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Report by the House of Representatives Standing Committee on Environment and Conservation

Bushfires and the Australian Environment

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Preface

The Committee believes that this is the first national inquiry into bushfires and recognises that bushfire prevention and suppression is a state responsibility and there are only limited areas where the Commonwealth can be directly involved.

It is apparent that there are a number of areas where the Commonwealth can co-operate with State and Local Governments to ensure that sound ecological management approaches are followed and loss of life and property damage are minimised. With this in mind the Committee has made a number of recommendations related to matters that are primarily the responsibility of the States. This should not be taken to suggest that the Committee considers that the Commonwealth should assume prime responsibility.

Members of the Committee

Chairman	Mr P. Milton, M.P.[1]
Deputy Chairman	Mr D.M. Connolly, M.P.[1]
Members	Mr M.A. Burr, M.P. Mr R.L. Chynoweth, M.P.[1] Mr R.F. Edwards, M.P. Mr G. Gear, M.P.[2] Mr A.A. Morris, M.P. The Hon. I.L. Robinson, M.P.
Secretary to the Committee	Mr. J.R. Cummins
Secretary to the Sub-Committee	i. Mr B. Nordin[3] ii. Mr I.A. Dundas[4]

1. Members of the Sub-Committee.
2. Appointed to the Committee on 7 March 1984 in place of Mr J.E. Reeves, M.P.
3. until 18 June 1984
4. after 18 June 1984

Terms of Reference of the Committee

(1) That a standing committee be appointed to inquire into and report on —

(a) environmental aspects of legislative and administrative measures which ought to be taken in order to ensure the wise and effective management of the Australian environment and of Australia's natural resources, and

(b) such other matters relating to the environment and conservation and the management of Australia's natural resources as are referred to it by —
   (i) resolution of the House, or
   (ii) the Minister responsible for those matters.

Terms of Reference of the Bushfires Inquiry

That the Committee inquire into and report on:

(a) environmental impacts of bushfires (including consequential impacts on species diversity and ecological balance);

(b) environmental impacts of preventative and control measures (including consequential impacts on species diversity and ecological balance);

(c) environmental impacts of bushfire risks associated with evolving and future lifestyles;

(d) potential for further development of insurance, taxation and other financial instruments to reduce environmental impact of bushfires;

(e) potential for further developing of zoning and other landuse management arrangements to reduce environmental impact of bushfires;

(f) adequacy of community information regarding fire management in natural and rural environments; and

(g) appropriate Commonwealth actions to ameliorate environmental impacts of bushfires, particularly in relation to national and international heritage.

Explanation of Terms

Aerial Ignition:	Lighting of fire for backburning or control burning by dropping incendiaries from aircraft.
Biota:	The living component of the environment — plants, animal and micro-organisms.
Bushfires:	In this report 'bushfires' describes fires that are not intentionally lit as part of a management program. They are sometimes referred to as wildfires.
Control burn:	In this report 'control burn' describes fires that are intentionally lit as part of a management program. It cannot be assumed that a control burn is always under control or burns according to plan. This term is synonomous with 'hazard reduction burn' and 'prescribed burn'.
Eutrophication:	A process which results in a depletion of the oxygen dissolved in the water in dams and streams. It is usually caused by an increase in the growth of plants and algae triggered by an inflow of nutrients.
Fire Regime:	The frequency, intensity and seasonality of the prevailing pattern of fire recurrence.
Sclerophyll:	A general term used in this report to describe forest (mainly eucalypt forest) other than rainforest. Wet sclerophyll forest occurs on higher rainfall sites, usually at higher altitudes and contains a denser understorey. Dry sclerophyll forest occurs on lower rainfall sites and is more open in appearance.

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Summary of Main Findings

After considering the evidence the Committee concludes that:

- fire has long been a part of the Australian environment and has played an important role in shaping the flora and fauna;
- European settlement resulted in significant changes to fire regimes and changes to plant and animal communities;
- the flora and fauna is generally well adapted to natural fire regimes and populations usually recover to prefire levels in a comparatively short period, but the impacts of bushfire on soils may be more significant;
- bushfire prevention and suppression activities can have environmental impacts, frequent low intensity hazard reduction burning to reduce fuel accumulation is the activity causing most concern;
- in many situations hazard reduction is the only effective and efficient technique that is available and must be used but, whenever it is used there is a need to consider the environmental impacts;
- alternative protection and suppression techniques need to be considered and in some cases it may be appropriate that no action be taken to prevent or contain bushfires;
- authorities need to take more care in fire prevention activities and should do more post fire rehabilitation, particularly in the area of soil conservation;
- extensive damage to property and loss of life will continue to occur unless property owners and authorities recognise the inevitability of bushfires and take proper action to protect their own property and to prevent unsound land use;
- the Australian community has largely ignored, or is ignorant of, the advice given by the authorities about bushfire survival and property protection and does not appear to have learnt the lessons of Ash Wednesday;
- the volunteer rural brigades make a very significant, and in many instances an essential, contribution to the welfare of the Australian community;
- the type and amount of training given to bushfire protection professionals and volunteers is inadequate in several respects;
- there is great scope to improve our knowledge of bushfires and the part played in the Australian environment;
- continuing research will result in a decrease in the loss of life and the amount of property damage;
- the Commonwealth is a significant land holder with a direct interest in bushfire mitigation;
- the Commonwealth has a role to play in providing resources and assisting the States.

Recommendations

The Committee recommends that:

1. the Minister for Territories and Local Government request the Local Government Minister's Conference to review the adequacy of existing land use and land use planning as it relates to bushfire mitigation;

   (paragraph 110)

2. the Minister for Housing and Construction request the Housing Ministers' Conference to consider adopting and publicising a housing bushfire protection standard;

   (paragraph 120)

3. the State Ministers responsible for Local Government and for Fire Services in consultation with the Australian Insurance Industry Council, review the funding of rural fire brigades with a view to finding more equitable arrangements than insurance premium levies;

   (paragraph 127)

4. the Department of Home Affairs and Environment co-operate with State Departments to develop a national awareness campaign dealing with bushfire survival, building protection, fire prevention and the role of fire in the Australian environment;

   (paragraph 138)

5. the Commonwealth Department of Education and Youth Affairs assist State Departments and authorities to develop video programs and education kits concerning bushfire topics which would be suitable at senior secondary levels;

   (paragraph 139)

6. the Minister for Education and Youth Affairs request the Commonwealth Tertiary Education Commission to review the teaching of bushfire science in tertiary forestry and land management courses;

   (paragraph 144)

7. the Minister for Primary Industry request the Australian Forestry Council to consider establishing a special fund to assist the universities to teach and carry out research in bushfire science;

   (paragraph 145)

8. an authoritative Australian fire ecology textbook be commissioned by the Commonwealth Government through the CSIRO for tertiary education purposes;

   (paragraph 146)

9. the Minister for Defence review the role of the Natural Disasters Organisation in respect of the operation of the Australian Counter Disaster College with a view to providing a national centre for bushfire training;

   (paragraph 150)

10. the Commonwealth Scientific and Industrial Research Organisation provide the resources necessary to enable the completion of the experimental and data analysis phase of Project Aquarius;

    (paragraph 161)

11. the Department of Science and Technology conduct a symposium to discuss the development and co-ordination of computer modelling and remote sensing related to bushfires;

    (paragraph 164)

12. the Australian Bureau of Statistics examine the need for, and the problems involved in, a national bushfire statistics series;

(paragraph 166)

13. the Minister for Home Affairs and Environment and the Minister for Primary Industry request the Australian Environment Council, the Council of Nature Conservation Ministers and the Australian Forestry Council to discuss the co-ordination of bushfire research with a view to establishing a co-ordinating unit within an appropriate authority, such as the CSIRO;

(paragraph 170)

14. the Commonwealth and State Ministers responsible for bushfire matters, jointly discuss the establishment and financing of a national bushfire research fund;

(paragraph 171)

15. the Commonwealth Scientific and Industrial Research Organisation maintain a significant bushfire research program after the completion of Project Aquarius;

(paragraph 173)

16. the Commonwealth review its research priorities to determine the feasibility of increasing the funding for CSIRO research into the ecological impact of fire regimes;

(paragraph 175)

17. the Department of Defence review its bushfire procedures to ensure they provide for full consultation with local authorities about fire prevention and pre-fire planning;

(paragraph 181)

18. the Commonwealth Departments of Administrative Services and Defence review the cost imposition to rural fire authorities caused by Defence land holdings and consider the need to provide additional financial assistance;

(paragraph 182)

19. the Minister for Home Affairs and Environment review the bushfire protection and management practices of properties of international and national importance;

(paragraph 189)

20. the Minister for Defence review the role of the Armed Services in bushfire fighting operations and establish mechanisms to facilitate closer co-operation with civilian bushfire authorities;

(paragraph 195)

21. (i) the Bureau of Meteorology continue to provide free fire weather services during the bushfire season,
    (ii) special purpose funds be provided to enable the Bureau to employ specialist fire weather meteorologists in each State,
    (iii) special purpose funds be provided to establish a network of remote weather stations;

(paragraph 201)

22. the Natural Disasters Organisation investigate the need for, and the means of establishing, a national bush fire fighting support service to acquire and deploy equipment that the State authorities cannot singly acquire;

(paragraph 202)

23. the Commonwealth Minister for Primary Industry request the Standing Committee on Soil Conservation of the Australian Agricultural Council to consider formulating a proposal for Commonwealth assistance with post fire soil protection works.

(paragraph 206)

CHAPTER 1

The Role of Fire in the Australian Environment

Adaptation of the Australian biota

1. Fire is an integral part of the natural Australian environment and, along with the climate, has played a significant part in the evolution of Australian flora and fauna. Not only are many species fire adapted but some are considered to be fire dependent. Some of the fire dependent plant species have characteristics which promote the development and spread of high intensity fire. There is also some evidence to suggest that part of the Australian fauna is fire adapted or dependent. However, it could be that the fauna species are adapted primarily to the vegetation.

2. Fossil records are meagre and it is not known when fire adapted plants first appeared. Evidence of ancient fires can be seen in the deposits of carbon in coal seams laid down from 250 million years b.p. (before present) to 10 million years b.p. For most of the tertiary period (beginning 60 million years ago), southern and central Australian were covered by rainforests. In this environment fires were probably as rare as in today's rainforests.

3. About twenty million years ago the climate became drier and patches of grassland appeared in central Australia. At the same time the incidence of fire apparently increased. It appears that the development of the fire tolerant component of the vegetatyion coincided with an increasing aridity and a higher incidence of fire. Four million years ago, fire adapted dry sclerophyll vegetation, (open forests and woodlands, with shrubs and grasses in the understorey) became more common.

4. By the time the Aboriginals arrived 40 000 years ago most of the continent was subject to a fairly high natural fire frequency, with lightning starting fires when forests were sufficiently dry. On the broad scale and over a period of thousands of years, it appears that Aboriginal burning had little effect on vegetation compared to the changes brought by the climate. It is probable that Aboriginal burning had a major impact only in the wettest areas, such as north-east Queensland and south-west Tasmania, where natural fires would have been rare and small.

5. While climate was the major influence on the environment, Aboriginal burning probably did affect the distribution of species and the vegetation pattern locally. Relatively clear patches of eucalypt forests, woodland and grasslands were maintained by frequent Aboriginal burning.

6. The arrival of Europeans in Australia has had significant effects on the native vegetation. The fire regimes of many, if not all, of the forest ecosystems have been altered dramatically and the European settlers have used fire differently to the Aboriginals.

7. The changes caused by Europeans favoured some species over others and altered the pattern of species distribution that had previously been maintained by Aboriginal burning regimes. The European settlers used fire with ignorance and fear and without sufficient understanding of the long term impacts. They also introduced exotic plants and grazing animals that took advantage of the changed conditions.

8. The fact that the Australian biota is fire adapted/dependent has been used to argue that there is a need for resource managers to use fire to maintain and preserve certain species and habitats. It has also been used to argue that burning to reduce fire hazards is an

environmentally sound practice which mimics natural conditions. The relationship between vegetation and fire is complex and such simple generalisations are not valid.

9. Species have become adapted to fire regimes, not to single fire events. A fire may be either beneficial or detrimental to a particular species depending on a number of variables such as the intensity and duration of the fire, the pre-fire condition of the biota, the period since the last fire, pre and post fire weather and the impact of the fire on other environmental factors. The effect of a single fire is not as environmentally significant as changes to the fire regime.

10. The manner in which some plants respond to fire does not always represent a specific fire adaptation. It may be a general response to stress and could be triggered by drought, frost, disease, or browsing. For these species fire is not essential. There are some species and communities which are fire sensitive and some species which are sensitive during part of their life cycle. For these, fire is inimical and often leads to the death of individuals and the elimination of local populations.

11. While the Committee accepts that the evolution of the Australian biota has been strongly influenced by fire and is now largely fire adapted it does not necessarily follow that fire must be used as a land management tool or that the impacts of deliberate burning are ecologically benign. The Committee believes that the management of bushfires and the deliberate use of fire are activites which should be carried out with an understanding of the role of fire and a clear recognition of the environmental consequences of changing the fire regime. There is an obligation on fire prevention and suppression authorities to make themselves familiar with the characteristics of the local environment and to take environmental impacts into account when planning and carrying out operations.

Ecological role of fire

12. In the short term the environmental impact of fires can appear to be severe. There is an obvious loss of vegetation and the understorey and ground cover species may be completely removed. The foliage of overstorey species may be scorched or removed and trees may be killed or severely scarred. Some animals may be killed by the fire or subsequently die due to the lack of food or be killed by predators. The soil may be bared and subject to erosion and streams may become silted. These effects are usually not as severe as they first appear.

13. Provided the vegetation is of a fire adapted type these effects are usually transitory and of no long term ecological significance. A number of witnesses reported that given a relatively stable climate, bushfires alone are unlikely to cause any long term change or species loss however drastic the short term change.

Soils

14. Soils are an important resource which are fundamental to the growth of plant life. They can be affected by fire due to the direct physical and chemical changes caused by heating and other changes which can follow removal of litter and vegetation.

15. The impact of a single damaging fire is more significant for the soil than for the flora and fauna because it takes very much longer to replace and repair lost or damaged soil. There is a great variety of soils and associated vegetation types and it is difficult to generalize but the Committee believes that there needs to be a greater awareness of the relationships between soils and fires.

16. The evidence submitted to the Committee suggested that the direct effects of heating normally only occur on the surface and to a depth of only a few centimetres. This depends on soil moisture content and the intensity and duration of the fire. Heating may not always be significant but it can be associated with the destruction of the soil organic matter and a

decrease in the water retaining properties. Heating can also make the soil more susceptible to erosion by lowering water infiltration and retention.

17. Soil heating is particularly important in relation to the soil biota, which plays an important part in the breakdown of litter and the recycling of nutrients. Intense wildfires have a sterilising effect on the soil and greatly reduce the populations of soil microbiota, but the effects of lower intensity fires are not as severe. The time required for the re-establishment of soil fauna populations may vary from a few days to several years.[1]

18. Soil nutrient levels can be altered in a variety of ways by complex processes following fires. The New South Wales Forestry Commission reported that although intense fires can cause an immediate reduction in the level of nitrogen in soils, they generally make some nutrients more available to plants.[2] The Victorian Soil Conservation Authority report that when ash accumulates on the soil surface the availability of calcium, phosphorus and potassium to plants increases.[3]

19. Intense fires may also reduce the absolute levels of nutrients in some forest soils by the removal of mobile elements in smoke and ash that is not returned to the forest floor. Losses may be small compared to the total share of nutrients in the system but these losses often come from the most readily usable part of the nutrient pool.

20. Exposure to wind and rain following removal of the litter and ground cover vegetation makes the soil susceptible to erosion and further nutrient loss. Erosion losses are only likely to be severe if there is heavy rainfall soon after fire, and before the vegetation becomes re-established. If heavy rain does follow a fire then massive soil loss can result. It was reported that erosion of over 100 tonnes of soil per hectare occurred in parts of Victoria following the Ash Wednesday fires in 1983. In some areas, where storms were more intense this figure may have been 1000 tonnes per hectare.[4]

Water resources

21. Bushfires have indirect and infrequent impacts on water resources. The magnitude and duration of these effects depend upon fire intensity, the rate of vegetation regeneration, the proportion of the catchment burnt, soil characteristics, topography and particularly the rainfall pattern after the fire. Severe impacts will only occur if fires are followed by heavy rain. Usually, bushfires have only a minor impact on water resources but in some circumstances severe fires can cause a serious degradation of water quality.

22. If the vegetation in a catchment is removed by fire, rainfall then strikes the ground with full intensity, dislodging soil particles and quickly exceeding the capacity of the soil to absorb water. The water then runs across the surface of the exposed ground carrying soil particles. The effects on catchments and water quality can include a marked increase in water runoff (the most commonly observed response), more erratic runoff and streamflow, low rate of ground water replenishment, erosion of creeks and water courses, increased sediment loads and turbidity in streams, increased siltation in dams and increased levels of nutrients in streamflow. It was reported that the deleterious effects on water catchments can continue for up to four years after a fire.[5]

23. Aquatic habitats can be degraded by the reduction in the quality of water runoff. The most significant impact is the increase in turbidity. Fauna species which require clear water for survival and reproduction may be temporarily lost from an area if heavy erosion occurs. The increased nutrient content of the water can cause eutrophication of dams and reservoirs.

Flora

24. The most obvious effects of bushfires are the consumption of dry and dead vegetation, and the scorching and death of some plants. This will not be serious if the

plants are fire adapted. Changes in soil fertility could have an effect on the plant species in the burnt areas. This is most likely to be transitory and of little long term significance.

25. Most plant species survive bushfires by using one or both of two basic mechanisms — one involving resprouting of damaged plants, the other a range of responses which result in new plants being established from seed. Resprouting depends on the ability of buds in the stems and base of the plant to survive the fire. These buds are triggered to produce new green material to replace the burnt foliage. This mechanism is characteristic of some species of eucalyptus and results in the well known 'feather duster' appearance of fire damaged forests.

26. The establishment of new plants is the result of a number of responses. Fire can cause flowering to occur and can trigger the release or germination of seed that was present before the fire but which survived on the plants or in the soil. The flowering response is characteristic of grass trees *(Xanthorrhoea spp)* while the seeding response can be seen in Banksias which store seed in woody fruits that do not open unless affected by fire. Many species of Acacia shed seed during periods when there is no fire but the seed is stored in the soil and does not germinate until the seed coat is cracked by the heat from a bushfire.

27. The effects of fires on flora varies depending on the species involved and the frequency, seasonality and intensity of the fires. The importance of vegetation types is illustrated by reference to the two main forest types in Victoria. Wet sclerophyll forests are subject to infrequent but intense wildfires which tend to kill much of the vegetation including large trees. The fire stimulates the regeneration of the Eucalypt species by stimulating seedfall. It also causes the germination of seed from understorey species. Dry sclerophyll forests are also subject to intense fires but these occur more frequently due to the drier conditions and more rapid accumulation of fuel. The species in these forests are more fire tolerant and recover more rapidly and tree death is less common.

28. Fires of the 'right' intensity and timing can trigger a successful survival response. However, harmful effects can follow fires of the 'wrong' time and fires that recur at the 'wrong' frequency. The possible deleterious impacts include the eventual local extinction of species when the interval between fires does not allow survivors to mature and produce seed or when there is a failure to stimulate flowering and seed.

29. The role of the timing and frequency of fire is indicated by research done on the vegetation of the sandstone country near Sydney. It was reported that a period of up to ten years is required between fires to allow some species to germinate and set viable seed.[6] In the absence of large amounts of seed stored in the soil more frequent fires cause a change in the composition of the flora.

30. Conversely, if fires are too infrequent the number of species will also decline and it appears that a fire frequency of one fire about every ten to fifteen years appears optimal for maintaining species diversity.[7] Change will also happen if the fires occur at the wrong time of the year and kill seed before it matures.

31. It appears that for some areas, such as the coastal regions of central New South Wales the ecologically optimum fire regime is for infrequent and hot fires but in other areas this type of regime may be damaging. The Committee notes that it is impossible to generalise about what is an environmentally acceptable fire situation. The importance of intensity, frequency and seasonality must not be overlooked particularly when land managers and fire controllers apply an artificial fire regime.

Fauna

32. Over 70% of Australian vertebrates (birds and animals) live in fire prone eucalypt forests. Intense fire can kill many animals, including highly mobile species such as birds.

For some time after the fire further losses can occur due to starvation and predation following the loss of habitat. Most animal groups suffer some degree of population reduction following fire. However wild fire has not been found to eliminate any species of bird or animal. Small numbers survive until the habitate regenerates to provide the food and shelter necessary for the increase in animal populations.

33. Studies have shown that fauna species return to regenerated forests within five years.[8] They are able to do this because some parts of the bush usually remain unburnt. The time needed for species to become re-established depends on a number of factors and varies according to the species involved. Little detail is known of the interactions between fire and fauna. As animals are dependent on the vegetation for food and cover, the recovery of populations after a fire depends on the pattern of recovery of the plant community.

34. The habitat requirement of some species is so specific that they can be considered to be fire dependent. The Leadbeater's possum, which at one time was thought to be extinct, relies on the hollows in fire killed trees for shelter and the shoots of regenerating saplings for food. These are found in the possums' preferred habitat only after intense fire. Other evidence suggests that in some cases the exclusion of fire has reduced the numbers of some species, such as the western hare wallaby and that the deliberate imposition of a fire regime may be necessary to ensure their survival.

Endnotes

1. Soil Conservation Authority of Victoria, Appendix to State Government submission.
2. Transcript, p. 826.
3. Soil Conservation Authority of Victoria.
4. Transcript, p. 1232.
5. Soil Conservation Authority of Victoria.
6. Transcript, p. 271.
7. Dr H. Wright, submission.
8. Transcript, p. 274.

CHAPTER 2

Changing Natural Fire Regimes

35. European settlement of Australia caused significant changes in the intensity, frequency and seasonality of fires. This resulted from the suppression of fire for the protection of life and assets and the deliberate use of fire for agricultural, pastoral and forestry purposes. Lighting of fires by accident or carelessness also resulted in changes to fire regimes.

36. Attempts at total bushfire prevention has not been successful and has resulted in long periods without fire during which unusually heavy fuel loads accumulated. When fires eventually occurred they were intense and difficult to control. Exclusion of fire, for unusually long periods has the potential to alter the composition and structure of the native flora. Those species which rely upon fire for successful regeneration will disappear or decrease.

37. The major cause of fires since European settlement has been escapes from agricultural and pastoral burning off. Arson, power line failure, careless use of campfires and forestry operations have also contributed to the problem. It has been estimated that three and a half times as many bushfires occur now compared to pre-European times in Australia.[1] Although most man made fires are either accidental or the result of carelessness, an increasing proportion are deliberately lit by arsonists.

38. The deliberate use of fire by land managers in natural areas falls into two categories — the controlled use of fire to reduce the amount of fuel and the use of fire to achieve ecological objectives. The actual techniques used may be the same for both categories but the aims are usually quite different.

Control burning

39. In recent years the most controversial use of fire has been the practice of deliberate burning. Fire has been widely used as a land management tool for many years and in more recent times has been increasingly used to reduce fuels for fire protection purposes. All of the State Forestry Authorities and some National Parks Services have control burning policies.

40. The Western Australia Forest Department was one of the first authorities to use broadscale control burning as a fire protection measure. Prior to 1953 they applied a fire exclusion policy in the prime jarrah (*Eucalyptus marginata*) forests. This scheme was initially successful in reducing the number and size of destructive fires. However there was a heavy build up of fuels and bushfire control became more difficult because the fires that did occur were more intense. The policy involved the establishment and periodic burning of fire breaks but the Forest Department found this to be expensive and time consuming. It was also the cause of numerous wildfires. They also found that, in the absence of fire, jarrah forest fuels accumulated for thirty to forty years. The failure of the exclusion policy was demonstrated by severe, widespread fires in 1949/50 and in 1954 the policy was changed to one of fuel reduction by prescribed burning.

41. The new policy provided for controlled burning in order to reduce the accumulation of fuels in those parts of the forests that had not been burnt for long periods. A Royal Commission into serious fires in 1961 supported this policy. It was only in control burnt

areas that the 1961 fires could be contained and considerable damage occurred over a large area where the fuels had not been reduced.

42. The aim of fire protection control burning is to reduce the amount of fuel available to the next fire. A number of factors influence fire behaviour but there are three elements which are essential for a fire to occur — heat, oxygen and fuel. Of these, fuel has the most important effect on fire intensity and behaviour. It is also the only factor that can be manipulated to reduce bushfires. Fuel is provided by the vegetation and consists primarily of dry grasses and leaves, twigs, barks and branches shed by trees and shrubs.

43. The thermal energy content in most vegetable matter is approximately 18 000 kilojoules per kilogram. For all practical purposes this remains constant, and it is the amount of fuel burnt which governs fire intensity. Fire control authorities therefore use low intensity fires in the cooler months to reduce the amount of fuel that would be available to fires occurring during the latter part of the year. Although fuel reduction can be carried out by mechanical means, manual removal of fuel or grazing, control burning is favoured as large areas can be fuel reduced relatively easily and cheaply.

44. Firefighters usually face two types of fire:

- surface fires which consume surface litter, other loose debris on the ground and low vegetation; and
- crown fires which run through canopies of trees as well as burning surface fuels.

Crown fires are the most difficult and dangerous fires to suppress, as they occur under severe to extreme weather conditions and can travel at some distance in front of the surface fire, throwing spot fires before them. Crown fires can only develop where there is a surface fire burning in at least 8 tonnes of available fine fuels per hectare.[2] Consequently, fire control authorities seek to control the development of crown fires by maintaining hazard reduction programs which will keep the fuel load below the level critical for crown fire formation.

45. Control burning consumes the surface litter, reducing the levels of available fine fuel and consequently the fire intensity. Under ideal conditions, 80% of the fine fuel can be burnt, but usually a reduction of 50–60% is achieved.[3] The aim is not to prevent fires occurring but to reduce fire intensity and rate of spread and to prevent crown fires. The effectiveness of a control burn depends on how much fuel is removed and the time that litter takes to re-accummulate and programs are usually based on a seven to eight year burning cycle.

46. The criticism of control burning ranged from the cautionary:

> '. . . frequent burning is potentially the most damaging factor for change . . . (when the Service applies fire it) . . . attempts to minimise the damage by limiting fire frequency . . .'[4]

through to the prohibitive:

> '. . . although expedient, control . . . burning should not be regarded as the ideal, or the only, means of creating and maintaining a firebreak, as there are valid objections on both ecological and aesthetic grounds . . . Broad area control burning should never be applied for protective reasons. . .'[5]

47. The alternate view is well summarised by:

> '. . . In a precise academically acceptable sense the overall long term effects of controlled burning are not known . . . In a pragmatic sense however the fact is that fuel is the only major factor governing fire intensity that can be manipulated by a practicable management measure and one moreover within which the effects are acceptable and very unlikely to be irreversible . . . Management of fuel loading over broad areas is consequently held to be the most indespensible of forest management tools . . . as a basis for the development of safe and cost/effective firefighting in severe weather'.[6]

Impact on soils and water resources

48. The impact of control burning on soils depends on the frequency and intensity of the fires. Control burns are usually of a lower intensity and have less effect than bushfires. Both the New South Wales and the Victorian Forestry Commissions indicated that some control burning induced minor changes to soil characteristics, including microbiota populations and nutrient status. These were shortlived and normal levels were re-established by natural processes. It also appeared that low intensity burning did not have any marked effects on erosion processes.

49. A single low intensity burn is not generally regarded as a major threat to soil values and the Victorian Soil Conservation Authority considers that the prudent use of control burning may result in reduced amounts of erosion compared to bushfires.[7] The impact of control burns depends on the timing and intensity of the burn, the soils and the vegetation.

50. Poorly planned and executed control burning which involves moderate to high intensity fires and frequent burning may repeatedly expose the soil and increase the risk of erosion and damage. Many Australian forest soils are relatively old, shallow and infertile and the rate of soil formation is slow. Therefore an increased incidence of fire presents a serious threat to soils if it causes an increase in the rate of soil loss.[8]

51. The Committee accepts the view that the impact of a single low intensity control burn may not be significant but believes that there is need for some caution. This is particularly so where relatively hot control burns are carried out and where they are likely to be long term impacts due to the accumulation of effects over a long series of frequent burns. The Committee agrees with the view expressed by the New South Wales Soil Conservation Committee that the erosion potential of control burns should be incorporated into burning prescriptions.[9]

52. Similar comments apply to the impact of control burning on water resources. The impact is normally not significant and water quality is not affected. However the changes which may result from frequent, repeated burning should be taken into account and the long term effect on water yields should be assessed.

Impact on flora

53. The impact of control burning on the flora is a matter of considerable concern and debate. Most concern relates to the changes in fire frequency, intensity and seasonal timing associated with control burning. The fire control authorities apply fire at times, frequencies and intensities which vary from those which occur in nature. The possible deliterious impacts are:

- the removal of fire-sensitive species by burning at a time interval which is less than that required to produce mature seeds;
- the destruction of flowers and immature seeds by burning at a time of year to which species are not adapted; or
- the failure of fires of a low intensity to stimulate adequate seedling germination.

54. An increase in fire frequency can cause the local extinction of species which regenerate from seeds carried by the mature plant. Such seeds lack dormancy and tend not to be stored in the soil. Fires stimulate the release of this seed which germinates as soon as conditions of soil moisture and temperature are favourable. The seedlings then grow to provide the next seed source. If a fire occurs before the seedlings reach maturity and produce new seed the species disappear from the area.

55. Hazard reduction burns are usually low intensity and may fail to stimulate the germination of soil stored seeds. This effect has been observed in Western Australia where previously abundant species have been replaced. In the jarrah forests in the south-west of Western Australia, control burn fires have not been hot enough to stimulate

the germination of soil stored legume seeds. The prescribed fire regime has favoured those species which regenerate from rootstocks and seeds stored on the plants.

56. Control burning generally has more effect on understorey than tree species, although any component of the vegetation can be affected. It has been found for example that the impact of frequent control burning in New South Wales reduces the amount and height of shrub vegetation and that this effect lasts longer than the fuel reduction achieved by the burns. The control burn will therefore have to be repeated before the vegetation fully recovers. This suggests that there is likely to be long term changes to the shrub cover in those areas included in control burn programs. Tree species can also be adversely affected and it appears that in some areas changes to fire regimes can result in an increased incidence of the disease associated with the soil fungus *Phytopthora cinnamomi.*

57. The impact of frequent control burning may be particularly severe in small isolated areas of remnant bushland, such as urban reserves. These areas do not have the diversity of species and range of habitats to allow them to withstand repeated control burning and it is less likely that there will be sufficient areas left unburnt to provide a base for recolonisation. The effects of burning in urban reserves around Sydney have been found to include a decrease in the native shrub layer and an increase in weed species. A well documented case involves the Lane Cove Vally *Banksia ericifolia* which has been eliminated by control burning.[10]

58. The effects of control burning were not always described as detrimental or serious. Some authorities argued that in most cases the effects were less than those of wild fires and that they were shortlived and minor in extent. In other cases it appears that even though control burning is done primarily for fuel reduction it may have some beneficial ecological effects. For example, studies in Western Australia showed that species representation is higher in regularly burnt areas and studies in New South Wales suggest that in some situations the growth of blackbutt *(E. pilularis)* is stimulated by low intensity controlled burns.[11]

Impact on fauna

59. The effect of control burn fire regimes on the fauna will only be significant when there is long term and permanent change to fauna habitats. Control burning aims to reduce the level of fuel in the forest but this fuel is also the essential habitat of some small mammals. Permanent changes to the fuel by repeated removal or by decreasing the contribution made by the vegetation to the accumulation of fuel will alter the animals' habitats.

60. Studies in Western Australia have found that prescribed burning reduces the number of small mammals in the first year.[12] However, recolonisation from unburnt areas begins as the vegetation starts to recover. Immediately after a fire there is a dramatic fall in population numbers, due largely to predation on the burnt ground where cover and protection is reduced. Population numbers then increase rapidly through breeding and recolonisation from unburnt areas. There are exceptions — one Western Australia species, the mardo *(Antechinus flavipes)* has been shown to be ill-adapted to frequent fires and is only found in long unburnt areas.

61. Similar results were found in Nadgee Nature Reserve, New South Wales where the populations of fauna reached high levels five to seven years after an apparently devastating fire (see Figure 1).[13] However a second fire in part of the Reserve allowed researchers to conclude that a fire frequency of about ten to fifteen years is optimum but more frequent fires may prevent populations building up. The impact of control burning on animal populations appears to depend on the species involved. Frequent burning may favour the larger, grazing species, such as wallabies and kangaroos but may be more detrimental to smaller more specialised animals.

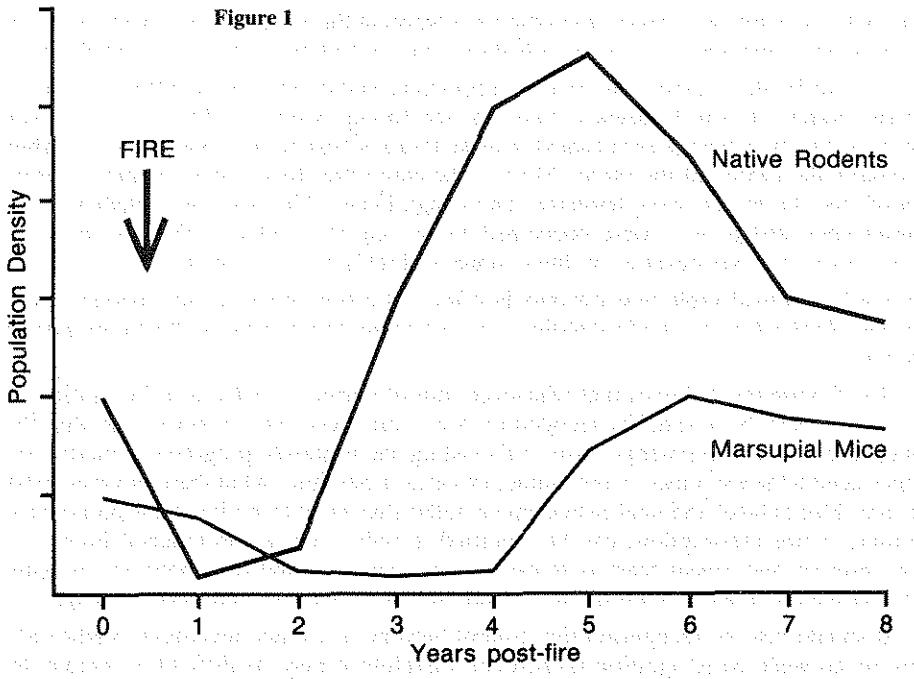


Figure 1 Changes in animal populations after a fire — Nadgee Nature Reserve

62. The season of burning appears to have significance to fauna populations. Some research indicates that cool season burning may disrupt the breeding of some species and that repeated burning may suppress population numbers. Other species which are slow to regain pre-fire population levels are also adversely affected, particularly where the fires are extensive and reduce the amount of unburnt bushland where some individuals would normally survive.

63. Regular low intensity burning can also have a significant impact on reptiles. Some of the larger species have low population densities and low reproduction rates and their numbers build up slowly after fire. One conclusion reported to the Commitee was that the ability of reptile populations to recover from a fire depends on the availability of unburnt vegetation to serve as a base for recolonisation.[14] Consequently a low intensity fire which burns all of an area is more deleterious than an intense fire which leaves some parts unburnt.

64. Less is known about the impact of control burning on insect and other invertebrate fauna that is dependant on the forest floor litter. Some information was available from the Western Australia Forest Department which reported that 80–90% of invertebrate populations in the upper soil and litter were killed by mild fires but this was followed by a rapid increase as the vegetation recovered.[15]

The ecological cost of control burning

65. It is inevitable that fires will continue to be a feature of the Australian environment and that from time to time, they will threaten and damage people's property and wellbeing. In some areas a form of fuel reduction will therefore be necessary. In many situations it appears that control burning is the only practical option open to fire control authorities. There are other fuel reduction techniques available. These include using machinery to break down fuels, manual removal and grazing. However the Committee

agrees with the view put forward by some fire control authorities that these techniques are expensive and impractical in most situations and unsuitable for general application.

66. It is difficult to assess the overall ecological significance of control burning. It involves changes to fire frequency, intensity and timing which are likely to have some impacts on the biota but the seriousness of these impacts depends on a number of variables particularly the timing of the burns. Most of the authorities that practice control burning reported that the effects were transitory and insignificant. This view was challenged by environmental groups who were concerned about long term effects. The divergence of opinion about the seriousness of these impacts highlights two matters:

- the need for considerable research into the effects of control burning (see chapter 5); and
- the need for caution and understanding in the planning and execution of control burning programs.

67. The Committee believes that whenever control burning is used as a fire mitigation tool there should be a specific recognition that some costs are involved and that this possibly includes environmental costs. All existing and proposed programs to modify fire regimes need to be examined to determine, as far as is possible, what these environmental costs are. Fire control and land management authorities need to review their programs to determine if fire prescriptions can be modified to reduce the environmental impact. In nature reserves and forests there is scope for land managers and fire controllers to apply hazard reduction control burning in a more selective way to minimise damage.

68. It should also be recognised that control burning is a crude technique, particularly where broad scale aerial ignition is used and therefore it may be difficult to predict the environmental consequences of a particular burn. With aerial burning large areas can be lit in a short period; however it was pointed out by the New South Wales Nature Conservation Society that the effect is not uniform over the area and some parts such as west-facing slopes and ridges will burn readily while other parts remain untouched by the fire.[16] In such cases the fuel reduction may not be effective so the burn will have to be repeated at frequent intervals.

69. The effectiveness of a control burn depends on how much fuel is removed and the length of time that litter takes to re-accumulate. A control burn is considered successful if forest litter is reduced to such an extent that fuel loads of eight tonnes per hectare will not be re-established for at least five to ten years. Hazard reduction programs are designed to prevent this re-accumulation and usually involve control burning at intervals of less than eight years.

70. It is the area of fuel accumulation rates that serious questioning of control burning has occured. Conservation organisations claim that fuel build-up rates occur at a greater rate than previously thought and that critical levels can be reached within three years of a burn rather than a five to ten year period.

71. Some preliminary studies into litter accumulation rates confirm that litter quickly recovers pre-burn levels (see Figure 2).[17] Consequently, in order to provide effective fire protection, rotation rates of control burning would have to increase. This may be neither environmentally acceptable nor cost effective. This problem can be reduced if programs including less frequent burning are applied. This would result in a mosaic of burnt, unburnt and regenerating areas. Fuel levels in these areas will, however, have to be carefully monitored, otherwise the effectiveness of control burning as a fire control measure will be lost.

72. Fire management in conservation areas presents a different set of management problems as fire is not always perceived as a threat to resources and in some cases can be applied to achieve wildlife management objectives. National parks services of various States agreed that control burning for fuel reduction needs to be carried out in parts of

reserves, particularly in peripheral areas adjacent to human settlements. Damage to wildlife values may occur but the need to provide fire protection to neighbours and park users must take precedence.

73. In nature reserves and forests there is scope for land managers and fire controllers to apply hazard reduction control burning in a more selective way. This includes buffer strip burning and the creation (by frequent burning) of crown fire free zones. Both of these may involve the loss of environmental values, however in small areas they may be more cost effective and less damaging than broad scale control burning.

74. Once the possible impacts are recognised it becomes necessary to decide whether or not it is appropriate to burn a particular area. The Committee believes that control burning for bush fire control purposes should only be carried out where it coincides with management plans which properly describe the areas to be burnt, the purpose of the burn

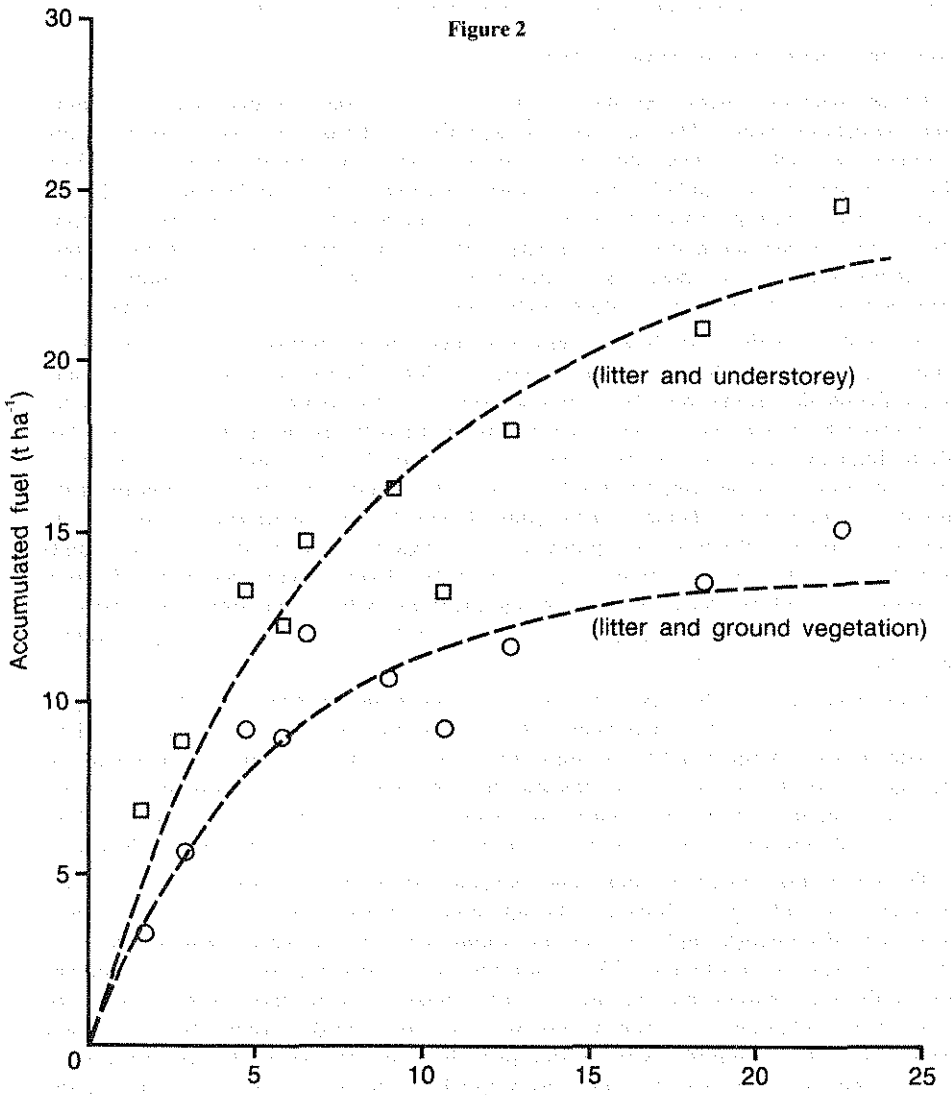


Figure 2 Fuel accumulation in dry sclerophyll forests — Blue Mountains

and the prescriptions to be applied. This requires specific land use planning and the assessment of the strategic value of control burning. This finding may be difficult to apply until the fire control and land management authorities catch up with the planning backlogs. It may involve a considerable amount of field survey and monitoring. The Committee believes that this work should be given priority to ensure that control burning programs are based on rational and informed decisions and are carried out only where necessary.

75. The approach advocated by the Committee should lead to a reduction in broadscale aerial control burning in remote areas. In locations far removed from inhabitated places or from valued assets there may be no economic justification for carrying out control burning. It would be more effective and more environmentally acceptable to concentrate protection works closer to the assets to be protected. The Committee can see no justification for control burning where the only effect would be to reduce the intensity of bushfires in remote natural areas that are not commercially managed.

Manual fuel reduction in small reserves

76. Urban bushland reserves of the type found in and around Sydney usually contain remnant vegetation types. They are more susceptible to damage by control burning and their small size makes it less likely that sufficient areas will remain unburnt to allow wildlife populations to quickly regain prefire numbers. The application of hazard reduction control burning programs would have a comparatively more significant impact in small urban conservation areas than in large reserves and forest areas. Situated as they are in metropolitan areas these small conservation reserves represent a unique urban environment whose aesthetic and cultural value needs to be reflected in their management.

77. Alternative methods of hazard reduction need to be utilised where possible to minimise disturbance to the environment. Selective land clearing to remove fuel by hand to create firebreaks around reserves is one alternative. This technique is limited to small areas of urban bushland and is impractical and too expensive for other areas. This method is labour intensive and, even in small areas, Town and Shire Councils are reluctant to adopt it due to cost. Consequently they rely on either voluntary labour or funding from community employment schemes. Local councils and bushfire authorities agree that the method can provide effective fire protection but requires a great deal of community co-operation to initiate and maintain effective selective hand clearing programs. There is also a need to introduce education and training programs when local authorities intend to rely on volunteers. If the authorities use untrained volunteers there is a risk that substantial damage may be done to the environment.

78. Hand clearing has also been criticised on environmental grounds. The clearing is selective and only removes small plants. The Committee heard of one example where large banksia were being retained but these were likely to decrease their seed production as they aged.[18] In this situation it is possible that this species would disappear from the area if small immature plants are continually removed. Concern was also expressed about the amount of nutrients which might be removed from an area by hand clearing.

79. The Committee concludes that hand clearing can be used for small urban reserves where it may be preferable to burning. As with control burning, hand clearing operations must be carefully planned and executed and should only be carried out where a real fire protection benefit can be obtained. The Committee was concerned that fire prevention and control authorities responsible for fires in urban reserves in northern Sydney were too quick to dismiss alternatives to burning and were too insistent that control burning should be carried out. The Committee believes that in Sydney and elsewhere the need for control burning in small reserves may have been overstated and that there is scope for fire control authorities to be more flexible in their choice of strategies. This does not mean that fire

should be totally excluded and in some cases it may be necessary to prescribe fire to provide the conditions necessary for the regeneration of some species.

The use of fire as a land management tool

80. The deliberate use of fire in natural areas is not always detrimental and fire can be applied to achieve certain environmental objectives. Prescribing burning for ecological management can be used where the intention is to:

- provide a diversity of age classes of vegetation;
- provide a series of successional stages of vegetation;
- favour species, communities and habitats;
- return areas to pre-European conditions; or
- create conditions conducive to the return of locally extinct species.

81. The deliberate application of fire could have unforeseen consequences and might not be successful. The Australian Conservation Foundation identified three requirements before environmental fire management should be applied:

- adequate scientific data about the effects of fire on native ecosystems;
- total local fire suppression capability, so that only prescribed fires burn in the area;
- accurate weather prediction for specific areas so that burning prescriptions can be accurately applied.

82. The Committee considers that 'state of the art' prescription burning does not meet these requirements and agrees with the Australian Conservation Foundation that the general use of prescription burning to manipulate habitats should not be applied until our knowledge and technology improves.

83. Although the Committee does not generally support broad scale burning for environmental objectives until we know more about the ecological consequences, it does believe that there are some cases where limited burning appears justified on the basis of the information so far available. For example, the Tasmanian National Parks and Wildlife Service stated that some form of managed firing of vegetation may be necessary to conserve the habitat suited to the endangered orange-bellied parrot.[19] This species feeds on sedgeland-heaths which has survived unburnt for three to fifteen years. Fifteen years after a fire the vegetation becomes unsuitable. Deliberate burning may be justified to preserve this species which now has a breeding population of only 170 individuals.

Endnotes

1. Transcript, p. 554.
2. Transcript, p. 90.
3. Transcript, p. 830.
4. Transcript, p. 926.
5. Transcript, p. 540.
6. Transcript, p. 831.
7. Soil Conservation Authority of Victoria.
8. Transcript, p. 964.
9. Transcript, p. 967.
10. Transcript, p. 291.
11. Transcript, pp. 828, 1808.
12. Transcript, p. 1808.
13. Transcript, p. 104.
14. Transcript, p. 279.
15. Transcript, p. 1854.
16. Transcript, p. 284.
17. R.J. Raison, P.V. Woods and P.K. Khanna, Dynamics of fine fuels in recurrently burnt eucalypt forests, *Aust. Forestry*, 46 (4), 1983, 294–303.
18. Transcript, p. 946.
19. Transcript, p. 1776.

Nadgee Nature Reserve, N.S.W., one month after a fire in an experimental area.

Nadgee Nature Reserve, N.S.W., five years after the fire — now a habitat favourable for all mammals. (CSIRO Division of Wildlife and Rangelands Research).

CHAPTER 3

Bushfire Prevention and Suppression

84. Fire controllers are faced with a limited range of techniques and equipment which they can use against bushfire. The options are further constrained by environmental factors including weather, fuels, topography and access. Their over-riding responsibility is to protect life and property and there is often little time available to make decisions and take action. It was therefore not surprising to find that the bushfire control authorities do not give high priority to environment protection during fire suppression operations. The Committee considers that the potential for protection and suppression measures to cause environmental damage should be identified and taken in to consideration by the authorities.

Measures taken before a fire

85. While fires of the size and intensity experienced on Ash Wednesday are rare occurrences, threats to human life and property occur in some regions every three to five years. Consequently, bushfire fighting organisations must continually carry out measures which will assist in the control of wildfire and the protection of life and property. The commonly used fire control measures are control burning (discussed in Chapter 2), cutting firebreaks (to isolate outbreaks of wildfire), and building fire trails (to facilitate access to fire prone and strategic areas).

86. Permanent fire breaks are established by fire control authorities to make a break in the fuel. They exist either as fuel reduced zones — created by mowing, grazing or burning, or as strips graded down to mineral earth. Fire trails are usually constructed to provide access and facilitate fire suppression operations. They can also act as a barrier to the spread of fires under moderate conditions. Fire breaks are wider than trails and are constructed to specifically stop or reduce the rate of spread of fires. The effectiveness of fire breaks in stopping high intensity wildfire is limited by the ability of such fires to throw fire brands over long distances. However, firebreakes can be used to contain fires by allowing access, forming the basis of fire line construction and backburning and providing refuge and escape routes for fire fighting crews. Under most conditions they are effective in reducing the fire's rate of spread and provide bushfire fighters with an opportunity to contain a fire.

87. Fire breaks and trails can have severe localised impacts on the environment, especially if constructed poorly. The chief impacts are increased erosion and siltation of streams, access for weeds, pest animals and plant diseases. A secondary effect specifically related to fire trails is the greater human access to remote areas. This increases the fire hazard through the increased possibility of deliberate or accidental ignition.

88. The Australian Conservation Foundation argued that the provision of fire trails should be minimised wherever possible and stated that trails should be rare in national parks and completely absent in designated wilderness areas.[1] The Committee partly agrees with this view. It considers that in some areas it is necessary to construct fire trails to protect life and property. This means that trails will have to be placed in national parks to provide access and protection around recreation areas and to prevent fires from escaping from reserves and burning neighbouring property.

89. The New South Wales National Parks and Wildlife Service told the Committee that

they consider that all bushfires have the potential to spread from areas under its control and threaten life and property.[2] The Service therefore accepts that some fire trails will have to be constructed but that the subsequent environmental impact must be carefully assessed. The Committee supports this view.

90. The Committee also believes that there are areas such as natural parts of parks and reserves remote from other assets where trail construction is unnecessary and the advantages of access are outweighed by the disadvantages. The New South Wales National Parks and Wildlife Service cited a survey in one National Park which revealed that nine out of every ten fires started from the edge of trails.[3] The Service stated that a lack of trails was not a disadvantage and that other methods could be employed in national parks. These included using helicopters to attack the fire, to start backburns and to provide access.

91. The Soil Conservation Service of NSW presented a detailed submission to the Committee outlining guidelines for the planning, construction and maintenance of trails. These guidelines were designed to minimise disturbance caused by fire trail construction. They show that it is possible, at a cost, to construct permanent trails giving due regard to the environment. Regular maintenance programs of these trails and equipment to construct the trails should include provision for the control of exotic weed infestation and measures to eradicate the transport of plant diseases on earthmoving equipment.

92. The Committee considers that fire breaks should only be used in conservation areas where the environmental impacts have been assessed as acceptable. An alternative fire break which minimises environmental impact can be created by thinning the overstorey vegetation and regularly slashing the understorey. In a eucalypt forest this is unlikely to stop a major forest fire but can provide a refuge or base for backburning and can be quickly converted to a more substantial break than untreated forest. Grazing is another option for fuel reduction of fire breaks but is not suited to conservation areas.

Measures taken after a fire occurs

93. Fire behaviour is dependent on fuel conditions and the weather and it is these conditions, along with access, topography, available resources and delays in detection which determine the ease and effectiveness of fire suppression methods. Several methods are available and the choice of tactics is dependent on fire intensity and weather conditions. Direct attack on the fire front usually cannot hold a fire of greater intensity than 3000 kilowatts per metre, while extreme conditions can produce fires up to 60 000 kilowatts per metre.[4]

94. In dry summer months the extreme level of intensity can be reached shortly after a fire breaks out. Therefore direct attack has to be effectively mounted soon after the fire starts if it is to be successful. If a successful direct attack on the flame front cannot be made then the authorities have to use indirect tactics. The objective of indirect fire attack is to establish fire breaks that will either stop the spread of the fire or which can be used for backburning. In some cases backburning is done from pre-existing permanent fire trails.

95. In high to extreme fire danger periods, unless the detection and suppression of outbreaks of fires are immediate, indirect methods of fire fighting are the most frequently used techniques. This often involves using earth moving machinery to construct temporary fire trails and to remove debris and fuel from permanent trails. During fire suppression operations there is insufficient time and equipment to follow proper construction techniques and to repair damage. Therefore the environmental impact can be quite severe, but can be overlooked in the aftermath of an apparently devastating wildfire. Often after fires these hastily constructed trails are left, or become *de facto* fire trails,

resulting in severe erosion. Bulldozers create severe soil disturbance which can lead to erosion. Trails made by hand tools have a more limited impact but the trails cut down to the soil are usually aligned straight up hillsides. This can also result in erosion.

96. The Committee believes that temporary trails should be closed and revegetated as soon as possible after a fire to minimise erosion. Alternatively work could be done to bring the trails to proper construction standards. The cost of such operations should be regarded as a normal part of the fire suppression operation.

97. The Committee also believes that the availability of new technology, particularly aerial fire fighting should reduce the need to construct temporary trails. The new methods may not replace traditional techniques but they do deserve more consideration and evaluation.

98. It was suggested to the Committee that it is not always necessary to attempt to contain wildfires. This is where the fire is predicted (with some certainty) to burn in a manner commensurate with a prescribed burn or where the fire is only going to burn in remote areas and not threaten life or cause damage to property or the environment and the fire can be considered to be part of the natural environment.

99. In some cases the potential for a fire to damage the environment will be low and there may be no threat to life and assets. If so it would be acceptable to allow the fire to run its natural course. The Committee believes that there is scope for the authorities to pause before sending fire fighters into remote areas to suppress bushfires. The New South Wales National Parks and Wildlife Service have tried a technique they call herding. This is an alternative to suppressing fires that are ecologically acceptable and invovles redirecting the course of the fire by deliberately burning out areas in its path. The aim is to prevent the fire from entering areas where it could do damage. The Committee considers this to be a useful technique that may help achieve environmental objectives while also reducing the risk to fire fighters. It obviously needs to be applied with caution and only in those situations where it is reasonably certain that it is safe.

Endnotes

1. Transcript, p. 573.
2. Transcript, p. 926.
3. Transcript, p. 954.
4. Transcript, p. 855.

CHAPTER 4

Bushfire Protection and Community Preparedness

Introduction

100. The history of bushfires in Australia has shown that extensive damage to property, injury and loss of life will result unless communities and land managers take appropriate measures to mitigate the threat from fire. Community protection involves more than fire prevention and suppression. It includes incorporating fire safety measures into building construction and siting guidelines, coupled with land use control and disaster planning.

101. In the course of its inspections the Committee was concerned to see people in fire devastated areas building virtual replicas of their destroyed houses without any apparent regard for fire protection. Similarly, new subdivisions in fire prone areas such as the Adelaide Hills, Blue Mountains and Dandenong Ranges contained a distressingly high number of homes which would have little chance of surviving a fire because they appeared to have been constructed without basic fire protection measures. This indicates that the majority of land developers and owners are either ignorant of the fire risks or believe that the responsibility for bushfire protection lies completely with fire fighting authorities. There is also a believe that preventative measures such as control burning carried out by the authorities can entirely overcome the bushfire problem.

102. The New South Wales National Parks and Wildlife Service pointed out that broad area control burning programs will not provide protection to urban areas in severe fire weather. They stressed that relying on fuel reduction in remote bushland areas to protect urban areas can be disastrous particularly when adequate protection measures are not undertaken in and adjacent to areas where people live.

Land use

103. Proper land use planning can contribute to bush fire protection by ensuring that assets are not placed in high risk areas. Land use control and regulation of subdivision location and design can minimize the fire risk. To date fire protection considerations have had limited priority in community development plans. This has resulted in poorly designed subdivisions with limited access in high fire risk areas.

104. The Committee saw examples of inappropriate subdivision design throughout high fire risk areas, consisting of residential allotments in heavily forested and steep land. In many cases houses were sited in the midst of thick bush with vegetation growing right up to the buildings. The Committee heard that 20 000 allotments in the Dandenongs, Upper Yarra and Pakenham districts of Victoria were in subdivisions which the authorities would now probably classify as inappropriate because of the high fire risk, and in the Warringah area north of Sydney the Committee saw new subdivision development that was sited in very high risk areas.[1]

105. That such development exists and is continuing reflects the low priority given to fire protection considerations in land management planning. Fire control officers generally agree that land use management which incorporates fire protection measures could significantly reduce the impact of bushfires and should be given higher priority.

106. The Committee strongly believes that State and local government authorities must

apply land use planning measures which include controls over the design and siting of individual houses and zoning mechanisms to either prohibit development or reduce potential development densitites in high bushfire prone areas. This should involve stringent controls over new subdivisions, restructuring of old and inappropriate subdivisions and restrictions on block size and unit development.

107. In relation to subdivisions there are two options available to these authorities. The first is to stop or modify further development and to acquire areas proposed for development. The Committee considers that it would be impractical and too costly to resume land where substantial improvements have been made and does not consider this an option, but undeveloped fire prone land should be resumed where it is proposed for residential subdivision. The Victorian Government has already repurchased a number of allotments in the Dandenongs area.

108. The second option is to restructure allotments and redesign subdivisions to reduce housing density, improve the siting of buildings and improve access. In Victoria some progress has also been made in the identification of subdivisions that need redesigning. The Shire of Upper Yarra developed a subdivision restructure program that aims to lower the potential housing density to acceptable levels based on land characteristics including bushfire risk. The Shire considers that the program was a compromise between the existing, unsatisfactory situation and proper orderly planning for the area and it recognises that one of the problems is the rights of the owners who acquired land in the expectation of being able to develop it.

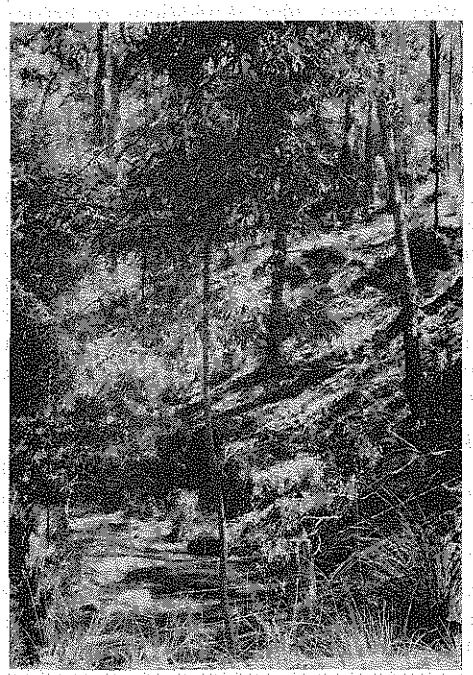
109. The Shire of Upper Yarra unsuccessfully tried to get a six month prohibition on development in fire prone areas to enable studies to be undertaken on the future of the unsuitable subdivisions but was unsuccessful.[2] The situation in the Shire is typical of fire prone areas elsewhere in Australia. The Committee believes that State and Local Governments throughout Australia over many years have been markedly reluctant, unwilling or unable to take firm action in respect of land use planning and development controls. There is a lack of comprehensive planning and regulation specifically related to bushfires and responsibility for the prevention and removal of hazards in semi-urban areas is fragmented.

110. The Committee is concerned that the adequacy of land use planning was not properly considered in the post Ash Wednesday reviews of the States' disaster responses. It therefore strongly recommends that:

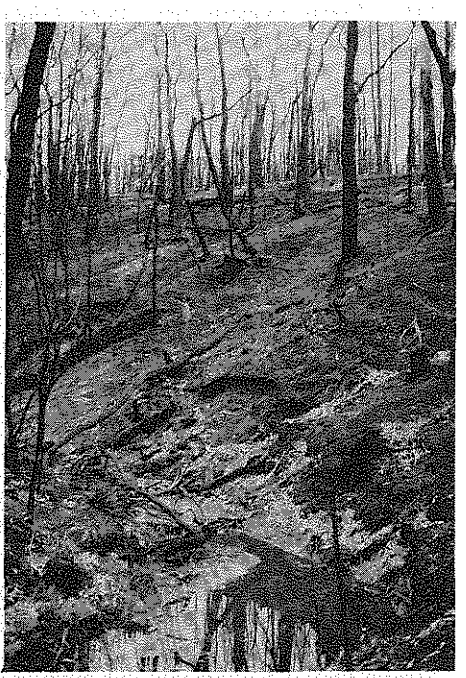
> **the Minister for Territories and Local Government request the Local Government Ministers' Conference to review the adequacy of existing land use and land use planning as it relates to bushfire mitigation.**

111. Land use on crown lands adjacent to residential subdivisions also needs to be reviewed to identify potential buffer zones and to ensure that the land use does not contribute to the incidence or severity of bushfires. The siting and management of open spaces such as golf courses and playing fields should be done in a way to form effective fire breaks, and roads should be located to maximise access and to also act as breaks. Councils and State Governments should also ensure that recreational activities such as picnicing and camping are located away from hazardous areas.

112. Rational plans will only be devised if the authorities have adequate information about the fire risk of the areas in question. The CSIRO has land use planning techniques which incorporate bushfire hazard mapping and most of the States are developing some form of mapping and zoning but this has not yet been widely used. The type of information that would flow from hazard mapping is required for the State Governments to identify the areas where special programs such as land resumption should be carried out.



Stoney Creek, Upper Beaconsfield.



Stoney Creek, Upper Beaconsfield, following Ash Wednesday fires. Note heavily eroded creek beds, sedimentation in the creek and absence of any ground cover to prevent further erosion. (Dandenong Valley Authority).

113. The Committee concludes that hazard assessment and mapping should be carried out by State and Local Government Authorities for all bush fire prone areas. This mapping should then be used as a basis for the definition of land use zones where bush fire sensitive activities are restricted or prohibited and where special regulations should apply.

Housing design

114. During its inspections of the Blue Mountains, the Dandenongs and Mr Lofty Ranges the Committee saw numerous examples of houses that, for bushfire protection, were poorly designed and badly sited — in some cases virtually built on the ashes or similar houses that were destroyed by fire. The Committee, for example viewed with great concern a house built on a steep slope surrounded by thick bush which was constructed after the Ash Wednesday fires in complete disregard of the inevitable fire which will someday consume it.

115. During bushfires most damage to houses is caused by embers lodging in openings and cracks in the house and gaining entrance through eaves, under tiles and in gaps around doors and windows. Burning embers can be present for up to 12 hours after a bushfire passes. It is obvious that housing with no protection against ember attack will be of considerable risk. The principles for building in fire prone areas have been known for many years, as a result of post fire surveys undertaken by organisations such as the CSIRO and country fire fighting authorities in each state. The earliest survey was carried out by the CSIRO in 1944 following the Beaumaris fire. It is significant that despite such surveys, there is little evidence of their recommendations being followed.

116. Local councils have been reluctant either to pass new regulations or enforce existing legislation concerning building codes, claiming that there would be public opposition to such controls. Some Shires, for example the Sherbrooke Shire, adopted policies and guidelines on design and siting of houses in high bushfire risk areas but have not enforced them.

117. It is difficult to delineate bushfire risk areas due to the random nature of the outbreak of fire. However there have been other situations where the public, the authorities, the building industry and the scientific community have recognised a hazard and worked to achieve a measure of protection by changing building standards (for example, the response made to the cyclone threat). Fire hazard mapping, as discussed in the preceding section would allow authorities to identify areas were extra control would have to be applied. The Committee believes that bushfires are an inevitable risk in some parts of Australia and those people who choose to live in a fire prone locality must take some responsibility for protecting their own property.

118. The Committee is concerned that efforts made to modify building design, techniques and materials after fires have been neglected, despite the amount of information available and the repeated number of fires. The Committee believes that a program of planned reconstruction similar to that following Cyclone Travey should have been implemented for the rebuilding after Ash Wednesday, but it now appears too late.

119. The information that was available to people who were rebuilding was largely ignored. This was partly because they wanted to rebuild quickly and partly because of the cost of incorporating better design features. However in view of the increasing popularity of semi-rural developments and subdivisions in bushland areas, and the destruction which can be caused by fires, the Committee believes that stricter control needs to be exercised through local councils over the siting and fire protection measure which should be incorporated into future housing design and construction.

120. The measures which people can take to protect their houses have been known for a long time and recent events have widened our knowledge. Although information and advice has been widely disseminated by the authorities the Committee saw no evidence that any of the authorities had formally adopted or endorsed a particular bushfire protection standard. The Committee considers that formal adoption of some building principles might help overcome the opposition and ignorance which characterised the rebuilding in Victoria and South Australia after Ash Wednesday. The Committee recommends that:

> **the Minister for Housing and Construction request the Housing Ministers' Conference to consider adopting and publicising a housing bushfire protection standard.**

Incentives and persuasion

121. It was suggested that it would cost an extra $3000 to $10 000 for people to include specific bushfire protection measures in their houses.[3] This is a significant cost when people are building but the failure to incorporate protection can result in much greater costs to the individuals and society if the house is again threatened by fire.

122. It was outlined to the Committee that incentives and penalties would encourage individual landowners to take fire protection meausres or to avoid building in fire prone areas. These are the use of taxation and insurance provisions. Taxation concessions could be given for capital expenditure which improved the bushfire resistance of houses and farm buildings. These might take the form of deductions of taxable income for expenditure on certain construction materials or on equipment such as fire extinguishers. State Government could offer grants or low interest rate loans to cover the cost of

incorporating fire protection measures. Insurance premiums could be adjusted so that houses built in certain fire prone areas would be subject to higher premium payments. Likewise, there could be reduced premiums for owners who constructed houses which were bushfire resistant or who maintained their properties free of undergrowth and forest litter.

123. There are a very large number of factors which affect the degree of fire risk of a particular property including:

- the amount of litter on the floor and the type of vegetation of the nearby bushland;
- the slope of the land;
- construction factors such as the sealing of the roof and the under floor space and the exposure of window frames;
- the amount of rubbish and flammable material stored around the house;
- the ease of access of fire fighters, and
- the type of precautions taken by the land holder.

For any particular building these factors are difficult to evaluate particularly as some of them change from time to time. Furthermore, it is the combination of the various factors which is important in determining the degree of exposure to danger in any particular case.

124. It is difficult to identify any major items which would be appropriate to relate to an insurance scheme or taxation provision. The measures which could attract a rebate would need to be assessed by skilled inspectors, and the cost of undertaking this at frequent intervals would be quite significant and would have to be borne by policy holders generally, or by taxpayers. This would tend to make any taxation or insurance incentive scheme impractical at the present time. The insurance industry itself does not support proposals for variable fire insurance premiums depending on location and fire risk.

125. The actual insurance premium reductions which could be achieved may be too small to provide an incentive for householders to undertake the necessary improvements to qualify for a reduction. The majority of policy holders are unlikely to be able to take advantage of reduced rates because the houses are entirely unsuited. Similarly the effectiveness of tax provisions might also be limited and it may be difficult to define where concessions should apply. The authorities will have to rely on regulation and legislation, supported by public education, to persuade people to make their houses safer and easier to protect. The Committee considers that State and Local Governments will need to take a stronger, more interventionist attitude to this problem and require householders to take bushfire protection measures in much the same way as the authorities enforce public health and building safety codes.

126. It was suggested that the problem of under insurance could be overcome by compulsory insurance schemes. One of the arguments in favour of compulsory insurance is that at present a proportion of insurance premiums are used to offset the costs of the fire brigades. People who fail to pay insurance obtain the benefit of fire brigades but do not contribute to the cost. In the Committee's view this represents an unfair penalty on those people who are prudent enough to take out insurance.

127. The Committee believes that there may be difficulties in identifying the land-owners who should be required to take out insurance and does not believe that compulsory insurance schemes would be effective. However the Committee does consider that there is a need to spread the cost of supporting fire brigades across the community. This would involve the introduction of a tax at the local government level which could be included with land taxes. This would replace the fire brigade levy component of insurance premiums. This will lead to a reduction in the cost of insurance and should result in an increase in the proportion of land-holders who take out policies. The Committee therefore recommends that:

The State Ministers responsible for Local Government and for Fire Services in *consultation with the Australian Insurance Industry Council, review the* funding of rural fire brigades with a view to finding more equitable arrangements than insurance premium levies.

Disaster planning

128. The Committee did not review the adequacy of existing bushfire disaster plans and considers that this has already been done in the States affected by the Ash Wednesday fires. However it was stressed to the Committee on a number of occasions that the major problems facing communities during life-threatening fire emergencies were:

- the lack of adequate warning time of an approaching fire;
- the confusion surrounding the progress, position and direction of a fire; and
- the uncertainty of safe evacuation routes and the inadequacy of safe evacuation centres.

These matters do not generally receive enough attention in disaster planning.

129. Resolution of these problems lies in the provision of an adequate fire warning system, such as the use of a specified radio station to broadcast regular fire bulletins and the designation of fire safe areas and evacuation centres. The management and protection of people in bushfire disaster situations requires the rapid interpretation and dissemination of considerble amounts of information. The Committee considers that this is an area where Councils and disaster authorities could more closely co-operate in the development of computer based data systems.

130. The Committee recognises that these disaster measures would only be needed in extreme emergencies, and that in most instances the need to resort to evacuation does not exist. The Committee believes that if adequate fire prevention measures are taken and individuals are educated to know what to expect and what to do if a fire is approaching then the loss of life and property damage will be greatly reduced. The Committee believes however, that in heavily populated bushland areas, such as the Adelaide Hills, Blue Mountains and Dandenong Ranges, fire disaster planning is needed to protect lives and prevent unco-ordinated mass evacuation which hampers the efforts of fire fighting crews. The major factor limiting the success of such planning is community awareness. This is discussed in more detail in Chapter Five.

Endnotes

1. Transcript, p. 928.
2. Transcript, p. 1239.
3. Shire of Upper Yarra, submission.
4. Transcript, p. 1514.

Information, Education and Training

Public eduction

131. The various bushfire control authorities in each State produce educational material aimed at informing, educating and training the general public. This information has three purposes:

- to educate the public about the dangers of bushfires and discourage illegal and careless fire lighting;
- to advise the public of the appropriate action to take in a bushfire; and
- to inform the public about fire management practice and outline fire control policies in relation to contentious issues such as the use of control burning.

132. The Committee found that an abundant amount of information was available but it was generally ignored by the public. Essential knowledge concerning survival in a bushfire, protecting houses and property and the regulations about fire control has been widely distributed and every major fire is followed by a small flurry of new publications. Despite these efforts there is little public awareness of the fire threat and action which should be taken to reduce the threat. This problem is particularly significant in bushland suburbs, where thick understorey and heavy litter build up are retained in close proximity to houses, and overhanging trees drop leaves on roofs.

133. The failure of public education campaigns can be seen in the area of fire prevention. The proportion of bushfires which originate from arson or carelessness is steadily rising, causing serious concern among firefighting authorities. A chief concern is that this increase is occurring despite extensive summer publicity campaigns aimed at preventing fires.

134. The failure of the public to implement known procedures for reducing the loss of life and damage to property during the 1982/83 bushfire season is another example of the lack of success of education campaigns. The South Australian authorities submitted that the deaths and destruction of the Ash Wednesday fires showed that the simple rules of property protection and personal survival had not been followed, or in many cases understood. The deaths of people in and around vehicles illustrated the inability of the community to absorb the procedures for survival in the form that this information is currently presented.

135. The Committee found that the public education material contained a clear and accurate message and that it had been widely distributed. Therefore it was not easy to see why the community had not taken heed of the authorities' messages. One possible reason is that the type of information provided does not cover those areas which the public considers relevant to their particular needs.

136. Submissions made by the public stressed the need for information about local disaster procedures. It was clear that the type of information required included matters such as when to evacuate houses and where to assemble, the local disaster authorites and personnel, who to report to for directions and where to get reliable information about the progress of the fire. The Committee does not advocate evacuation of able bodied people as the standard response to bushfires and believes that it may be counter productive. However it appears that many people are unlikely to take the advice about staying in the

home until the fire passes and there are some people who should not stay, including the frail, aged and young. Therefore the Committee considers that the information about disaster procedures, including evacuation, should be made available at a local level.

137. Another possible reason for the failure of publicity campaigns is the reliance on the distribution of printed material on a large scale. It was suggested that programs be developed which made more use of audio-visual material and that there was a need to involve people in field days or displays and lectures at the local level. These types of activities would require the fire control authorities to improve the skills and resources of their education officers and to make more use of public education specialists.

138. Each of the different authorities in each of the States independently publishes its own literature. The Committee saw no evidence to suggest that this material was contradictory or deficient but believes that it is likely that a more sustained and efficient program could be undertaken if activity was centralised and co-ordinated. A considerable effort dealing with disaster planning at the local community level would still be required to supplement the standard State-wide material. The Commonwealth could assist by conducting or sponsoring general campaigns which provide information which has general application nationally. The Commonwealth could also make resources available to assist the States to carry out their own programs to deliver material that is applicable at the local levels. The Committee recommends that:

> **The Department of Home Affairs and Environment co-operate with State Departments to develop a national awareness campaign dealing with bushfire survival, building protection, fire prevention and the role of fire in the Australian environment.**

As part of this campaign the Department should also undertake research to find out why past campaigns have failed and to identify ways of ensuring that future publicity is more effective.

139. Some public education material should be produced in a form which is suitable for use in the schools. The development of appropriate educational programs directed at higher levels of secondary education are regarded as particularly effective as these students represent the most receptive and potentially influential sector of the community. The Committee recomends that:

> **the Commonwealth Department of Education and Youth Affairs assist State Departments and authorities to develop video programs and education kits concerning bushfire topics which would be suitable at senior secondary levels.**

140. A number of conservation bodies reported that there was a need to expand the public's awareness about bushfires to include a consideration of the ecological role of fire. The most common attitude is to regard fire as something which is intrinsically bad and potentially damaging. In an ecological sense this is not always the case and there are situations where it is acceptable to allow a fire to run its course. The Committee was told about anti-conservation reaction after the Ash Wednesday fires and considers that this type of attitude is a major obstacle to the adoption of proper fire protection measures. The Committee considers it is important that the public, particularly those living in fire risk areas, appreaciate that fire is a part of the Australian environment, has a positive ecological role and that it is inevitable that bushfires will occur. Measures which should be taken to protect people and property need to be stressed rather than total reliance on hazard reduction measures in bush land areas which may have serious adverse biological impacts. The Committee believes that the ecological role of fire and its place in the natural Australian environment should be strongly emphasised in all the education material produced by the bushfire control authorities.

Professional training and education

141. The quality and amount of training and education given to the people involved in bushfire prevention and suppression is grossly inadequate. Most of these people are 'part-timers' who have other professional and technical duties or are volunteers. Very few are full-time professionals with specialised training.

142. The Australian community relies on professionally trained foresters to provide much of the direction in bushfire prevention and suppression. Their fire protection duties extend beyond the immediate needs of commercial forestry. The New South Wales Forestry Commission told the Committee that it plays a *de facto* role as a public fire suppression agency and is regularly called upon not only to provide fire fighting services in the community interest but also to co-ordinate and control other authorities during large scale fire emergencies.[1]

143. There are two tertiary institutions which train foresters in Australia. These are at the Australian National University and the University of Melbourne. At both these institutions little attention is given to bushfire management. Neither University employs permanent tenured staff to teach fire protection and suppression. The new syllabus from the Forestry Department of the Australian National University does not provide for classroom teaching at fire science and appears to offer only limited exposure during a short period of field teaching. The practical training in fire prevention and suppression at the Australian National University is insufficient and it does not reflect the important role that foresters play in community fire protection.

144. The Committee considers that the provision of tenured fire science teaching specialists and specific theoretical and practical teaching are essential. Given the staffing formula which apply at the Universities the Committee notes that this would only occur if special dedicated funding was provided. Accordingly, the Committee recommends that:

- **the Minister for Education and Youth Affairs request the Commonwealth Tertiary Education Commission to review the teaching of bushfire science in tertiary forestry and land management courses.**

The Committee expects that this review would be carried out in consultation with the Commonwealth Departments of Primary Industry and Home Affairs and Environment.

145. The Committee further recommends that:

- **the Minister for Primary Industry request the Australian Forestry Council to consider establishing a special fund to assist the universities to teach and carry out research in bushfire science.**

146. Parts of the Australian National University's forestry course deal with fire ecology and the environmental role of fire. However, this is an area where the Committee found considerable debate and disagreement, particularly in regard to issues such as control burning. There has been disagreement and varied interpretation about theoretical concepts and research results. There is a need for a definitive fire ecology textbook containing Australian information to serve as a basic reference and to put the evidence and arguments in a balanced way. Therefore the Committee recommends that:

- **an authoritative Australian fire ecology textbook be commissioned by the Commonwealth Government through the CSIRO for tertiary education purposes.**

This book would complement the text on Bushfires in Australia published by the Commonwealth Government and the CSIRO in 1978.[2]

147. The Committee believes that the volunteer rural brigades make a very significant and in many instances an essential contribution to the welfare of the Australian

community. Their effectiveness and efficiency depends on the strength of community support and involvement.

148. Bushfire control authorities carry out their own in-house training programs to instruct fire controllers and fire crews in the operation of equipment and the carrying out of fire suppression operations. This type of training is essential, particularly where the authorities rely on volunteers and staff who only work part-time on bushfire matters. These people do not normally receive any other outside training which qualifies them for this task. New South Wales for example has 140 Shires involved in fire prevention and control and a significant number of these employ full-time control officers who are without formal training.[3]

149. The Tasmanian National Parks and Wildlife Service expressed concern that training programs for employees and volunteers recruited for bush fire work was limited to 'the use of pumps and radios and fighting of going fires' and that there is insufficient attention to fire prevention and environmental protection.[4] The Committee believes that the breadth of training given to bushfire crews should be broader, particularly for senior officers. Some of this training needs to concentrate on fire fighting techniques and must necessarily be carried out in the field at a local level. Most States have established courses to deal with this part of the training need. There is also a need for education programs which cover matters such as planning and organisation, fire prevention, basic fire physics and fire behaviour, environmental ecology, safety and educational techniques. These could be taught by professional teachers at a state or national level.

150. A number of witnesses requested the establishment of a national bushfire school. The CSIRO stated that there was serious need for some sort of national training facility and a gradual move toward the co-ordination of technology. The State forestry authorities suggested that the Australian Counter Disaster College run by the Natural Disasters Organisation may have the potential to be used for national training of bushfire operators particularly senior fire control officers.[5] The Committee considers that if such a school were established it would help the transfer of new information and the dessemination of the results of current research and technological development. It would also help improve the efficiency, effectiveness and professionalism of bushfire training. Accordingly the Committee recommends that:

- **the Minister for Defence review the role of the Natural Disasters Organisation in respect of the operation of the Australian Counter Disaster College with a view to providing a national centre for bushfire training.**

Endnotes

1. Transcript, p. 841.
2. R.H. Luke and A.G. McArthur, Bushfires in Australia, A.G.P.S. Canberra 1978.
3. Transcript, p. 78.
4. Transcript, p. 1782.
5. *The 1982/83 Bushfires*. Report by the Standing Committee on Forestry of the Australian Forestry Council.

CHAPTER 6

Research and Interpretation

Research needs

151. Many of the individuals and organisations who made submissions to the inquiry, including some of those who advocated control burning as a fire protection measure, suggested that there was a need for more research into the environmental impact of fires. It was also apparent from the Committee's own examination that basic information was not available in some areas including:

- fire behaviour, fire physics and fire meteorolgy;
- effectiveness and environmental impacts of prevention and suppression measures — particularly control burning;
- ecological role of fire;
- statistics about fire events; and
- community responses to public education campaigns and why these have not been successful (see Chapter 5).

152. The CSIRO and the State forestry authorities and some tertiary education and research institutions have conducted small bushfire research programs. With the recent exception of CSIRO's Project Aquarius, these have not received high priority in the allocation of funds and resources. None of the organisations have been able to maintain adequate, on-going levels of fundamental research and their work has been carried out on an ad-hoc basis according to the immediate needs of individual organisations without sufficient attention to long term problems.

153. The dissemination and interpretation of information which has been collected has also been inadequate. Consequently there is considerable disagreement about the scientific basis of field operations. Data which have been derived from studies of particular species has also been used to make generalisations about other situations where the effectiveness and impact of programs might be quite different. The overall consequence of the lack of information and misinterpretation is that field operations have been implemented without a complete knowledge of the consequences. If the level of understanding is increased it is likely that operations will become more effective and there will be a decrease in environmental damage.

154. Following the Ash Wednesday fires, the CSIRO convened a meeting to consider the research needed to improve bushfire prevention and control. The participants included researchers and officers of the CSIRO, the rural fire authorities, the State forestry authorities, the Natural Disasters Organisation and the National Centre for Rural Fire Research. In addition to outlining the research required to improve fire prevention and control, the meeting also covered two other important areas. The problem of education and training of fire controllers was identified as being of major importance. This matter was discussed further in Chapter 5. Similarly, the question of the ecological efects of fires was recognised as a most important one to land managers and fire controllers faced with the need to develop environmentally safe and realistic fuel policies.

Fire behaviour

155. In respect of basic fire behaviour research, which forms the basis of fire control techniques, the CSIRO meeting found that there was a strong need to continue the work in

the area commenced by the Project Aquarius team. The meeting also found that there was probably not a great need for further general research into the fuel management problem but there was some aspects that required more research, including prescribed burning. Other areas identified for further work included research into fuel properties, heat transfer, weather systems, fire control technologies including infra-red scanning and mapping methods and the health effects on fire fighters.

Fire Suppression

156. The main research program into fire behaviour and suppression is Project Aquarius. The primary aim of the Project is to compare the cose effectiveness of large air tankers with that of conventional bushfire suppression techniques. Extensive research is being carried out in both fire behaviour and suppression techniques. The research program was due to finish in 1983/84 but due to adverse weather conditions, experiments using chemical retardents on high intensity fire were postponed, and no conclusive results were achieved. Preliminary results indicate that aircraft are most effective in initial attack but at the low intensity level of fires which have been studied, fire crews were just as effective.[1] The Committee considers that the successful finalisation of this research is imperative so that the proper role for aircraft can be identified.

157. Aircraft have already been shown to be useful for infra-red scanning to map the locations and rates of spread of fires. This technique was used by the CSIRO to plot their experimental fires, and used in the Warburton fire on Ash Wednesday to relay pictures of the fire front to crews. The development of this technology to provide routine real time images of fire fronts would be a most significant development in fire fighting. The Committee received a number of submissions about aerial fire fighting but considers that it is inappropriate to make any conclusions until Project Aquarius reports.

158. An important part of the Project's assessment of the relative effectiveness of suppression techniques was a study of ground attack crews and their performance at the flame front. The main purpose of these studies was to find out how fast firefighters can construct a fire break and at what fire intensity their work rate is impaired. This type of information is critical to fire control officers, but again, due to adverse weather conditions, the experiments were cancelled.

159. The cost benefit analysis part of the Project is a computer based economic model which is designed to assess the cost effectiveness of various suppression techniques under a variety of simulated conditions. The model can compare the effectiveness of aerial tankers of different capacities with the effectiveness of fire crews using bulldozers on a variety of fires in a variety of terrains, and the relative cost effectiveness of the measures.

160. The report from Project Aquarius, due to be published in the first quarter of 1985, has been postponed because of the incomplete experimentation. It was emphasised to the Committee that the future of the project is in question due to a lack of funds to finalise the experimentation period. It is essential for the Project to finish its data collection if any meaningful results are to be obtained. The Committee considers that there is immense benefit to be gained from the Project. The benefits will lie in the increased ability of land use managers and fire control officers to determine the effectiveness of control and suppression techniques. This will allow for the better planning and deployment of resources. The impact of bushfires could be substantially reduced and environmental considerations could be more easily incorporated into fire control plans.

161. The Commonwealth Government has made no commitment to the continuation of the type of research done by Project Aquarius or the retention of the Project team. In Australia there are about 23 scientists involved in rural fire research and eleven of these face retrenchment when Project Aquarius comes to an end.[2] The Committee recommends that:

- **the Commonwealth Scientific and Industrial Research Organisation provide the resources necessary to enable the completion of the experimental and data analysis phase of Project Aquarius.**

If necessary the Commonwealth should provide supplementary funds.

162. Technological development is also occurring in other areas outside Project Aquarius. One area with potential, but where progress has been slow, has been the development and application of computer models for the solution of fire prevention and suppression problems. The NSW National Parks and Wildlife Service have already made some progress in this area with their Pre-Plan Model. This model enables fire managers to predict fire behaviour under any regime of site conditions, vegetation, fuels, previous fire history and meteorological conditions. The Committee believes that this type of development has wider application and commends the Service's work to other fire management authorities. A side benefit of the preparation and application of computer models would be the establishment of data series which would assist managers and planners.

163. The development of computer models and the implementation of more effective fire management procedures would be facilitated by more effective fire mapping systems. Satellite remote sensing appears to have an application and could be used in the following way:

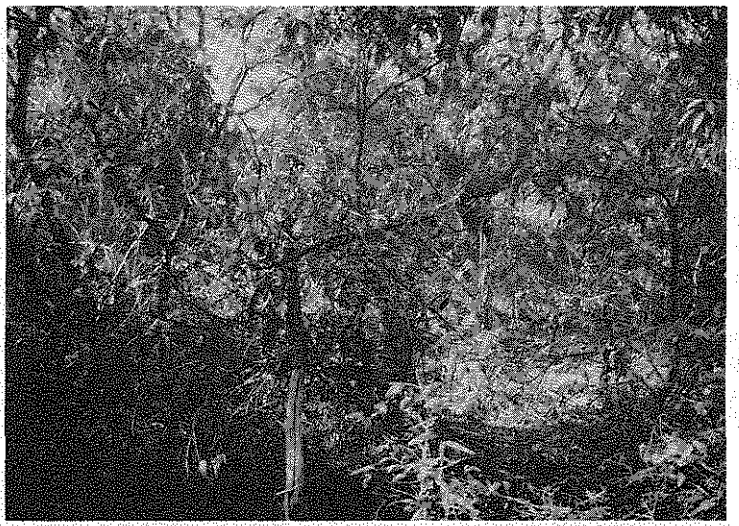
- monitoring fire events — at present the Landsat satellite has limited application to short term fire events but has proved useful in the monitoring and mapping of extended fire events in inaccessible areas. It provides the potential means of identifying, recording and establishing an inventory of fires. This could be integrated into a retrievable data base;
- monitoring of long term reconstruction of burn areas;
- preparedness planning — it should be possible with further research to prepare fuel maps useful in the determination of potential fire risk areas. Linked with information systems on topography and weather conditions, realistic forecasting procedures for fire control could be developed.

164. There are a number of investigations presently being undertaken in Australia which relate to the use of remote sensing in assessing the environmental impact of bushfires. The Committee considers that research workers need to be brought together in order to co-ordinate their findings and develop an overall strategy for the provision of an adequate bushfire mapping program suited to the needs of the Australian environment. Accordingly, the Committee recommends that:

- **the Department of Science and Technology conduct a symposium to discuss the development and co-ordination of computer modelling and remote sensing related to bushfires.**

Statistics

165. Given the serious impact of bushfires on Australian communities and the important role they play in natural ecological processes, it is surprising to find that there is no centralised collection of statistics relating to bushfires, particularly where this could lead to the development of more cost effective prevention and suppression operations. The Committee was not able to obtain basic information such as the annual cost of damage by bushfires in Australia or the total cost of bushfire prevention and protection. Data are gathered by a variety of fire control and land management authorites and very few of the data series are complete or comparable. The information which is available is not collected at State or national level. Some private organisations, for example the Insurance



Urban bushland, northern Sydney, before fuel reduction treatment.

The same location, fuel reduced using selective hand clearing.

Council of Australia, collect information from all the States but their data does not represent the total cost to the Australian community.

166. It is recognised that the task of collecting data on a national basis would be particularly difficult because there are a number of agencies in each State which respond to bushfire occurrences and which gather their own statistics. The likelihood of being able to collect and validate complete, unduplicated and standardised information is remote but such information would be very valuable to planners. Therefore the Committee sees benefit in a further invetigation of this problem and recommends that:

- **the Australian Bureau of Statistics examine the need for, and the problems involved in, a national bushfire statistic series.**

The series should include items such as fire recurrence (date, time, period of burning), location, fuel types, the value of asset losses and expenditure. An Australian standard (SAA 2577) fire event reporting system has been formulated and designed to facilitate the

Urban bushland, Wahroonga, northern Sydney, fuel reduced using controlled burning. (Helen Petersen).

collection of standardised data for computer entry. It relates mainly to urban and building fires and has limited application to bushfires, but a similar approach could be considered for the proposed bushfires statistics series.

Ecological role of fire

167. It is accepted that much of the Australian biota is adapted to fire but there is only a limited understanding of the actual mechanisms involved for many of the species. This understanding must be achieved to enable land managers to use fire as part of a management program.

168. To date, little long term research has been carried out to determine the fire intensities and frequencies which are optimal for plant species survival. In addition, the role of fire in controlling the spread of plant diseases is little understood. The Committee believes that long term research into the optimum fire regimes of plant species and the role of fire in the environment should continue in order to facilitate a better understanding of the effects of burning programs on flora and allow a more environmentally responsible approach to be made to land management.

Research Co-ordination and Funding

169. At present bushfire research is spread across a number of organisations including; various divisions of the CSIRO, universities, colleges of advanced education, national parks authorities, State forestry authorities, the Australian Museum and the National Centre for Rural Fire Research. Some of these organisations have only minor bush fire research programs while others carry out comparatively major research. The results of their work is disseminated through small groups such as the Australian Forestry Council's Research Working Group and priorities are identified by ad hoc groups or by the various organisations acting independently. The Committee is concerned that the present unco-ordinated situation could lead to inefficiency through the duplication of programs and the failure to apply the results.

170. The Committee believes that the Commonwealth and States should agree on a co-ordinated approach to bushfire research. This would include the analysis and

interpretation of research results, developing applications to practical management and the definition of new areas for research as required. The body most suited to undertake this task is the CSIRO, through its Division of Forest Research, in consultation with land management authorities. Accordingly the Committee recommends that:

- **the Minister for Home Affairs and Environment and the Minister for Primary Industry request the Australian Environment Council, the Council of Nature Conservation Ministers and the Australian Forestry Council to discuss the co-ordination of bushfire research with a view to establishing a co-ordinating unit within an appropriate authority, such as the CSIRO.**

171. It would be difficult for any organisation to undertake this task unless funding above the budgets already allocated to research were provided. The Committee considers the Commonwealth and the States should contribute jointly to the provision of staff and funds for this purpose and recommends that:

- **the Commonwealth and State Ministers responsible for bushfire matters, jointly discuss the establishment and financing of a national bush fire research fund.**

172. *This fund could be used for research and interpretation into fire behaviour and fire* suppression areas including the collection of statistical data. Expenditure from the fund could also be made available for research programs approved by a Commonwealth-State consultative body such as the Australian Association of Rural Fire Authorities.

173. The Committee is greatly concerned that after CSIRO's Project Aquarius is complete the amount of bushfire research done in Australia will be greatly reduced and the capability to do future research will be lost at the national level. This is likely to occur despite the potential of continuing research to lead to significant reductions in the loss of life and damage to property. The Committee accordingly recommends that:

- **the Commonwealth Scientific and Industrial Research Organisation maintain a significant bushfire research program after the completion of Project Aquarius.**

If the CSIRO is unable to do this research within its own organisation then the Commonwealth should consider providing resources to some other body, such as the National Centre for Rural Fire Research at the Chisholm Institute.

174. The areas in which research should be envouraged include:

- fire physics and behaviour;
- fuel reduction, including control burning;
- fire suppression techniques;
- fire meteorology;
- fire ecology, including the effects of modified fire regimes;
- technology, research and development, particularly computer modelling and remote sensing; and
- effectiveness of public education campaigns.

175. The Committee is particularly concerned that the development of fire management prescriptions will be hampered by the lack of ecological research. There is also the possibility that in the absence of such information programs will be applied which will result in unacceptable environmental damage, therefore the Committee recommends that:

- **the Commonwealth review its research priorities to determine the feasibility of increasing the funding for CSIRO research into the ecological impact of fire regimes.**

176. The lack of information about the costs and expenditure involved with bushfires

prevents the Committee from identifying the likely cost and effectiveness of research, but the indications are that research would be comparatively inexpensive and highly beneficial. One researcher for example suggested that a continuing annual program of $800 000 was required and this would lead to a fifty per cent reduction in loss of life and an eighty per cent reduction in building loss.[3] The damage done on Ash Wednesday was probably in excess of $500 million.[4] The Committee considers that a research budget of less than $1 million could therefore be easily justified.

Endnotes

1. Transcript, p. 1990.
2. Transcript, p. 2071.
3. Transcript, p. 2091.
4. Transcript, pp. 1174, 1512.

CHAPTER 7

The Commonwealth's Role

The Commonwealth as a land holder

177. The Commonwealth owns or occupies five and a half million hectares of land, not including the Australian Capital Territory.[1] Some of this land is in towns and cities or in areas not subject to bushfires. Much of it is in that part of rural Australia where bushfires are a regular occurrence. The main Commonwealth land occupiers outside the Australian Capital Territory are the Department of Defence which holds over half of all Commonwealth occupied land and the Australian National Parks and Wildlife Service which occupies about one third.

178. The Department of Defence considers that the areas it owns and leases need to be protected from bushfires if they are to continue to be used for the Department's training program.[2] The Committee agrees with this view, not only because of defence uses but also because that land has natural values which need to be protected. Additionally, the Commonwealth must be a good neighbour and not a source of bushfires.

179. The Armed Services all have fire management policies which involve preventative action, education, control and planning. Preventative measures include control burning and are based on advice from experts and authorites from outside the Department as well as from its own staff. The Department recognises that control burning can have environmental impacts. Accordingly, its management plans include provisions to reduce this impact and the Department is involved in co-operative research into control burning effects. The Committee has no reason to doubt that the Department of Defence's approach to the management of the bushfire problem on its lands is sound and supports the continued research and the further development of management plans.

180. There have been instances when bushfires have burnt from Defence land into other areas but evidently this is not a serious problem. However the Department's land holdings are very extensive and in some localities it is a major land holder. The Committee was told that the Holsworthy firing range near Sydney for example poses a bushfire problem for a number of Councils. Local bushfire authorities are reluctant to take action on a firing range because of the fear of unexploded ordinance but bushfires do not respect property boundaries and civilian firefighters will have to become involved if the Armed Services fail to contain fires before they cross the boundary of defence land. The effectiveness of State authorities in dealing with this problem would be increased if they had a full appreciation of the potential for fires occurring and spreading from Defence land and the capacity of the Defence Department to suppress fires.

181. The Committee is satisfied that co-operation between Defence and civilian organisations is adequate during and after a bushfire but it is not clear that sufficient prior consultation and joint planning occurs. The Department must work closely with local civilian bushfire control authorities, and it must be involved like any other responsible land holder, in joint planning and prevention activites. The Committee recommends that:

- **The Department of Defence review its bushfire procedures to ensure they provide for full consultation with local authorities about fire prevention and pre-fire planning.**

182. There are indications that the existence of extensive Commonwealth land holdings

presents some problems to rural fire authorities and involves them in the incursion of extra costs. In New South Wales for example the Commonwealth provides 0.08% of the ongoing costs of the States fire services. This is a payment to offset the cost of protecting Commonwealth property. However, in that State none of this payment is redistributed to rural fire authorities. The Committee considers that it is unreasonable for State and Local Government Authorities to bear these costs and accordingly recommends that:

- **the Commonwealth Departments of Administrative Services and Defence review the cost imposition to rural fire authorities caused by Defence land holdings and consider the need to provide additional financial assistance.**

If necessary the Commonwealth should establish a system to assist rural fire authorities.

183. The Australian Capital Territory is in a region subject to comparatively frequent bush fires. A large proportion of the Territory consists of forest covered hills and mountains and grazing lands. Severe fires have burnt in or through the Territory on a number of occasions since the Capital was founded. Some of these fires have been difficult to contain becuase of the rough terrain the west and south of the Territory and extreme fire weather that can occur during the summer months.

184. Most of the land in the Territory has been acquired by the Commonwealth and the Government has accepted the responsibility of protecting the Territory's residents from bushfires. The Commonwealth has also taken steps to reduce the threat of fires entering the Territory from the mountainous country to the west and to prevent fires spreading from the Territory into neighbouring New South Wales. This has involved leasing State owned land on the Territorial border for fire protection purposes, co-operating with the New South Wales authorites in fire prevention and suppression measures and establishing an authority to deal specifically with bushfires throughout the Territory.

185. The Committee believes that continued provision of proper arrangements to manage bushfires in the Territory must be considered during the development and implementation of Territorial self government. It is not appropriate for the Committee to canvass the arguments on the sort of administration which should be developed in the Territory. However it notes that the previous arrangement which placed bushfire management in the hands of a single specialist authority seemed to work well.

Management of Heritage Areas

186. There are some areas in which the Commonwealth has an interest but does not own or occupy. These are places identified as having national or international environmental significance. Five areas have been accepted for world heritage listing — Kakadu National Park, Great Barrier Reef Region, Western Tasmanian Wilderness National Parks, Willandra Lakes Region and Lord Howe Island. Only Kakadu, the Willandra Lakes and Western Tasmania have bushfire problems.

187. The Commonwealth is directly involved in the management of Kakadu which it occupies under a lease arrangement with the traditional Aboriginal owners. The plan of management for the park includes provision for a fire management policy. This is based on ecological and cultural factors and the need to protect life and property. The traditional Aboriginal owners of the park requested that the fire regimes evolved over millenia be restored. This was a major factor in determining the fire policy.

188. Most of the national and international heritage areas are subject to some form of positive management which includes bushfire protection. The Committee believes that in these areas it is essential that the proper role of fire be defined and that, where necessary, planned fire regimes be applied and protection is provided against bushfires. The Australian Heritage Commission stated that bushfires constitute a severe threat to cultural heritage in some areas.[2] Sites particularly vulnerable include Aboriginal carved and

scarred trees, other significant trees and historical houses and gardens in bush/rural areas.

189. The maintenance of the Register of the National Estate and the identification of world heritage areas is not intended to create an obligation for owners or managers to comply with Commonwealth land management objectives or to carry out any protection activities. Nor does it necessarily mean that the Commonwealth should be directly involved in these areas. Given the environmental significance and the potential for damage of fire, the Commonwealth should consider its role in fire management of areas of international and national significance. Accordingly the Committee recommends that:

- **the Minister for Home Affairs and Environment review the bushfire protection and management practices of properties of inernational and national importance.**

If this review identifies a need for the Commonwealth to provide additional resources then funds should be provided from the National Estates Grants Program.

The Commonwealth's role in fire protection

190. The Commonwealth has no direct role in bushfire prevention and suppression in the States, except to provide assistance when requested. This assistance can be quite extensive. It was reported for example that the Department of Defence used 11 bulldozers, 250 vehicles including tankers, several aircraft, miscellaneous equipment and over 3000 personnel in support of the Victorian rural fire authorities during February 1983.

191. The principle governing Defence assistance to civil authorities is that State services are responsible for combating natural disasters and civil emergencies in the first instance. Commonwealth Government resources are available for support in areas where the State authorities are unable to cope. Defence assistance will only be effective in the prevention of disasters if it is provided before an emergency situation reaches disasterous proportions. Therefore it is necessary for State authorities to anticipate when they will require assistance and they must make requests before they reach the limit of their ability to cope. It is also necessary for Defence authorities to respond quickly to these forecasts and requests.

192. It was noted that during the Ash Wednesday fires Defence assistance was good but would have been more effective if provided at an earlier stage. It was also suggested that the early provision of large numbers of personnel was not required but that there was a need to provide specialist personnel and equipment and to assist in particular tasks. Some of the Services' equipment is unique to the Defence forces but particularly useful in bushfire fighting (for example the large helicopters) and could make a significant contribution if used early enough.

193. In some areas there was confusion and ignorance about the Armed Services' resources and their potential to assist. Some authorites may have limited their requests because of a lack of knowledge of what the Services had to offer. The Committee considers that this is further evidence of the need for the Department of Defence to be more closely involved in the routine pre-fire planning by rural fire authorities.

194. The Defence forces need specific bushfire training to enable them to work more effectively with civil authorities. At present not all the Defence personnel who could be called upon receive this training. This shortcoming has been recognised by the Australian Armiy which is reviewing its training using material from the New South Wales Bushfire Council. The Committee believes that the Armed Services need to expand their training in this area to increase the effectiveness of their personnel in military and civil assistance operations.

195. The Department of Defence has made a significant contribution to bushfire disaster

mitigation and will continue to do so. The Armed Services offer mobile, disciplined and self supporting personnel able to carry out fire fighting and support duties. They have considerable resources available including aircraft and heavy earthmoving equipment. The Committee considers that if the most effective and efficient use is to be made of the Services then consierable joint planning, preparation and liaison between the Armed Services and civilian authorities is required. Accordingly the Committee recommends that:

- **the Minister for Defence review the role of the Armed Services in bushfire fighting operations and establish mechanisms to facilitate closer co-operation with civilian bushfire authorities.**

This review should cover Armed Services preparedness, including the adequacy of training, organisation and equipment.

Bushfire fighting support services

196. Fire fighting organisations throughout Australia stressed to the Committee the vital need for extremely accurate weather forecasts. Whilst the Bureau of Meteorology is regarded as providing a valuable service a number of areas were identified where improvements could be made. These relate to the need for more advanced warning of frontal movements and wind changes and more regional and local fire weather forecasts.

197. These improvements would supplement the routine fire weather services and allow fire controllers to better plan their attacks on fire fronts. Adequate warning of wind changes could also help prevent the loss of fire fighters already working on the fire. It would also help identify those areas where special measures might need to be taken to protect the public and to maintain communications.

198. To achieve these improvements the Bureau of Meteorology would need to provide at least one fire weather specialist in each State. However due to funding and staffing difficulties, the Bureau is unable to do this. To provide one specialist in each of Queensland, South Australia, Western Australia and Tasmania and two in each of the more fire prone States of New South Wales and Victoria would cost approximately $250 000 per annum. The value of the potential savings of life and property cannot be estimated but the Committee believes that the benefits obtained by using these specialists would far outweight the costs.

199. The Bureau would also need to establish a network of automatic remote weather stations. This would give up to date information and allow the Bureau to more accurately forecast the passage of south east changes. This is of vital importance in bushfire fighting because the arrival of such changes has repeatedly been associated with loss of life and fire blow ups. Again, due to technological and funding limitations, the Bureau is unable to establish an adequate network. The system would consist of stations capable of measuring wind speed and direction, air temperature, humidity and barometric pressure. In each State the remote stations would be linked to a central station through Telecom lines, Forest Service and fire authority radio networks, and special radio networks that could be established to service the system.

200. It is difficult to estimate the cost of this sytem because details of the required number and locations of the stations have not been identified. However the establishment cost would be probably less than $2 million. The Committee considers that this would be a worthwhile investment that could be spread over several years. It would greatly improve the Bureau's capability and the potential savings in life and property are large.

201. The Committee recommends that:

- **i the Bureau of Meteorology continue to provide free fire weather services**

during the bushfire season;

ii special purpose funds be provided to enable the Bureau to employ specialist fire weather meteorologists in each State;

iii special purpose funds be provided to establish a network of remote weather stations.

202. New technology is available or is being developed which will make bush fighting more effective and efficient and which may reduce the environmental impact of fire fighting operations. The new technology includes the development of aerial fire fighting using large and sophisticated systems and infra-red scanning to detect fire fronts. The equipment and support systems associated with this new technology are often beyond the capacity of individual bushfire authorities to acquire and operate. The Committee believes that the acquisition and application of new technology would be facilitated if a national co-ordinating and funding body was involved. The Commonwealth in co-operation with the States could fill this role and acquire specialised, high cost equipment and operate it in support of State bushfire control authorities. Accordingly the Committee recommends that:

- **the Natural Disasters Organisation invetigate the need for, and the means of establishing, a national bush fire fighting support service to acquire and deploy equipment that the State authorities cannot singly acquire.**

Other areas of Commonwealth assistance

203. Areas were the Commonwealth has a role in bushfire prevention and environment protection have been discussed elsewhere in this report. They include: provision of specialised services including meteorology; research and data gathering; training, and education and public awareness.

204. There are two other areas where it was suggested the Commonwealth should use its fiscal powers to provide assistance to the States. These were to encourage particular fire prevention methods and to encourage post-fire soil rehabilitation.

205. It was proposed to the Committee that the Commonwealth use its fiscal powers to encourage control burning for protection against bushfires. On the other hand it was also proposed that the Commonwealth provide incentives for the States and local government authorities to adopt more environmentally acceptable fire protection measures to replace control burning. The Committee sees difficulties in both arguments. Bushfire protection is essentially a State responsibility. The Committee believes that the Commonwealth does however have some role to play in assisting the States in bushfire prevention and suppression assistance but assistance should not be given in a way which dictates the choice of bushfire prevention and suppression strategies.

206. One of the most severe impacts of intense bushfires is the exposure of soils to erosion. The Committee was concerned at the potential for serious soil loss that could follow a cycle of bushfire and heavy rain. Consequently, the Committee considers that State Soil Conservation Authorities should implement programs to stabilise and rehabilitate soil following bushfires. The primary objectives of rehabilitation programs would be to prevent erosion in those areas where it would present the greatest hazard to public utilities such as road and water supply.

207. Soil protection works carried out in Victoria after the Ash Wednesday fires were of three types: work to hold the soil in place; work to trap moving soil, and work to stimulate the regeneration of ground cover. The Committee considers that this type of work along with fire trail repair and restoration is the most important environment protection activity that can be taken after a fire. The extent of this activity has been limited by the lack of

funds available to land management and soil conservation authorities. Consequently, the Committee recommends that:

- **the Commonwealth Minister for Primary Industry request the Standing Committee on Soil Conservation of the Australian Agricultural Council to consider formulating a proposal for Commonwealth assistance with post fire soil protection works.**

P. MILTON
Chairman
22 August 1984

Endnotes

1. Department of Administrative Services, Annual Report 1982/83.
2. *Transcript, p. 160.*
3. Australian Heritage Commission, Submission.

Appendix 1

Conduct of the Inquiry

1. On 25 May 1983 the Minister for Home Affairs and Environment referred the following matter to the Committee for inquiry and report:

(a) environmental impacts of bushfires (including consequential impacts on species diversity and ecological balance);

(b) environmental impacts of preventative and control measures (including consequencial impacts on species diversity and ecological balance);

(c) environmental impacts of bushfire risks associated with evolving and future lifestyles;

(d) potential for further development of insurance, taxation and other financial instruments to reduce environmental impact of bushfires;

(e) potential for further developing of zoning and other landuse management arrangements to reduce environmental impact of bushfires;

(f) adequacy of community information regarding fire management in natural and rural environments; and

(g) appropriate Commonwealth actions to ameliorate environmental impacts of bushfires, particularly in relation to national and international heritage.

2. On 26 May 1983 the Committee resolved to inquire into the environmental impact of bushfires, using the terms of reference proposed by the Minister. On 8 September 1983 the Committee appointed a Sub-committee to conduct the inquiry.

3. The Sub-committee has taken evidence from 102 witnesses representing Commonwealth and State Government departments and instrumentalities, local government bodies, community and environmental groups, academics and individuals appearing in a private capacity. A list of witnesses who have appeared before the Committee is at Appendix 2. The Committee has received 135 submissions and taken 2 104 pages of evidence at public hearings. Evidence given at public hearings is available for examination in Hansard form at the National Library and at the Committee Office in the House of Representatives. Public Hearings have been held in Canberra, Sydney, Brisbane, Melbourne, Adelaide, Perth and Hobart. The Committee has conducted inspections in Sydney, the Blue Mountains, Brisbane, Belgrave, Cockatoo, Upper Beaconsfield, Mt Macedon, Aireys Inlet, Nowa Nowa, Melbourne, Adelaide Hills, Manjimup and Hobart.

4. The Committee acknowledges the co-operation and assistance from all those who made submissions, assisted with inspections and to those witnesses who gave oral evidence to the Committee.

Appendix 2

List of Witnesses

ALLEN, Dr J.B.	Senior Assistant Secretary, CSIRO
ANDERSON, Mr E.M.	A/g First Assistant Secretary Department of Home Affairs and Environment
ARMSTRONG, Mr G.J.	Assistant Director, National Parks and Wildlife Service of New South Wales
BARBER, Mr J.R.	Assistant Chief Officer and Officer in Charge of Research Unit, Country Fire Authority, Victoria
BARCHARD, Mr R.P.	Executive Officer, Rural Fires Board, Queensland
BARR, Mr J.P.	Executive Officer, Natural Disasters Organisation, Department of Defence
BAYLY-STARK, Mr H.J.	Scientific Liaison Officer, National Parks and Wildlife Service, Tasmania
BENSON, Mr D.H.	Consultant Ecologist, Nature Conservation Council of New South Wales
BLANKS, Mr A.D.	Protection Officer, National Parks and Wildlife Service, Tasmania
BRIDGEWATER, Dr P.	Director, Bureau of Flora and Fauna, Department of Home Affairs and Environment
BROWN, Mr G.F.	Regional Forester, Central and Northern Sector, South Australian Woods and Forests Department
BULLARD, Mr D.A.	Bush Fire Officer, Board of Fire Commissioners of New South Wales
CATFORD, Mr A.R.	New South Wales Liaison Officer, Australian Conservation Foundation
CHAPMAN, Mr J.F.	Convener, Ad hoc Committee Bushfires, Electricity Supply Association of Australia
CHEAL, Mr D.C.	Biologist, National Parks Service, Victoria
CHENEY, Mr N.P.	Senior Research Scientist, CSIRO Forest Research
CHRICHTON, Mr T.P.	Superintendent, Research Division, South Australian Country Fire Services
CHRISTENSEN, Dr P.S.	Inspector, Research, Forests Department of Western Australia
CLAUS, Mr R.	Park Protection Officer, Queensland National Parks and Wildlife Service
CLINNICK, Mr P.F.	Catchment Investigations Officer, Soil Conservation Authority, Victoria
CORNELL, Mr B.E.	Fire Management Officer, National Parks Authority, Western Australia
CRACK, Mr B.J.	Director, Division of Land Utilisation, Department of Primary Industries, Queensland

DEMPSTER, Mr J.K.	Chief Wildlife Conservation Officer, Department of Conservation, Forests and Lands, Victoria
DONALDSON, Maj. R.G.	Chief Inspector, Army Fire Service, Army, Department of Defence
DORAN, Mr D.J.	Deputy Regional Chief Officer, Southern Region, Tasmanian Fire Service
DORMER, Mr P.	Private Citizen
DOWDEN, Dr H.G.M.	Research Officer, Wood Technology and Research Division, Forestry Commission of New South Wales
FISHER, Col. R.W.	Deputy Director, Accommodation and Works — Army, Facilities Division, Department of Defence
FREE, Mr R.A.	Assistant Commissioner, Forestry Commission of New South Wales
GILBERT, Dr J.M.	Chairman, Forestry Ecology Research Fund, Forestry Commission, Tasmania
GILL, Dr A.M.	Principal Research Scientist, Division of Plant Industry, CSIRO
GRAHAM, Mr B.J.T.	Senior Agricultural Advisor, South Australian Department of Agriculture
GRIFFIN, Prof. D.M.	Head, Department of Forestry, Australian National University
HAMER, Mr W.I.	Planning Liaison Officer, Victorian Department of Agriculture
HAMILTON, Mr M.T.	Community Education Officer Department of Conservation, Forests and Lands, Victoria
HAMWOOD, Mr K.R.	Fire Protection Officer, Queensland Forestry Department
HARRIS, Wing Comm. B.D.	Operational Requirements, Air Force Office, Department of Defence
HENRY, Mr J.P.	Deputy Chief Co-ordinator, Bushfire Council of NSW
HICKMAN, Mr J.M.	Director of Country Brigades, Tasmanian Fire Service
HOARE, Superintendant T.M.	Deputy Director, Security, Navy and Naval Provost Marshal R.A.N.
HODGE, Mr G.C.	Senior Operations Officer, Tasmanian State Fire Services
HOPMAN, Lt-Col. J.H.	Senior Executive Officer (Environment) Facilities Division, Department of Defence, Canberra
INGLES, Mr A.W.	Fire Research Officer, Tasmanian Forestry Commission
JACKSON, Capt. M.D.	Director, Joint Operations and Plans, Department of Defence
JOHNS, Mr L.C.	Director and Chief Executive, Country Fire Services Board, South Australian Country Fire Services

JOHNSON, Dr R.W.	Director, Botany Branch, Department of Primary Industries, Queensland
JOHNSTON, Mr J.B.	Fire Protection Officer, Victorian Forestry Commission
JOSEPH, Mr L.	Project Officer, Nature Conservation Society of South Australia
KAYE, Mr E.	Alderman, Willoughby Municipal Council
KENNINGS, Mr A.C.H.	Chief Health Surveyor, Ku-ring-gai Municipal Council
KOWALD, Maj. B.	Chief Inspector, Army Fire Service, Logistics Branch, Department of Defence
LANDSBERG, Dr J.J.	Chief, Division of Forest Research, CSIRO
LAWSON, Sqn Ldr K.G.	Ground Defence and Fire Services, Royal Australian Air Force
LESTER, Mr L.R.	Consultant, Insurance Council of Australia
LUKE, Mr R.H.	Consultant, Board of Fire Commissioners of New South Wales
McNAMARA, Mr P.J.	Acting Conservator of Forests, Forests Department of Western Australia
McNICOL, Mr I.	Clerk, Water Programs Branch, Department of Resources and Energy
MANDERSON, Mr A.	First Assistant Secretary, Water and Development Division, Department of Resources and Energy
MARTIN, Mr G.V.	Private Citizen
MEDHURST, Mr G.	Protection Manager, National Parks and Wildlife Service of New South Wales
MILL, Mr S.J.	Agricultural Economist, Department of Primary Industries, Queensland
MOSS, Mr F.J.	Assistant Manager, Market Services Division, Insurance Council of Australia
MOUNT, Mr A.B.	Acting Fire Management Officer, Tasmanian Forestry Commission
MUIR, Mr B.G.	Ecologist, National Parks Authority, Western Australia
MURRAY, Mrs J.	Member, Willoughby Environmental Protection Association
NEWLAND, Mr N.P.	Manager, Operations, National Parks and Wildlife Service, South Australia
NEWSOME, Dr A.E.	Senior Principal Research Scientist, Division of Wildlife and Rangelands Research, CSIRO
NICOLSON, Dr A.J.	Scientific Services Officer, Division of Forest Research, CSIRO
O'BRIEN, Mr T.R.	Director, Systems and Secretariat Section, Environment Contaminants Branch, Department of Home Affairs and Environment

ODGERS, Mr B.J.	Director, Environment Economics, Department of Home Affairs and Environment
O'LOUGHLIN, Mr T.D.	Co-director, Tasmanian Conservation Trust
PACKHAM, Mr D.R.	Director, Research, National Centre for Rural Fire Research
PETERSEN, Mrs H.M.	President, Union of Lane Cove Valley Conservationists
PHIPPS, Mr T.	Director-General, South Australian Department of Environment and Planning
PITMAN, Prof. M.G.	Director, Institute of Biological Resources, CSIRO
PRATT, Mr J.	Senior Forester, South Australian Woods and Forests Department
PRINEAS, Mr P.J.	Consultant, Nature Conservation Council of New South Wales
RAMSAY, Dr G.C.	Principal Research Scientist, Division of Building Research, CSIRO
RANKING, Col. B.G.	Assistant Director, Plans and Operations, Natural Disasters Organisation
RECHER, Dr H.	Consultant Ecologist, Nature Conservation Council of New South Wales
RICHARDS, Miss J.M.	Co-ordinator, Grass Roots Council, Victoria
RICHMOND, Mr R.R.	Fire Control Officer, Forestry Commission of New South Wales
ROBERTS, Mr R.W.	Director of Environment Research and Services, Soil Conservation Service of New South Wales
ROBLEY, Mr J.A.W.	Director, Bushfires Board of Western Australia
SHARPE, Mr P.W.M.	Honorary Secretary, Save the Dandenongs League
SHIELDS, Mr J.	Manager, Advisory Services Group, Victorian Ministry for Planning and Environment
SMITH, Mr I.F.	Fire Management Planning Officer, Tasmanian State Fire Service, Hobart
SNEEUWJAGT, Mr R.J.	Officer in Charge, Fire Protection Branch, Forests Department of Western Australia
SPIES, Mrs G.	Secretary, Willoughby Environmental Protection Association
SUSANS, Wing Comm. M.R.	Joint Operations-3, Department of Defence
TANSLEY, Mr M.R.	Town Planner, Shire of Sherbrooke
TEGART, Mr A.J.	Planning and Research Officer, Bush Fire Council of New South Wales
THOMPSON, Mr K.E.	First Assistant Secretary, Environment Division, Department of Home Affairs and Environment
TOYNE, Mr A.R.	Private Citizen
URWIN, Mr N.	Environmental Specialist, Department of Environment and Planning, New South Wales

WEATHERHEAD, Mr R.J.	Convener, System Planning Committee, Electricity Supply Association of Australia
WEBSTER, Mr R.G.	Director, Assets Management, Department of Management and Budget, Victoria
WHITE, Mr B.J.	Fire Control Officer, Warringah Shire Council
WICKING, Mr P.J.	Controller of Parks and Reserves, Willoughby Municipal Council
YORSTON, Mr R.G.M.	Senior Fire Protection Officer, National Parks Service, Victoria
YOUNG, Mr A.S.	Manager, Central Hills Sector, South Australian Department of Environment and Planning.

Appendix 3

List of Submissions

Persons and Organisations who made submissions but did not appear at public hearings.

A.C.T. Bushfire Council
APM Forests Pty. Ltd.
Abbott, Mrs P., Longley, Tas.
Abrecht, D.G., Department of Environmental Biology, Australian National University
Anglesea-Airey's Inlet Society
Arapiles Shire Council
Ararat City Council
Austwick, L., Mogareeka Inlet, N.S.W.
Avon Shire Council
Baker, Mrs L., The Basin, Vic.
Ballan Shire Council
Batson, N., Country Fire Authority, Vic.
Beer, B., Surrey Hills, N.S.W.
Bell, Mr J.E., Tecoma, Vic.
Bell, Mrs N.T., Mount Wilson, N.S.W.
Bellingen Shire Council
Bird Observers Club, Vic.
Blue Mountains City Council
Blue Mountains Tourist Association
Bourke, Mr K.A., Mosman, N.S.W.
Cheney, Mr N.P., Waramanga, A.C.T.
Coffs Harbour Shire Council
Commonwealth Treasury
Conservation Commission of Northern Territory
Conservation Council of South Australia
Cooper, Mrs H., Artarmon, N.S.W.
Cunningham, C.J., University of New England
Dandenong Valley Authority
Dawson, M., Australian National University
de Mestre, Dr N., Royal Military College
Department of Territories and Local Government
Det Norske Veritas
Echuca City Council
Energy Authority of N.S.W.
Far South Coast Environment Group
Forest Products Association
Fox, Dr J.E.D., Western Australian Institute of Technology
Gould League of N.S.W.
Greater Lithgow City Council
Greater Taree City Council
Greenland, J., Tathra, N.S.W.
Groom, Mrs J., Niddrie, Vic.
Hampden Shire Council
Harrison, J., Country Fire Authority, Vic.
Hawker de Haviland Australia Pty. Ltd.

Hawkesbury Shire Council
Healesville Shire Council
Heidelberg City Council
Hobbs, Dr J.E., University of New England
Hudson, Mr K.B., Upper Beaconsfield, Vic.
Huntington Moore, J., Winton, Vic.
Ingwersen, Mr F., Higgins, A.C.T.
Ipswich City Council
Jensen, Mr R., Wentworth Falls, N.S.W.
Johnson, Mr P.C., Ruse, N.S.W.
Ku-ring-gai Bushland and Environment Society
Lane Cove Bushland and Conservation Society
Lane Cove Municipal Council
Livestock and Grain Producers' Association of N.S.W.
Lower Blue Mountains Conservation Society
McKinlay Shire Council
McMonigal, Mr I.C., Valley Heights, N.S.W.
Milne, Dr A.K., University of New South Wales
Minister for Administrative Services
Minister for Science and Technology
Mosman Parklands and Ashton Park Association
Mount Arthur Reserve Trust
Mount Wilson Voluntary Bushfire Brigade
Mudgee Shire Council
Myrtleford Shire Council
Nambucca Shire Council
National Capital Development Commission
National Parks Association of N.S.W.
National Trust of Australia (New South Wales Branch)
National Trust of Australia (Victorian Branch)
Neighbours of National Parks Association
Nelson, F., Cressy, Vic.
Nobel, Dr I., Australian National University
Omeo Shire Council
Orange Field Naturalist and Conservation Society
Pakenham Shire Council
Pal, Mr J., Ivanhoe, Vic.
Parish, Mr C., Garfield, Vic.
Parris, Mrs M.J., Merimbula, N.S.W.
Pearce, Mrs H.P., Allambie Heights, N.S.W.
Pritchard, Mr A., Dover Heights, N.S.W.
Rogers, G.W., Bacchus Marsh, Vic.
Russell, Mr R.B., Bullengarook, Vic.
Seymour Shire Council
Shackleford, Mr R., Emerald, Vic.
Simon, Clarke, St. George Pty. Ltd.
Smith, K.W.V., Stirling, S.A.
South-West Forests Defence Foundation
Stawell Shire Council
Strathfieldsaye Shire Council
Strider, Humpty Doo, N.T.
Tambo Shire Council

The Australian Heritage Commission
The High Ridge Creek Conservation Society
Townsville Regional Conservation Council
Treasure, Mr A.J., Bairnsdale, Vic.
Upper Yarra Shire Council
Upper Yarra Valley & Dandenong Ranges Authority
Wakool Shire Council
Warfe, L., Dromana, Vic.
Warringah Shire Council
Wright, Dr H., Roseville, N.S.W.

Appendix 4

List of Exhibits

1. COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANISATION
   Appendix 3, 4, 5 of CSIRO Submission dated September 1983
2. COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANISATION
   Infra-red Photographs of Ash Wednesday Fires in Victoria
3. COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANISATION
   'A Survey of Houses Affected in the Beaumaris Fire, January 14 1944'
4. COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANISATION
   Photographs of Impact of Ash Wednesday Bushfires on Housing
5. BOARD OF FIRE COMMISSIONERS N.S.W.
   'Bushfire Risks in the Willoughby Municipality'
6. VICTORIAN STATE GOVERNMENT
   Pamphlets on Fire Prevention
7. FORESTS COMMISSION OF VICTORIA
   Pamphlets on Fire Prevention
8. MR J.B. JOHNSTON, FORESTS COMMISSION OF VICTORIA
   'Fire Prevention and Suppression on Forested Public Lands in Victoria', Submission presented on behalf of the Victorian Forestry Commission
9. STATE ELECTRICITY COMMISSION, VICTORIA
   Pamphlets on Bushfire Prevention
10. MR A.R. TOYNE
    Statements Relating to a demonstration of the Bushbaby Fire Shelter
11. MR L.C. JOHNS, DIRECTOR, SOUTH AUSTRALIAN COUNTRY FIRE SERVICE
    'South Australian Country Fire Services — 1984 and Beyond'
12. SOUTH AUSTRALIAN STATE GOVERNMENT
    Summary of Fire Statistics 1974–75 to 1982–83
13. TASMANIAN FORESTRY COMMISSION
    Fire Management Planning Course 1983, Manual and Source Documents
14. TASMANIAN FORESTRY COMMISSION
    'Possible Bushfire Mitigation Roles for the Commonwealth'
15. TASMANIAN FORESTRY COMMISSION
    'Guidelines for Fuel-Reduction Burning Under Dry Forests'
16. TASMANIAN FORESTRY COMMISSION
    'Fire and Forest Management in Tasmania'
17. COMMONWEALTH SCIENTIFIC & INDUSTRIAL RESEARCH ORGANISATION
    Graph of Comparison of Canadian and Australian Data on Suppression Effectiveness of Fire Retardant and Water

18. DEPARTMENT OF HOME AFFAIRS AND ENVIRONMENT
'Tree and Vegetation Loss: A Case Study of the Australian Response'

19. DEPARTMENT OF HOME AFFAIRS AND ENVIRONMENT
Statement of Kakadu Bushfire Policy

20. NATIONAL CENTRE FOR RURAL FIRE RESEARCH
Data on Survival of Houses During Bushfires