Report of the Fire Review Panel

Conducting a Review of the Department of Conservation and Land Management's (CALM) prescribed burning policy and practices and Wildfire Threat Analysis

as required in the Ministerial Conditions set for the implementation of

Amendments to the 1987 Forest Management Plans and Timber Strategy and Proposals to meet Environmental Conditions on the Regional Plans and the WACAP ERMP

March 1994

A Report to the Hon Kevin J Minson MLA
Minister for the Environment

by the Fire Review Panel conducting a Review of the Department of Conservation and Land Management's (CALM) prescribed burning policy and practices and Wildfire Threat Analysis as required in the Ministerial Conditions set for the implementation of

Amendments to the 1987 Forest Management Plans and Timber Strategy and Proposals to meet Environmental Conditions on the Regional Plans and the WACAP ERMP

Panel members

Hon A.A. Lewis JP (Chairman)

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March 1994

The task
The panel's task derives from a condition relating to the approval of CALM's 1992 Forest Strategy by the Minister for the Environment. The Condition is:

"Within 12 months of this proposal being given the authority to be implemented the proponent shall initiate a public review of its prescribed burning policy and practices and the Wildfire Threat Analysis. This should be done with close involvement of the Research and Monitoring Committee. If possible it should be linked with a review of the provisions of the Bush Fires Act."

Terms of reference
The panel will:

- review CALM's Fire Management Policy and suggest changes which it considers to be necessary;

- consider whether it is appropriate for CALM to carry out prescribed burning for fuel reduction and habitat management within south-west forests and heathlands;

- consider the value of prescribed burning as a measure to minimise the potential damage caused by wildfires and maximise the ease of fire control in the south-west; and suggest any changes which it considers would improve the effectiveness of the prescribed burning program in minimising the threat of wildfire to humans, valuable assets and ecosystems;

- consider the adequacy of field resources to implement any proposed fire management system;

- consider the environmental impacts of current prescribed burning practices in the south-west, including effects on flora, fauna, air quality, water catchments and aesthetics, and suggest changes to practices which would minimise any undesirable, permanent changes;

- consider the technique of Wildfire Threat Analysis developed by CALM and appraise its value as a means of determining and ranking hazards and values threatened; and suggest ways this approach can be improved;

- examine the provisions of the Bush Fires Act which impinge on any of the above factors; and suggest how these might be amended, so as to maintain community safety from bushfires as well as environmental standards, and ensure the Government and its agencies are not subjected to litigation in relation to fire management policy and practice.

FIRE REVIEW PANEL

Review of CALM's Prescribed Burning Policy and
Practices and Wildfire Threat Analysis

15 March 1994

The Chairman
CALM Fire Review Panel
PO Box 179
NEDLANDS WA 6009

Hon. K. Minson
Minister for Conservation and Land Management
Dumas House
PERTH WA 6000

Dear Minister,

We enclose the report of the CALM Fire Review Panel which was completed today.

The Panel and its technical Advisers have worked extremely hard to make sure that every aspect of the subject has been covered without transgressing into areas covered by other bodies. Members of the Panel and the Advisers were unanimous in their conclusions and this considering the diversity of background they come from, was an interesting highlight of the Panel.

We feel there is a need for constant vigilance on any aspect of Fire, but particularly with the reduction of hazards, be they in the bush or around the home.

Yours sincerely,

Sandy Lewis

Phil Cheney

David Bell

Enquiry into CALM's Prescribed Burning Policy and Practices, and Wildfire Threat Analysis in the South-west Region of Western Australia

Recommendations

Preamble

The Fire Review Panel has considered carefully and unemotionally the terms of reference and made the following recommendations using our own experiences and all the evidence that has been presented to us. We have considered written evidence from over 220 submissions and oral evidence from more than 125 separate individuals and groups.

1) Review CALM's Fire Management Policy, and suggest changes which it considers to be necessary.

RECOMMENDATIONS

1) That Fire Management become the fourth program within the CALM organisation, and that this program receive an additional $3 million per annum and steps be taken to implement this over the next three years.

2) That the Fire Management Policy needs to be expanded to included recruitment, training, re-training and retirement benefits.

3) That all fit, young CALM staff be required to participate in prescribed burning operations.

4) That designated training areas be set aside for practical instruction on wildfire suppression.

5) That CALM employ professional journalists to liaise with the media to explain CALM's prescribed burning program.

6) That CALM undertake a program with the Education Department to introduce fire management and fire ecology into school curricula.

7) That the word "monitoring" be replaced with "well-planned strategic research", as its use in policy and strategy documents is particularly misleading.

2) Consider whether it is appropriate for CALM to carry out prescribed burning for fuel reduction and habitat management within South-west forests and heathlands.

RECOMMENDATIONS

1) That the Government publicly declare that regular prescribed fire is essential to minimise extensive wildfires and publicly recognise that CALM is the appropriate authority to carry out prescribed burning for fuel reduction and habitat management within South-west forests and heathlands.

2) That CALM develop clear strategies for prescribed burning and fire suppression in areas affected by *Phytophthora cinnamomi.*

3) That no-planned-burn areas in National Parks have clearly defined objectives and strategies for suppression.

4) That grazing be considered as a replacement for fuel reduction burns in areas of management where such activities have formerly taken place and have an acceptable role in the protection of social, economic and conservation values.

5) That there is a need for on-going research to identify and refine 'habitat management' prescription burns for rare and endangered plants and animals. In the absence of knowledge there should be the provisions of sufficient funding to allow an emphasis to diversify fire management regimes with a range of frequencies, intensities, seasons and sequence.

3) Consider the value of prescribe burning as a measure to minimise the potential damage caused by wildfires, and maximise the ease of fire control in the South-west; and suggest any changes which it considers would improve the effectiveness of the prescribed burning program in minimising the threat of wildfires to humans, valuable assets and ecosystems.

RECOMMENDATIONS

1) That the Government accept that prescribed burning to modify fuel loads is the most cost-effective way to modify fire behaviour and is essential to minimise the potential damage from wildfires.

2) That CALM burning plans should be better integrated with long-term logging plans, wildlife corridor planning and plans for landscape reserves.

3) That CALM investigate greater use of helicopters for prescribed burning.

4) Consider the adequacy of field resources to implement any proposed fire management system.

RECOMMENDATIONS

1) That CALM train sufficient manpower in each region to undertake the first two shifts on any fire. This may require additional new crew and extended training.

2) That CALM urgently upgrade strategic access roads and water points.

3) That all CALM staff, male and female, undertake fire management training each year.

4) That consideration on work place agreements be made between unions and CALM.

5) That CALM seek triennial or rolling funding arrangements for fire management.

6) That CALM provide appropriate clothing and insignias for fire fighting staff.

7) That CALM continue to investigate specialised equipment for fire suppression and integrate helicopters into all aspects of fire management as these become more available.

5) Consider the environmental impacts of current prescribed burning practices in the South-west, including effects on flora, fauna, air quality, water catchments and aesthetics, and suggest changes to practices which would minimise any undesirable, permanent changes.

RECOMMENDATIONS

1) That the necessary funding be provided to the prescribed burning program to increase the diversity of season, intensity, frequency and sequence of fires on any single area to ensure that no species will become threatened or extinct.

2) That fire management in some areas be tailored to the requirements of particular rare species. While longer-unburnt areas are important in each ecosystem to increase habitat diversity, and in some cases for particular species, they should be designed on the best available ecological data and located to minimise threats to life, property and the likelihood of accidental ignition.

3) That introduced predators, particularly the fox, are having an enormous impact on fauna which become more exposed to predation following fires. Patchy burns which leave refuge areas and small area, high-intensity habitat creation burns are useful, but control of foxes should also be carried out where rare fauna are at risk, and control methods developed for feral cats.

4) That the longer term responses of some flora and fauna to particular fire regimes are not yet fully understood. Research should be conducted to enable burning programs to be better tailored to organism requirements.

5) That the area burnt in Autumn be increased subject to the needs for specific habitat management.

6) Consider the technique of Wildfire Threat Analysis developed by CALM and appraise its value as a means of determining and ranking hazards and values threatened; and suggest ways this approach can be improved.

RECOMMENDATIONS:

1) That CALM's Wildfire Threat Analysis is an essential fire management tool and that the ranking of values is appropriate for CALM areas; that is human life continues to receive the highest priority.

2) That CALM commit resources to extend the Wildfire Threat Analysis to include private lands adjacent to CALM's estate and be pro-active in involving both shire and local interest groups in the process of priority setting.

3) That CALM continue its development of the Wildfire Threat Analysis including GIS and/or other computer databases where appropriate.

4) That CALM examine ways to display the firespread component of Wildfire Threat Analysis, particularly in areas adjacent to CALM lands.

7) **Examine the provisions of the Bush Fires Act which impinge on any of the above factors; and suggest how these might be amended, so as to maintain community safety from bushfires as well as environmental standards, and ensure the Government and its agencies are not subjected to litigation in relation to fire management policy and practice.**

RECOMMENDATIONS

1) That it be a statutory requirement for each Shire to have an up-to-date fire management plan.

2) That the Prohibited Burning section be removed from the Act.

3) That the limit of equipment insurance covered in the Act by Local Authorities be up-graded.

4) That the Act be strengthened to extend the protection against litigation to Government Agencies who employ firefighters.

5) That the Act should be strengthened so that people who have not reduced hazard on their land to an acceptable level lose any chance of litigation and insurance redress.

Enquiry into CALM's Prescribed Burning Policy and Practices, and Wildfire Threat Analysis in the South-west Region of Western Australia

Expanded Explanation

Preamble

Fire can be a primary agent in the clearing of native forests and heathlands. Paradoxically, fire, when properly used, can be a most effective and least expensive tool in maintaining a healthy and productive forest economy. Excepting equatorial rainforests, fire has played a natural and important role in the development of virtually all forest, woodland, heathland and grassland ecosystems. If fire is excluded, other processes must be substituted to fill fire's role if the ecosystem is to be maintained. If fire is to be utilized in land management, its role in the dynamics of the ecosystem must be clearly understood and fire applied at the proper time and the proper intensity. Fire can be a devastating experience when it impinges on human life and property.

The vegetation in the South-west forest regions of Western Australia, an area of approximately 2.5 million hectares and includes the jarrah, karri, tingle, wandoo and tuart forests and their associated coastal heathlands, has evolved in a Mediterranean climate. That is a climate which is characterised by regular winter rain, an annual summer drought associated with high temperatures, low humidities and occasional periods of very strong, dry winds. This environment ensures that every summer the vegetation is desiccated and flammable. The conditions for a fire of conflagration proportions only requires the simultaneous occurrence of heavy fuels, strong and dry winds and a source of ignition.

The principle of using fire to reduce the impact of wildfires has long been recognised. Fire was undoubtedly used by aboriginal Australians although the exact reasons that they applied fire may not now be fully known. Early settlers regularly "burnt-off" to protect crops and pastures and foresters in Western Australia pioneered the science of prescribed burning from the early 1950's. Today, prescribed burning in Western Australia is a carefully planned operation to achieve quite specific management objectives across the forest and adjacent estate.

Studies of disasters caused by any natural phenomena have shown that the magnitude of the disaster is greatest where the incidence of the phenomena is infrequent, and the population is generally unprepared. In Western Australia the fuel reduction policies of the Western Australian Department of Conservation and Land Management (CALM) combined with a reduced use of fire by the rural community for clearing and improved fire suppression have reduced the occurrence of conflagration fires over the past 30 years to a point

where today people, unfamiliar with bushfires, may believe that intense wildfires cannot occur.

Moreover, the population is increasingly urbanised and few people are exposed to fires of even low intensity. In many areas this has caused people to question the rationale of CALM's prescribed burning practices to prevent conflagration fires and to suggest that a policy of only fire suppression is both feasible and environmentally more desirable.

Like fire in the home, fire in the forest can bring comfort and benefit or threat and destruction depending on how wisely it is utilized and controlled. Proper fire management requires an understanding of how a forest fire burns, how it affects the ecosystem through which it burns, and how managers over the years have developed organizations, systems, and equipment to ensure that fire in land use management is a benefit rather than a liability.

It has been the intent of the Fire Review Panel (the "Panel") to consider carefully and unemotionally the terms of reference and make recommendations of a balanced nature using our own experiences and all the evidence that has been presented to us. This we have endeavoured to do to the best of our ability. In the process of review, we have considered written evidence from over 220 submissions and oral evidence from more than 125 separate individuals and groups. The following report provides the consensus of the Panel under each of the terms of reference.

1) Review CALM's Fire Management Policy, and suggest changes which it considers to be necessary.

The Department of Conservation and Land Management Policy Statement No. 19 on Fire Management Policy of May 1987 has been reproduced as Appendix 1 and changes suggested by the Panel have been provided in tandem for comparison. The terms of reference have been specifically couched in terms of the fire management policy in relation to prescribed burning and it is with this emphasis that we have made suggestions to the general policy of fire management.

Areas of priority have been highlighted below in order to emphasize particular aspects of the Fire Management Policy which the Panel feels strongly. It is a major concern of the Panel that due to monetary constraints over the recent past, that the lives of fire fighters are being progressively put at risk. This has not resulted in any death on the fire line so far and may not in the future, but it is apparent that there is a significant increase in mental and physical strain on the fire fighters and may well have contributed to the premature death of retired fire fighters. Causes of stress include limitation in staff numbers, an aging fire fighting force, reduced quantity and quality of equipment, reductions in the areas receiving prescribed burns to reduce fuel loads, inadequately maintained fire road

access to be able to suppress wildfires, and reduced compliance with requests to make adjacent private properties safe from fires.

The annual report of the Executive Director of CALM should include a statement of whether the planned strategic burning for that year has been achieved, a detailed explanation giving reasons if the planned burning has not been achieved and further comments if cumulative changes are in any way threatening the effectiveness of the strategic burning schemes. It is apparent from testimony from a range of sources that CALM has been "drawing from its bank account" of the previous decade of excellent fire management and has not kept up with planned schedules of prescribed burning, even in those plans to which have been publicly and openly agreed to, such as in National Parks. It is the belief of the Panel that the buildup of flammable fuels in particular areas has greatly reduced options in fire management, especially in suppression. A documentation of the status of planned and completed fire management operations would provide the basis for remedial redress of the prescription schedules.

The Panel feels there is a need for the CALM to develop a policy and proper strategies related to fire management training. The Panel recognises CALM as the most knowledgeable organisation in the State to train both its own staff and also associated rural bushfire fighting personnel in the proper use and control of fire in the forest and rural environment, yet there is no policy or strategies regarding the continuation and amplification of this practical knowledge into the future in the CALM Fire Management Policy statement. Currently training begins with prescribed burning as the basis of experience for wildfire suppression, yet there is no training for suppression techniques in high fuels and experience of fire behaviour in higher fuel loads is generally limited. There appears to be a lack of will by CALM to tackle fires in heavier fuel loads because they feel they cannot tackle these fires no matter what the weather conditions. In some way this argument has been used as a justification for the fuel reduction program.

Although CALM's policy is to provide well-trained and well-equipped fire fighters, it is the opinion of the Panel that this standard has been allowed to fall below acceptable levels. The Fire Management Policy needs to be expanded to include recruitment, training, retraining and retirement benefits. The policy should ensure that CALM recruits fit, young workers to undertake suppression and prescribed burning, that these workers are properly trained, and that there is a policy of retraining or increased benefits for early retirement of workers engaged in fire control. Examination of early retirement conditions and benefits in other fire services would seem appropriate. A policy for the employment of seasonal fire fighters for integration with regular crews is needed.

The policy should recognise formally that training for fire suppression requires: formal or classroom instruction; regular practical training on high-intensity fires in difficult fuel types; and a period of apprenticeship under experienced officers before the variability and danger of fire situations can be fully appreciated. Strategies could include: formal competency-based fire training for all fit, young employees of CALM; the establishment of training areas in heavy fuel types for formal practical training in suppression techniques under

conditions likely to be encountered; and a formal involvement of all fit, young staff on prescribed burning operations via a secondment in districts for a period during the prescribed burning season to work with regular crews.

The rationale for this suggestion is that training for fire suppression requires both formal instruction and a period of apprenticeship under the supervision of experienced fire fighters. In the past, training has been largely "on-the-job" and supplemented by regular experience on prescribed burning operations. Although prescribed burning during conditions that are relatively mild is an excellent training environment for new recruits, it does not prepare them for suppression in heavy fuels under dangerous conditions. Formal practical instruction on wildfire suppression under dangerous conditions has been neglected, yet this is exactly what is expected of CALM fire fighters. This is evident from submissions from both CALM officers and crews that they are not at all confident of undertaking suppression in heavy fuels, seem unsure of the fire behaviour to expect or appreciate the limits of their abilities under prevailing weather conditions. The view has been expressed that it is unsafe to suppress fires in fuels older than 6 years. However, CALM policies for regeneration of karri and jarrah, for development of fauna habitat and for retention of longer unburnt areas requires fire fighters to undertake suppression in 15 to 30 year old fuels. It is apparent they are insufficiently trained for this task.

The Panel feels that both the electronic and print media in Western Australia have a great responsibility to the public to put the fire situation and especially that of the use of prescribed burning for protection in a far more professional and less emotive manner. Words like "totally destroyed" and "devastated" may appear to a journalist to be worthy of selling a paper or show, but never do we hear that Australia has had the potential for fire for nearly 30 million years and even under a conservative regime of a one fire every 100 years, any particular piece of forest or heathland must, therefore, have received 300,000 separate fires. The flora and fauna are remarkably adapted to cope with fire and all existing species have had to evolve mechanisms to survive in ecosystems affected by fire. The Panel is concerned that there has been an apparent imbalance in the reporting of aspects of fire management, especially prescribed burning to protect forest and human values. Extreme preservationist philosophies have been given precedence and seldom have there been stories on the practical people, the people that attempt to control the fires, or problems that rural communities face in coping with the annual danger of living with the potential for wildfire. This perceived or real imbalance in the media reporting has had a significant effect on the morale of CALM staff involved with fire fighting and fire management. The media has portrayed the fire protection staff of CALM in terms not far short of "environmental vandals" and there is a buildup of resentment from the fire fighters who risk their lives even at prescribed burns so that others may be safe. The Panel view with the utmost gravity the role of the Media in the whole fire management question and hope after the experience of the past few months in the eastern Australian States, that a more balanced and "in depth" picture of fire in Western Australia society can be painted by them.

The Panel is even more concerned that teachers also have a poor appreciation of the role of fire in the Australian environment. They appear to have chosen to teach a simplistic view that all fire is bad and denigrate the forest workers who light prescribed fires without a recognition that they also are the same people that have to fight wildfires.

The Panel holds CALM partly to blame for allowing this situation to develop. Their premier magazine, "Landscope", and the staff magazine rarely report on the suppression achievements of CALM workers or give them credit for the excellent service they provide for the community. Better strategies are required to promote fire management which might include appointment of journalists to liaise with and motivate the press and a concerted and professional program to introduce fuel management and fire ecology into the schools curriculum

The CALM policy on fire management requires integration and interactive association with the public, and, therefore, there must be a more active attempt to involve Shires, special interest groups and individuals in understanding the CALM fire management program. There is a need for on-going public education campaigns to keep citizens reminded of our history of lost lives and damage resulting from wildfires and the role prescribed burning plays in the reduction of wildfire risk. There also is need to present to the public that there are positive ecological outcomes related to implementation of the fire management policy.

It appears to the Panel that, with assets of both CALM and its neighbours at risk and because each of the present three programs expends considerable funding on fire, all concerns relating to fire should be managed in a totally separate fourth program on fire management matters. The need for training, public education, research, etc. is obvious and with further development both inside and outside the Department the pressures related to fire will only get greater. There has to be some recognition by Government that extra resources are needed to manage the huge increase in additional land that CALM is now being asked to control. Whether these resources are contributed separately by Government to a Fire Program or from an increased CALM budget is not the Panel's concern, but we have the belief that it should be a direct contribution to fire prevention and suppression. When compared with other States, their area, population, etc., a doubling of the present $3 million over the next three years would not be inappropriate. CALM is recognised as the only body in the State that can carry out that role and for the general community good, there should be a Fire Program that does not rely on management whims of either program managers or the corporate executive.

In consideration of the policy of fire management, "monitoring" was reported to be an integral part of the policy, yet there was no clear cut understanding of what this concept meant in practice. It should be the objective of well-planned research projects on strategic sites to determine the extended-time implications of prescribed burning operations. This should be carried out by appropriate members of the research staff of CALM and be designed in such a way as to be continued over the required time extent of the research project by

other research staff. Post-incident documentation of some measure of the "quality", "effectiveness", "impact", or other such vague terms, for every burn would be uneconomic, unrealistic and unmanageable and should be removed from the list of policies and strategies of CALM.

RECOMMENDATIONS

1) That Fire Management becomes the fourth program within the CALM organisation, and that this program receive an additional $3 million per annum and steps be taken to implement this over the next three years.

2) That the Fire Management Policy needs to be expanded to included recruitment, training, re-training and retirement benefits.

3) That all fit, young CALM staff be required to participate in prescribed burning operations.

4) That designated training areas be set aside for practical instruction on wildfire suppression.

5) That CALM employ professional journalists to liaise with the media to explain CALM's prescribed burning program.

6) That CALM undertake a program with the Education Department to introduce fire management and fire ecology into school curricula.

7) That the word "monitoring" be replaced with "well-planned strategic research", as its use in policy and strategy documents is particularly misleading.

2) Consider whether it is appropriate for CALM to carry out prescribed burning for fuel reduction and habitat management within South-west forests and heathlands.

The Panel has reviewed prescribed burning for hazard reduction around Australia. It is an appropriate policy in all States. It is the conclusion of the Panel that it is appropriate for CALM to carry out prescribed burning for both fuel reduction and habitat management within South-west forests and heathlands. The theory of prescribed fuel-reduction burning has a sound basis in the research which has been conducted into the relationship between fuel load and fire behaviour. As a consequence, fuel reduction has assisted fire control operations under a wide range of conditions. The lowered incidence and intensity of wildfires in areas that have been subjected to prescribed burning for fuel reduction is incontrovertible. Therefore, the use of ecologically-conscious prescribed burning as an efficient and relatively cheap method of reducing fuel levels should continue to play a major role in modifying the natural events system in the future.

In fact, the Panel feels so strongly that prescribed burning is the most economic and ecologically acceptable way to reduce the potential of wildfires that it recommends that the Government formally and publicly choose between wildfire and prescribed burning as the means to manipulate forest fuels. It is our opinion that prescribed burning is the proper alternative.

Prescribed burning for fuel reduction must be planned and executed in concert with strategies for fire suppression, disease control, forest and habitat management, and reservations for scientific study. All strategies are inter-related and have implications for each other.

There is concern that dieback caused by *Phytophthora cinnamomi* is likely to be more destructive for certain vegetation types (e.g. vulnerable Proteaceae-dominated heathlands) than repeated high-intensity wildfires. While there is no documented evidence that either low- or high-intensity fires can be correlated with the incidence or spread of *Phytophthora cinnamomi,* suppression using bulldozers to construct fire lines can contribute to the spread of the disease. Proper hygiene measures may be rendered impossible due to emergency fire line construction. Thus, the interval between prescribed burning in quarantine areas may be reduced to the minimum acceptable rotation for most understorey species to minimise the spread when fires develop. Suppression strategies in these areas may have priority for fast initial response, but once initial attack fails an automatic response to burn-out from established compartment roads and tracks may be essential.

There is a major concern over the management of no-planned-burn areas in National Parks. There seemed to be few defined objectives for no-planned-burn areas and so no clear strategies for fire suppression or a clear appreciation of the consequences that wildfires in these areas may have for the natural values within the areas and the likely impacts down-wind. Certainly variable burning regimes including the provision for wildfires is an acceptable management regime provided such a regime does not pose an unacceptable threat to life and property. The location, size and cost of maintaining no-planned-burn areas in a number of National Parks needs to be rationalised and increased funding provided to implement the fire management plans in these National Parks.

Current 10-year duration management plans in National Parks should be able to be altered when new information and circumstances dictate. The Leeuwin-Naturaliste National Park plan currently appears to have major planning flaws in relation to no-planned-burn areas and adjacent regions of public properties.

Fire management options in National Parks should be flexible and incorporate the potential for grazing or other fuel reduction techniques. For example, grazing in the Ludlow Forest National Park in some form and in some areas appears an appropriate strategy to supplement rotational prescribed burning. It may be appropriate to utilize herbicides to reduce fuel buildup in some areas as in firebreaks where erosion is a likelihood. Alternative strategies to burning should receive research consideration.

There is a role for prescribed burning for the management of rare and endangered plants and animals and a continuing need for on-going research to identify and refine such prescriptions. In the absence of knowledge there should be the provision of sufficient funding to allow an emphasis to diversify fire management regimes with a range of frequencies, intensities, seasons and sequence. There is some concern that the option of no burning followed by wildfire intensities is worse than providing a range of burning regimes.

Following a wide review of fire management programs in W.A., Victoria and N.S.W., the Panel finds that there is no other organisation in Australia with the knowledge and practical abilities in fire management to protect and maintain natural and human values that is at or better than the standard set by CALM. CALM should continue to be the management corporation charged with fire management in the forests and heathlands in the South-west of Western Australia.

RECOMMENDATIONS

1) That the Government publicly declare that regular prescribed fire is essential to minimise extensive wildfires and publicly recognise that CALM is the appropriate authority to carry out prescribed burning for fuel reduction and habitat management within South-west forests and heathlands.

2) That CALM develop clear strategies for prescribed burning and fire suppression in areas affected by *Phytophthora cinnamomi.*

3) That no-planned-burn areas in National Parks have clearly defined objectives and strategies for suppression.

4) That grazing be considered as a replacement for fuel reduction burns in areas of management where such activities have formerly taken place and have an acceptable role in the protection of social, economic and conservation values.

5) That there is a need for on-going research to identify and refine 'habitat management' prescription burns for rare and endangered plants and animals. In the absence of knowledge there should be the provisions of sufficient funding to allow an emphasis to diversify fire management regimes with a range of frequencies, intensities, seasons and sequence.

3) Consider the value of prescribe burning as a measure to minimise the potential damage caused by wildfires, and maximise the ease of fire control in the South-west; and suggest any changes which it considers would improve the effectiveness of the prescribed burning program in minimising the threat of wildfires to humans, valuable assets and ecosystems.

The value of prescribed burning as a fire control tool must be assessed in terms of the potential behaviour of a wildfire burning in heavy fuels under conditions of extreme fire danger. The maximum potential intensity or energy release of a wildfire in Western Australia is estimated to be more than 100,000 kW m^{-1} of fire front. At this level of energy release, flames would extend beyond twice the height of the forest canopy (including the tallest trees in the karri forest); induced winds may develop tornado characteristics and uproot mature trees and break off pole-sized trees, overturn heavy-duty tankers and throw innumerable fire-brands many kilometers down wind; these will start new fires, which in turn will rapidly develop the characteristics of extreme fire behaviour.

The maximum level of fire intensity that can be suppressed by any means (including the largest air tanker operation) is between 2000 and 3000 kW m^{-1} in the jarrah forest and perhaps up to 3500 kW m^{-1} in karri forest. At this intensity the fire is still a surface fire in medium to good quality jarrah forest but is throwing numerous fire-brands around 50 m down wind ahead of the fire. Suppression of the head fire, while possible, is extremely dangerous as only slight changes in the weather or fuel load can increase the flames into a crown fire, increase the concentration and distance that spotfires ignite ahead of the fire and lead to the entrapment of fire fighters. The intensity at which suppression can be successfully undertaken is only 2-3% of the potential intensity of wildfire.

Most prescribed burning is of an intensity less than 500 kW m^{-1} or 0.5% of the potential intensity of wildfire. The only way man can modify the behaviour and intensity of wildfires is to reduce the fuel load available for combustion and to alter the structure and characteristics of those fuels. Theoretically this can be done in a number of ways (e.g. grazing, slashing, etc.) but the only practical way to achieve fuel reduction over sufficient area to substantially modify high-intensity fires, and to change the flammability of the bark on the trees and thereby reduce the spotting potential of the fire, is by low-intensity prescribed fire.

Reducing fuel loads by prescribed burning or other means is not designed to stop wildfires (although fires may be stopped by areas which have been burnt up to 2 years, previously). Rather it is designed to reduce the intensity of wildfires under all conditions, reduce flame heights, rates of spread, and the number and distance that fire-brands are thrown ahead of the fire-front and thereby make fire suppression easier. Some wildfires burning in fuel reduced areas will still burn at an intensity which will be beyond physical control until weather conditions abate. However, these fires will be less damaging to timber and wildlife values, will develop and spread less rapidly and eventually be confined to a smaller area than fires burning in heavy fuels under the same weather conditions.

The Panel is in no doubt that the planning (up to 7 years in advance) and execution of prescribed burning by CALM officers is highly professional and not equalled anywhere in the world. However, management of the forest estate for timber, conservation, and aesthetic values is making the task considerably more complex and more costly than it has been in the past. Burning to reduce fuel loads in areas of young regenerated forest or to provide specific habitat for fauna requires prescriptions within a much narrower range of environmental conditions than have been required in the past. There is some concern that long-term logging plans and burning plans are not sufficiently integrated.

The Panel considers that the Government should recognise the increasing complexity of fire management and the unacceptable stress that is being placed on CALM officers by the provision of inadequate resources and conflicting demands of local pressure groups. There is a need for CALM to use helicopters more widely for the ignition of smaller blocks with restricted time frames now being considered in fire management schemes.

Greater emphasis on the positioning of logging in relation to protection burning in the years following logging should occur. The planning section of CALM should examine carefully the implications of leaving wildlife corridors and areas reserved for landscape aesthetics and ensure that these do not compromise the efficiency and effectiveness of fuel management operations.

There is a concern of the Panel that no matter what CALM does on the lands under their management, there are instances where the fuel conditions of adjacent private lands present a significant risk to human life and values. Under these situations, CALM cannot be held accountable for what happens on public and private lands if the private land holders do not reduce fuels. Shires and private landholders must be required to conform to Bush Fire Act requirements regarding the management of fuel loads and fire risk.

It is a concern of the Panel that past successes of CALM in preventing major wildfire events has lead the public into the belief that such events cannot occur in the future. A public malaise in regard to self-protection against wildfires has developed in the recent past in Western Australia because CALM has been very successful in the prevention of major wildfire events. It should be emphasized that fire management is a community activity and CALM is only one party in the strategy of risk assessment and fire management to protect regions where many public and private sectors have values at risk.

RECOMMENDATIONS

1) That the Government accept that prescribed burning to modify fuel loads is the most cost-effective way to modify fire behaviour and is essential to minimise the potential damage from wildfires.

2) That CALM burning plans should be better integrated with long-term logging plans, wildlife corridor planning and plans for landscape reserves.

3) That CALM investigate greater use of helicopters for prescribe burning.

4) Consider the adequacy of field resources to implement any proposed fire management system.

The Panel considered the question of adequacy of field resources at length and feels the major factor in implementing an effective fire management program lies in the number of continuously available, competently trained and properly fit staff employed by CALM. Whether the future choice of fire management systems is biased toward prescribed burning or suppression of wildfires, manpower resources are currently a major limitation. When it is realized that CALM is protecting more than $3 billion of assets in forest products alone without the values of nearby homes, villages and other human developments, the ecotourism value of a uniquely beautiful flora and enormously interesting fauna and the major drinking water resources for Western Australia, the $3 million of the annual fire protection budget for all CALM lands is exceptionally miserly. If Government believes that the above assets are worth preserving then a conscious effort has to be made, despite the cost, to carry out this task efficiently.

There are inadequate resources to implement the current management system, let alone any proposed system. The manning levels of fire crews in CALM have fallen drastically and when the concern of age and fitness of the existing crews is added, emergency measures need to be taken. It is the Panel's belief that each CALM region should be able to man the first two shifts at any fire it attends, and if this means that more CALM personnel have to receive fire training, so be it. The attitudes of some CALM employees that they don't have to attend fires or fire training is not acceptable and the Panel recommends that <u>all</u> CALM employees, male and female, should receive fire training each year.

The Panel believes there is a need for the minimum of 20 new young, fit crew members to be hired and trained. A crew of five should be allocated to each of the three main forest management regions with one mobile crew to be moved with the fire seasons to cover wildfire risk. Further, there is a need for at least 50 seasonal workers to assist in prescribe burning operations and wildfire suppression for some 20 weeks a year.

Consideration should be given to work place agreements between the AWU staff and CALM regarding flexible working hours. Annualized payments and flexible hours would be beneficial to both the trained fire management staff and CALM, resulting in reduction of overtime and weekend costs during periods of greater fire management activity and forest fire risk.

There has been a concern presented that CALM tends to move District Managers too often. Area managers should be allowed to remain for longer periods of time and encouraged to become part of the social structure of the local community.

Due to the planning for prescribed burns taking place in one financial year and the commencement of the burning schedule taking place in the next financial year, there are situations where considerable cost wastage has occurred when funding limitations have meant numbers of scheduled burns have had to be delayed. It is the recommendation of the Panel that triennial or rolling funding arrangements be provided to CALM in regards to fire management.

The Panel feels that the use of contractors should be balanced against the contractor's own requirements and that a payment be made for the use of men and machines from this source. Bush Fire Brigades are also a great source of potential help to CALM and the Panel believes these Brigades should receive training on a regular basis from CALM personnel. This would involve helping at prescribed burns as well as suppression duties. The Panel considers that a payment should be made to the Brigades for this help and this payment maybe offset against the purchase of aging, but well-maintained CALM fire fighting equipment.

It has been widely recognised that CALM crews are the most skilled and experienced fire fighters in Western Australia, yet they are unrecognisable during emergencies due to a lack of appropriate insignias or distinctive clothing. It is recommended that the employees of CALM be provided with appropriately designated protective clothing for fire prescription and prevention work. Distinctive clothing would be of benefit under conditions where a number of organisations are involved in fighting a single fire. The CALM fire fighting staff should appear to be the professional fire fighting staff that their practical skills already show. Distinctive protective clothing would result in beneficial publicity to CALM during emergencies where news crews are on the scene of a fire.

The Panel would encourage an interaction between CALM and local Bush Fires Brigades in aspects of practical training in fire management and suppression. Theoretical training, currently provided by the W.A. Bush Fires Board, should continue. However, CALM, as the premier fire fighting organization of the State, is the appropriate organisation to provide practical training.

The Panel also identified a need for the improvement and up-grading of strategic access roads and water points and believes that an initial additional funding provision be made with an increased annual amount to be provided for the maintenance of these tracks and water points. There seems to be no reason to doubt the amount suggested by CALM of $650,000 additional in this regard.

With regard to vehicles, the Panel would like to see a faster turnover time for all units dedicated to fire and an association be developed with the Bush Fires Board to transfer these units into the Brigade areas. CALM should recognize the role of new technological advances such as helicopters, cherry pickers to saw out burning limbs, and specialized sanddune fire attack vehicles, in fire suppression and must train people in integrated aircraft, ground equipment and hand tool fire fighting techniques for initial attack in high fuel zones such as those that build up in no-planned-burn areas of National Park. Also, the use of helicopters

should be integrated in all areas of fire management. Specialty roles for helicopters lie in observation and management of crews, precise implementation of burning operations during suppression and prescribed burning, detection of spot fires, assisting crews in the location, suppression of spot fires and proper use of water bombing buckets. At the same time, the use of helicopters and other new expensive technologies should be viewed in their ability to improve fire management rather than for acquire greater amounts of monies for suppression alone.

The use of helicopters may well be in conjunction with other Departments and, thus the costs shared. Although many submissions mentioned the use of aircraft, the Panel believes that the money needed for this type of protection would be better spent on hazard reduction. This opinion is reached on the basis of not only Australian research (e.g. Project Aquarius) but from comments from practical fire fighters both in Australia and overseas.

The depletion of CALM physical plant, such as bulldozers and graders is also of concern to the Panel and when one compares the five bulldozers maintained by CALM with the 55 in the Victorian Department of Conservation and Natural Resource, the reason for that concern is obvious and in line with our concern about access and water points it may be that a greater number of fire fighting and road maintenance units will be needed for even the most basic level of fire management.

There is a funding need to improve education, training and involvement in the fire management program of those living in semi-rural areas. Complacency increases with the time since the last major fire. Attention to education by the Shires, Brigades, W.A. Bush Fires Board and CALM should occur before the fire danger period commences. Pro-active publicity should be targeted toward enclaves of public developments near and within National Parks. Such people are presently mostly untrained but probably will be the first on the scene when a fire occurs. Presently these people tend to consider that fire protection is the sole role of CALM.

CALM will certainly endeavour to reduce the intensity of wildfires on CALM lands, but as emphasised earlier fuel reduction in the forest does not prevent fires, and large wildfires burning under extreme weather conditions will throw some spot fires down wind of the fire front across wide fire breaks. The importance of fuel reduction and property maintenance must be emphasised in both the urban/rural fringe and within rural towns to enable these spot fires to be controlled by fire brigades and residents.

RECOMMENDATIONS:

1) That CALM train sufficient manpower in each region to undertake the first two shifts on any fire. This may require additional new crew and extended training.

2) That CALM urgently upgrade strategic access roads and water points.

3) That all CALM staff, male and female, undertake fire management training each year.

4) That consideration on work place agreements be made between unions and CALM.

5) That CALM seek triennial or rolling funding arrangements for fire management.

6) That CALM provide appropriate clothing and insignias for fire fighting staff.

7) That CALM continue to investigate specialised equipment for fire suppression and integrate helicopters into all aspects of fire management as these become more available.

5) Consider the environmental impacts of current prescribed burning practices in the South-west, including effects on flora, fauna, air quality, water catchments and aesthetics, and suggest changes to practices which would minimise any undesirable, permanent changes.

In a wide review of the impact of the prescribed burning practices of CALM in the South-west forests and heathlands, the Panel finds that there is no evidence that the current practices have resulted in major disruptions to the natural ecosystems of these vegetation types. CALM should continue to endeavour to carry out burning in these ecosystems using a range of frequencies, times of ignition, intensities and sequential regimes in order to provide conditions in the forests and heathlands for full expression of the flora and fauna, and of vegetation structure and complexity, of these ecosystems. There is a continuing need for research, especially long-term research, to further document the impacts of fire management variables on the biotic and abiotic environment affected by CALM's fire management. Increased consideration and allocation of research funds should be made to document the long-term impacts of fire management in the South-west region. Long-term research studies of the ecological effects of fire management regimes should be established across a broad range of vegetation types where prescribed burning can be practised. Consideration of "tailored" fire regimes should be made in the short term to advantage particular gazetted rare species. These considerations should be made commensurate with aesthetic, recreational, tourist and timber values, but be tempered in relation to risks to life and property.

It is the opinion of the Panel that it is appropriate to allow prescribed burning during all periods of the year. From available information of lightning strikes, it is apparent that ignitions can occur in all months of the year and have for at least the last several thousand years. Such lightning strikes and/or aboriginal burning practices have influenced the forests and heathland for eons and resulted in a natural mosaic of plant community ages within any region of

the South-west. Today, fire should be considered to be as much a part of our forest and heathland ecosystems as the sun and the rain.

A very large number of submissions to the Panel appealed for CALM to increase the proportion of their prescribed burns carried out in Autumn. We feel, however, that in many cases, understanding of the biological consequences of greater fuel consumption and increased fire intensity was limited. For example, testimony was received from farmers in the far south condemning CALM for their Spring burns due to the potential for re-ignitions during Summer. The impact of higher intensity Autumn burns on timber resources and conservation values, however, must also be considered by CALM. It is the view of the Panel that an increase in the proportion of prescribed burns under dry fuel and dry soil conditions should be encouraged. Also representative, older age-since-last burnt areas within each major ecosystem should also be maintained. However, both recommendations rely on the provision of greater funding to ensure the protection of conservation, social and economic values in these areas. The Panel is of the opinion that it is still appropriate to have the majority of prescribed burns in the Spring period, but CALM research should determine a proper mix of seasons in the regimes of hazard reduction prescriptions for any particular area.

It is the considered belief of the Panel that for given fuel loads and atmospheric conditions, the intensity of fires and the implications to the ecosystem are predominantly related the dryness (and, therefore combustibility) of the forest floor fuels and not to "season" per se. Each year a seasonal continuum of fine fuel wetting and drying occurs, driven by the precipitation and evaporation cycles of the climate of Western Australia. Wet and cool season burns tend to move slowly across the forest floor and leave more unburnt, refugial regions within the perimeter of the burn compared to dry and warm season fires, which move more rapidly and cause almost complete consumption of the understorey vegetation, leaf litter and logs, particularly hollow logs, which provide habitat and shelter for many species. Although prescribed burning intensity may be increased at the drier end of the continuum, only during wildfire conditions does fire consume material of the forest canopy in addition to the understorey vegetation and litter layer.

August through October in Western Australia are peak periods of floral and faunal reproduction and fires may affect flowering and fruiting plants and birds nesting in the lower vegetation strata. The relatively slow moving and discontinuous fire fronts under moist fuel conditions, however, allow for a greater proportion of the ground-dwelling animals to escape the fire. Also the patchy nature of moist condition prescribed burns provide refugia for litter-dwelling invertebrates, slow-moving reptiles, marsupial habitat logs and trees, and flowering and fruiting plants. In moist-fuel fires in the South-west, gully regions, peatlands and swamp habitats are generally spared. These habitats in the South-west are often the sites of rare and uncommon flora and fauna. Greater amounts of essential soil and litter nutrients, especially nitrogen, are retained in the ecosystem during conditions of low-intensity fires. Fire intensity during moist-fuel conditions may be insufficient to raise soil temperatures to a level

required to induce seed germination of soil borne seed, thus reducing the numbers of these species in the floral composition of the forests.

Conversely, prescribed burns through dry fuels fully consume most of the upland understorey vegetation and litter, many logs and some dead standing trees and often consume the gully, peat and swamp habitats. The higher fuel consumption in dry-soil fires would be expected to release greater amounts of carbon dioxide and may disperse nutrient-bearing ash more widely. Faster moving and more contiguous fire fronts might be expected to result in greater numbers of animal deaths. Dry-fuel fires would consume more of the nesting logs and trees of the animals, but high-intensity burns also create new nest hollows and fallen logs. Dry-fuel fires provide greater area of ash beds which favour the establishment of serotinous seed storage species. Fires in dry fuels and dry soils can result in enhanced establishment of particular soil seed store species because of a requirement of a heat shock or smoke exposure treatments to cue germination.

The major difference between Autumn prescribed burns and Summer wildfires is the greater intensity of wildfires which generally results in a higher percentage of the living vegetation being consumed, often including the crowns of the trees. Wildfires generally spread much more quickly and the recovery rates of the ecosystem would be expected to be much more protracted in comparison to fires prescribed for fuel reduction. Broadscale wildfires, under any circumstance, are considered to be too great a stress on the natural ecosystems of the forests and heathlands of the South-west to be allowed a part of any good management strategy. For the consideration of wildlife conservation, wildfires tend to result in a uniformly and completely consumed understorey and litter layer leaving too few refugia over too large an area.

The Panel recognises that the long-term maintenance of certain species of flora and fauna and vegetation structures can be threatened by any fire regime, including fire exclusion. At one extreme, regimes of multiple, short-interval, high-intensity burns can stress populations of obligate seeding species which require several years to produce reasonable numbers of seeds and reduce their population density in comparison to resprouting species. At the other time extreme, populations of large marsupials are reduced in long-unburnt habitats as these sites provide only limited amounts of favoured food resources. Therefore, a wide range in the fire intensity, frequency, season of burn and sequential regime of fires should be prescribed for each major vegetation region of the South-west taking account of the management objectives for each location. However, strategic and tactical planning is essential for success, and prescriptions must never be allowed to include fire intensities, frequencies or season of burning which will be too dangerous, too expensive in relation to the values protected or too limiting on the choice of conditions specified.

An hypothesis relating to forest floor litter build-up being reversed in areas unburnt for a long (but unsubstantiated) time was related to the Panel and views were sought in the wider scientific community regarding its validity for Western Australian plant communities. It is the Panel's view of the current research from a range of research institutes and a review of the scientific literature

available that there is no documented and quantified evidence that total fuel loads of the vegetation of the south-west of Western Australia actually begin to reduce given post-fire periods of greater than 40 years. The composition of forest floor fuel changes with time since fire and forest floor litter habitats in sections of the forest which have remained unburnt for 20 to 50 years tend to contain a higher proportion of the more recalcitrant fractions of detritus. In the early period of litter accumulation on the forest floor, leaf litter forms the most substantial contribution, but as the litter layer develops, the more slowly broken down fractions of the fuel, such as bark, branches, boles and fruit material, become increasingly dominant. The consequence of this fuel load buildup is that under dry fuel and dry soil conditions, high-intensity fire is the most likely result. Control of forest floor litter loads remains the only cost effective means of fire intensity management for the protection of conservation, social and economic values in the South-west forest region. The most likely consequence in long-unburnt areas is a high-intensity wildfire.

The flora of any ecosystem evolves in relation to environmental regimes of stress and the individual species populations in such ecosystems occur because the fluctuations of stress in the ecosystems do not fall outside the species population's ability to cope with the stress. Limits of tolerance in each species can be measured individually, such as the limit of tolerance to drought, light levels, salinity level and fire, but each population must be tolerant to all to be present in any particular habitat. However where species are absent, it cannot be concluded that some stress of the environment is beyond the limits of tolerance for that species because it may be that seeds are not available in the habitat and species are absent merely due to lack of propagules. Populations of plants differ in the way they cope with fire and two major "strategies" have been described in relation to fire: a seedling re-establishment (or "seeder") strategy because fire kills adult plants and a strategy where adults plants tend to survive fires and resprout from protected buds under bark and soil (or "resprouters"). These strategies represent the extremes of a continuum in relation to tolerance to fire and many plant species display somewhat intermediate attributes in relation to the periodicity of seedling establishment. One end of the continuum emphasises tolerance to fire and the other an emphasis on taking advantage of open post-fire habitats for population enhancement. Each strategy is a response to fire and neither should be considered to be "fire sensitive" or "advantaged by fire". It is the consideration of the Panel that the flora of the South-west forests and heathlands is eminently adapted to cope with fire and the current management of this environmental stress by CALM lies within the tolerance limits for populations of all known species in this region.

In any terrestrial ecosystem, faunal communities are intimately associated with the vegetation communities which occur throughout their habitat. Where the vegetation is subjected to recurrent disturbances such as fire, and becomes adapted to these disturbances, similar patterns would be expected to occur in the fauna. In the South-west, extensive research has shown that this is indeed the case. Animals of the forests consistently demonstrate a capacity to recover their population densities after fire. The rate of recovery depends on the species characteristics, its habitat and the type of fire or fire regime. The fire ecology of some animal species is well known, and fire regimes can be tailored to suit their

specific requirements. For other species, generalisations are necessary and variable fire regimes are appropriate to accommodate the range of likely responses. Species which are commonly associated with the later successional stages following a fire need to be identified, and their specific requirements determined.

When considering fire in relation to fauna, it is important not to confuse temporary impacts on individual animals with longer-term trends, which often have a nett beneficial effect. During any fire, some animals will perish. However, in the absence of fire, changes in the vegetation will also result in the decline and disappearance of some species. Provided a fire is not too intense, many animals will escape the flames by sheltering in hollow trees, logs, burrows and unburnt vegetation. An appropriate and variable fire regime will provide habitat regeneration by producing edible epicormic growth and legumes, and shelter in thickets, newly formed logs and hollows.

The relationship between fire and the conservation of animals must be viewed in an overall context. In State Forest, multiple land use objectives require that other land uses, such as timber and water production, recreation, and in some areas mining, must be taken into account. In other areas, such as Nature Reserves and National Parks, there is more flexibility to specifically tailor fire management to fulfil defined conservation objectives. In these cases, fire management will be aimed at either conservation of biodiversity, or management for particular species. The following sections describe the fire response patterns of particular faunal groups, and reviews how these relate to current fire management practices.

Birds are easily able to escape all but the most intense fires. The densities of some species decline after fire while others increase. Burning in Spring will cause mortality of nestlings, while intense Autumn burns may leave less suitable habitat for a period which depends on the requirements of particular species. Species which inhabit lower vegetation strata are affected for a longer time than canopy dwelling species. However, all forest inhabiting bird species recover within 4-5 years, and provided fire regimes include variable season and intensities, no species is likely to suffer long-term decline. This variability is important given that few research projects have investigated the long-term effects of specific fire regimes. Fires which are too frequent or too intense and widespread should be avoided. However, no bird species occurring in the main forest block are known to be dependant on very long-unburnt habitat; in fact evidence suggests that species numbers actually decline in very long-unburnt areas.

Outside the forest block, there are several species which are thought to have declined, partly as a result of fire. The Noisy Scrub Bird, Western Whip-bird, Western Bristle-bird and the Ground Parrot are all rare, and limited to few areas of suitable remnant habitat along the south coast. However, their relationship with fire is not straight forward. While fire probably played a part in their decline, they would have been adapted to cope with the patchy fires caused by lightning and Aborigines. When Europeans arrived, fires became less frequent, but more extensive. The patchiness which creates suitable post-fire vegetation

communities declined, and these birds only survived in areas where the landscape resulted in naturally patchy burns and longer-unburnt areas. Extensive research has since shown that fire is necessary to regenerate the habitat of these species. For the Ground Parrot, research from Victoria recommends a mosaic of recently burnt and longer-unburnt areas, while local studies have shown the other species require relatively long intervals between fires. Western Bristle-birds occur at a lower density in 45 year old habitat compared to 20 year old areas. The patterns for all of these birds are similar to those of other species, only the specific details and optimal fire frequency are different.

For birds, it can be concluded that current fire management policies will not cause long-term decline of species, provided that the frequency, intensity and season of fires are varied, burns are patchy, and the requirements of particular rare species are taken into account.

For Australia as a whole, more mammals have become extinct since the arrival of European man than any other vertebrate class. Clearing and introduced predators have been identified as being largely responsible for most of these extinctions, however, changed fire regimes are also known to have caused the decline of some species. Mammals are less mobile than birds. Some are territorial, and have low reproduction rates. All medium-sized mammals are vulnerable to fox and possibly cat predation. Given all of these characteristics, some mammals might be expected to demonstrate sensitivity to particular burning practices.

Numerous studies have been conducted on the relationship between fire management and the ecology of key mammal species. These studies have provided invaluable information on particular species, and it is now possible to make generalisations about responses to fire. As with birds, the patchiness and intensity of fires is important. The presence of unburnt areas such as stream zones following Spring burns provides sites where animals can shelter, and from which they can later recolonise. For many, occasional more intense fires are necessary for habitat regeneration. The rapidity with which a species returns to pre-burn densities depends on its shelter and feeding requirements, mobility and reproductive strategy. Species which shelter in burrows, have broad feeding requirements, high reproductive rates and mobility readily recolonise early post-fire successional stages. Others which have specific feeding requirements, low reproductive rates, low mobility and whose shelter does not offer good protection from fire, take longer to recolonise. However, provided fire regimes include a range of seasons, intensities and frequencies, and the specific requirements of rare species are taken into account, no mammal species is likely to become extinct.

The greatest threat to many species is fox predation. Fires which decrease the amount of cover increase their vulnerability to foxes, cats and other predators. However, as fires are necessary for habitat regeneration, the solution is not to stop burning, but to control predators. Research has shown that once fox control is achieved, numbers of many mammal species increase dramatically as post-burn predation declines. It is recommended that continued efforts be made to reduce the effects of feral predators on the native animals of the forests and

heathlands of the South-west. The threats to populations of many native animals by fox and cat predation appear greater than the imposition of prescribed burning. Burning, which may be essential for habitat regeneration, exposes species to these predators and increases mortality levels of prey species above those which would otherwise occur. Continued efforts should be placed on the direct control of the major source of problem, which is the populations of foxes and cats.

Some species which occur mainly outside the forests, such as the Honey Possum, reach their highest densities at 15 years after fire. The Dibbler was though to be vulnerable to fire and may have declined due to widespread intensive burns. However, further research has shown that these species do recolonise burnt areas. Thus, as with birds, species are adapted to fire, but differ in their specific responses and the optimal fire frequency. Burning programs should be flexible so that species which require particular seral stages do not become genetically isolated if such areas are widely separated. Under the present regime, this is unlikely to occur. Species might decline in vegetation which is at a sub-optimal seral stage, but they subsequently recolonise when suitable habitat develops. For these and many other fauna species it is important that, whenever possible, remnant vegetation is not all burnt at once. Previous experience has shown that mammal species can be eliminated from small reserves after the reserve was subjected to a single, intense wildfire.

Compared to mammals, less information is available for reptiles, however, the few studies that have been conducted indicate that this group does not generally show strong post-fire successional trends. Like mammals, the rapidity of their response depends on the mobility, food and shelter requirements and reproduction rate of each species. Species which inhabit dense litter are more vulnerable to fire, and take longer to recolonise. However, there is no evidence to suggest that current fire policies are likely to have long-term detrimental effects on any species, provided the variable fire regimes discussed above are implemented.

Even less information is available on the impact of burning regimes on amphibians, but the limited research suggests that most frog species do not experience long-term declines following fire. However, in the lower South-west, two new species of frogs have recently been discovered; *Geocrinea alba* and *G. vitellina*. Their distribution is restricted to peat swamps. Hot Autumn burns can cause *G. alba* to disappear from these swamps. Given that such sites support these and possibly other important species, their protection from inappropriate fires is critical. Low-intensity Spring burns conducted when the peat is too moist to burn may be necessary to reduce surrounding fuel loads and minimise the risk of hot summer wildfires.

A number of studies have investigated the responses of invertebrates to fire in the forests of the South-west. The majority of these studies have not been sufficiently rigorous to adequately assess the long-term impacts of fire on these organisms. Problems have included a lack of pre-burn information, insufficient time for the post-burn recording period, specimens are rarely identified to species, and most studies only investigated a single fire event so information on

long-term effects is generally lacking. However, some useful studies have been conducted. These can be combined with existing knowledge on invertebrate ecology, and the effects of fire on the vegetation to make reasonably confident predictions concerning the effects of fire.

In many ways, the patterns are similar to those found in other groups, such as mammals. The intensity and patchiness of the fire influences the rate of post-fire recovery. For some groups, such as burrowing Mygalomorph spiders, Autumn burns probably have little immediate effect while for Winter active litter decomposing species, Spring burns cause less disruption. A fire regime which included variable burning seasons would probably conserve more species than a single-season regime. Some studies have shown that diversity is greater at intermediate post burn ages than in long unburnt areas. This correlates with results found for plants. For the jarrah and karri forest, inland woodlands and heathland, until more detailed research shows otherwise, a fire regime which includes variable season, intensity and frequency is the most appropriate strategy.

It is the opinion of the Panel that low-intensity fires have little effect on soil-water infiltration rates or other parameters likely to affect water quality in streams, but wildfires can increase sediment level, nutrient levels and the amount of organic material in streams. There is a direct relationship with the severity of the fire and the impact on stream invertebrates and stream trophic structure due to the increased levels of sediments carried into the stream ecosystems. Some specialised habitats such as caves also contain specialised fauna species, which theoretically could be affected by nutrient input and turbidity caused by runoff following intensive fires and rain. Care should be taken when burning these areas.

It is apparent that currently accepted standards related to smoke particulate matter and ozone levels have been exceeded in the Metropolitan region due to prescribed burning. Requirements to consider the potential of releasing smoke into the Metropolitan airshed have also reduced the number of days available to complete prescribed burning schedules, resulting in increased risk to protection of forest economic, social and conservation values and a reduction in the potential to control wildfires. We are aware that CALM and the EPA are considering practical methods to maximise the window of burning opportunities while protecting health and encourage this continued dialogue.

RECOMMENDATIONS

1) That the necessary funding be provided to the prescribed burning program to increase the diversity of season, intensity, frequency and sequence of fires on any single area to ensure that no species will become threatened or extinct.

2) That fire management in some areas be tailored to the requirements of particular rare species. While longer-unburnt areas are important in each ecosystem to increase habitat diversity, and in some cases for particular species, they should be designed on the best available ecological data and located to minimise threats to life, property and the likelihood of accidental ignition.

3) That introduced predators, particularly the fox, are having an enormous impact on fauna which become more exposed to predation following fires. Patchy burns which leave refuge areas and small area, high-intensity habitat creation burns are useful, but control of foxes should also be carried out where rare fauna are at risk, and control methods developed for feral cats.

4) That the longer term responses of some flora and fauna to particular fire regimes are not yet fully understood. Research should be conducted to enable burning programs to be better tailored to organism requirements.

5) That the area burnt in Autumn be increased subject to the needs for specific habitat management.

6) Consider the technique of Wildfire Threat Analysis developed by CALM and appraise its value as a means of determining and ranking hazards and values threatened; and suggest ways this approach can be improved.

The Panel reviewed CALM's system of evaluating wildfire threat by considering values at risk, the risk of ignition, and considerations of suppression response in terms of the wildfire behaviour expected under defined environmental conditions. It is probably the most practical and comprehensive system for planning the distribution of resources and for setting priorities for prescribed burning anywhere in Australia.

The wildfire threat analysis (WTA) system was well accepted by CALM officers, but was little known by bushfires agencies, Shires and private citizens adjacent to CALM's operations. It appears that CALM has involved few external groups in the wildfire threat analysis process.

The main benefit of the system is that decisions about setting relative values can be discussed widely with all groups likely to be subjected to the threat of wildfires. It is the Panel's opinion that had CALM involved its near neighbours in the process there would be a far better understanding of CALM's decision making and a better understanding, particularly amongst adjacent Shires that they could not rely entirely upon CALM for protection. The wildfire threat analysis process would demonstrate the need for Shires to be more involved in planning for wildfires and equipping themselves for the protection of areas under their control.

The classification and ranking of values used by CALM is appropriate for setting priorities on CALM land. Areas where there is a significant threat to human lives in the event of wildfire are given the highest ranking while areas where there are sole, known, sustainable populations of fire-vulnerable, threatened species are assigned the next highest value on a par with areas of high property value. The use of WTA for fire management planning within a Shire

may well establish a ranking of values at threat which is different to that adopted by CALM.

Conservation groups generally had little understanding of the process but recommended in general terms that a more sophisticated and computer based system be developed to take account of local species and communities that they considered to be particularly important. The Panel feels that while computerisation is necessary to extend the system beyond CALM's estate the process of mapping and community discussion is vitally important to establish relative values and are an essential first step in the analysis.

The use of the CSIRO bushfire spread model could assist both CALM and Shire officers to appreciate the development and potential of wildfires burning through their areas under extreme conditions.

RECOMMENDATIONS:

1) That CALM's Wildfire Threat Analysis is an essential fire management tool and that the ranking of values is appropriate for CALM areas; that is human life continues to receive the highest priority.

2) That CALM commit resources to extend the Wildfire Threat Analysis to include private lands adjacent to CALM's estate and be pro-active in involving both shire and local interest groups in the process of priority setting.

3) That CALM continue its development of the Wildfire Threat Analysis including GIS and/or other computer databases where appropriate.

4) That CALM examine ways to display the firespread component of Wildfire Threat Analysis, particularly in areas adjacent to CALM lands.

7) Examine the provisions of the Bush Fires Act which impinge on any of the above factors; and suggest how these might be amended, so as to maintain community safety from bushfires as well as environmental standards, and ensure the Government and its agencies are not subjected to litigation in relation to fire management policy and practice.

With the realisation that the Bush Fires Act is to be re-written, the Panel would suggest that the following be considered:

That each Shire be required to have an up-to-date fire management plan and that in the first instance CALM be allocated the resources to assist in drawing

up these plans. The fire management plans should have as much public input as possible and this input should include participation to a degree that reminds all involved that public lands belong to the whole community. If the community is to take responsibility for its wildfire protection, the importance of consulting with the community generally on all aspects of wildfire protection cannot be overstated. Shire plans should reflect community interests and aspirations generally by requiring a process of community consultation before the adoption of the plan. This is needed so that a realisation is heightened that CALM and volunteers are not the only people who have a fire management responsibility; the whole community does.

The implementation of these plans should be audited by CALM within 3 km of its estate and by the Bush Fires Board outside that area. The Panel further recommends that although it appears that the Act allows and in most cases encourages local authorities to take action in regard to prevention and suppression of fire that the above ensures they do. A further recommendation is that the Prohibited Burning section be removed from the Act and that all burning inside the periods a Local Authority believe to be dangerous be by permit. This would include CALM burns.

Submissions were received that were critical of the lack of roadside burning and although the Panel believes Local Authorities have the power to implement this, fears of litigation and increasing fuel levels have seen a decline in the numbers of roads burnt.

It appears to the Panel that the Act allows and indeed in most cases encourages local Government to take action with regard to prevention and suppression of fire but there is a hesitancy in some Shires to take on litigation because of the cost. Certainly the Shires that do use their full powers have found that they have public opinion behind them.

Another area in the Act that needs to be upgraded is the limit of the equipment insurance covered by local authorities. Possibly instead of a dollar amount being specified, this amount could be linked to a percentage of, say the purchase price of the average Government motor vehicle.

Town planning is another area that the Panel believes that needs the input of competent fire authorities. While many decisions have been made in the past that are creating potential problems, the Panel feel that individuals must themselves be responsible for their own properties, i.e. the person who owns the fuel, owns the fire. Further, the Panel believes that if it is legally possible, the Act should be written so that people who have not taken the require hazard reduction methods should lose any chance of litigation and insurance redress.

A final recommendation is that the Act be strengthened to extend the protection against litigation, which is provided for an individual acting in good faith, to the Government Agencies that employ firefighters.

RECOMMENDATIONS

1) That it be a statutory requirement for each Shire to have an up-to-date fire management plan.

2) That the Prohibited Burning section be removed from the Act.

3) That the limit of equipment insurance covered in the Act by Local Authorities be up-graded.

4) That the Act be strengthened to extend the protection against litigation to Government Agencies who employ firefighters.

5) That the Act should be strengthened so that people who have not reduced hazard on their land to an acceptable level lose any chance of litigation and insurance redress.

USEFUL DEFINITIONS

BACKBURN = BACKFIRE: A fire set along the inner edge of a control line to consume the fuel in the path of the head of a fire.

BUFFER:
(1) A fuel-reduced zone to assist in the control of high-intensity prescribed fires.
(2) A zone surrounding areas where fire exclusion is desired, where prescribed burning may be carried out.

BUSHFIRE: any unplanned fire.

BURN:
(1) An area over which fire has run
(2) A fire set deliberately to meet some management objective. e.g. PRESCRIBED BURN, BACKBURN, REGENERATION BURN

BURNING OFF: Generally, setting fire - with more or less regulation - to areas carrying unwanted vegetation such as rough grass, slash, and other fuels

BUSHFIRE = WILDFIRE: Any uncontrolled fire burning in forest, scrub or grassland.

CASUAL FIREFIGHTER: A non-agency individual hired locally to assist in firefighting actions on one specific fire.

ECOTYPE:
(1) A subdivision of a biological group that maintains its identity through isolation and/or environmental selection.
(2) A locally adapted population of a species that has a distinctive limit of tolerance to environmental factors.

FIREBREAK: Any natural or constructed discontinuity in a fuel bed utilised to segregate, stop, and control the spread of fire or to provide a control line from which to suppress a fire.

FIRE DANGER: Sum of constant and variable fire danger factors affecting the inception spread and resistance to control of a bushfire.

FIRE DANGER RATING: an index which predicts the relative rate of spread and intensity of a fire, and its potential to do damage and suppression difficulty.

FIRE HAZARD: describes the fuel potentially available for burning and takes into consideration such factors as location, quantity, arrangement, and current or potential flammability of the fuel. when considered in combination with fire weather variables, it determines the difficulty of suppression once the fuel is ignited and also signifies the potential threat to human life, property and other assets.

FIRE MANAGEMENT: the planning, conduct, and review of all aspects of fire prevention, fire suppression and use of prescribed burning in land and natural resource management.

FIRE RISK: refers to the relative chance or probability of fires starting and is determined by the presence or absence of causative agencies. The degree of risk in an area is assessed by studying the probable frequency of dry electrical storms and the many ways in which people use or cause fires. As fires cannot burn with fuel, risk must be studied in conjunction with fire hazard.

FIRE THREAT: Sum of all factors which effect the inception, spread, difficulty of control of a fire and the damage it may cause.

FUEL: Any plant or plant product that burns.

MULTI-STAGE BURNING: prescribed burning carried out in several stages, over a season, in order to progressively remove fuels as they dry out.

NO-PLANNED-BURN AREA: An area where no prescribed burning will be undertaken for the period of the management plant (usually 10 years).

PRESCRIBED BURNING = PRESCRIBED FIRE = CONTROLLED BURNING: the planned application of fire under selected weather and fuel conditions so that the fire is confined to a predetermined area and burns with the intensity and rate of spread necessary to achieve the objectives of management.

PRESCRIPTION: A written statement defining the objectives to be attained, as well as the conditions of temperature, humidity, wind direction and speed, fuel moisture, and soil moisture or drought index under which the fire will be allowed to burn. Also, it should specify the expected rate of spread, fire intensity and flame height and the limit of the geographic area to be covered.

PUBLIC LAND: any land controlled or managed by any public agency or authority.

REGENERATION BURN: A prescribed burn carried out to prepare a seed bed for the regeneration of desired species.

Appendix 1.

Fire Management Policy

Original		Suggested	
1. INTRODUCTION			
	This policy is based upon the following premises:		
1.1	Fire has occurred naturally from time to time in practically all lands managed by CALM. Fire has therefore played some part in determining present vegetation structures and composition.	1.1	Fire has been a major contributor to the ecology of all lands managed by CALM. The use of fire on these lands by its managers has to recognise this fact.
1.2	Under natural conditions, practically all ecosystems are made up of a mosaic of vegetation associations and structural stages according to their fire histories. The scale of the mosaic varies in different ecosystems.	1.2	Under natural conditions, practically all ecosystems are made up of a mosaic of vegetation associations and structural stages according to their fire histories. The scale of the mosaic varies in different ecosystems.
1.3	Fires from natural causes (e.g.. lightning) will inevitably occur. Fires resulting from human activities, either deliberate or accidental will also occur, but may be minimised by effective public education and awareness, and by legislation.	1.3	Fires from natural causes (e.g.. lightning) will inevitably occur. Fires resulting from human activities, either deliberate or accidental will also occur, but may be minimised by effective public education and awareness, and by legislation.

1.4 In Western Australia, weather conditions occur every year under which fires can be so intense as to be impossible to contain with currently available technologies and resources. Such fires can threaten human lives, and resources valued by the community, and their control involves considerable public expenditure and risks to fire-fighters.

1.5 The speed and intensity at which fire burns is related to the quantity of accumulated dry litter or other fine plant material. In some ecosystems, or in some high risk/high value situations, accumulated fuel loads can be reduced by prescribed burning. This reduces the likelihood of intense fires even under extreme conditions, and improves the capacity for fire-fighters to safely control a fire.

Within each major fuel type there is a recognised weight of dry fuel above which fire-fighting forces are not likely to be able to contain wildfires burning under normal hot summer conditions.

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Within each major fuel type there is a recognised weight of dry fuel above which fire-fighting forces are not likely to be able to contain wildfires burning under normal hot summer conditions.

1.6	Much of departmental land, particularly in the south west, has a common boundary with well developed private assets such as towns and farms, the protection of which reduces the flexibility for fire management.	1.6	Much of departmental land, particularly in the south west, has a common boundary with well developed private and public assets such as towns and farms, the protection of which combined with CALM's own operations reduces the flexibility for fire management.
1.7	Information about the long term effects of different fire regimes, including fire exclusion on many ecosystems is limited, and any management policy must be under constant review and accompanied by research and monitoring programmes.	1.7	Information about the long term effects of different fire regimes, including fire exclusion on many ecosystems is limited, and any management policy must be under constant review and accompanied by both strategic, short-term and long-term research programs
1.8	The Department has a moral and legal obligation to comply with those provisions of the Bush Fires Act, and CALM Act relating to fire prevention and control of wildfires on or near CALM lands.	1.8	The Department has a moral and legal obligation to comply with those provisions of the Bush Fires Act, and CALM Act relating to fire prevention and control of wildfires on or near CALM lands.
2. OBJECTIVES The fire management goal of the Department of Conservation and Land Management is:		The fire management goal of the Department of Conservation and Land Management is:	
2.1	To protect community and environmental values on lands managed by the Department from damage or destruction from wildfire	2.1	To seek to minimise the impact of wildfire on the social, economic and conservation values on lands managed by the Department.

2.2 To use fire as a management tool to achieve land management objectives, in accordance with designed land use priorities	2.2 To use fire as a management tool to minimise threat of fires spreading from lands managed by CALM and damaging neighbors.
3. POLICY	
3.1 Fire Suppression	3.1 Fire Suppression
1. The Department will meet its legal obligations under the Bush Fires Act and Conservation and Land Management Act by responding to fires occurring on or near CALM land to a degree that is appropriate to the values at risk.	1. The Department will meet its legal obligations under the Bush Fires Act and Conservation and Land Management Act by responding to fires occurring on or near CALM land to a degree that is appropriate to the values at risk.
2. The Department will assess its response to a fire in the light of potential damage to the following values in order of priority. (i) Human life; (ii) Community assets, property or special values (including environmental values); (iii) Cost of suppression in relation to values threatened.	2. The Department will assess its management of a fire in the light of potential damage to the following values in order of priority. (i) Human life; (ii) Community assets, property or special values (including environmental values); (iii) Cost of suppression in relation to values threatened.

3. Where values dictate the Department will: (i) provide a detection system which will give timely warning of the presence of a fire threatening community of environmental values; (ii) provide a well trained and equipped suppression organisation capable of containing several simultaneous unplanned fires under extreme weather conditions in conjunction with other fire fighting organisations.	3. Where values dictate the Department will: (i) provide a detection system which will give timely warning of the presence of a fire threatening community of environmental values; (ii) provide a well trained and equipped suppression organisation capable of containing several simultaneous unplanned fires under extreme weather conditions in conjunction with other fire fighting organisations.
3.2	3.2 Training 1. Ensure that basic fire management and suppression training is undertaken by all staff. 2. Reserve identified training areas in difficult fuel types for practical training in fire suppression.
3.2 Use of Fire 1. Use planned fire only where this use is in accordance with an approved management plan, or, where such a plan does not exist, to protect and maintain the designated priority land use.	3.3 Use of Fire 1. Use planned fire in accordance with an approved management plan, or, where such a plan does not exist, to protect and maintain the designated priority land use.

2. Prepare written prescriptions in advance, for approval by senior designated officers, before any planned fires are undertaken.

3. For areas where primary land use is wildlife conservation, use fire in such a way as to promote the greatest possible diversity and variety of habitats within prevailing physical or financial constraints.

In small conservation reserves and where information on the impact of fire is limited fire will be used conservatively. In such areas the use of fire will be restricted to:

(i) Protection of neighbouring community assets; and

(ii) as far as is achievable and within safe limits, ensuring that different seral stages following fire are represented.

2. Prepare written prescriptions in advance, for approval by senior designated officers, before any planned fires are undertaken.

4. Use prescribed fire or other methods to reduce fuels on appropriate areas of CALM lands, where it can be demonstrated that this is the most effective means of wildfire control, and where undesirable ecological effects do not result.

   The frequency of fuel reduction measures will be governed by the rate of build-up of fuels; the degree of risk to human lives, the value of the assets to be protected; the known sensitivity to fire, or dependence on fire, of the kinds of plants and animals present; and the resources available to carry out the work.

3.3 Liaison

1. Ensure effective liaison with neighbours, Bush Fires Brigades, Shires, Bush Fires Board and other fire control organisations.

2. Support the concept of Shire District Fire Plans and promote mutual aid interagency agreements for fire control and lands of mixed tenure with common fire problems.

3.4 Liaison

1. Ensure effective liaison with neighbours, Bush Fires Brigades, Shires, Bush Fires Board and other fire control organisations.

2. CALM will participate in Shire District Community activities related to the use of fire.

3.4 Public Awareness

The Department will provide for public education in relation to the prevention of fire, and the role and use of fire in ecosystem management, and hazard and risk reduction.

3.5 Research

The Department will undertake research into fire prevention and control, fire ecology and fire behaviour on CALM lands to improve the scientific basis for, and effectiveness of Fire Management Programmes.

3.5 Public Awareness

The Department will provide for and actively promote public education in relation to fire ecology, the prevention of fire, and the role and use of fire in ecosystem management, and hazard and risk reduction.

3.6 Research

The Department will undertake research into fire prevention and control, fire ecology and fire behaviour on CALM lands to improve the scientific basis for, and effectiveness of Fire Management Programs.

4. STRATEGIES

4.1 Fire Suppression

Suppression of unplanned fires on or threatening departmental land will be given priority over normal activities, except for those involved with safeguarding human life.
A detection system based on aircraft, lookout towers or ground patrol, will be used in designated areas where early warning of a fire occurrence is essential to enable rapid control measures.

In other areas, the Department will rely on neighbours, staff presence, the public, or commercial aircraft for reports of fire outbreaks.

When a fire is detected an appreciation will be made to estimate its likely spread and potential to cause damage to life, property or environmental value.

Unplanned fires will be contained to the smallest possible area by the most appropriate means available taking into consideration the values at risk and the impact of the suppression activity on the environment.

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In other areas, the Department will rely on neighbours, staff presence, the public, or commercial aircraft for reports of fire outbreaks.

When a fire is detected an appreciation will be made to estimate its likely spread and potential to cause damage to life, property or environmental value.

Unplanned fires will be contained by the most appropriate means available taking into consideration the values at risk, the prevailing and forecast weather, and the impact of the suppression activity on the social, economic and conservation values.

4.2 Use of Fire

Prescribed fires will be used to achieve a range of management objectives, including fuel reduction, habitat management, forest regeneration and the management of scenic values.

According to management objectives, appropriate prescriptions will be developed, and staff will be trained in their application.

Monitoring of the effects of fires will be undertaken wherever effective systems have been developed and resources are available.

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4.3 Liaison

The Department will participate in the preparation and implementation of Shire District Fire Plans and interagency agreements.

Departmental staff will attend Bush Fire Advisory Committees and Brigade meetings where appropriate, to foster and encourage good working relationships with other fire fighting organisations.

Where practical, departmental staff will assist with fire control activities on a neighbour to neighbour basis with local Bush Fire Brigades and other fire control organisations.

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4.4 Public Awareness

Education of the public on the prevention of wildfire and on the use and role of planned fires will be promoted through the provision of literature, films and talks. Special attention will be directed towards school groups.

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Appoint professional journalists to liaise with the media to explain CALM's fire management program.

Undertake a program with the Education Department to introduce fire management and fire ecology into school curricula.

4.5 Research

The Department will undertake research and will encourage research by other agencies and institutions into the fields of:

1. Fire behaviour in major vegetation types;
2. Fire ecology;
3. Fire equipment development;
4. The application of information technology to fire management;
5. Fire detection, prevention and suppression system;
6. Remote sensing for fire mapping and detection purposes;
7. Alternative methods of fuel reduction;
8. Social aspects of fire prevention and arson.

4.5 Research

The Department will undertake research and will encourage research by other agencies and institutions into the fields of:

1. Fire behaviour in major vegetation types;
2. Fire ecology; both short- and long-term.
3. Fire equipment development;
4. The application of information technology to fire management;
5. Fire detection, prevention and suppression system;
6. Remote sensing for fire mapping and detection purposes;
7. Alternative methods of fuel reduction;
8. Social aspects of fire prevention and arson.

4.6 Operations-Research Interface

The Department will ensure that there is a rapid transmission of research results into policy and operations. Research and specialist staff will help to develop and update operational prescriptions and monitoring systems.

The Department will sponsor relationships between its staff and other agencies or organisations concerned about fire by the publication of research findings, holding workshops and seminars, and public participation in management plans.

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