that the respective communities should be involved in implementing them]. Power lines should be put underground to reduce the risk of starting fires.

Some submissions were not in favour of CALM having to compromise or sacrifice conservation values for the safety of inappropriately sited new subdivisions which had been built in high fire risk areas, stating that the inherent risks should be borne by the developers. Submissions also made the point that, although the Western Australian Government has adopted the Australian standard for risk management (AS/NZS 4360) neither CALM nor FESA is applying it to wildfire management, instead using wildfire threat (or hazard) analysis as a planning tool.

The role of volunteer firefighters was mentioned. Volunteer brigades are a vital resource in smaller communities and on the fringes of the metropolitan area. Their training needs to be commensurate with the roles that they are called upon to perform; sometimes they are called upon to put out more than just grass fires, and the skills and equipment required are different.

Smoke from prescribed burning over south west communities was a significant issue for many respondents. However, others commented that they would rather have to put up with smoke from a prescribed burn than be burnt out by a wildfire. It appeared that the community seemed to react to smoke from prescribed burns but not from wildfire smoke. Suggestions were made that those at risk health-wise from smoke could be offered accommodation in a motel for the duration of the burn, as apparently they do in Florida (USA).

Active involvement and information programmes are needed if community support and greater tolerance for smoke is to be achieved.

Opinions varied on whether or not to protect harvestable trees, or those earmarked for future harvesting. Some saw no reason to protect them because WA already produces 20% more plantation timber than is needed by any industry, while, on the other hand, others consider that they have a considerable resource value and should therefore be protected commensurate with that value.

On the issue of fire research people offered lists of topics that they considered to be important to study. Many requested that much of this work should be done by independent bodies, perhaps using raw data gathered by CALM. People had divided views on if, or how the precautionary principle should be applied-many were in favour of applying best knowledge available at the time to fire situations rather than awaiting the definitive set of data in the future to settle issues.

The most important issues raised in submissions were seen to be:

- the need for CALM to develop and implement a robust and transparent fire management and reporting framework which includes accountability;
- the need for meaningful and measurable key performance indicators and independent audits;
- the need to recognise the effect that climate change has on soil and fuel moisture levels, litter accumulation and vegetation growth rates, and to factor it in to fire management practices;
- the capability for early detection and rapid suppression of all wildfires;
- making the distinction between decision-making during a wildfire, and wildfire risk management planning;
- continuous learning and adaptation of practices and ongoing staff development, including in wildfire risk management, as new information comes to hand; and
- planning for new subdivisions in peri-urban areas should require the developers and relevant government departments to ensure that the proposal meets at least the minimum fire safety requirements to ensure that wildfire risk, and vehicular access, can be maintained at an acceptable level within the subdivision. If it fails this test the development should not be approved.

3. CALM's fire management policy and practices

3.1 CALM's draft policy on fire management

CALM's current draft Fire Management Policy (February 2004) and the appendix outlining the rationale and principles for fire management practices cover the aspects of and issues arising from fire management comprehensively. Some of the key statements in the policy follow.

Firefighter and public safety is the first priority in every fire management activity, followed by the protection of biodiversity, cultural and property values. Fire is to be used to achieve a range of land management objectives including: the conservation of biodiversity; maintenance of ecosystem health and productive capacity; conservation of soil, water and catchment values; conservation of natural and cultural heritage; regeneration and protection of native forests and plantations; and protection of human life, community assets, indigenous heritage sites, recreation sites and scenic values.

Prescribed burning plans are to incorporate both nature conservation and protection objectives so as to optimise outcomes. The planning of prescribed burning will require the integration of multiple objectives and must take into account the role of planned fire in the maintenance of biodiversity and reducing the risk of wildfire.

A variety of fire regimes incorporating different frequency, intensity, season and scale will be applied at the landscape scale (tens of thousands of hectares) and these regimes will unavoidably include some random wildfires. Planning for prescribed burns will address strategic protection from large fires, as well as landscape scale and land management unit scale plans (several hundred to several thousand hectares) that provide for the protection and conservation requirements at each of these levels.

The EPA supports the expressed objectives.

The Conservation Commission also has a mandate in the development of policies and management plans for the majority of CALM-managed land, and in auditing the outcomes. There must be close collaboration between these two bodies to ensure the policies and practices are achieving the required outcomes efficiently and effectively.

3.2 CALM's prescribed burning programme

In the course of conducting this review, the EPA has gained the impression that CALM's planning and operational processes are not well understood and appreciated by the wider community. In an attempt to alleviate this situation, the processes used by CALM are succinctly set out below in the shaded section.

3.2.1 Planning[1]

Prescribed burning on CALM-managed lands is carried out in accordance with the approved management plan for that land, but the EPA notes that not all have specific area management plans. Under S33(3) of the *CALM Act*, CALM must act in accordance with such plan, or in the absence of a management plan can only undertake "necessary operations" or "compatible operations". These are covered by Interim Management Guidelines (an interim mini-management plan). Within the framework of the management plan, regional strategic plans

[1] **Text in shaded areas relates to information provided to the EPA at its request. This information is distinct from the EPA's advice, which comprises the remainder of the bulletin's text.**

consider the long-term requirements for protection and the fire management requirements of other activities. Prescribed burning operations and the resultant burnt area are highly visible, but the planning underlying prescribed burning operations, is not. It includes consideration of:

- vegetation classifications and the vital attributes of key flora;
- Wildfire Threat Analysis;
- Fauna Distribution Information System; and
- other management requirements;

and is summarised in a rolling Master Burn Plan.

The *Master Burn Planning* process aims to optimise the various requirements, and identifies both the areas to be considered in the burning programme, and the preferred season (using precedents to inform the decision so as to increase the prospects of achieving a broad diversity of objectives). Regional Master Burn Plans are reviewed biannually in a process that integrates strategic protection requirements with those for biodiversity protection, and requirements associated with other forest activities including logging and silviculture, research programs, weed and feral animal control programmes, endangered species programmes, fauna programmes, recreational activities and protection of landscape values, as well as the needs for community protection.

CALM's planning takes into account the fragmentation issue. Factors considered to minimise the effects of fragmentation include:

- the size of the reserve;
- vegetation and fauna associations;
- nature of surrounding lands (eg farmland or contiguous with private bushland);
- potential for weed invasion;
- options for burning a portion only of the reserve;
- grazing pressures on small burnt areas post fire; and
- alternative protection.

Prescribed burning for fuel reduction is not normally carried out in small isolated reserves. The protection benefits are generally low, are likely to be negated by subsequent weed invasion, and such areas are generally not a great hazard, There is often a much greater risk of fires entering these areas from outside than of starting within them, and protection planning is focussed more on perimeter breaks to reduce the risk of fire entering, and on suppression in the surrounding lands (where fire suppression is usually easier). Prescribed burns for purposes other than fuel reduction may be carried out for specific purposes such as habitat management or species regeneration, or to assist with weed control programmes, etc.

The burning plan is and must be integrated with other activities, which may themselves have long lead times. Planning for individual burns may need to commence up to eight years in advance of the burn, if soil disturbing activities are proposed for the area, in order to allow for dieback interpretation and on-ground demarcation. The long-term nature of this planning is illustrated by considering an area proposed to be logged. This planning takes into account:

- that to allow for dieback interpretation, the area must be unburned for a minimum of 3 (preferably 5) years. Following interpretation, dieback must be demarcated in the field, prior to burning;
- silvicultural burning requirements;
- regenerated areas need protection from fire for 15 years;
- logging debris will add to the fuel load. The area and/or surrounding buffer (depending on the required intensity of the post-logging silvicultural burn) should be burned prior to logging to reduce the fuel load; and
- logging resulting in regeneration is concentrated to the extent possible to allow for buffers to be burnt to provide strategic long term protection.

Wildfire Threat Analysis identifies fire protection requirements and priorities. It considers the values at risk (including biodiversity values), the likelihood of ignition, detection and suppression response capabilities, and potential fire behaviour. It is used by CALM to consider the threat from and response to wildfires in the south west forests (Muller, 1993) and to provide a standard and repeatable process for decision-making. The outputs from this analysis are primary inputs to fire management planning and are used each year to guide the location of prescribed burns so as to best protect environmental and community values (Armstrong, 2004).

The fire requirements (including areas from which fire is to be excluded) associated with management activities are identified through the plans for the relevant programmes (logging programmes, research plans, control programme plans, species programmes, etc). Many activities require fire, and prescribed burns are undertaken for a range of purposes, including habitat maintenance (eg regeneration of thickets), regeneration silviculture (eg advance burns to aid lignotuber surveys; tops disposal burns to protect residual stands; release burns to remove competition and stimulate lignotuber development), as well as the reduction of fuels so as to reduce the spread and intensity of wildfire.

Recent developments at CALM in remote sensing and GIS technologies now permit more comprehensive planning and analysis. Within the south west forests, 26 Landscape Conservation Units (areas within which plant species and communities have evolved under similar environmental conditions) have been identified. The acceptable fire regime and an idealised fire age distribution for each unit are determined, based on a study of the vital attributes of a number of plant species. As part of the Master Burn Planning process, the fire age distribution (resulting from both planned fire and wildfires) within each unit is compared with the idealised distribution, and burning is targeted to those areas that are over-represented.

A *Fauna Distribution Information System* relating to the maintenance of habitat to protect fauna has been developed by Christensen (unpubl.) for south west forest areas to enable fire planning also to consider animals. The system provides information on the needs of specific vertebrate fauna and of their habitats, and is intended to be applied to areas identified for prescribe burning to maintain fauna values at both the local and landscape scales (Armstrong,

2004). These developments allow biodiversity to be incorporated more effectively in the planning.

Prescriptions are prepared for each proposed burn, including a field fuel assessment to confirm fuel levels are as predicted prior to any decision as to whether the burn should be included in the current program.

CALM's detailed burn prescription comprises the following components:

- pre-burn and Environmental Checklist (CLM 32). This identifies early in the planning phase actions that are required, relating to the environment, people, or property, including notifications. All actions must be completed and signed off before the burn can proceed;
- description of treated area;
- 1:25,000 map showing forest types, including location of warning signs, water points, control lines, preparatory work required, location of fuel sampling lines, and areas of special interest;
- burn purpose and objectives;
- field fuel assessment records and calculations;
- planned conditions for each lighting, including limits for the Fire Danger and Soil Dryness indices;
- planned lighting strategy for each lighting;
- burn preparation, including Phytophthora Management Plan;
- necessary approvals (burning on other lands, approval to take flora, etc) as appropriate to the burn;
- resources required;
- approval signatures: all burn prescriptions are reviewed and must be authorised by a senior officer. All aerial burn prescriptions must be authorised by Fire Management Services; and
- the post-burn assessment record.

3.2.2 Operations

The detailed burn prescription associated with the conduct of a prescribed burn was summarised above. The actual conduct of a prescribed burn requires careful and detailed planning of the operation. This involves:

- assembly of the burning teams, often drawn from many districts;
- organising catering and accommodation for the duration of the burn;
- deployment of the required plant and equipment;
- detailed briefings and assignment of responsibilities;
- careful attention to the current and forecast weather pattern;
- comprehensive notification of all the potentially affected community;
- and many other details.

3.3 Wildfire management

CALM has a responsibility to respond to fires occurring on or near to land under its management. In the south west of WA (the region encompassed by this review) the values and risks are such that the response must be to suppress wildfires as soon as possible, and CALM has established infrastructure and operational arrangements to achieve this objective. These are outlined below.

Detection
The detection system comprises a combination of fire lookouts and light aircraft. Aircraft fly predetermined circuits to maximise detection coverage. Hours of operation for towers and the flight schedules for detection aircraft vary according to the fire danger.

Detection is also provided through public reporting. Fires at times occur at night, when CALM's detection system is not normally manned, and public reporting is a prime source for detection and notification of such fires after dark.

Early detection is essential to allow action whilst fires are small. Much of the CALM managed land is distant from private land, and reliance on early detection by the public is not feasible. Whilst the focus for the detection system is CALM-managed land, it also provides coverage over private land near the boundary, and often reports fires well before reports are received from the public.

Rapid Response
Staff and fire crews are placed on standby after-hours and on weekends and public holidays in readiness for a rapid response. The hours of standby, the numbers of crew, and their location, is pre-determined according to the fire danger, but is further modified on a daily basis according to the current fire situation. For example if there are a number of burns "live" or going wildfires in other areas that may require assistance, levels would be increased. Under very high or extreme conditions, staff are on 24 hrs standby.

Access and Water Points
Early arrival of suppression forces at a fire improves the likelihood of success. Time is important. To enable crews to respond quickly, roads and tracks must be maintained. Although often serving multiple purposes, including recreational access, much of the road and track network in the forest areas is maintained primarily to provide fire access.

Although "dry" fire fighting techniques are used because of the limited water in most forest areas, water remains a critical requirement. In most of the forest areas there are long distances between suitable natural water supplies suitable for filling tankers. To reduce turn-around times for tankers, water points are constructed and maintained.

Aircraft
Aircraft are used for detection, water-bombing, ignition, and crew transport. Aircraft are quicker than ground transport, and are used to ferry relief fire crews between distant districts when required for extended fires, but are not suitable for all fires. (Initial crews must travel by road so they can take the necessary tankers and equipment with them).

Water bombers can often reach fires more quickly than ground crews, and can reduce the spread of fire until ground crews arrive. However, they are not

suitable on their own for broad-scale forest fires. They are also extremely valuable in assisting to protect specific values (eg houses).

Both fixed wing aircraft and, in recent years, helicopters are used for aerial ignition, both for prescribed burning and for fire suppression. Particularly for large fires where indirect attack some distance from the fire is required, aerial ignition is an important tool to burn the area between the fire front and the established control line.

Aerial surveillance of going fires is important to provide valuable intelligence to better plan fire suppression strategies and tactics.

Fire Equipment

Equipment ranges from hand tools to aircraft, and includes a fleet of light, medium and heavy 4WD tankers, bulldozers and loaders. This equipment is regularly maintained to ensure it is immediately available when needed. There are regular equipment checks, for example, many kilometres of fire hose are pressure-tested annually. With the decline in the forest industry the availability of contractors with heavy machinery has diminished giving rise to the potential for problems if many fires are to be suppressed at one time. CALM collaborates with other agencies both nationally and internationally in equipment development, and introduces relevant improvements into its operations.

Liaison and Coordination

Close ties and contractual arrangements are in place with the Bureau of Meteorology for forecasting services, smoke plume prediction and associated ongoing research. There is also strong liaison with FESA/LGA/Brigades at all levels, including LEMAC, Fire Advisory Committees, and at a State level. For the community, information and warnings are published and broadcast. Advisory signs and “fire danger boards” are maintained.

Decision Support Systems

In wildfire situations there is usually a need to prioritise actions, identify critical areas and allocate resources to achieve best outcomes. This is particularly the case following dry lightning storms, where many fires can be started in a short space of time, and firefighting teams are fully extended. CALM has developed and continues to improve Decision Support Systems to assist its operational staff.

Extending this, CALM is contributing to the development of a Bushfire Threat Analysis system based on the principles of AS/NZ 4360 (Risk Management) covering all lands (not just CALM land).

CALM’s research programme is also contributing to improved wildfire management.

4. EPA's Review of CALMs Policy and Practice in Fire Management

4.1 Prescribed burning

As well as examining CALM's planning and operational procedures and attending an actual prescribed burn, the EPA also notes the advice from its expert consultant and from others with long experience in this field, nationally and internationally. As a consequence, the EPA considers that CALM has developed advanced fire management practices, with the planning and operations being both comprehensive and thorough.

The EPA, however, considers that there are aspects that can be improved, and these are the subject of recommendations in the discussion below.

4.1.1 Fuel reduction

There is a degree of dispute in the community on the value of prescribed burns for reducing fuels. This may stem from data which indicate there is no reduction in the number of wildfires as a consequence of prescribed burns. The value is not in reducing the number of wildfires, but rather in reducing the intensity and increasing the prospects of suppressing them, and of reducing the damage they cause to biodiversity values and to property.

The EPA considers there are many studies which validate this conclusion. The submission to this review by N.P. Cheney, a Senior Principal Research Scientist with CSIRO Division of Forestry Products, provides a convincing, referenced, and easily understood synopsis of this issue. While his submission (titled *Fire, for what purpose*?) is posted on the EPA's website its main points are summarised here:

Under extreme conditions a single fire can burn out between 60,000ha and 100,000ha in eight hours, and multiple fires burning close together may induce higher rates of spread. The drivers of fire are the moisture content of the vegetation, or fuel, the amount and structure of the fuel, and the wind speed. Fires will spread if the fuel supply is continuous and the moisture content is below that required for extinction of the fire. Even if the supply of fuel is discontinuous, headfires will spread where the threshold value of wind speed is exceeded and firebrands are carried ahead of the fire. Fires in much of the south west forest would continue to burn overnight for at least three months of the summer season because heavy fuels will remain alight.

The effects of fire on biota are largely determined by heat transfer processes, the two most important being convection and conduction. Convection transfers heat to the above-ground biota. The strength of this transfer is determined by the intensity of the fire-if it is high enough it will kill above-ground flora and fauna. Removal of the forest canopy changes the amount of sunlight reaching the forest floor and will cause different regrowth responses. Conduction transfers heat below ground and through bark. The conductivity of the substrate is primarily determined by its moisture content, not by fire intensity. The depth of penetration of heat sufficient to kill soil biota or

germinate soil-stored seed depends mostly on the total fuel load, its moisture content, and also that of the soil. There will therefore be different responses depending on the depth that different seed lies below the ground surface.

Prescribed burning reduces the total load of fine fuel and the height and flammability of elevated fine fuels such as shrubs and suspended dead material. Burning is the only practical way of reducing the fibrous bark on trees, this being the prime source of firebrands that cause spotting. Prescribed burning modifies fire behaviour by:

- reducing the speed of growth of the fire from its ignition point;
- reducing the height of flames and rate of spread;
- reducing the spotting potential by cutting the number if firebrands and the distance they are carried downwind; and
- reducing the total heat output of the fire.

The more heat that is released by a fire, the more effort that is required to suppress it. Higher flames mean that the fire is more responsive to changes in wind direction and thus more dangerous. Heavy fuels require more water to suppress combustion, more work to build a fire line and more effort in mopping up to ensure the fire line is secure. Where fuels have been allowed to accumulate to equilibrium levels the work required to build fire line and the urgency of suppression in a reduced window of fire weather mean that bulldozers or other tracked machinery are the only effective options available.

In a eucalypt forest with a tall understorey, the fuel types can be grouped into several layers of different compaction. In decreasing order of compaction these are:

- compacted surface litter bed of leaves, twigs and bark (~60% of fuel load);
- leaf, bark and twig litter suspended near surface in low shrubs and grasses or the base of taller shrubs;
- an elevated layer of shrubs;
- intermediate layer of small trees and the fibrous bark of overstorey trees; and
- the canopy of the overstorey.

In most forests, although different layers may present a greater or lesser hazard at any one time, the fuel characteristic that appears to be the most important in determining the fire spread is the near-surface fuel layer.

From these layers the following measures of hazard are used to define fuel characteristics:

- surface fuel loading;
- near-surface fuel hazard score;
- elevated fuel hazard score; and
- overstorey bark hazard score.

These characteristics change with age since the last fire (data are quoted from Project Vesta experiments on two sites, in northern and southern jarrah forest). The rate of change is most rapid in the first five years or so for all categories of fuel hazard, but continues to increase more slowly up to 20 years (the maximum age of data available to date). Elsewhere, observations in forests

that were unburnt for more than 50 years showed the near-surface fuel hazard still increasing. It appears that the single fuel variable that best predicts fire behaviour is the near-surface hazard score. This layer can continue to increase even after shrubs senesce, because the fine fuel of litter, bark and twigs is suspended on the woody material of the shrub stems and fallen branches from the overstorey.

It is the EPA's view that CALM's fuel reduction programme is imperative to reduce the extent of the damage caused by wildfires to biodiversity and other assets, while recognising that prescribed burns may also affect biodiversity. It notes, however, that there are still gaps in our understanding of the impacts of prescribed burns on biodiversity values, and that adjustment to the programme and operations are likely as the knowledge base improves. The EPA has provided advice on the need for adaptive management in ***section 4.1.2.***

4.1.2 Biodiversity

It is evident that prescribed burns impact on biodiversity values, both advantageously and detrimentally. CALM is very aware of this and biodiversity maintenance features as an important objective in planning and conducting prescribed burns. Several of the sections below relate to this aspect. The EPA identified that fragmentation is important with respect to impacts on biodiversity conservation and that management with regard to fire needs to support and not exacerbate the consequences of this. Prescribed burning therefore needs to be planned carefully to avoid the potential for harmful impacts.

CALM has provided to the EPA a paper titled *Ecologically Based Fire Management-integration of multiple land use objectives* (R. Armstrong, 11th Annual AFAC Conference, October 2004) which describes recent developments in its approach to meeting its objectives. Reference was also included in the shaded 'Planning' section to the identification of 26 Landscape Conservation Units and establishing burning regimes to optimise the fire age distribution of vegetation in each unit.

While acknowledging this work and the importance CALM places on maintenance of biodiversity in its prescribed burning programme, the EPA is aware that the knowledge base for, and understanding of ecological systems are both far from complete. It is, therefore, essential that an adaptive management approach be adopted in the implementation processes, continuously upgrading the planning and operations to take account of new information and insights. This, in turn, requires a thorough approach to the setting of objectives, and to the identification and monitoring of indicators to determine whether those objectives are being achieved. It also requires an ongoing research programme to interpret the information, to help to unravel the complexities, and to guide the adaptation process. CALM has made clear that it fully supports this approach, and it is a strong player in the actual process.

CALM and others must continue to develop our understanding of ecological systems and ensure that an adaptive management approach is taken to

continually improve the fire management process, with particular emphasis on conservation and enhancement of biodiversity. The EPA is particularly concerned to ensure that the information engendered by the prescribed burn programme is gathered and used. To quote from Armstrong's paper:

> *Each prescribed fire that is planned is viewed as an opportunity to apply an adaptive management approach to fire management. Each prescription is an opportunity to test a hypothesis and add to the knowledge of ecological fire management. A burn prescription may identify a number of monitoring requirements to determine if the stated objectives of the burn have been achieved and to provide new knowledge.*

This is welcomed, but the EPA is not convinced that the practice is as good as the intent. Its concerns are reflected in some of its recommendations pertaining to identification and monitoring of key indicators, particularly for maintenance of biodiversity; and use of an adaptive management approach which takes into account improvements in knowledge and understanding generated through research and operating experience.

EPA considers a further step may be necessary to ensure sufficient emphasis is given to the maintenance of biodiversity in actual practice, whilst recognising that protection of human life remains the priority.

The EPA recommends that, in planning the annual burn programme, assessment of fire requirements for biodiversity outcomes be given first consideration, and that any shortcomings from this approach for the other objectives be taken into account in a second round process to achieve all priority objectives.

4.1.3 Burn patterns

In any prescribed burn, there is general agreement that a mosaic of burnt and unburnt patches is essential, but there are differing views as to how this is best achieved, particularly in relation to the area encompassed by a prescribed burn. The EPA accepts that there must be control lines surrounding a burn, and believes that CALM's current practice of identifying blocks within existing tracks is sensible. Smaller burns would require more control lines, with a higher ratio of disturbance. Furthermore, while smaller burns can create a mosaic between burns (but with greater uniformity within the burn), a larger burn provides greater opportunity for a more natural mosaic within the burn, relying on fuel moisture differential and natural variation in fuels. Critical areas must be protected from the burn by the use of bare earth control lines or other practices. Determination of the mosaic pattern and percentage area burnt are important indicators to be measured following each prescribed burn (see sections 4.1.2 and 4.1.6)

4.1.4 Season for burns

Another matter on which there is a range of views is the seasons in which prescribed burns are conducted, some favouring only autumn, others only spring. In fact no one fire regime suits all species; this includes season of burning. Burning in both autumn and spring is necessary to achieve the range of objectives. While autumn burns burn more, and are hotter, they also

regenerate more as they stimulate regeneration of those seeds that require a heat trigger (as the heat pulse penetrates deeper into dry soil). Spring burns can result in high regeneration from resprouters.

The different characteristics of spring and autumn burns can be used to advantage for specific vegetation/habitat management. For example, the heartleaf thickets that provide shelter for Tammar Wallabies (and others) are fire-sensitive, and spring burns are required in the surrounding forest so the gully thickets do not burn (and to protect them from summer wildfires). However, they senesce and begin to break down after about 20–30 years, and require fire to regenerate. Therefore seasonality of prescribed burns is tailored to maintain and regenerate as appropriate. To summarise, no one fire regime (including season) suits all species equally. The fire that favours one species will be to the detriment of another, therefore to cater for all, variation is needed.

There is also a pragmatic reason for the two seasons; whilst there are more days suitable for prescribed burning in spring than in autumn, there are not enough days in either season to carry out the amount of annual prescribed burning that is required (for all the various reasons described elsewhere), given the restrictions imposed by cycling weather patterns and threats to metropolitan air quality if the burn timing is wrong.

4.1.5 Smoke and emissions

Smoke from fires, whether wildfires, prescribed burns, or domestic fires, can exacerbate or precipitate health problems amongst susceptible members of the community, and it is appropriate therefore to restrict exposure to smoke to the extent possible.

CALM's planning processes incorporate consideration of the forecast weather conditions for the period of the prescribed burn, and there is close liaison with the Bureau of Meteorology in this regard. The weather conditions that are normally suitable for safe fuel reduction burning in the south west are often the same conditions that lead to smoke being blown by southerly winds into the metropolitan area. Particular attention is given to avoiding smoke over the Perth metropolitan area; there are generally only 1-2 incidents each year where the smoke particulate (PM10) standards are exceeded (pers. comm. A. Grieco, DoE). The National Environmental Protection Measure (NEPM) allows up to five days per calendar year where the standard of $50\mu g/m^3$ averaged over 24 hours for particle matter size PM10 may be exceeded. Consideration is also given to other population centres, but it has to be recognised that it would be impractical to restrict planned burns only to periods when the risk of spread of smoke over populated areas is very low. Even for the metropolitan area it is impossible to achieve certainties, in the light of the time taken to conduct prescribed burns and the limitations of longer term weather predictions. Judgements have to be made on the basis of best information available, and the costs and benefits of the burn programme.

The cost/benefit analysis would be improved if more information and understanding of the impacts was available. It is hoped the work programme within the Perth Air Quality Management Plan will help in this regard,

however, more studies are needed. The emphasis should be on the effects of smoke on human health, and on balancing the risks to human health of smoke from prescribed burning on the one hand, against the increased probability of intense wildfires, associated smoke and other risks, if the prescribed burning programme were to be cut back in order to reduce the smoke from prescribed burns.

The implementation of a prescribed burn is the culmination of long and detailed planning processes at both a strategic and operational level. It involves input from other agencies-FESA, the Bureau of Meteorology, the Air Quality Branch of the Department of Environment-and local government. Likewise, the community should be informed.

CALM has in place set procedures for all of the above, with proforma sheets to be completed to help ensure nothing is overlooked. The detailed burn prescription dictates what should be happening on the day of the burn.

Despite the extensive planning leading up to the day of a prescribed burn there are variables, for example the weather conditions, which cannot be accurately predicted or controlled. A burn may have to be postponed on the day on which it is intended to be carried out. Even if the burning teams are mobilised they have to be prepared to change tack if weather conditions vary too much from predictions. CALM should continue to work with the Bureau of Meteorology in particular on smoke modelling and smoke trajectory prediction so as to reduce the risk of smoke exceedences in urban areas.

4.1.6 Auditing

As stated earlier, CALM's planning process is considered to be comprehensive and thorough in addressing CALM's objectives. However, as a consequence of the Audit consultancy commissioned by the EPA and from other inputs, including from CALM itself, the EPA is of the view that auditing of the outcomes of prescribed burns to determine whether the aims and objectives have been achieved needs to be improved. This is particularly so in relation to biodiversity objectives. The EPA recognises this is a most difficult task, requiring considerable resources and a long-term commitment. It is, however an essential step in understanding the values and costs of prescribed burns and guiding the changes necessary to optimise the effectiveness for biodiversity.

The EPA is aware of, and supports, the steps being taken by CALM in this regard. Considerable effort is going into the use of remote sensing to establish the effectiveness of a burn, a technique that should enable many of the important parameters to be measured in a most cost-efficient way. EPA also understands that the responsibility for some post-burn follow up includes CALMScience staff, for example where there are specific habitat objectives requiring a more intensive audit. This would include the critical areas burnt/unburnt against the stated objectives and could include fauna counts. In areas where the primary objective is fuel reduction, post-burn inspections would generally be by district staff, to confirm a satisfactory result and the security of the fire edge.

Performance indicators are linked to both the objectives of the burn, and to the Wildfire Threat Analysis. The annual burning targets relate to the priorities established through the Master Burn Planning process, to ensure the highest priority areas are targeted. As these priorities remain the same from year to year, a broad measure of effectiveness is the area burnt (in hectares) each year as compared with the objectives. It should be noted that the consequences of wildfire, both in terms of area and location, are taken into account in CALM's prescribed burn planning.

Two key effectiveness indicators that CALM uses are:

- for its prescribed burning the areas of prescribed burning actually completed against the rolling 10 year average figure; and
- for fire suppression, the percentage of all wildfires that are effectively suppressed before those fires exceed 5ha in Priority 1 and Priority 2 areas under 95 percentile weather conditions.* The standard to be exceeded is 95% of all forest fires requiring suppression by direct attack.

Whilst the above indicators are important, they do not necessarily address the impacts on biodiversity of a regular prescribed burning programme. Therefore performance indicators which are meaningful and measurable and include measurements of, or surrogates for the following, need to be applied to all prescribed burns:

- maintenance of species generally (including vertebrates and invertebrates);
- maintenance of indicator species;
- loss of habitat trees-hollow logs, invertebrates;
- breeding and seeding cycles;
- vulnerability to dieback spread;
- catchment water quality;
- increase in salinity;
- spread of weeds;
- the extent of mosaic achieved-(the 5% to 35% range is too wide);
- meeting objectives for fire exclusion areas.

If surrogates are used, they must be capable of measuring the performance indicators listed above. Possible surrogates include:

- temporal and spatial diversity (to include burnt/unburnt patches);
- burn intensity and season;
- time since last fire; and
- fuel mixture and drought index.

The EPA recommends that, for each prescribed burn,

- **CALM should document the rationale for, and mode of operation to achieve the stated objectives;**

* * the 95 percentile weather conditions are days when forest fire danger is below 'very high' and 'extreme' as calculated in CALM's Forest Fire Behaviour tables (1998). Firefighters work safely and effectively under these conditions in standard forest fuels

- **CALM report on whether the performance indicators have been met; and**
- **CALM develop and apply indicators to measure burn outcomes against the stated objectives for individual prescribed burn areas, particularly where the objectives are related to biodiversity issues like fire exclusion areas and habitat regeneration burns.**

Audit is, of course, one of the prime roles for the Conservation Commission (as required by Condition 2 of the Forest Management Plan 2004-2013), but despite some recent increases, the resources provided to the Commission are insufficient to undertake these duties at a viable and acceptable level.

The EPA recommends that the Conservation Commission be responsible for auditing the prescribed burning programme, and that this audit forms part of the auditing for the 2004-2013 Forest Management Plan.

4.1.7 Public consultation and communication

In its own public consultation process for this review, the EPA received mixed messages on the consultation and communication conducted by CALM for its prescribed burning programme. Some reported that it was good and that it had improved in recent years, while others were dissatisfied and had difficulty in learning about the programme or obtaining briefings on a particular planned burn. It is important to try to overcome any such shortcomings.

The communications and consultation processes set down by CALM are sound in principle. It is in the implementation where breakdowns in communication can occur, dependent as they are on individual competencies and on the effort which the community is prepared to make to access the information.

Noting that good consultation takes time and resources**,**
the EPA recommends that CALM further develops and supports appropriate community involvement programmes to provide an effective interface in relation to its prescribed burn programmes, and reports to those communities on the outcomes of any recommendations made, with such reports to be available to the general community.

The EPA reiterates that it considers CALM's planning and operational processes are not well understood by the community.

The EPA recommends that CALM should document for the public and make readily available its planning and operational processes for prescribed burning.

4.1.8 The 'prescribed burn' objectives

Several submissions, in response to the question posed in the Discussion Paper, made the point that a target described in hectares for prescribed burns was not appropriate; that the target should instead be determined on the objectives which are to be achieved. The EPA agrees entirely with this view, as does CALM. To quote from CALM's submission:

CALM should set targets for its prescribed burning program. These targets should be based on clearly defined objectives for biodiversity management and community asset protection.

The submission goes on to elaborate these objectives, but also points out that operational targets (ie areas burnt, in hectares) are necessary to determine annual budgets, and are also necessary for the measurement, monitoring and reporting of performance.

The approach CALM has taken to its fire policies and management practices is risk-based. The implication behind this is that, as with all natural resource management regimes, there is a resource constraint behind decisions which need to be taken at both policy and operational levels.

The EPA is of the view that the important reasons for CALM to engage with the community on its fire policies and practices are (1) to take account of community input in deciding on reasonable levels of risk, and (2) for the community to understand its obligations and responsibilities with respect to fire management.

A resource base for CALM to implement its policies and practices to the level of risk established following community consultation is therefore necessary. The EPA notes that CALM has failed to achieve its fire management objectives for the past several years, until this last year, and that resource constraints were a significant factor. The government recognised this in the past year by providing additional funds.

The EPA recommends that the funding for CALM's fire management operations should be reviewed and adjusted to enable CALM to reach its objectives, as modified from time to time in the light of improved information and understanding, **particularly in regard to biodiversity maintenance.**

4.2. Wildfire

The EPA emphasises again the relationship between wildfire and a prescribed burning programme. The frequency of wildfires is not reduced as a consequence of a prescribed burning programme, but the intensity of such wildfires is ameliorated and the ability to suppress them is enhanced (Cheney, 2004).

This is of particular relevance in the Perth metropolitan area where the political sensitivity of smoke from prescribed burns over the metro area restricts the number of days burning is possible. As a consequence the fuel loads in these peri-urban areas have built up to higher levels than might have ideally been the case if the only consideration was the reduction of flammable fuel loads to reduce the severity of fires around Perth. It should also be remembered that the smoke factor from wildfires is uncontrollable and could be severe from an intense wildfire that is difficult to control because flammable materials have been allowed to build to higher than ideal levels.

Wildfires of greater intensity have more impact on biodiversity values (Burrows and Abbott, 2003).

It is important therefore, that CALM maintains its capability to suppress wildfires, which it does through a combination of activities: prescribed burning, establishment and maintenance of the infrastructure described in section 3.3, and skilled and experienced teams to implement its fire management programmes. There is a concern that the human resource base is proving difficult to maintain particularly as a consequence of the establishment of the Forest Products Commission, which employed many former CALM personnel.

To supplement its own heavy equipment, CALM has a long-standing arrangement with the timber industry to make available industry equipment to fight wildfires, which is mutually beneficial. The reduced size of the industry has, however, led to a reduction in the availability of such equipment and associated personnel, and CALM has to rely more on its own resources. It is handling this effectively, including arrangements to deploy such equipment rapidly to bushfire sites. Nevertheless, it does impose an additional resource requirement on CALM which needs to be recognised.

The EPA recommends that CALM undertake periodic forward-planning exercises to ensure readily deployable equipment and a skilled-workforce of the appropriate size are available to handle wildfires, and hence to contribute into the future to the achievement of its fire management objectives.

4.3. Training

CALM staff and crews involved with fire are highly trained. Training courses are nationally accredited, and CALM's training is recognised as being of a high standard. CALM is a nationally recognised Registered Training Organisation and was recently audited against the national standards and found to be compliant. It has run training courses for State departments in Victoria and Queensland and staff from several other Australian States and New Zealand have attended its training courses.

All fire staff are individually accredited for the roles they can fill, and a database of their training, competencies and current accreditation is maintained.

Fires are managed under the national Incident Control System, which is part of the Australasian Interagency Incident Management System, and all persons involved with managing a fire are trained for their role in ICS. No CALM staff are permitted on the fireline or beyond the forward control point unless they have undertaken a basic level of fire safety training. This includes support staff providing transport and supplies to the fire crews.

Prescribed burning plays an important role in practical skill development as part of the training. Training covers not only the fire fighting, but all related

aspects such as supply, aerial attack coordination, etc. Any concern, then, lies not with the competence of CALM staff and crews, but rather with the numbers of trained individuals available to CALM to conduct its fire management programmes.

4.4. Research priorities

It is worth noting the research that CALM is currently undertaking and a list is attached as Appendix 2. CALM is a partner in the National Buhfire Cooperative Research Centre and is a key participant in (a) research into fire behaviour in shrublands and woodlands, and validation of Project Vesta findings with the CSIRO to provide improved fire behaviour information in drier (wildfire) conditions to improve both the effectiveness and safety of wildfire operations and (b) a study into the effects of fire regimes in south west forest landscapes over fifty years, and the development of fire regimes to meet biodiversity conservation objectives.

From the list of refereed papers, books and book chapters which CALM has produced, both by itself and in partnership with others, the EPA is confident that the research is of a high calibre. It is also relatively easy to reach the judgement that the research undertaken is relevant to CALM's role and responsibilities. The increased emphasis on collaboration with other agencies and with universities is welcomed.

The long term nature of the research required to provide the information necessary to improve, for example, biodiversity outcomes and decision-support systems places an imperative on at least maintaining the resources dedicated to research. It also emphasises the imperative of well-planned collaborations, such as the Bushfire Cooperative Research Centre, to make efficient and effective use of both financial and human resources on a national scale. CALM is particularly well placed, both to undertake and to coordinate long term research projects.

The EPA recommends that CALM's research budget be at least maintained in real terms and that collaborative, peer-reviewed research programmes with universities and other agencies be encouraged.

From the submissions received and from discussions with experts in the field, the EPA considers the following are some important areas for study.

Fire ecology (the way that fire interacts with other ecological processes)
Despite a considerable body of knowledge, there are many gaps, particularly of individual species and especially invertebrates and their role in reducing leaf litter. Not enough is known about biodiversity in the forest, nor the effects of regular burning on biodiversity and dieback. Studying the extent of historical Nyungar burning and the reasons, cultural or otherwise, of burning practices, would give a greater understanding of what plants and animals were favoured by the regimes.

Much of the research is based on jarrah and karri forest systems. Work should also target the ecosystems outside of these, such as coastal heath. Mapping of potential fire return periods for the vegetation of the south west, and of the incidence of fire refuges, related to 'rare and endangered' plants would fill an important gap. Conversely, a submitter has requested more work to understand the effects of long fire exclusion, suggesting it could lead to senescence, smothering, lack of flowering and germination, nutrient lockup, decay and termite activity.

Research should focus on confirming and refining (and defining limits of) broadly applicable principles that can be utilised in managing ecosystems.

More long term fire effects studies are needed to confirm (or otherwise) hypotheses based on current observation, knowledge gained from studies of individual species, historical studies, and short term studies. One submission has pointed to the need for work on seed production, viability and seed bank dynamics to check assumptions in seed bank models.

Fire behaviour (how fire behaves in the various fuel/vegetation types across the State under various conditions of weather and fuel characteristics)
Current prediction models are good for slow moving, low intensity fires (eg prescribed burning) but under-predict higher intensity fire behaviour (eg the recent Project Vesta research has shown that existing models under-predict spread rates by a factor of 2 to 3). Vesta will provide improved models for dry sclerophyll forests, but not for karri and shrubland types. Improved models are required for decision support systems to aid planning and risk analysis, to underpin fire suppression strategies and tactics, and to improve fire fighter safety.

Societal issues
These include:

- how people think about, react to, or perceive fire;
- the health effects of smoke, from both wildfires and prescribed burns;
- development and use of a methodology to balance the risks/costs/benefits of prescribed burning versus wildfire;
- valuation of the total economic, environmental and social costs associated with wildfires.

Climate change (how the likely impact of projections for climate change (reduced rainfall, lower moisture levels) will affect fire occurrence, ecosystem resilience and biodiversity.

The above suggestions are not all-encompassing; establishing a research programme which uses available resources most effectively is a difficult exercise which demands input from experts in the field. While CALM undoubtedly seeks the views of experts the EPA considers that there could be benefits from the establishment of a more formal process in this regard.

The EPA notes that the Conservation Commission has established a research advisory committee drawn from departments and universities and with an

independent Chair. This committee appears to be well suited to provide advice on and direction for the research programme; its membership and terms of reference can be extended if necessary.

The EPA recommends that the Conservation Commission's Research Advisory Committee be tasked formally to advise on CALM's fire research activities.

5. Other advice

5.1 Property protection

The interface between housing subdivisions and the bush has increased, much of it in fire-prone areas, and concomitantly the risk to properties and human lives from fire. The EPA is given to understand (CALM submission on Hodgson's report) that, while certain authorised CALM officers have powers they may exercise, CALM has legal advice to the effect that it is not bound by the Bush Fires Act and Fire Brigades Act. However, under common law, CALM accepts that it has a duty to take all reasonable care to eliminate or minimise foreseeable risk or harm and could be held liable for injury or harm caused by fire which a departmental employee had negligently lit or negligently failed to control. This manifests as a belief by CALM that it has a legal obligation to take all reasonable care to extinguish or control bushfire on lands it manages, and an obligation to manage the risk of wildfire either entering or exiting the lands it manages. CALM applies a risk management approach to discharging its implied fire protection responsibilities to minimise wildfire impacts and potential liabilities.

However, it is important to recognise that the Government will never be able to, and should not have to, protect all private property and owners from all fires at all times. CALM's submission states that every landholder is obliged to manage the risk of wildfire on his or her property. The EPA endorses this view. Individuals in the community should accept responsibility for their own protection from fire, particularly if they have chosen to live in areas where the fire risk is high. The FESA guidelines and AS 3959 *Construction of Buildings in Bushfire Prone Areas* deal specifically and comprehensively with these aspects. In order that individuals might better appreciate the risks that they incur by living in certain fire-prone areas they need easier access to appropriate information, not only on building codes but on the causes and basic science of fire. It would be better for people intending to settle in fire-prone areas to be appraised of such information before committing themselves to such a move.

The EPA sees as important the creation of buffer zones for the strategic minimisation of flammable materials surrounding communities. These are not necessarily to prevent fires, but to reduce the intensity of fires around communities and hence the scale of destruction. (It needs to be kept in mind that under extreme weather conditions fires are virtually unstoppable). Within this zone a different strategy should be applied to ensure that fuel levels are kept lower than in any adjacent CALM-managed forested areas. Measures

other than prescribed burning (such as grazing, physical clearing of scrub and grasses, etc) should be employed in this buffer area where more suitable and effective than prescribed burning and these measures may need to be carried out more regularly.

In recommending the creation of low-fuel buffer areas around high value assets the EPA is not implying that the adjacent CALM-managed forest should not be prescribe-burnt, but rather that it should be recognised as having different values and therefore a different regime of prescribed burning is more appropriate. The EPA acknowledges that it would not be appropriate to rely on a buffer alone around towns to prevent wildfires from entering towns. Buffer zones may in fact create a false sense of security for people living in communities and lead to some people underestimating the amount of personal responsibility they need to take to improve fire safety. There are many cases where fires have burnt into towns and suburbs (for example in Canberra in 2003) across open cleared ground because the intense fires in the crowns of trees kilometers away generate embers which are blown by attendant strong winds into settled areas, there to start spot fires. More effective fire protection strategies should integrate appropriate planning measures at the suburban development stage with private landowner risk minimisation strategies.

5.2. Responsibilities of State and local government

The problems associated with peri-urban development, discussed above, lead to consideration of the role and responsibilities which State and local government authorities should have in relation to fire hazard and the protection of the community. As the population of WA increases housing developments are often proposed and subdivisions created in areas where the fire hazard from adjacent forested areas is elevated and, in some cases, in enclaves within the forested areas. Such subdivisions create hazards and the Western Australian Planning Commission and local government authorities should give serious consideration to the acceptability of such subdivisions due to the high fire risk. If approvals are given despite the high fire risks, appropriate measures to address the attendant risks need to be applied and potential residents informed of the risks.

The EPA understands that many, but not all, local government authorities use the Australasian Inter-Service Incident Management System for fire management. Many, but not all, local governments prepare plans and procedures in the event of wildfires.

The EPA is of the view that all local governments in areas prone to wildfires should undertake thorough risk analysis studies and prepare comprehensive fire emergency procedures. Local government should also be able to set and enforce minimum standards for land developments and building codes, to take into account local risk factors.

5.3. Legal framework

The EPA notes the advice of its consultant Athol Hodgson regarding the legal framework within which CALM conducts fire management. CALM in its own submission to the EPA's Discussion Paper has acknowledged that

existing legislation is not explicit with respect to its legal obligations regarding fire management and is open to the possibility for changes to the legislation to provide greater clarity. The EPA notes that the Office of the Auditor General has concluded its own review into:

- coordination across firefighting organisations for responding to major bushfires; and
- planning and other preparations needed to support other firefighting efforts.

It found that there is a high level of goodwill and cooperation across firefighting organisations which support firefighting efforts, particularly at regional levels. However, the examination found that organisational arrangements for fighting major bushfires need to be better coordinated and that, overall, firefighting organisations need to be better prepared. Accordingly the examination recommended that, in addition to specific tasks for FESA and fire fighting organisations, Government should establish a State-wide command structure across volunteer Bush Fire Brigades and emergency management legislation which clarifies State and local governments' responsibilities and rectifies the deficiencies in the State's bushfire Emergency Management Plan.

More details are available on the Auditor General's Office website.

5.4. Greenhouse gas emissions

Prescribed burning produces greenhouse gas emissions. The EPA recognises that without a regime of prescribed burning the south west would run a risk of much more severe wildfires, with their attendant emissions. However, in the light of the State Greenhouse Strategy and the EPA's Guidance Statement for Minimising Greenhouse Gas Emissions, so that a start can be made to understand whether or not the issue is significant, the EPA considers that carbon accounting for CALM's prescribed burning (appropriately attenuated by the gradual regrowth of vegetation) should be carried out. This may be done more effectively through collaboration with the Bushfire and the Greenhouse Accounting Cooperative Research Centres.

5.5. Fire management in other regions of ecological importance in the State

This review has encompassed only three CALM administrative regions, in the south west of the State. There have been calls for the EPA to broaden its brief to consider other areas, such as the eastern agricultural areas, the Pilbara and the Kimberley. The EPA recognises that there are serious fire management issues that should be addressed in other parts of the State, especially in the Pilbara and Kimberley areas, but to have done so would have greatly extended the terms of reference for this study, taken much more time and would have been outside of the terms of reference of the review. The EPA considers that CALM should, as a matter of urgency, review fire management procedures in these other areas and report its findings and recommendations to the Minister.

6. Conclusions

The EPA was requested by the Minister for the Environment to conduct a review of CALM's fire policy and management practices in its Swan, South West and Warren administrative regions in the context of the Department's obligations to manage fire on the lands it manages for the multiple objectives of:

- *protection of human life;*
- *biodiversity conservation and protection;*
- *protection of assets including strategic infrastructure on managed lands;*
- *protection of environmental health; and*
- *the reasonable protection of neighbouring properties and assets.*

The EPA's review of CALM practices has involved the community via information days at various country and metropolitan centres and through a public review of its Discussion paper which generated eighty submissions.

The EPA recognises that a fuel reduction programme is a key strategy in reducing the extent and damage to biodiversity and other assets, which might otherwise be caused by wildfires. The value of a prescribed burning programme is not in reducing the number of wildfires, but rather their intensity, to assist in its suppression, and to reduce the damage they may cause to biodiversity.

The EPA supports the objectives expressed in CALM's draft policy and finds that it and the attached appendix outlining the rationale and principles for fire management practices are comprehensive. However, despite the fifty or so years of accumulated fire research that has been undertaken by CALM and others there are still many gaps in our knowledge and understanding of the complex ecosystems of the south west, for example the increasing effects of fragmentation of the forest areas, and climate change, including declining rainfall. Therefore, an ongoing research programme and an adaptive management approach need to be used by CALM to continuously upgrade its fire planning and operations as new information becomes available. CALM supports this approach.

The Conservation Commission, as the custodian of CALM-managed lands, also has a mandate in the development of policies and management plans, and in the auditing of outcomes of CALM practices, and the EPA regards close collaboration between CALM and the Conservation Commission in these matters as very important to effect the required outcomes. The EPA considers that the Conservation Commission should be responsible for auditing prescribed burns.

With regard to the stated objectives for managing fire the EPA considers that the protection of human life must be a priority and that CALM's planning and procedures for life, assets and strategic infrastructure on its managed lands are effective. The EPA considers that practices in place are appropriate for minimising smoke from prescribed burns in the metropolitan area. Further consideration should be given, however, to the effects of this smoke on human

health to establish the full significance of this relationship so that it can be balanced against the risks of wildfires to health and property.

With respect to neighbouring properties and assets in peri-urban developments and towns and communities in the south west forest areas, CALM has an obligation to manage the risk of wildfire either entering or exiting the lands it manages and applies a risk management approach to discharging its implied fire protection responsibilities to minimise wildfire impacts and potential liabilities. The EPA endorses the concept of buffer zones, in which the amount of flammable vegetation is reduced, both on surrounding CALM-managed lands and on the adjacent privately-owned portions. The EPA notes, however, that whilst Government should be leading in its planning and provision of subdivisions that are safely located with respect to wildfire, Government will never be able to protect all private property , nor should it be expected to. Land and property owners need to accept responsibility for their own protection from fire, especially if they have chosen to live where the risk of fire is elevated.

The EPA recognises that the impact of prescribed burning on biodiversity is not adequately known or understood and understands that the community has strong and conflicting views on whether present practices address this adequately. While it is explicitly mentioned in CALM's draft policy, there is insufficient information on the effects of prescribed burning on WA's south west ecosystems to allow the EPA to come to a conclusive view that optimum outcomes are being achieved. As a consequence a cautionary approach needs to be followed, and adaptive management techniques applied as more information becomes available from fire ecology research. The EPA considers that more research is required in this area as a basis for the introduction of improvements to current fire management practices to facilitate the protection and enhancement of biodiversity.

The set of issues raised and the recommendations made will require ongoing assessment to determine whether they are achieving the desired outcomes and improvements suggested. The EPA believes that this fits into the same timeframe as is used for the review of the Forestry Management Plan and suggests that a formal review be considered in unison with the review of the Forestry Management Plan.

7. Summary of Recommendations

A fuel reduction programme, as employed by CALM, is seen and endorsed by the EPA as a key strategy in reducing the extent and damage to biodiversity and other assets which might otherwise be caused by wildfires.

The EPA provides the following recommendations:

1. In planning the annual burn programme, assessment of fire requirements for biodiversity outcomes be given first consideration, and that any shortcomings from this approach for the other objectives be taken into account in a second round process to achieve all priority objectives.

2. For each prescribed burn:

- CALM should document the rationale for and mode of operation to achieve the stated objectives;
- CALM report on whether the performance indicators have been met; and
- CALM develop and apply indicators to measure burn outcomes against the stated objectives for individual prescribed burn areas, particularly where the objectives are related to biodiversity issues like fire exclusion areas and habitat regeneration burns.

3. The Conservation Commission be responsible for auditing the prescribed burning programme, and that this audit forms part of the auditing for the 2004-2013 Forest Management Plan.

4. CALM should further develop and support appropriate community involvement programmes to provide an effective interface in relation to its prescribed burn programmes, and report to those communities on the outcomes of any recommendations made, with such reports to be available to the general community.

5. CALM should document for the public and make readily available its planning and operational processes for prescribed burning.

6. The funding for CALM's fire management operations should be reviewed and adjusted to enable CALM to reach its objectives, as modified from time to time in the light of improved information and understanding, particularly in regard to biodiversity maintenance.

7. CALM should undertake periodic forward-planning exercises to ensure readily deployable equipment and a skilled workforce of the appropriate size are available to handle wildfires, and hence to contribute into the future to the achievement of its fire management objectives.

8. CALM's research budget should be at least maintained in real terms and that collaborative, peer-reviewed research programmes with universities and other agencies be encouraged.

9. The Conservation Commission's Research Advisory Committee should be tasked formally to advise on CALM's fire research activities.

REFERENCES

Armstrong, R. (2004). *Ecologically Based Fire Management-Integration of multiple land use objectives.* Proceedings from 11th Annual AFAC Conference and Inaugural Bushfire CRC Conference. Perth, WA.

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

Cheney, N.P. (2004). *The Role of Land Management Agencies in Protecting the Community from Bushfire.* 11th Annual AFAC Conference and Inaugural Bushfire CRC Conference, October, 2004. Perth, WA.

Department of Conservation and Land Management. (2003). *Submission to the House of Representatives Select Committee on the Recent Australian Bushfires.* Perth, WA.

FESA/WA Planning Commission. (2001). *Planning for Bush Fire PROTECTION*. Perth, WA.

McArthur, A. G. 1962. *Control burning in eucalypt forests*. Forestry and Timber Bureau Leaflet 80.

McCaw, L., Cheney, P. & Sneeuwjagt, R. 2003. Development of a scientific understanding of fire behaviour and use in south-west Western Australia. *Fire in ecosystems of south-west Western Australia: impacts and management*. Leiden: Backhuys Publishers, pp 171-187.

Muller, C. (1993). *Wildfire Threat Analysis Manual*. Department of Conservation and Land Management (unpublished) report.

Rodger, G.J. (1961). *Report of the Royal Commission. Appointed to Enquire into and Report upon the Bush Fires of December, 1960 and January, February and March, 1961 in Western Australia*. Perth, WA.

Standards Australia. (1999). *Construction of buildings in bushfire-prone areas. AS 3959-1999.* Strathfield, NSW.

Appendix 1

List of Submitters

LIST OF SUBMITTERS

Wildflower Society of Western Australia (Inc)	Wildflower Soc of WA (Inc) Eastern Hills Branch	Bridgetown Greenbushes Friends of the Forest
Collie Conservation Group	Leeuwin Environment Inc	Blackwood Environment Society
Conservation Council of Western Australia Inc	G Shanhun/EARTH	South Coast Environment Group
Wilderness Society and Greening Australia	Busselton Dunsborough Environment Centre	Western Australian Forest Alliance
Australian Bush Heritage Fund-Klaus Braun	Denmark Weed Action Group	Australian Association of Bush Regenerators (WA)
Preston Environment Group	Environmental Defenders Office (WA)	The Vines Property Owners Association
South-West Forests Defence Foundation	Fire for Life	WA Farmers Federation
Dr P Christensen	Dr C Sharp, MLA	Dr F McKinnell
J Sargison-Kennedy	P K Sargison	R Underwood
Val	C Poustie/CCWA	D Ward
G Foulsham	J Vukovich	C Muller
A R Gilovitz	G Fernie	G South
T Middleton	R Vinicombe	I Bell
J A Reynolds	D Warnock	P Omodei, MLA
J Evans	A J Pedro	K H Titelius
J Williamson	D Laslett	Z Moore
K Simone	M & V Connor	M Wilson
D Ludlam	L Kippert	R Minchin
J Austin	B Leonhardt	J Johnson
D Fewings	S Hycza	J Anderton
C Tallentire	P Atahan	P Rakela
D Wills	N Rakela	G North
J Catalano	S Coulson	CSIRO/N P Cheney PSM
CALM	Fire Management Research Working Grp-Dr L McCaw	CSIRO Forestry and Forest Products/J Gould
Department of Environment	Conservation Commission of Western Australia	FESA of WA
Department for Planning and Infrastructure	Water Corporation	UWA-Chair of Zoology Prof. S D Bradshaw
Shire of Manjimup	Shire of Nannup	Shire of Mundaring

Appendix 2

Current (Annual Research Activity Report 2003-04) fire research projects in the CALM Science Division

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
CURRENT FIRE RESEARCH PROJECTS IN THE SCIENCE DIVISION
EXTRACT FROM ANNUAL RESEARCH ACTIVITY REPORT
JULY 2003-JUNE 2004

Project Vesta – prediction of high intensity fire behaviour in dry eucalypt forest
SPP # 97/03

Team members
L McCaw (0.5), R Smith (0.2), J Neal, (0.2); Total (0.9).

Aim
- To develop a national fire behaviour prediction system for dry eucalypt forests.
- To quantify changes in fire behaviour as fuels develop with age.
- To develop new algorithms describing the relationship between fire spread, wind speed and fuel characteristics.
- To characterize wind speed profiles in forests with different overstorey and understorey structures.

Summary of progress and main findings
Fire spread and fuel data have been analysed to identify the key variables influencing fire spread. Conclusions that can be drawn at this stage include that:
- It is possible to identify fuel variables that provide better explanatory power for rate of spread than does surface litter fuel load.
- Fuel variables can account for site-related differences in vegetation structure and density, making models transportable across a range of site conditions.
- Visually-based hazard rating systems have potential to replace more labour-intensive methods of fuel assessment for application in rate of spread prediction.
- The project has also demonstrated that fire size has a significant effect on the potential rate of spread and that existing fire behaviour models tend to consistently under-estimate rate of spread for fires with a head wider than 100 m.
- A project was implemented to test the application of fuel measurement system and fire behaviour findings from WA's Jarrah forest to eucalypt forest around Tumbarumba, NSW. One member of the team spent 2 weeks in Tumbarumba in February 2004, assisting with experimental set-up, fire behaviour measurements and post-burn assessment.

Management implications
- This will enable greater control over the results of prescribed burns and allow more flexibility in the use of fire in conservation.

Future direction(s)
The project has been completed and a report was delivered to the Australasian Fire Authorities Council, the co-ordinating body representing agencies that supported the project. Ongoing work will be required to prepare manuscripts for publication in scientific journals, and to develop material for training and technical transfer purposes. Further experimental fires to validate the results of Project Vesta in a range of south-eastern Australian forest types will be undertaken through the Bushfire Cooperative Research Centre.

CALM Region(s)
South West, Swan, Warren.

IBRA Region(s)
Jarrah Forest, Warren.

Assessment of the emissions of dioxins from bushfire activity in Australia
Consultancy to Environment Australia's National Dioxins Program

Team members
L McCaw (0.1), R Smith (0.1), J Neal (0.1); Total (0.3).

Aim
To sample particle mass and gaseous emissions from prescribed and wildfires in forests, plantations and heathlands in south-west Western Australia. Data will be used to quantify the contribution that bushfires make to national dioxin emission levels.

Summary of progress and main findings
- Environment Australia has initiated a National Dioxins Program to determine levels of dioxins in the general environment, and sources of dioxin emissions from bushfires and motor vehicles. Sampling of emissions from bushfires is being co-ordinated by CSIRO Division of Atmospheric Research, with field measurements undertaken by participating organizations in several states.
- Samples were collected from 3 low intensity prescribed fires in south-west forests over the 2002/03 season. A further 3 samples from silviculture and fuel reduction burns were achieved before the end of December 2003. The results from this sampling were combined with samples from the other States and have been incorporated in a project report by CSIRO Division of Atmospheric Research.

Management implications
- Unknown at this stage.

Future direction(s)
No further work anticipated.

CALM Region(s)
Warren Region, South West, Swan, South Coast.

IBRA Region(s)
Jarrah Forest, Warren.

The long-term effect of various fire regimes on floristics of Jarrah forest understorey species
SPP # 93/099

Team members
B Ward (0.25), G Liddelow (0.1); Total (0.35).

Aim
To determine the optimal fire regime for providing protection and maintaining biodiversity in understorey vegetation of the Jarrah forest.

Summary of progress and main findings
- This research is yielding valuable information about the post-fire responses of a wide range of taxa. Ongoing measurement of these plots is vital to trace fire impacts and regular and repeated burning of the treatments is also essential to the success of this study.
- Spring treatments (3 plots at Lindsay block), were completed and an autumn treatment at McCorkhill block was attempted but failed to burn due to light fuels and high moisture content (20%). These will be carried over and added to next year's program.

Management implications
- Appropriate fire regimes for the conservation of floristic diversity in southern forest uplands.

Future direction(s)
- Maintain fire treatments.
- Measure floristics for all plots in spring 2005.
- Preliminary analysis of data following floristic measurements in 2005 and review study.

CALM Region(s)
Warren, South West.

IBRA Region
Jarrah Forest.

The effect of wildfire on fungi
SPP # 98/0015

Team members
R Robinson (0.33); R Smith (0.1), K Pearce (0.17); Total (0.51).

Aim
To investigate the effects of wildfire on fungi in Karri forest and to monitor the succession of fungi on burnt sites in Karri forest.

Summary of progress and main findings
- The results show that a distinct and recognizable fungal flora fruits on recently burnt sites. A number of fungi appear to be stimulated to fruit by fire or take advantage of the post-fire conditions. As time progresses those fungi that are adapted to post-fire conditions are replaced by species more commonly found in unburnt forest.
- Field work completed (5 yrs of results).
- Annual report completed.
- Book chapter published (Robinson, RM and Bougher, NL 2003. The response of macro-fungi to fire in jarrah (*Eucalyptus marginata*) and Karri (*Eucalyptus diversicolor*) forests. *In* Abbott, I and Burrows, N (Eds). Fire in Ecosystems of south-west Western Australian: Impacts and Management, pp. 269-289).
- Scientific paper in preparation (Robinson, RM, Mellican, A and Smith, RH. The succession of macrofungi following a wildfire in karri regrowth forests in Western Australia.)

Management implications
- Results contribute to information on the management of fire for maximizing biodiversity in karri forest.

Future direction(s)
- The next monitoring will be undertaken in 2008 (coinciding with 10 yrs post fire). Laboratory work will continue to catalogue and identify voucher specimens collected throughout the project.
- Results for the first 5 yrs to be published in a scientific paper.
- Collaborate with colleagues from other agencies with identification of voucher specimens.

CALM Region
Warren.

IBRA Region
Warren.

The impact of wildfire, in old growth forest of the Walpole-Nornalup National Park, on short-range endemic invertebrates and their forest floor communities
SPP # 2003/03

Team members
I Abbott (0.02), A Mellican (0.02), P Van Heurck (0.5); regional staff - E Middleton; Walpole-Nornalup Parks Association & Walpole community volunteers; Total (0.54).

Aim
To inventory the differences in species compositions of the arthropod litter communities containing short range endemics, at forest sites long unburnt, prescribed burnt and burnt in a recent wildfire.

Summary of progress and main findings
- 16 trapping sites established in Dec 2001.
- Sites trapped in Dec 2001, Feb 2002, Dec 2002, April 2003, Dec 2003 and May 2004.
- Volunteers trained in biosurvey methods in July 2002. Beetle identification workshop Dec 2003.
- Bio-Track seminar (E Ladhams of Macquarie University) on identification, curation and analysis.
- c. 1500 morphospecies sorted and added to Nuyts Collection by volunteers.
- Local curator Jacqueline Manning employed part time to supervise volunteers.
- 312 beetle species identified by honours student D Herath and validated by A Szito.
- Gary Muir (Walpole Wilderness Eco-cruises) setting up website and access database.
- A new microscope, digital camera and digital image program purchased for WNNPA.
- Located several new populations of the short range endemic millipede (*Cynotelopus notabilis)*. Another population of this millipede found in spring 2004.
- Due to the training of volunteers, from the Walpole Nornalup National Parks Association and the Walpole community, in biosurvey techniques, it has been possible to sort large numbers of specimens collected from the 4 trapping sessions. Volunteers have gained a greater understanding of the use of prescribed fire in the conservation of old growth forest biodiversity and are becoming increasingly interested and skilled in invertebrate biosurvey.

Management implications
- The Nuyts Invertebrate Collection contains a large proportion of invertebrate species previously undescribed from the old growth forests of the south coast. The distribution of these species within the wide range of fire ages surveyed will provide fire managers with important conservation information on a large segment of the local biodiversity, including short range endemic taxa.
    - Analysis of the 312 beetle species collected indicates that more than two thirds of species are site-specific and are restricted to particular fire ages and microhabitats (floor, log, tree butts or hollows) within forest types (karri, tingle, marri and jarrah).
    - Beetles occur in most feeding guilds present in forest ecosystems and represent c. 20% of Earth's biodiversity. The Nuyts beetles probably represent a major proportion of the biodiversity of the old growth forests. This beetle fauna is proving to be a sensitive indicator of fire management impacts and indicates a need to manage for a diversity of fire ages, of both recently and long unburnt patches within each forest type.

Future direction(s)
- Education of the local community through production of Discovery Centre displays, talks and photographic field guides.
- Supply of ecological information to local tour guides and operators.
- Education and attraction of tourists.
- Provision of a large species collection of an entire litter community for the use of local and international taxonomic specialists.

- Provision of a database, analysis and reporting of the species compositions of sites with different fire ages for the use of fire managers and planners in old growth forest parks.

CALM Region
Warren.

IBRA Region
Warren.

Nutys Wilderness post wildfire monitoring
SPP # to be allocated

Team members
B Ward (0.05), G Liddelow (0.1), R Cranfield (0.05) P Van Heurck (0.1) L McCaw (0.05), R Smith (0.05) Frankland District Staff as required; Total (0.4).

Aim
To monitor impact of severe wildfire on plants, invertebrates, vertebrate fauna and stand structure.

Summary of progress and main findings
- Data collection 2003 completed for plants, mammals, reptiles, amphibians and stand structure.
- Data collection for birds and invertebrates completed for 2003 and 2004.

Management implications
- Appropriate fire regimes for the conservation for the flora and fauna diversity in wilderness areas.

Future direction(s)
- Complete monitoring of plants and stand structure, mammals, reptiles and amphibians for 2004.
- Review monitoring program after 2006 sampling.

CALM Region
Warren.

IBRA Region
Jarrah Forest.

Landscape and fire management interactions and their effects on distribution of invertebrate biodiversity
SPP # 01/03

Team members
A Wills (0.3), I Abbott (0.01); Total (0.31).

Aim
- To document the effects of topography on the distribution and abundance of invertebrates in Jarrah forest.
- To determine whether landscapes provide natural fire and climatic refuges in the Northern Jarrah forest.

Summary of progress and main findings
- Sorting of ants, beetles and spiders to morphospecies level completed and data entered into database.

Management implications
- Not yet apparent as analysis of data not completed.

Future direction(s)
- Complete sorting of other orders to morphospecies level.
- Assemble database and analyse.
- Write up and publish in refereed journal.

CALM Region
Swan Region.

IBRA Region
Jarrah Forest.

Fire mulga study: post burn monitoring
SPP # 1993/0141

Team members
S van Leeuwen (0.05), B Bromilow (0.05), T Start (0.05); Total (0.15).

Aim
To investigate the effects of fire on the biota of Mulga communities in the Hamersley Range. The primary objective is to monitor the effects of controlled burns and wildfires on the biota of a number of previously identified Mulga woodland community types. Sampling strategies to achieve this outcome include the re-sampling of 24 permanent inventory sites and the resurvey of 70 km of transect.

Summary of progress and main findings
- Continued plant identification process and refinement of floristic database.
- Continued sorting of invertebrate samples.
- Provided advice to Pilbara Region on fire management of mulga woodlands and implications of wildfire suppression activities on biodiversity values of fire sensitive Mulga woodland communities.
- Reviewed environmental impact statements, made recommendations and provided advice on the potential environmental impacts of proposed developments to Environmental Protection Branch, DEP, EPA and DOIR.

Management implications
- Advice provided to regulatory authorities on the likely impacts of mining developments on mulga woodlands.

Future direction(s)
- Complete botanical identifications and commence floristic analysis.
- Re-sample the 70 km of line transect and analyse change in community structure that has occurred as a consequence of fire.
- Prepare manuscript on the floristic differentiation between Mulga woodland communities within the Hamersley Range.
- Ongoing sorting on invertebrate samples and commence identification of ants.
- Refurbish permanent inventory sites and undertake a sampling session.
- Ongoing liaise with Ecosystem Research Group, School of Plant Biology, and the University of Western Australia over preparation of manuscripts for 'Pilbara Disturbance Ecology' book.

CALM Region
Pilbara.

IBRA Region
Pilbara.

Fire effects on desert vertebrates
SPP # 1993/0092

Team member
D Pearson (0.1) Total (0.1).

Aim
To research the impacts of spring 'patchy' (= potential prescribed) fires and summer wildfires on the small terrestrial vertebrates, invertebrates and flora of hummock grassland in the Great Victoria Desert and make recommendations for management.

Summary of progress and main findings
- The Queen Victoria Spring study site is one of the few long-term fire monitoring sites in arid Australia (commenced 1986). A fire in Jan or Feb 2003 burnt the entire area, leading to the termination of the field component of the study in March 2003 with the removal of most traps.
- Spider samples were identified by P Langlands, an Honours student at Curtin University and form the basis of his thesis.

Management implications
- The season and intensity of fires have profound effects on the terrestrial vertebrates in spinifex grasslands. Patchy spring fires enhance local diversity but create opportunities for open areas specialists. Extensive summer fires remove several mammal and reptile species. Patchy spring fires are the preferred fire management strategy to conserve biodiversity in these grasslands.

Future direction(s)
- Recover remaining equipment from the Queen Victoria Spring site. Final vegetation sampling.
- Write up spider data for publication with Peter Langlands and Karl Brennan.
- Analyse vertebrate trapping data and publish papers on fire impacts on dragon lizards, dasyurids and rodents.
- Lodge collections of flora with WA Herbarium and vertebrates with WA Museum.

CALM Region
Goldfields.

IBRA Region(s)
Great Victoria Desert, Coolgardie.