A SUBMISSION TO —

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Sub Committee on Environmental Impact on Bushfires

THE FORESTS DEPARTMENT OF WESTERN AUSTRALIA

MARCH 1984

HOUSE OF REPRESENTATIVE STANDING COMMITTEE

ON ENVIRONMENT AND CONSERVATION

SUBCOMMITTEE ON ENVIRONMENTAL IMPACT ON BUSH FIRES

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1. FIRE MANAGEMENT PHILOSOPHY

1.1 Introduction

The Forests Department of Western Australia is responsible for the prevention of uncontrolled fires threatening life, community assets and forest values in and adjacent to State Forests in the south-west of W.A. Although wildfire is a natural part of the Australian environment, modern society does not need to tolerate the destruction of such values as life, property, timber, water catchments and flora and fauna values, if there are means by which it can be avoided or minimised.

1.2 Values at Risk

Many community assets are threatened by wildfires. Some 90,000 people live on farms or in country towns in and adjoining State Forest in the south-west, while the metropolitan and outer suburban areas north and east of Perth abut the northern jarrah forest. Approximately 800,000 ha of farmlands directly adjoin State Forest. This, and a further 2,500,000 ha of private property in the south-west, would be threatened if uncontrolled fires started in State Forest.

Other values threatened by fire include the major metropolitan and rural water supply catchments, the timber resource, flora and fauna conservation areas, scientific study areas, plus many tourist sites and recreational areas.

National Parks, Wildlife Reserves and other public lands adjoining State Forest also require protection from fires. (See Appendix 5.).

1.3 Historical Background

A policy of fire exclusion was practised by the Forests Department from soon after its creation in 1918, up to 1953. During this time the continued buildup of forest litter and debris fuels made wildfire control progressively more difficult and almost impossible, even on days of moderate fire weather. The massive, destructive wildfires of 1949/50 (Donnybrook fire stretched 200 km) highlighted the failure of the fire exclusion policy.

In 1954 the policy was changed to one of fuel reduction by prescribed burning. This was given greater impetus following the recommendations of the Royal Commission set up to investigate the severe wildfires of 1961. The considerable successes achieved in this State and the many bitter experiences of other States have clearly demonstrated that the most effective means of fire control is through reducing fuel accumulations on the forest floor. This is achieved by the practice of broadscale rotational prescribed burning. Without this fuel reduction burning programme, it may not be possible to provide a positive measure of protection for both the forest and the community.

1.4 Alternative Fire Protection Options

Three major options are available to forest fire protection authorities, they are:

1.4.1 Allow fires to run their natural course:

This 'let burn' policy has never been seriously considered in W.A. Nowhere in the south-west are forests extensive enough to guarantee that fires would not burn out and destroy adjacent property values. In addition, the Bush Fires Act specifically requires an occupier of land to extinguish a bush fire occurring on that land during the prohibited burning time.

1.4.2 Carry out a little prescribed burning, but rely mainly on a large suppression force to rapidly and effectively contain fires:

This option has been adopted by the U.S. Forest Service, and to a lesser extent by forest services in Victoria, N.S.W. and South Australia. It has been rejected in W.A. because -

(i) it required a massive investment in manpower and equipment, the majority of which can only be used seasonally;

(ii) it has been shown that where heavy fuels exist, modern equipment and large suppression organisations are powerless to halt fires burning under severe summer conditions which recur each year.

1.4.3 Reduce forest fuels to a level whereby wildfires do not exceed an intensity beyond which they can be easily suppressed by a well-organised force:

This is the policy adopted by the W.A. Forests

Department by means of broadscale rotational prescribed burning. This is the most effective and economic method of limiting fuel build-up and thereby minimizing the threat of uncontrollable fires. In this operation, fires are systematically lit in the forest under carefully chosen conditions during the spring, early summer and autumn months.

Other methods, such as grazing and mechanical crushing of forest debris, are sometimes employed to provide low fuel buffer zones in areas such as pine plantations where the use of prescribed fire may not be appropriate.

Although an efficient and effective suppression organization is required to control fires within and adjacent to fuel reduced areas, the organization does not require the massive build-up needed to implement option 1.4.2.

Fuel reduction by rotational prescribed burning is not appropriate for all areas. Areas set aside for specific habitat management, research and young regrowth forests are examples of such areas. Longer intervals between prescribed burns, and alternative measures of ground fuel control, e.g. by grazing, creating buffers, improving access and preplanning rapid attack can be applied alone or in combinations appropriate to each situation. The protection of all areas is important to the Department, and as management requirements become more complex, protection from wildfire will demand an increasing commitment

by the Department.

Although control measures can be taken to reduce ground fuels in the forest, wildfires still occur, as no control measures can actually prevent lightning fires or irresponsible acts by humans. For fire suppression the Department has developed an effective fire detection and communications network, specially trained and equipped fast-attack forces, and a large fire suppression organization.

2. OPTIMUM FIRE REGIMES FOR STATE FOREST MANAGEMENT

Under Western Australian conditions, fuel reduction by prescribed burning has provided an economical, effective and safe means of broadscale hazard reduction to facilitate the control of wildfires under severe summer conditions.

The frequency of burning rotations for the purpose of hazard reduction is based on the knowledge that our suppression organization can be expected to control wildfires under summer conditions in fuels of 8 tonnes/ha in jarrah forest and 19 tonnes/ha in karri forest types. The rate of accumulation of litter and debris varies with forest and canopy type, but 5 to 8 years represents the average range of rotations of hazard reduction burns.

The advantage provided by fuel reduction burning arises in multiple wildfire situations, when suppression priorities can be set so that fires burning in light fuels and not threatening life or property are allowed to burn until the more dangerous

fires have been contained.

Initially, fire protection was associated primarily with timber values and the adjoining life and property assets. However since the adoption by the Department of its multiple land-use policy in the mid-1970s, use of fire has been modified to meet multiple land management objectives including catchment protection, fauna and flora conservation and recreation. For example, detailed fire treatment and protection plans exist for the Managed Nature Conservation MPAs at Perup and Dryandra. In these areas fires of varying frequency, intensity and season of burning have been prescribed to promote appropriate wildlife habitats. Similar fire management plans are currently being compiled for the full range of the Department's Management Priority Areas.

The variety of purposes for which prescribed fire is to be used will undoubtedly increase with time, as research information on the complex interrelations between fire and the various components of the forest ecosystems becomes available. Where fire effects data for any of the major forest ecotypes are not known in detail, fire management plans incorporating a range of burning regimes are implemented in an attempt to cover the varying requirements of the forest system, whilst otherwise maintaining an adequate level of fire protection. As research results become available and technological advances are made, burning strategies will be modified to meet land management objectives more precisely, whilst also ensuring the overall safety and welfare of the community.

3. EFFECT OF PRESCRIBED BURNING

3.1 General

Like eucalypt forests throughout Australia, the forest ecosystems of the south-west of Australia have evolved in a severe fire climate and the vegetation has characteristics indicative of its long-term association with fire. These include woody fruits which open as a result of fire, hard seeds which accumulate in the soil and require fire to stimulate their germination, and subterranean rootstocks or lignotubers containing dormant buds that produce vigorous shoots when above-ground portions are killed by fire.

Within any large prescribed burn there is a wide range of fire behaviour. This results from variations in the forest, the fuel and the topography within the burn area. A typical burn has a mosaic of burnt and unburnt sections. The burnt area will often express the effect of mild, moderate and high fire intensities. These patterns change with successive burns over the same areas. The unburnt areas vary greatly in extent and offer important refuge for mammals, reptiles, birds and insects, from the immediate effects of fire.

3.2 Forest Trees

Under prescribed fire conditions, leaf scorch may occur to 30 metres in mature forests. No loss of growth increment or timber degrade results, although old fire scars may be enlarged and ultimately lead to the destruction of the tree in isolated cases. Tree crowns frequently show enhanced

vigour and appearance after moderate intensity burns.

3.3 Vegetation

Studies on the effects of prescribed burning on south-west Australian forests indicate that vegetation response to fire depends on forest ecotypes. In wet sclerophyll forest (e.g. karri, tingle) regeneration after fire is primarily from soil-stored legume seed, with some regeneration from lignotubers. In dry sclerophyll forests such as jarrah, regeneration is predominantly from lignotubers with some germination of soil-stored seed. Field trials in karri show that fires that burn away all the leaf litter to expose the bare soil, result in a high level of legume regeneration. However, in the drier jarrah forests, legume seeds are often buried by ants and an intense fire is needed to generate sufficient heat to stimulate germination.

Studies in W.A. forests have indicated that species and family representation is higher in regularly burnt areas than in unburnt areas.

3.4 Fauna

Studies in W.A. and in other states have found that prescribed burning reduces the number of small mammals in the first year or so. However, recolonisation from unburnt areas begins quickly as vegetation starts to recover. The number of large mammals tends to remain fairly constant in the long-term. Birds show surprisingly small changes following fire, with a tendency for populations to increase

to above pre-burn levels in the first or second year after burning.

3.5 Soil and Litter Micro-Fauna

Substantial deaths of litter fauna occur during fires of even low intensity. However some organisms move ahead of the flames to unburnt refuge areas and then rapidly colonise the burnt areas. Less mobile soil micro-fauna can also survive mild fire by burying in the soil beyond the destructive reach of fire. There is considerable evidence to show that micro-fauna and flora activity is stimulated by increased nutrient levels following fires, and usually areas return to pre-burn populations within 3 or 4 years.

3.6 Soil Values

Studies in Western Australian forests revealed no differences between unburnt jarrah soils and those regularly burnt at low intensities over 25 years. Hatch reported that any temporary losses in mineral nutrients after mild burns in jarrah were made up by the natural leaching of litter in the following years. Many other studies have shown that nutrient losses via smoke and surface run-off are made up by atmospheric nutrient inputs in rain, leaching of litter, and by symbiosis of legumes.

All W.A. forest soils are very infertile by world standards, and have a poor capacity to retain nutrients. In the absence of fire, nutrients become locked-up in woody tissues

and litter and are thus unavailable for plant growth. Fire is needed to mineralise these nutrients and thereby improve forest health and vigour.

3.7 Reference Articles

The summary of fire effects given above has been gleaned from an extensive array of papers and publications A list of these articles, which concentrate on W.A.F.D. research work, is given in Appendix 4.

4. PUBLIC EDUCATION ON FIRE MANAGEMENT

4.1 Printed Data

Periodically the Forests Department publishes "Forest Focus" a full-colour magazine which provides information on forestry and is aimed at the general public and school children. There is no charge for this publication, which includes both technical and general information. Several articles on fire-related themes have been published and a list is attached as Appendix 5. From time-to-time a Special Forest Focus is produced, and S.F.F. No. 1 (Appendix 1) on Fire Management in W.A. was produced in 1981. This has reached a wide audience in W.A., throughout Australia and overseas. Attached as Apps. 2 & 3is a list of recently published Research Papers dealing with fire-related topics.

4.2 Public Participation

Field staff lecture extensively to schools and service clubs on Fire and Fire Management. The Department offers expert advice on fire as requested by organisations including mining companies and Local Government.

4.3 Media Involvement

Media contact is limited usually to advice on aerial prescribed burning operations and information on severe wildfires. However the recently conducted research projects Narrik and Aquarius saw several feature articles published in the West Australian, Daily News and Countryman. The Department makes every effort to bring to the media's notice, new developments and any newsworthy items concerning fires and fire management.

5. CO-ORDINATION OF THE VARIOUS RESPONSIBLE AUTHORITIES

5.1. INTERACTION WITH OTHER STATE GOVERNMENT DEPARTMENTS

Bush Fires Board

- Board Membership
- Training, Lecturing etc.
- Interagency Agreements on Fire Prevention and Suppression
- Provision of Services
  Detection & Intelligence, Aircraft
- Liaison

W.A.W.A.

- Training - Fire Gangs
- Interagency Agreements
- Technical Advice
- Provision of Services. Assist with co-ordinated Fire Suppression activities and Detection

National Parks

- Board Membership
- Interagency Agreements
- Training Personnel
- Provision of Services
  Radio Links, Equipment, Servicing

P.W.D.

- Provision of Services
  Fire Control on designated lands
- Technical Advice
  Fire Breaks etc.

S.E.S.

- Joint Planning
- Technical Advice
- Provision of Services
- Co-ordination

S.E.C.

- Provision of Services
- Technical Advice
- Assistance with Fire Control under power lines through State Forest

Police

- Technical Advice
- Co-ordination

Westrail

- Technical Advice

Youth, Sport and Recreation

- Interagency Agreements (Burning)

Metropolitan Water Supply

- Technical Advice
- Fire Control on designated catchments and water reserves

5.2 Interaction with Commonwealth Government Departments

Army

- Interagency Agreements
- Provision of Services

R.A.A.F.

- Interagency Agreements
- Provision of Services

Bureau of Meteorology

- Liaison

Department of Aviation

- Liaison - Aviation Matters

5.3 Interaction with Other Bodies

Shire Councils and Bush Fire Brigades

- Technical Advice
- Provision of Services
  Detection etc.
- Liaison
- Assist with development of and participate in Fire Management Plans

Industry

- Technical Advice
- Liaison
- Interagency Agreements
  (mostly mining companies)

Farming Community and Outlying Settlements

- Provision of Services
  Detection
- Liaison
- Co-ordination
- Technical Advice

Private Forestry

- Provision of Services
  Detection etc.
- Technical Advice
- Liaison

5.4 Joint Fire Protection Planning

Where fires occur on private property adjoining State Forest, a close liaison exists between the Forests Department and the Bush Fires Board and Local Government which provides for rapid and effective attack on such fires. Similar liaison arrangements exist with other land managing organisations adjoining State Forest, including National Parks Authority and Department of Fisheries and Wildlife. Such arrangements cover prevention measures and suppression tasks and are formalised in District Fire Protection Plans. These plans are developed in consultation with the Bush Fire Advisory Committees at Shire and Regional Levels and coordinated by the Bush Fires Board. Such preparatory planning is to be encouraged as a vital pre-requisite to effective fire protection and suppression.

In addition, the Bush Fires Board liaises with Local Government and the Town Planning Board and developers, to ensure that fire safety provisions are incorporated in the design and planning of special rural subdivisions such as hobby farms.

Adequate planning for fire protection before subdivision is particularly important for developments adjoining such areas as National Parks and State Forest. Whereas protection measures under the Bush Fires Act are adequate and liaison can be simply arranged with a single resident owner, application of these measures to and liaison with several (often absentee) owners of special subdivisions, is difficult. The task of bush fire control officers is complicated by the need for many contacts and even if developers are prepared to provide adequate areas for firebreaks inside the subdivision, coordinated fuel reduction is difficult, with the result that the costs of providing basic fire protection buffers inside the adjoining Crown Land falls upon the public managing agency.

Planning and maintenance of adequate standards of fire protection for residential developments in outer metropolitan areas is also a matter of concern. Whilst much can be done by public education, it is imperative that the provisions of the Bush Fires Act in respect to firebreaks and fuel reduction, continue to be fully implemented in these areas, to protect the owners and their assets from the common misapprehension that serious damage by wildfire "cannot happen to me".

In both the cases of special rural and residential subdivisions in outer metropolitan areas, it is strongly recommended that the attention of Local Authorities be drawn to the need for giving full consideration to fire protection requirements, prior to planning approval.

5.5 Co-ordination in Fire Emergencies

For State emergencies the Bush Fires Board provides fire control coordination, communication and liaison between all the various firefighting resources.

Where a fire is likely to threaten State Forest, the Forests Department takes control of firefighting operations as provided for in the Bush Fires Act. A large fire covering both State Forest and other lands is sectorized such that fire organisations are allocated those sectors in which they may have a vested interest. The co-ordination of private sectors is the role of the Bush Fires Board liaison personnel with the Forests Department in overall control.

Control of fires away but not remote from State Forest is normally exercised by the local Shire through their Bush Fire Brigades. The Bush Fires Board provides liaison where necessary. The Forests Department assists in such suppression activities if there are no overriding commitments on State Forest.

Control of fires in urban situations in gazetted Fire Districts is the responsibility of the W.A. Fire Brigades Board. While this organisation is concerned with protection of life and property and is not generally equipped for rural fire control, there are firm arrangements for mutual suppression operations, for example, at Wanneroo.

In the control of large fires the State Emergency Service may be called upon to support the firefighting organisations

in operations including rescues, civilian evacuation and transport.

For State Fire Emergencies, the Joint Services Local Planning Committee is the avenue for access to the Armed Forces for manpower, trucks and other equipment.

The Armed Forces are an important resource of well-equipped, disciplined manpower and heavy plant. However, their value in large fire emergencies could be vastly improved if they were to receive prior firefighting training, and if prearranged plans could be developed to ensure their immediate availability in a large-scale emergency.

The question of basic training has been raised at a number of conferences following last year's fires in the Eastern States and has been endorsed by the Australian Forestry Council for consideration by Federal Government. The matter is so important as to warrant its commendation to the Committee of Enquiry for similar action.

Bush firefighting is a highly skilled and specialised operation. It requires accurate weather forecasting, prompt and accurate detection, manpower well-trained in handling the fuel types encountered and good coordination and communications, even for a single wildfire. The Forests Department's services in these respects, are available to Local Authorities in the south-west, as far as possible.

Under multiple fire situations, such as during Cyclone Alby when the Bush Fires Board and the Forests Department jointly assumed control of some 87 fires throughout the south-west, it is most important that strategic and tactical control is handled by the organisations and people who possess the specialised expertise.

In rural fire emergencies the State Emergency Service has a vital role in providing logistical support and the Police Department has an equally important role in looking after the safety of people, and as far as possible, property.

Workable arrangements for the necessary concerted but complimentary liaison in the south-west, have been developed and tested by experience and are written into the existing fire protection plans. Extension of this concept and annual joint updating of these plans in consultation with all the agencies involved and the Local Authority, is to be encouraged as the basic way of ensuring reasonable standards of fire protection for rural communities.

APPENDIX 2 .

FOREST FOCUS ARTICLES ON FIRE

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Fire in S.W. forest ecosystem.

No. 23	April 1960	Tree Lookouts
No. 24	September 1980	Aircraft of the Forest
No. 25	March 1982	Bush Pasture in the S.W.
No. 25	" "	Using Prescribed Fire to Manage Forest Fauna
No. 26	June 1982	Playing Possum

APPENDIX 3.

LIST OF RECENT FIRE RESEARCH PUBLICATIONS

Research Paper No.	1	Understorey Fuels in Karri Forest
	7	Assessing Maritime Pine Fuel Quantity
	8	Fire Effects on Understorey Shrubs
	9	Measuring Forest Fuels
	11	The Effect of Prescribed Burning on the Fauna of the Jarrah Forest
	20	Recovery of Maritime Pine After Severe Crown Scorch
	31	Food Requirements and the Effect of Fire on Mardoo Population
	36	The Development of an Electrical Ignition System for Forest Regeneration Burning
	37	Increased Girth Increment Associated with Crown Scorch of Jarrah
	38	The Ecology of Boronia in W.A. Forest Areas
	41	Natural Fire Periodicity in the Karri Forest
	41	Fuel Removal, Fuel Conditions and Seed Bed Preparation in Karri Slash Disposal Burns
	60	Quantifying *Pinus radiata* Slash Fuels
	62	Crushing the Thinning Slash Problem
	67	Fire Hazard Reduction by Grazing

APPENDIX 4.

BIBLIOGRAPHY ON FIRE ECOLOGY, FIRE BEHAVIOUR AND WILDFIRE

Abbott, I. and Lonergan, O. (1983). Influence of fire on growth rate, mortality, and butt damage in Mediterranean forest of Western Australia. Forest Ecology and Management 6.p.139-153. W.A. Forests Dept. Report No. 32.

Bornemissza, G.F. (1969). 'The re-invasion of burnt woodland areas by insects and mites (Abstract).' Proc. Ecol. Soc. Aust. 4, 138.

Campbell, A.J. and Tanton, M. 'Effects of Fire on the Invertebrate Fauna of Soil and litter of a Eucalypt Forest' in 'Fire and the Australian Biota' p.215-242

Christensen, P. (1974). 'The concept of fauna priority areas.' In Proc. Third Fire Ecology Symp., Monash Univ. & Forests Comm. Vict., Melbourne, pp. 66-73

Christensen, P. (1977). The biology of Bettongia penicillata, Gray 1837, and Macropus eugenii, Desm. 1817, in relation to fire. Ph.D. thesis, Univ. of Western Australia.

Christensen, P.E. and Kimber, P.C. (1975). 'Effect of prescribed burning on the flora and fauna of south-west Australian forests.' Proc. Ecol. Soc. Aust. 9, 85-106

Christensen, P., Recher, H. and Hoare, J. (1981) 'Responses of Open Forest to Fire Regimes' in Fire and the Australian Biota p.367-394.

Craig, F.G. (1969). 'Fire effects on hydrological values.' First Fire Ecology Symposium, Monash Univ., Vic.

Gardner, C.A. (1957). 'The fire factor in relation to the vegetation of Western Australia.' W. Aust. Nat. 5, 166-73

Gill, A.M. (1975). 'Fire and the Australian flora: A review.' Aust. For. 38, 4 - 25.

Good, R.B. (1981). 'The Role of Fire in Conservation Reserves' in Fire and the Australian Biota p. 529-550.

Harris, A.H. and Wallace, W.R. (1959). 'Controlled Burning in Western Australian forest practice.' Paper to ANZAAS 34th Congress, Perth.

Hatch, A.B. (1959). 'The effect of frequent burning on the jarrah (Eucalyptus marginata) forest soils of Western Australia.' J. Boy. Soc. W. Aust. 42, 97-100.

Hatch, A.B. (1960). Ash bed effects in Western Australia forest soils. Forests Dept. W. Aust. Bull. No. 64.

Hallam, S.J. (1975). Fire and Hearth: A Study of Aboriginal Usage and European Ursurpation in south-western Australia. Australian Institute of Aboriginal Studies, Canberra.

Humphreys, F.R. and Craig, F.G. (1981). 'Effects of Fire on Soil Chemical, Structural and Hydrological Properties' in Fire and the Australian Biota p.177-202

Jacobs, M.R. (1955). Growth Habits of the Eucalypts. Comm. Aust. For. Timb. Bur., Canberra.

Jones, P.M. (1977). 'Regeneration burning.' Paper presented to 5th meeting of Aust. For. Council Res. Working Group No. 6, Melbourne.

Jones, R. (1969). 'Fire-stick farming.' Australian Natural History 16, 224-8.

King, A.R. (1963). The influence of colonization on the forests and the prevalence of bushfires in Australia. CSIRO Aust. Div. Phys. Chem., Mimeo Rep.

Kimber, P.C. (1978a). Increased girth increment associated with crown scorch in jarrah. W. Aust. For. Dept. Res. Pap. No. 37.

Kimber, P. (1978b). Some effects of prescribed burning on jarrah forest birds. Third Fire Ecology Symposium, For. Comm. Vict. and Monash Univ., pp. 49-57.

Leonard, B. (1978). The effects of burning on litter fauna in eucalypt forests. Proc. 3rd Fire Ecology Symposium, For. Comm. Vict. and Monash Univ. 1974, 43-6

Luke, R.H. and McArthur, A.G. (1978). Bushfires in Australia. Australian Government Publishing Service, Canberra.

Luke, R.J. (1961). Bushfire Control in Australia. Hodder and Stoughton, Melbourne.

McArthur, A.G. (1962). Control burning in eucalypt forests. Comm. Aust. For. Timber Bur. Leafl. No. 80.

McArthur, A.G. (1967). Fire behaviour in eucalypt forests. Comm. Aust. For. Timber Bur. Leaflet No. 107.

McArthur, A.G. (1968). 'The fire resistance of eucalypts.' Proc. Ecol. Soc. Aust. 3, 83-90

McArthur, A.G. and Cheney, N.P. (1965). 'The effect of management practice on streamflow and sedimentation from forested catchments.' J. Inst. Engs. Aust. 37, 417-25.

Main, A.R. (1980). 'Fire tolerance of heathland animals.' In R.L. Specht, ed., Ecosystems of the World. Vol. 9B. Heathlands and Related Shrublands. pp. 85-90. Elsevier, Amsterdam.

/3

Mount, A.B. (1964). 'The interdependence of the eucalypts and forest fires in southern Australia.' Aust. For. 28, 166-72.

Mount, A.B. (1969). 'Eucalypt ecology as related to fire.' Proc. Tall Timbers Fire Ecology Conference 9, 75-108.

McCaw, E. (1981). Fire and Stem Damage with particular reference to jarrah (Eucalyptus marginata) Forests Department of W.A. p.100.

Packham, D.R. and Peet, G.B. (1967). Developments in controlled burning from aircraft. CSIRO (Aust.) Chem. Lab., Melbourne.

Peet, G.B. (1965). Controlled burning guide for the northern jarrah forest of Western Australia. W.A. For. Dept.,Bull. No. 74.

Peet, G.B. (1971). 'Litter accumulation in jarrah and karri forests.' Aust.For. 35, 258-62. (37,38).

Peet, G.B. (1971b). A study of scrub fuels in the jarrah forest of Western Australia. W. Aust. For. Dept. Bull. No. 80.

Peet, G.B. (1971). 'Litter accumulation in jarrah and karri forests.' Aust. For. 35, 258-62.

Peet, G.B. and van Didden, G.W. (1973). Fire effects on understore shrubs. For. Dept. W. Aust. Res. Pap. No. 8.

Peet, G.B. and Williamson, A.J. (1968). 'An assessment of forest damage from the Dwellingup fire in Western Australia.' Paper to 5th Inst. For. Conf., Perth.

Rodger, G.J. (1961). Report of the Royal Commission appointed to enquire into and report on the bush fires of December 1960 and January, February and March 1961, in Western Australia

Recher, H.F. and Christensen, P.E. (1980). 'Fire and the evolution of the Australian biota.' In A.Keast, ed., Biogeography and Ecology in Australia. Junk, The Hague.

Rothermel, R.C. (1972). A mathematical model for predicting fire spread in wildland fuels. USDA For. Serv. Res. Pap. INT-115.

Shea, S.R., Malajczuk, N. and Kitt, R.J. (1976). Promotion of understorey native legumes - a possible method of control of P.cinnamomi in the northern jarrah forest of W.A. Abstracts of papers, 2nd National Plant Pathology Conf., Aust. Plant Path. Soc., Brisbane.

Shea, S.R., McCormick, J. and Portlock, C.C. (1979). 'The effect of fires on regeneration of leguminous species in the northern jarrah (Eucalyptus marginata Sm.) forest of Western Australia.' Aust. J. Ecol. 4, 195-205.

Shea, S.R., Peet, G.P. and Cheney, N.P. (1981). 'The Role of Fire in Forest Management' in Fire and the Australian Biota p.447-470.

Sneeuwjagt, R.J. (1973). Measuring forest fuels. W. Aust. For. Dept. Res. Paper No. 9.

Sneeuwjagt, R.J. (1971). 'Understorey fuels in karri forest.' Research Paper No. 1 Forests Dept. of Western Australia.

Sneeuwjagt, R.J. and Peet, G.P. (1979). Forest Fire Behaviour Tables for Western Australia. Forests Dept. of Western Australia.

Springett, J.A. (1971). 'The effects of fire on litter decomposition and on soil fauna in a Pinus pinaster plantation. IV. Colloguium pedobiologiae.' Ann. Zool. 17, 257-63.

Springett, J.A. (1976). 'The effect of prescribed burning on the soil fauna and on litter decomposition in Western Australian forests.' Aust. J. Ecol. 1, 77-82.

Underwood, J.R. (1973). Natural fire periodicity in the karri (E. diversicolor F. Muell) forests For. Dept. W. Aust. Res. Pap. No. 41.

Underwood, R.J. and Christensen, P.E.F. (1981). Forest Fire Management in Western Australia. Special Forms No. 1. Forests Department of W. Aust.

Vines, R.G. (1968). 'Heat transfer through bark and the resistance of trees to fire.' Aust. J. Bot. 16, 499-514.

Vines, R.G. (1974). Weather patterns and bush-fire cycles in southern Australia. CSIRO (Aust.) Div. Chem. Technol. Tech. Pa. No. 2.

Wallace, W.R. (1965). 'Fire in the jarrah forest environment.' J. Roy. Soc. W. Aust. 49, 33-44.

Warcup, J.H. (1981). 'Effects of Fire on the Soil Micro-flora and Non-vascular Plants' in Fire and the Australian Biota p.203-214.

APPENDIX 5.

AREAS PROTECTED BY W.A. FORESTS DEPARTMENT

Land Tenure	South-West of State ha	Inland ha	Total ha
State Forest	1,868,390	781	1,869,171
Timber Reserves (Forests Act)	86,649	32,243	118,892
Freehold Land (C. of F.)	26,370	-	26,370
Total	1,981,409	33,024	2,014,433

Under the Forests Act the Department protects and manages an area of 2,014,433 hectares of State Forest, Timber Reserves and Freehold Land; 1,981,409 hectares in the south-west and 33,024 hectares in the remote areas of W.A., mainly in the Goldfields.

In addition, the Department is also directly involved in the protection of a further 360,000 hectares of other Crown Lands within the State, under Interagency Agreements with such organizations as the Bush Fires Board, Department of Army, and National Parks Authority. To this could be added some 500,000 ha covering private properties protected within 3 km of State Forest and Timber Reserves' boundaries, to provide a total area under protection of about 2,870,000 hectares.