2009 Victorian Bushfires Royal Commission

Expert Witness Statement of Richard Sneeuwjagt

I, RICHARD SNEEUWJAGT, of care of the Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, in the State of Western Australia, state as follows:

A. Introduction

1. I am currently employed as the state Manager of the Fire Management Services Branch (**FMS**) of the Department of Environment and Conservation (**DEC or Department**) previously known as the Department of Conservation and Land Management (**CALM**).

2. I have held this position continuously since 1992.

3. My functions, roles and responsibilities include senior oversight and coordination of all fire management operations conducted in Western Australia; review and development of fire management policies, practices and standards; liaison at State, national and international levels on strategic fire issues; the development and roll-out of fire planning; fire monitoring and data and information systems, radio and satellite communications; application of fire research; fire training programs; provision of fire equipment; and aviation services.

4. As the State Fire Manager, I oversee the coordination of fire management programmes provided through FMS Branch. The delivery of the fire management services is undertaken by the Department's Regions and Districts. The FMS Branch that I head is responsible for ensuring that the Department's fire management policies, plans and standards are understood and properly applied by all staff involved in fire programs and services.

5. From 1984 to 1991 I held the position of the Principal Fire Officer within the Fire Protection Branch of CALM. In that position I had primary responsibility for coordinating the Department's fire prevention, planning, prescribed burning and fire training program, development and delivery.

6. During 1980 to 1983 I held the position of Regional Leader in Forest Protection and Regeneration in the Southern Forest Region of the WA Forests Department based at Manjimup. I was responsible for developing, planning and coordinating the fuel reduction burning strategy for the southern forest types that includes the karri and tingle 'moist' forest ecosystems.

7. From 1977 to 1980 I held the position of District Manager of Pemberton Forest District (Forests Department) with responsibilities for leadership and administration of all activities within the District including forest management, fire protection, prescribed burning, recreation and tourism, and nature conservation.

8. From 1969 to 1976, I held the position of Fire Research Scientist at the Manjimup Research Station where I was responsible for forest fire behaviour research that involved the conduct of about 200 experimental fires within native forest types, pine plantations and grasslands. I was primarily responsible for the research and analysis that lead to the development of the Forest Fire Behaviour Tables or "Red Book" (Sneeuwjagt and Peet, 1976[1]). The Red Book is used by WA fire managers to predicting forest fuel moisture contents; fire spread rates, fire intensity and scorch heights. This information is required to determine correct timing and spacing of ignitions to achieve the desired burn outcomes.

9. In 1973 and 1974 I achieved a Master of Science (Fire Research) at the University of Washington, Seattle, USA involving a study of the fire behaviour and fuel models of the US National Fire Danger Rating System.

10. Since 1984, I have been a key contributor to the development and implementation of the Department's fire management policies and practices including strategic fire management planning systems; prescribed burning planning and applications programs; fire threat and risk analysis and assessment decision tools; strategic burning plans and buffer systems; fire training and development programs.

11. Since 1992 I have undertaken the responsibilities of the Department's State Fire Coordinator for many of the large, complex fire emergencies on Departmental lands.

12. I have published more than 30 scientific papers and articles on fire research, fire management and related topics. I have presented papers on fire management and prescribed burning at numerous national and international Fire Conferences and forums throughout the world.

13. I have held a number of positions of leadership in fire and emergency management at State and National levels that include the following:

    - National Chair (2004 to 2008) of the Australasian Forest Fire Management Group (FFMG)which consists of the leaders in fire management of forestry, parks and rural land management agencies throughout Australia and New Zealand.
    - Director Australasian Fire Authorities Council (AFAC) in 1995-2002, and national Chair of the AFAC Rural Fire and Land Management Strategy Group (1997-2001).
    - Member of the United Nations Wildland Fire Advisory Group and Australia's representative on the FAO Fire Experts Group responsible for developing the International Fire Management Code.

[1] Sneeuwjagt, R.J. and Peet, G.B. (1976). *Forest Fire Behaviour Tables for Western Australia*. Forests Dept WA.

- Australia's representative on the International Liaison Group responsible for coordinating the programming of the International Wildland Fire Conferences and the International Wildland Fire Summit. I was the Director for the speakers program for the 3rd International Wildland Fire Conference in Sydney, October 2003.
- Coordinator for Australia and New Zealand deployment of 118 fire fighters/specialists to USA to assist with large fires in August – October 2006.

14. In 2008, I was awarded the Australian Fire Service Medal for my contribution to fire management services over 40 years.

B. DEC's Fire Management Role

15. DEC is the lead agency responsible for conserving Western Australia's rich diversity of native plants, animals and natural ecosystems, and many of its unique landscapes. It is also responsible for regulating protection of the environment including the quality of air, water and soil. Under the *Conservation and Land Management Act 1984* (CALM Act), DEC manages more than 27 million hectares of lands and waters, including national parks, marine parks, conservation parks, regional parks, State forests and timber reserves, nature reserves, and marine nature reserves.

16. Sections 33(1)(a) and 33(3) of the CALM Act provide for the Department to manage lands to which the Act applies, according to management plans or, in the absence of a management plan, in accordance with the necessary or compatible operations provisions of the Act depending on the land category. Fire management activities are subject to these provisions.

17. Fire Management for biodiversity conservation and community protection is a key responsibility of DEC. DEC has direct statutory management responsibility for lands under the CALM Act, but also has fire preparedness responsibility on a further 89 million hectares of unallocated Crown land and unmanaged reserves in the State.

C. Bushfire Responsibilities within Western Australia

18. Under the Western Australian Emergency Management Arrangements that are outlined in the State Emergency Management Committee Policy Statement No. 7, the Department is recognized as the Hazard Management Agency (HMA) for wildfires on DEC-managed lands. Under these arrangements, the HMA "is responsible for ensuring that emergency management activities pertaining to the prevention of, preparedness for, response to and recovery from a wildfire are undertaken". The HMA's responsibilities include the preparation of a strategic plan or arrangements (WESTPLAN-BUSHFIRES) that is designed to cope with wildfires on or near DEC-managed lands, and that includes details of joint agency operational arrangements.

19. Under the existing legislative arrangements, bushfire management responsibilities within Western Australia are shared between DEC, the Fire and Emergency Services Authority (FESA) and local government authorities. Each of these organisations has the authority and responsibility to manage bushfires and to command resources within its own jurisdiction.

20. *Fire and Emergency Services Authority of Western Australia (FESA).* In accordance with Part II 5(2) of the *Fire Brigades Act 1942*, FESA has operational responsibility for bushfires inside gazetted fire districts. These districts include most rural townships, regional centres and the greater portion of the Perth metropolitan area. FESA also supports local governments by providing adv ice on technical and operational matters and training volunteers.

21. FESA may assume control of fires on local government controlled land if required to do so by the relevant local authority. FESA may also assume control of fires if the Minister for Emergency Services declares a bushfire emergency or if a bushfire emergency period is declared in the designated area. Under recent changes to the Bush Fires Act 1954, Section 13(4)(5) FESA can assume control of fires on DEC-managed lands depending on the nature and extent of the bushfire emergency.

22. *Local Government Authorities* are responsible for the establishment and management of Bush Fire Brigades and for extinguishing fires on areas outside the Gazetted Fire District, with the exception of DEC-managed lands. Bush Fire Brigades also respond to fires burning on Unallocated Crown Land (UCL) outside of Gazetted Fire Districts.

23. Under section 45(a) of the *Bush Fires Act 1954*, a local government is able to request FESA or DEC to take control of a large bushfire. Of the local governments with bushfire responsibilities, 76 have initiated formal handover agreements with FESA for this eventuality.

24. *Department of Environment and Conservation*. Under the WESTPLAN-Bushfires plan, the DEC is recognized as the lead bushfire agency for bushfires on DEC-managed lands covering 26 million hectares. In July 2003, the Department was allocated the role of managing fire preparedness and prescribed burning on non-metropolitan, non-townships unallocated Crown land (UCL) and unmanaged reserves that cover about 89 million hectares throughout the State. The responsibility for fire suppression on these lands remains with local government authorities.

D. Overview - Fire Management in the forested regions of South-West of Western Australia

25. This statement is limited to discussing the role and use of prescribed burning in the south-west of Western Australia as this is the most similar to the forests, parks,

farmlands and rural communities in most parts of Victoria (except the Mallee and Wimmera regions).The south-west forest regions contain about 2.4 million hectares of DEC-managed lands that include State forests, National Parks, Nature Reserves and other categories of conservation reserves. The regions outside of the south-west of Western Australia do not possess contiguous forests, and do not have the relatively high population and community assets that are present within the south-west region. The approach to bushfire mitigation in the more 'remote' regions is mostly focused on narrow buffer burning and maintenance of access tracks and fire breaks.

26. The bushfire hazard in the south-west of Western Australia is as severe as any region in the world. It is one of the few regions in the world that has the combination of tall forests, which shed tonnes of highly flammable material each year, and a strong Mediterranean-type climate with cool wet winters and warm to hot dry summers. Vegetation is flammable for five to seven months each year during which there are periods of high temperatures, low humidity and high winds generated by unstable frontal movements, intense low pressure systems (cyclone remnants), deep coastal troughs and strong land and sea breezes. This gives rise to many days of Very High, Severe and Extreme fire danger in the south-west. On average 3 to 5 days of Catastrophic fire danger days occur each year in parts of the south-west.

27. The combination of flammable vegetation and climate, together with lightning and humans as an ignition source, has ensured that fire has been an environmental factor that has shaped ecosystems in Western Australia (like other ecosystems) over many thousands of years. Consequently, native species and ecosystems have evolved physical and behaviour traits that enable them to not only persist with fire, but in many cases, depend upon certain fire regimes.

28. Prescribed or planned fire is used in Western Australia as a tool for fuel hazard reduction and bushfire mitigation and for ecosystem management. Planned fires are also used to maintain and enhance nature conservation values (eg: protecting and regenerating a diversity of wildlife habitats; rehabilitating degraded areas; creating a diversity of post-fire seral stages, etc); and maintaining ecosystem processes such as nutrient cycling. Planned fire is also used to achieve land management objectives such as water catchment management and the regeneration of native forests and understorey vegetation associations after disturbance by timber harvesting.

29. In many cases, planned burns are undertaken at landscape scales to achieve both protection and ecological management objectives by varying the seasons, fire intensities, and the interval between fires.

30. The Department has an obligation to ensure that the fuel hazard on the public land which it manages does not pose a serious threat to human life and property as a consequence of wildfires. As a land management agency, DEC recognizes that in fire-prone environments, proactive fire management in particular prescribed

burning, is integral to, not incidental to, good conservation and land management. If wildfires cannot be managed, then it is unlikely that other land management objectives will be achieved.

E. Fire Management Policy and Code of Practice

31. DEC's fire management business is guided by a comprehensive policy document (Policy Statement No. 19[2] [Attachment 1]. The policy contains the fire management objectives for DEC-managed lands and policy statements pertaining to safety and risk; use of fire; fire suppression; wildlife prevention; liaison; and research. Also included in the policy are a set of Principles for Fire Management and the requirements for policy implementation. The policy was updated in October 2005 following a comprehensive round of public consultation and review by the Environmental Protection Authority (EPA).

32. DEC has also prepared a Code of Practice[3] [Attachment 2] for fire management which provides a framework for fire management and procedures on lands managed by the Department (DEC-managed lands). The Code is intended to enable the efficient, effective and safe management of fire on Departmental lands to achieve land management objectives, and protect human life, property and environmental values from the deleterious effects of wildfire or inappropriate fire regimes.

F. Historical Development of Current Fire Management Policies

33. There is considerable evidence that prior to European settlement of WA in 1829 (Swan River), Nyoongar Aborigines used fire widely and frequently for a myriad of reasons, although the actual frequency with which Aboriginal people burn the forest is debatable. Following European settlement, there was little attempt to deal with bushfires in the south-west until after the passage of the Forests Act in 1918 and the establishment of the Forests Department in 1919.

34. From 1924 through to the 1950's there was an attempt to protect from fire large compartments of forests that had been cut over and regenerated. Some narrow strip burning between firebreaks was undertaken in the remainder of the forest, but most of it simply burnt from time to time in bushfires.

35. By the 1940's the absence of a program of broadscale planned burning and improved fire suppression saw heavy fuels steadily accumulating with time in most forest areas. From the late 1930s onwards, wildfires had started to become very large and difficult to control as fuels accumulated across the region. In the long protected compartments fires became uncontrollable once they exceeded about a hectare in size, even under mild weather conditions.

[2] Department of Environment and Conservation (DEC) (2005). Fire Management Policy. Policy Statement No. 19.
[3] Department of Environment and Conservation (DEC) (2008). Code of Practice for Fire Management, May 2008.

36. In recognition that the attempted fire exclusion policy was failing, and as foresters better understood the role of fire in the environment, the Forests Department in 1953, introduced a policy of broadscale prescribed burning to manage fuel build-up. Because of the heavy fuels in most of the areas to be prescribed burnt, implementation of the policy was cautious and slow at first. Most of the initial burning in the northern jarrah forests was actually done in winter. In the late 1950's, there was reasonable progress in ground burning programs in some parts of the dry jarrah-marri forests in the northern forest regions. However, little effective burning was actually undertaken in the dense southern forests, principally because of lack of access and problems with predicting fire behaviour in complex karri and karri-tingle fuels. Up to 1960/61 there remained large tracts of forests throughout the south-west that were long unburnt and carried heavy fuel accumulations that would feed intense conflagrations that occurred during the 1960/61 fire season.

37. The inevitable consequence of the early policy of the restricted use of broad scale burning culminated in massive wildfires in the summer of 1960/61. Preceded by drought, ignited by numerous lightning strikes and fanned by strong hot winds, intense wildfires swept through the forests of the south-west. The town of Dwellingup was burnt, as were the smaller settlements of Holyoake, Nanga Brook and Karridale. There were serious losses of houses, buildings, infrastructure, pasture, stock and fencing. Fortunately no one died in the fires, but many were injured, and the cost to the community was enormous.

38. In the wake of the 1961 fires, a Royal Commission was held. The report of the Commission (Rodger, 1961[4]) contains many recommendations concerning measures necessary to prevent and control bushfires. From the point of view of the Forests Department, recommendation 20 was the most significant. It read:

> ***"The Forests Department (is to) make every endeavour to improve and extend the practice of control burning to ensure that the forests receive the maximum protection practical consistent with silvicultural requirements."***

39. This did not represent a complete redirection of policy for south-west forests, rather it endorsed the policy which had been adopted in 1953. The Royal Commission's recommendations were adopted in full by the Government of the day, and have not been rescinded over the intervening years.

G. Research and Operational Developments in the Wake of the Dwellingup fires

40. Since 1961 fire scientists and fire practitioners in Western Australia's Forests Department , and the successor agencies (CALM and DEC), have developed a

[4] Roger, G.J. (1961). Report of the Royal Commission appointed to enquire into and report upon the bushfires of December 1960 and January, February and March 1961, in Western Australia.

sound understanding of how forest, woodland and plantation fires behave (their speed and intensity) under different conditions of fuel quantity, fuel moisture content, weather and topography. (McCaw, Cheney and Sneeuwjagt 2003[5]). In parallel with the fire behaviour research, extensive studies have been undertaken on the fire impacts on biota and ecosystem processes in major forest types in Western Australia.

Major themes in the outcomes of the research and developments that occurred in the wake of the 1961 bushfires are as follows.

Fire Behaviour

41. The research undertaken in WA forests has resulted in the development of fuel accumulation and fuel moisture models. This knowledge was incorporated into the Forest Fire Behaviour Tables (Sneeuwjagt and Peet, 1976) known locally as "The Red Book" (Attachment 3). The Red Book is used today by DEC managers and field staff in planning and implementing prescribed burns programs and wildfire suppression operations. Live and dead vegetation (fuel) powers a bushfire. The fundamental relationship between fuel structure and quantity, and the speed and intensity of a forest fire, has been well established since the 1960's. Reducing the amount of fuel over a significant proportion of the landscape by prescribed burning will significantly reduce the potential speed, intensity and damage potential of wildfires and greatly improves opportunities for safe suppression. This is the rationale behind prescribed burning.

42. The effect of fuel conditions on fire behaviour has been most recently investigated by **Project Vesta** (Gould et al, 2007[6]). This national study involving CSIRO and CALM (now DEC) and a variety of fire and land management agencies was conducted in the dry eucalypt forests of Western Australia, and examined the relationships between fuel age and fire behaviour by quantifying age-related changes in fuel attributes and fire behaviour in dry eucalypt forests typical of southern Australia. More than 100 experimental fires were lit under dry summer conditions of moderate to high fire danger at two sites with different understorey vegetation types ranging in age from two to 22 years since fire.

43. The fire behaviour research has demonstrated that the forward rate of spread of a fire is directly related to characteristics of the surface fuel bed and understorey layers, with the near-surface fuel layer having the strongest effect on rate of spread. The near-surface layer provides a common fuel descriptor for a wide

[5] McCaw, W.L., Cheney, N.P. and Sneeuwjagt, R.J. (2003). "*Development of scientific understanding of fire behaviour and use in south-west Western Australia*". In: Fire in ecosystems of south-west Western Australia : impacts and management (Edit. I Abbott and N Burrows). Backhuys Publishers.

[6] Gould, J.S., McCaw, W.L., Cheney, N.P., Ellis, P.F., Knight, I.K., Sullivan, A.L. (2007) Fire in dry eucalypt forest: fuel structure, fuel dynamics and fire behaviour. Ensis-CSIRO, Canberra ACT, and Department of Environment and Conservation, Perth WA.

range of dry eucalypt forest types that are visually very different because of the characteristics of the understorey shrubs. Experimental data also confirmed the influence of understorey shrub height on flame height, and the contribution of bark characteristics and surface fire intensity to the spotting process.

44. The Vesta Study found that the persistence of the effect of prescribed burning in reducing the fire behaviour and spotting potential is determined by the rate of change in fuel characteristics over time, but a measurable benefit may last for up to 20 years in some forest types.

45. The Project Vesta experiments indicate that fires in fuels older than about seven years will prove difficult to control under average summer conditions of High to Very High fire danger in open eucalypt forest. This finding is consistent with the conclusions of the Victorian study by McCarthy and Tolhurst (2001)[7] which found that forests with an overall fuel hazard above the High category offered little prospect of assisting wildfire suppression.

46. There will be circumstances when conditions exist that produce abnormally severe fire behaviour. Such occasions appear to have occurred during the 2003 Canberra fires and the 2009 Victorian "Black Saturday" bushfires. Further research is needed to understand fire-atmospheric interactions leading to abnormal fire behaviour, including conditions immediately after a dry cool change.

Fire and Biodiversity

47. The decision to expand the use of low intensity planned fire to manage wildfire in Western Australian forests in the 1960's initiated a comprehensive program of scientific research and technical development to underpin fire operations. This research has been summarized in a book, "Fire in ecosystems of south-west Western Australia: impacts and management" (Abbott and Burrows, 2003[8]).

48. Studies into effects of forest fires on soil physical and chemical properties, flora, fauna, water resource values and forest regeneration commenced in the early 1960s and have continued since. This work has resulted in a major increase in knowledge about forest and some non-forest ecosystems and their response to fire. While knowledge is incomplete, there is an adequate knowledge base to devise and implement fire regimes that are likely to be beneficial to the environment.

[7] McCarthy, G.J. and Tolhurst, K.C. (1998). *Effectiveness of Broadscale Fuel Reduction Burning in Assisting with Wildfire Control in Parks and Forests in Victoria*. Fire Research Report No. 51. Dept of Natural Resources and Environment, Victoria.

[8] Abbott, I. and Burrows, N.D. (2003). (Editors) *Fire in ecosystems of south-west Western Australia: impacts and management*. Backhuys Publishers.

49. The following key scientific principles, which in various forms have been embraced by a number of Australian conservation and land management agencies, are applied to guide fire management in south-west Western Australia biomes:

- The vegetation and climate of south-west Australia make it highly prone to bushfire. Native species and communities have developed a variety of physical and behavioural adaptations to many, but not all, fire regimes.

- Species and communities vary in their adaptations to, and reliance on, fire. Knowledge of the temporal and spatial scales of fires in relation to the life-histories of organisms or communities involved underpins the planned use of fire in natural resource management.

- The biological impact (killing power) of a single fire event and the rate of recovery (of bushland and/or of human communities) is proportional to the intensity and size of the fire. Very large and intense wildfires cause high levels of mortality and damage to native plants and animals, and irreversible loss of topsoil. Post-fire recovery may take many decades, or even centuries where old-growth forests have been killed. On the other hand, low intensity, patchy fires have little long term impact on the biota, which recovers relatively quickly from such events.

- Fire diversity (diversity of frequency, intensity, season and scale) benefits biodiversity at the landscape scale. A mosaic of patches at difference seral stages from recently burnt to long unburnt will provide greater habitat diversity than large homogenous tracts of either long unburnt or recently burnt vegetation.

50. The use of planned fire (prescribed burning) is controversial, with opponents claiming that it is environmentally damaging. While some extreme fire regimes can be harmful to the environment, especially in combination with other factors such as fragmentation and invasive species, there is no evidence that current prescribed burning for fuel management and other purposes has resulted in any species losses or in any other environmental degradation. In fact there is growing evidence that, implemented correctly (appropriate interval, intensity, season and scale), prescribed burning can benefit biodiversity at the landscape scale by providing diverse habitats (seral stages) and by reducing the size and intensity (severity) of damaging wildfires.

H. Aerial Prescribed Burning

51. In the 1960s it was apparent that there were insufficient personnel and other resources to undertake the amount of prescribed burning that needed to be done during the limited number of suitable burning days by the traditional method of strip burning by teams of people walking through the forest. A technique for lighting prescribed fires by dropping incendiaries from aircraft under specific

conditions of fuel and weather was conceived and developed in Western Australia. Not only did this allow more area to be prescribed burnt under the desired (prescribed) fuel and weather conditions, it was much safer and less expensive than using ground crews. DEC has lead the development of a compact and fast-action, automated aerial incendiary machine that provides great flexibility for lighting up both small (200 ha) and large burn areas (up to 15,000 ha) with rotary and fixed-wing aircraft. The Department hires up to three aircraft during the peak burning periods in order to achieve the planned burn programs throughout the state.

I. Land Management Objectives

52. Prescribed fire is used by DEC to achieve a range of land management objectives including the protection of human lives and community assets; conservation and maintenance of ecosystem health and productive capacity; conservation of soil, water and catchment values; regeneration and protection of native forests and plantations; and protection of natural and cultural heritage, recreation sites and scenic values.

(i) Conservation and Protection of Biodiversity

The Department has set fire management objectives at landscape scales that include the maintenance of biodiversity, diverse ecosystem structures and habitats, and protecting relatively fire-sensitive ecosystems and niches from frequent fires and from large, intense bushfires. The management strategies that are applied to achieve these objectives include the use of planned fires to develop and maintain an interlocking mosaic of recently-burnt and long-unburnt patches of vegetation, and patches burnt in different seasons and intervals between burns. Maintaining diverse fire regimes that vary in season, frequency, intensity and patchiness provides a range of habitats and opportunities for native plants and fauna, given that no single fire regimes is optimal for all species and ecosystems.

Burn patchiness and protection of fire-sensitive habitats is best achieved by low intensity fire set under moist conditions in spring or autumn months, when variation in fuel moisture across the landscape will result in patchy burn patterns. Relatively fire-sensitive ecosystems are best protected by burning the more flammable and fire-resilient ecosystems in which they are embedded. On the other hand, intense summer bushfires under dry conditions are less patchy, can impact large areas, and burn more habitat elements. Fire management programs, including prescribed burning must restrict the size, intensity, frequency and impact of bushfires on ecosystems and species.

(ii) Catchment protection and water production values

53. Prescribed burning has been an important aspect of catchment protection in the surface water catchments of Perth's water supply reservoirs for many decades. There have been very few instances where intense wildfires have caused

detrimental impacts such as sedimentation and turbidity in these catchments. This is due to the prescribed burning program that has established and maintained a mosaic of low fuel areas that ensure that the size and intensity of wildfires is minimized. The notable exceptions to this general pattern occurred following the Mt Cooke wildfire in 2003 and the Mundaring-Karragullen wildfire in 2005, both described below. The winter rains that followed these two fires produced significant erosion and sedimentation impacts in parts of the catchments of the Serpentine and Mundaring reservoirs.

54. There have been no recorded instances where broadscale low intensity prescribed burning has caused erosion, sedimentation or turbidity in Perth's catchments.

55. Research and operational trials have shown that there can be significant increases in streamflow and surface water yields where strategic prescribed burning is carried out in forested catchments compared with leaving catchments in a long unburnt state. Western Australia's water supply authority, the Water Corporation, and the water regulator, the Department of Water, are both strong advocates of DEC's prescribed burning program. This support is founded on the contribution to both catchment protection and water production. The Water Corporation makes a financial contribution towards the completion of several strategic prescribed burns in Perth's catchments each year.

(iii) Regeneration and protection of native forest and plantation timber values

56. Prescribed burning is used to regenerate native jarrah and karri forests following timber harvesting in the south-west. The benefits include the stimulation of seedfall, seedbed preparation and the removal of logging debris that could increase the risk of future damage to the regenerated trees.

57. Regular prescribed burning also plays a part in the thinning of sub-dominant seedlings and young regrowth trees and in maintaining the health of the forest ecosystem through understorey regeneration and nutrient cycling.

(iv) Protection of Recreational and Visitor Sites

58. The forested areas of the south-west WA are widely used for a range of recreational pursuits. These include camping, bushwalking, cycling, picnicking, orienteering, regaining, motor sports, inland fishing and many others. DEC has a duty of care to provide for the safety of the visitors who are welcomed on to DEC-managed lands.

59. One aspect of visitor risk management is the reduction of forest fuels, which if left unburnt could result in a wildfire that causes loss of life and property. DEC implements buffer burns around high use recreation sites, but an equally important action is the mosaic of burning carried out more broadly throughout the forest areas, that will reduce the incidence of high intensity and fast moving wildfires.

J. Planning for Prescribed Burning

60. The Department's fire management planning aims to identify all the potential environmental, social and economic risks associated with wildfires and prescribed burning operations on Department-managed lands.

61. The Department has adopted a risk management process consistent with the Australian/New Zealand Standards for risk management that includes the following contributing factors:

- The values at risk from wildfires or inappropriate fire regimes;
- The probability of wildfire occurring and impacting on vulnerable assets;
- The likely wildfire behaviour;
- The capacity for rapid detection and effective fire response to wildfires;
- The capacity for suppression of wildfire and the potential consequence for local communities and the environment.

62. The fuel reduction burn program is targeted to favour those areas adjacent to more populated communities, where there is a higher risk of wildfires starting and impacting on lives and assets.

63. Fuel reduction burns are required to have threshold levels of burn cover (usually greater than 60 percent) and fuel quantities in major forest fuel types which represent the limits beyond which fire behaviour in summer conditions will be severe and too dangerous to be suppressed. To achieve these "burn cover" and "fuel quantity" thresholds usually requires multiple ignitions that enable forest fuel types with different drying regimes to be burned safely and effectively.

64. In order to achieve the standards for burn cover and fire behaviour in multiple ignition forest burns, burn controllers rely on The Forest Fire Behaviour Tables ("Red Book") to provide reliable predictions on the fuel moisture contents and fire behaviour for each forest fuel structural types. It is considered that the Red Book is far more accurate and useful than the McArthur Forest Fire Danger Meter Mk V,(McArthur A.G.1973[9]) used in other Australian states and territories. The key advantage that the Red Book has over the McArthur Meter is that it provides reliable estimates under prescribed burning conditions of the following factors that influence fire ignition, fire spread and fire intensity for the major WA forest fuel types;

- Surface Litter Moisture Content;
- Profile Moisture Content
- Proportion of fuel bed available to burn

[9] McArthur, A.G. (1973). *Forest Fire Danger Meter*. MEV

- Available fuel quantities of the surface and near-surface litter ; understorey shrub fuels
- Fuel accumulation rates and fuel load estimates under different moisture contents.
- Wind speed ratios (Canopy to Ground) for varying forest types and densities
- Hours of burning available under different weather and fuel conditions
- Guides on ignition patterns and burning hours available to safely achieve burn objectives

This information is essential in determining the most suitable burning conditions for mixed forest types which dry out at different rates and can only be burned safely on separate days when the fuel moisture and weather factors match the prescribed conditions.

65. Forest fire managers in south-west of WA aim to maintain fine surface fuel quantity (dead leaves, twigs, bark of <6 mm diameter) below about 8 - 9 tonnes per hectare and 15–19 tonnes per hectare for jarrah and karri forests respectively, over about 50 percent of the forest area. The higher fuel loading for the karri reflects its more mesic, hence less flammable condition over longer periods during the year. The time taken for fuels to reach these levels depends on the rate of accumulation. This varies across the forest from about 6 to 9 years, depending on the site productivity and rainfall.

66. Where forest fuels are less than 3–4 years since last fire, fires will be of low intensity and are relatively easy to control even under severe fire weather conditions because there is insufficient surface fuel to maintain fire spread. Case studies on wildfires have shown that fuel reduced areas that are less than 6 years since last burn are effective in reducing the fire behaviour of large going fires provided the fuel reduced areas are sufficiently large in relation to the size and intensity of the bushfire, and are adequately dispersed across the landscape. To be effective as strategic fuel reduced burn buffers, prescribed burns should have minimum dimensions of area (>1500 ha), depth (>3 kilometers) and width (>3 kilometers).

67. The proportion of burnt/fuel reduced area within a burn unit needs to be at least 60 percent. In mixed forest fuel areas, the >60 percent burn cover threshold can only be achieved by multiple ignitions that target different fuel types as these dry out progressively over several days, weeks or even months. Prescribed burns that are either small or only partially burned (<60 percent) are unlikely to provide strategic protection in the event of large, intense bushfires.

68. Experience gained over several decades in the fire prone southwest of WA has shown that the effectiveness of prescribed burning to reduce the severity and impacts of wildfires is a function of the proportion of the landscape that is regularly prescribed burnt, the resultant distribution of fuel ages across the landscape, and the scale or patch size of the burn units.

69. Experience over the past 49 years in south-west of Western Australia has shown that fuel reduction through prescribed burning should extend to 7 to 8 percent of the forested landscape in the south-west of WA each year (ie: 175-200,000 ha/annum) to enable fire controllers to control major bushfires under severe summer conditions (Sneeuwjagt 2008[10]). When the annual prescribed burn program fell below 4 percent (<100,000 ha) on three out of four years during the drought years from 1998/99 to 2002/03, the incidence of large wildfires (> 10,000 ha) increased significantly in the following years. This trend has been reversed in the past six years during which the prescribed burn totals have again reached levels between 6 to 8 percent.

70. The annual 'Area Burnt' is not the only consideration of the effectiveness of the prescribed burn program. DEC is very mindful of strategic protection requirements, often small in area, to protect towns and assets such as utilities.

71. Based on the risk analysis tool called the 'Wildfire Threat Analysis'(WTA) (Muller, 1993[11]), prescribed burns are located and scheduled through the development of a rolling three year (six-season) Indicative Prescribed Burn program. Through this risk analysis process, fuel reduction zones are identified and maintained in a state of relatively low fuel levels by regular burning. This is employed around settlements and urban-rural interface. However, many fires that impact on the urban interface often start deep in the forest/rural areas. Thus the burning for fuel reduction needs to be strategically in more remote locations where unplanned fires can be controlled well before they reach the populated areas. In the absence of fuel reduced areas in more remote locations, the threat of large catastrophic fires that generate major ember storms is greatly increased. The occurrence of such ember storms is now a rarity in the south-west forest since the introduction of broadscale prescribed burning in 1961.

K. Implementation of Prescribed Burning

72. DEC's prescribed burns are thoroughly planned and implemented to ensure these meet the burn objectives with low risk of escape and impact on neighbouring lands and communities.

73. Well in advance, each proposed burn is surveyed in detail. The assessment includes:

    (i) An environmental audit in which the possible impacts of the burn are identified and evaluated in accordance with a comprehensive checklist.

---

[10] Sneeuwjagt, R.J. (2008) *Prescribed Burning: How effective is it in the control of large forest fires*? Paper presented at 2008 AFAC – Bushfire CRC Conference, Adelaide, South Australia.

[11] Muller, C (1993) *Wildfire Threat Analysis – A decision support system for improved fire management*. Department of Conservation and Land Management

(ii) A safety check to identify all persons, assets, properties or forest operations that may be put at risk by the burn; and

(iii) A stratified random fuel assessment to determine and map fuel types, fuel quantities and any areas susceptible to flame scorch.

74. A detailed burn prescription is then prepared for each proposed burn. This comprises a set of agreed burn objectives and success criteria that meets the burn purpose. These objectives and standards are developed in consultation with relevant program leaders and district/regional managers.

75. The burn prescription includes a calculation of the fire behaviour for each fuel type, which will meet the burn objectives based on the fuel assessment, the weather and fuel moisture conditions which must occur on the day of each ignition. The lighting pattern identified in the prescription includes the boundary "edge burn", as well as the core lightings for each specified fuel type. Mixed forest burns may have as many as 5 ignitions on separate days spread over weeks or even months depending on the drying patterns of each fuel type. This can range from the open/non-forest vegetation heaths to the dense, mesic karri forest forests.

76. Each prescription is checked and approved by a senior and experienced officer as well as the area manager.

77. There are a series of preparatory operations undertaken before a burn is commenced. The boundary tracks are cleaned up; dangerous trees adjacent to the burn edge are identified and treated; dense understorey shrubs on the burn boundaries are scrub rolled to enable these to be burnt under mild conditions; and water points and turn-around points are maintained.

78. Neighbours located within three kilometers of the burn boundary are notified. Any concerns raised by the neighbours and other stakeholders such as wine grape growers are addressed where possible. This includes modifying the burn ignition and schedule to minimize risk of smoke impacts on neighbours or communities.

79. Upto 60 percent of annual prescribed burns are conducted during the months of October to December each year to take advantage of the favourable fuel moisture and weather conditions that prevail during the spring/early summer period. The "Spring" burns must be well secured by edge burns along the perimeter roads, and must be burnt out to a minimum of 60 percent, preferably up to 80 percent, to minimize the risk of re-ignition of unburnt patches over the following hot and dry summer months. The "edging burn" needs to be at least 50 metres deep as this makes for easier control of the main burn later, and minimizes mopping-up and patrol costs.

80. At the completion of every days burning, edges are inspected, and essential mopping-up undertaken. In some cases, night patrols are mounted by fire crews and tankers to ensure the safety of the burn.

81. The procedures have proven to be highly effective in minimizing the incidence of burn escapes. The escapes that do occur represent less than one percent of all wildfires attended by DEC each year.

L. Effectiveness of Fuel Reduction Burning in Control of Major Bushfires

82. The south-west of Western Australia, with a Mediterranean-type climate of hot, dry and windy weather during the summer months and highly flammable forest fuels, is highly prone to bushfires. It is therefore not surprising that about 800 fires started by lightning, arson or mischance occur across the landscape of the south-west each year. About 300-400 wildfires occur on or near to DEC-managed lands. In most years less than one percent of these fires exceed 5000 hectares.

83. The combination of hot and dry weather, flammable fuels and ignition sources could be expected to result in the regular occurrences of large uncontrollable wildfires that threaten lives, destroy properties and severely damage forests, plantations, water catchments and ecosystems.

84. On the contrary, the forest region of south-west Western Australia has experienced few large fires (greater than 10,000 hectares) since the implementation of broadscale prescribed burning and the implementation of other fire control measures following the 1961 bushfires. Since that time there have been no forest fires greater than 30,000 hectares, no lives lost in forest fires, few injuries, and few instances of multiple property losses. In the past 20 years, the average annual area burned by wildfires in the south-west forest regions is about 20,000 hectares, which is less than one percent of the landscape managed by DEC. On average, approximately 95 percent of all wildfires are less than 100 hectares, and less than 1 percent are greater than 2,000 hectares.

85. This contrasts with the severity and extent of wildfires in the forests of south-east Australia, where many very large bushfires have occurred on a regular basis resulting in loss of life, very significant damage to property, infrastructure and the environment, and a substantial expenditure of resources in fire suppression and post-fire recovery.

86. In Western Australia the topography is subdued and highly accessible, making it easier to undertake rapid attack on initiating fire and to implement prescribed burning. On the other hand there are many similarities in the forests and fuel types in Victoria and other eastern states, and there are many similarities in the weather and fuel factors that influence fire behaviour and impacts. There is no fundamental difference in the structures and flammability of the WA forest fuels in comparison with most forests in south-east Australia with the possible exception of the Mountain Ash forests. WA forests rapidly accumulate highly flammable ground fuels (litter, bark, twigs, and branches). Due to the annual summer drought, these fuels dry out to low moisture content levels from as early as November to April every year. The fire behaviour in long unburnt forests can be just as severe and destructive in Western Australian forests (as described earlier

in relation to the Dwellingup fires in 1961) as they are in south-east Australian forests. Extreme high intensity crown fires that kill large tracts of mature fire tolerant eucalypt forests were a common feature in long unburnt forests throughout the south-west regions during the decades prior to the application of broad scale prescribed burning in 1961.

87. The main difference in approach to fire management between the south-west and south-eastern Australian states is the scale, intensity and frequency of prescribed burning undertaken by land management agencies. In Western Australia forests between six (6) to eight (8) percent of the landscape is prescribed burned by DEC each year, compared with one or two percent in south-eastern States. In addition to the larger scale and size of the prescribed burn program across the forested landscape, the WA practice of burning more than 60 percent of each burn unit differs with south-eastern states burn cover achievements that are often limited to much less than 50 percent.

Case Studies of Past Bushfires

88. The effectiveness of prescribed burning in wildfire control has been documented in nine case studies in south-west of WA by Underwood *et al* (1985[12]). These case studies were drawn from fire records maintained by the WA Forests Departments over the period 1969 to 1984, and included nine case examples of the severe bushfires that were blown by gale force winds of up to 130 km/hour during the passage of Cyclone Alby on 25th April 1978. During the dry summer conditions, 92 bushfires burned out of control in south-west WA. They spread at rates of upto 8 km/hour with extensive long range spotting. Although 54,000 hectares was eventually burnt, only 7,000 hectares of this was in State forest due to low fuels maintained by earlier prescribed burning. The study by Underwood et al clearly demonstrated that in every case the presence of well spaced fuel reduction burns undertaken in the previous 3 to 4 years prevented the development of much larger and more intense fires that could have led to serious social and economic costs to the community. A similar finding was made in a case study by McCaw (1996[13]) on two wildfires that posed a severe threat to property and community assets on the outskirts of Perth.

89. While there are several other published examples of case studies that demonstrate how fuel-reduction burning has modified wildfire behaviour under average summer conditions, there are also examples of where the behaviour of wildfires burning under extreme weather conditions has been significantly modified by fuel

[12] Underwood, R.J., Sneeuwjagt, R.J. and Styles, H.G. (1985). The Contribution of prescribed burning to forest fire control in Western Australia: Case Studies. In: "Fire Ecology and Management in Western Australian Ecosystems". WA Institute of Technology. Environ. Studies Group Report No. 14. (J Ford Edition).

[13] McCaw, W.L., Neal, J.E. and Smith, R.H. (1996). Effects of fuel reduction burning n fire behaviour and suppression difficulty of an intense wildfire in jarrah (E. marginata) forest – a case study. CALMScience **2**(2) : 141-148.

reduced areas. Two such case studies involving very high intensity forest fires burning under severe weather conditions in south-west Western Australia are presented below.

Mt Cooke Fire – January 2003

90. The Mt Cooke fire in the Monadnocks Conservation Park on DEC-managed land about 70 kilometres south-east of Perth resulted from a lightning strike. For various reasons, fire had been deliberately excluded from large sections of this reserve for 17-20 years, so the wildfire burned as an intense crown fire under severe weather conditions (maximum temperature 36^{o}C; low humidity; gusty north-west winds from 25 to 35 km/hr). The fire burned fiercely up the slopes and along the spine of Mt Cooke in a south-east direction for about 25 kilometres and eventually burnt out 18,000 hectares in 24 hours.

91. When the headfire reached forest blocks that had been prescribed burnt between one to seven years before, the fire intensity reduced considerably and fire fighting forces equipped with bulldozers were able to attack the flanks of the fire. Even though the weather conditions remained severe, the headfire was able to be contained when it slowed after running into areas that had been prescribed burnt for fuel reduction three to five years before.

92. A spatial analysis of the impact of the Mt Cooke fire on the forest canopy and understorey vegetation based on the Landsat satellite data (Figure 1) clearly demonstrates the reduction in fire intensity and crown damage within fuel reduced areas.

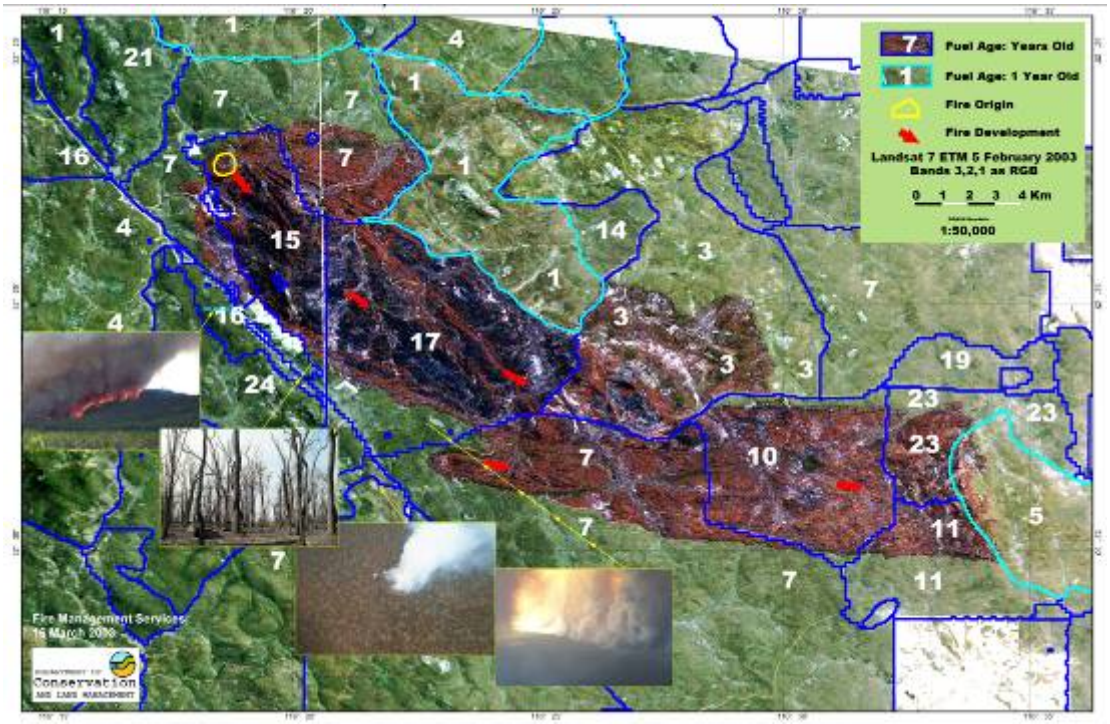

Figure 1. Landsat image of Mt Cooke Fire of January 2003 showing the benefit of DEC's prescribed burns in controlling this very intense wildfire.

Mundaring-Karragullen Wildfire – January 2005

93. The Mundaring-Karragullen fire which burnt during 15-25 January 2005 is another example of a high intensity forest fire that was eventually contained with the assistance of numerous prescribed burns. The fire was the result of seven arson-caused ignitions on land managed by DEC east of Karragullen and within 20 kilometres to the east of the Perth Hills suburbs.

94. A detailed study of the fire behaviour of the Mundaring-Karragullen fire was undertaken by former CSIRO fire scientist Phil Cheney (2009 in press)[14] to reconstruct the fires during the initial westerly and south-westerly spread on 15-17 January 2005 (See Figure 2). Three major tongues of the escalated fire travelling at an average rate of spread of 900 m/hour burned towards the Brookton Highway and the Hills suburbs of Roleystone and Araluen. When it crossed the Brookton Highway the fire ran into two and four year old fuels resulting from fuel reduction burns, where its spread was either stopped completely or checked to such a degree that suppression was straightforward and safe.

Figure 2: Perimeter of the Mundaring-Karragullen wildfire of 15-25 January 2005 in relation to DEC's prescribed burns conducted in previous 5 years.

[14] Cheney, N.P. (2008b) Karagullen-Mundaring Fire January15-25, 2005 (Perth Hills Fires 71-81). Report to the Department of Environment and Conservation, Perth, WA.

95. Cheney found that the fuel reduction program carried out by DEC in the preceding years enabled the suppression forces to safely contain the head fires before they burnt into the Hills suburbs of Roleystone and Gosnells. In addition, other parts of the fire were slowed by low fuel zones created by fuel reduction burning conducted during the previous 6 years. As a result, this fire that could have destroyed hundreds of homes and threatened lives was able to be controlled despite the severe weather conditions with minimal property loss or damage.

96. Case studies can also provide insight into how the final shape of a wildfire may be influenced by the pattern and extent of prescribed burning, and by suppression activities. For example, the spread of fire can be modelled for different fuel situations and the difference between the predicted and observed final fire shape and values impacted used as a measure of the difference attributable to fuel treatment. This approach was used by Cheney who was able to reconstruct the projected fire perimeter of the Mundaring-Karragullen fire in the absence of fuel reduction burning in the past 20 years (See Figure 3). Such a scenario was commonly encountered in the ACT, NSW and Victorian fires of 2003 and the Victorian fires of 2006 and 2009. Under the 20 year old fuel scenario, Cheney estimated that the fire would have burnt westwards over the Darling escarpment and into the suburbs of Roleystone, Armadale and Gosnells in less than 24 hours after ignition, causing significant damage and possibly loss of life.

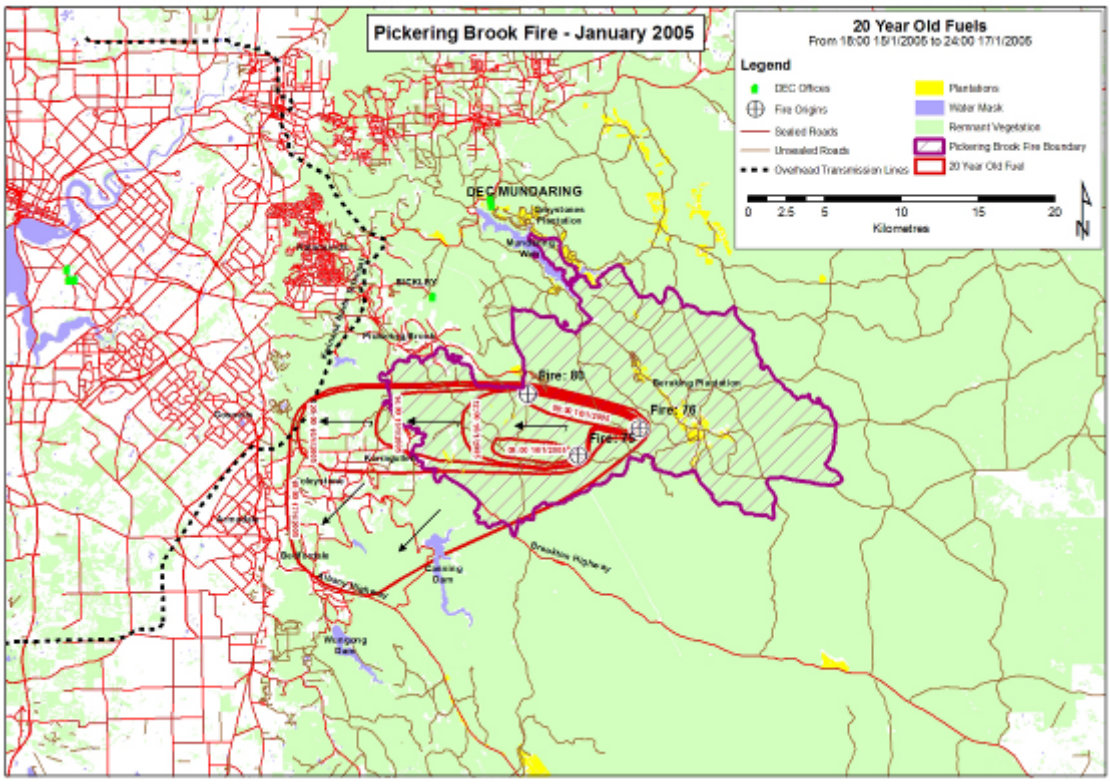

Figure 3: Projection of the headfire of the Mundaring-Karragullen wildfire in the absence of the DEC prescribed burns west of the actual fire perimeter.

97. This case study demonstrated that if fuel reduction burning is to be effective under severe summer conditions, spatial and temporal scale thresholds of fuel management must be exceeded. Burning must be regularly undertaken within large blocks throughout the forested landscape and not just immediately adjacent to high value assets such as private land and townsites, and a significant proportion of the landscape must be treated (at least seven to nine percent per annum).

2008 Study into the Relationships between Areas of Prescribed Burning and Wildfires

98. The contribution of prescribed burning to fire control is likely to persist for several years and any comparison between the areal extent of prescribed burning and wildfire areas should include a spread of years. An investigation into the possible relationship between the areal extent of prescribed burning in preceding years and the unplanned fires over subsequent years was undertaken by me on the south-west forest data from 1961/02 to 2007/08 (R Sneeuwjagt 2008[15]).

99. This period covers the start of the application of prescribed burning to broad areas, with high levels in the 1960's and 1970's and gradual reductions as the burn program became more refined and targeted to achieve integrated biodiversity conservation and community protection objectives. The variations in the extent of the annual prescribed burning programs over the 47 years of this study provide sufficient data to determine whether the different levels of annual burning have an impact on the total area of wildfires that occur in subsequent years.

100. The results of this analysis indicate that the area of wildfires is influenced by the amount of prescribed burning that has been achieved in the preceding period. A strong correlation exists between the area of prescribed burning achieved in one year and the accumulated area of wildfires averaged over the following five years (R^2=0.77). This correlation, as expressed as a polynomial relationship, is remarkably strong despite the inherent variations from year to year in wildfire areas that may be due to confounding influences other than the amount of fuel reduced areas that is present across the landscape (see Figure 4).

[15] Sneeuwjagt, R.J. (2008) *Prescribed Burning: How effective is it in the control of large forest fires*? Paper presented at 2008 AFAC – Bushfire CRC Conference, Adelaide, South Australia.

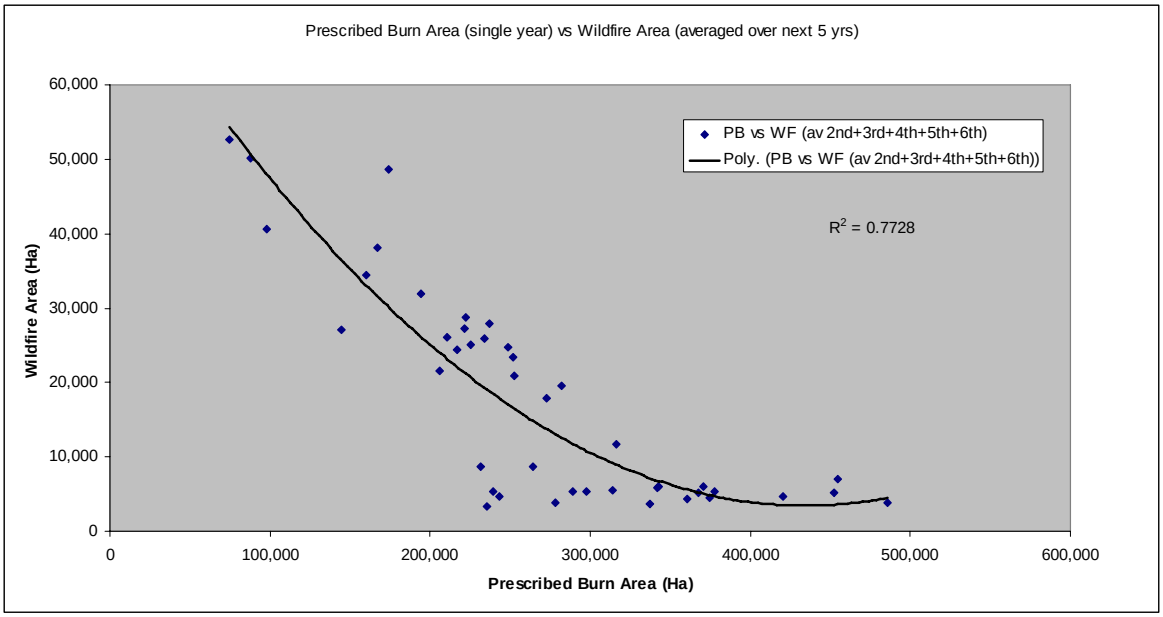

Figure 4. Strong Correlation between the Average Annual Area of Prescribed Burns in a single year, and the Average Area of Wildfires over the following four years in south-west forest regions of WA.

101. In addition, a strong correlation exists between the area of prescribed burns averaged over four years, and the area of wildfires averaged over the subsequent four years (see Figure 5).

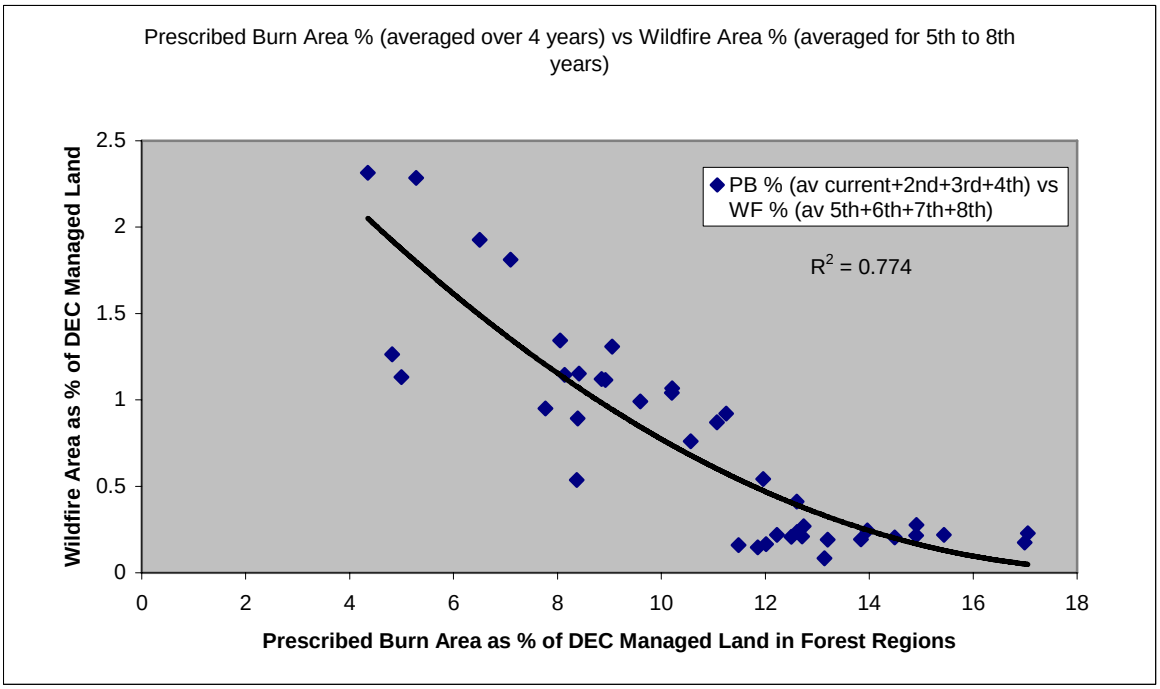

Figure 5. Strong Correlation between the Annual Area of Prescribed Burns averaged over 4 years and the Area of Wildfires averaged over the following four years in south-west forest regions of WA.

102. A recent study of wildfires and prescribed burning records dating back to the 1950's on approximately one million hectares within the Warren Region of south-west WA was undertaken by Boer et al (2009)[16]. Their principal finding was that the area treated annually by prescribed fire had had a significant effect on the annual number and areal extent of unplanned bushfires over a 52-year period. They concluded that areas burned under a six year cycle significantly reduced the bushfire hazard.

The role of prescribed burning in reducing incidence of wildfires

103. A study by McCaw *et al.* (2008[17]) demonstrated that prescribed burning will also reduce the incidence of fires by maintaining areas of sparse fuel that are less likely to remain alight following ignition. Lightning-caused fires should be randomly distributed at a landscape scale, making the expected incidence of ignition directly proportional to the area of each fuel age. Analysis of fire statistics for forests in the south-west of Western Australia between 2000 and 2006 shows that lightning-caused fires are less likely to be sustained in areas where the fuel is less than five years old.

104. Under the burning program undertaken by DEC in recent years, the area with fuel less than five years old makes up around 30 percent of the forest estate. The fact that there are very few fires occurring in this area, and those that do are easily suppressed, makes a very substantial difference to the total fire workload during lightning storms when suppression forces can be easily overwhelmed by a large number of almost synchronous fires. In lighter fuels created by prescribed burning there is less spotting and this reduces the rate of fire spread and the suppression difficulty compared to fires burning in long unburnt forests with heavy fuel accumulations.

105. Fuels management can also have important benefits to fire suppression that are subtle and difficult to quantify, such as increasing the safety, efficiency and effectiveness of suppression strategies. In this situation the lack of fuel management decreases the probability of first attack success under increasing fire weather conditions.

106. In conclusion, the WA analysis indicates that in order to restrict the extent of wildfires to impacting less than one percent of the landscape each year, the

[16] Boer, M.M., R.J. Sadler, R.S. Wittkhun, L. McCaw and P.F. Grierson (2009). Long-term impacts of prescribed burning on regional extent and incidence of wildfires – "Evidence from 50 years of active fire management in SW Australia Forests". Forest Ecology and Management 259, p.132-142.

[17] McCaw, W.L., J.S. Gould and N.P. Cheney.(2008) *Quantifying the effectiveness of fuel management in modifying wildfire behaviour*. International Bushfire Research Conference 2008 incorporating the 15th Annual AFAC Conference, 1-3 Sept 2008.

proportion of the landscape that needs to be fuel reduced is between seven to nine percent per year (or 35 to 45 percent over five years). In the case of south-west WA, the annual prescribed burning target of 200,000 hectares, which equates to about eight percent of the DEC-managed estate, is likely to result in average wildfire extent of less than about 25,000 hectares per year (or about one percent) and more importantly, to significantly reduce loss of life and property and reduced environmental damage.

107. The experience gained in Western Australia should be transferable to similar forest types in other parts of Australia. It must be pointed out that where there are tall wet sclerophyll ash forests as in Victoria and Tasmania, these present special difficulties in achieving effective fuel reduction burns under mild conditions. In those situations, focus may need to be given to fuel reduction in adjacent dry forests that may provide suitable fuel reduced buffers around and within the ash forests.

M. Other Hazard Management Practices

108. Hazard reduction strategies other than prescribed burning, such as mechanical treatment of vegetation (ie: scrub rolling, slashing or chaining) and grazing with livestock is considered and applied where appropriate in meeting fire protection and land management objectives for the land in question.

109. The use of mechanical fuel modification is rarely used in forested vegetation types as these strategies are costly and largely ineffective in modifying fire behaviour in forest fuels. Scrub rolling of shrub dominated, non-forest vegetation can be useful as a means of containing prescribed burns and wildfires, as these can provide relatively safe firelines from which to ignite backfires.

110. Grazing of woodlands with native grassy vegetation is applied to a very limited extent in the eastern margins of the south-west forest regions. Due to the patchiness of the occurrence of suitable grassy understorey within these woodlands, grazing is not regarded as an effective means of hazard reduction for the control of major bushfires.

111. The use of planned fire to reduce hazards and minimize the loss of life, property and services, and to achieve biodiversity conservation objectives is a more cost effective and environmentally sound method of fuel management over large areas than using alternative methods including mechanical, chemical, biological and grazing methods.

N. Operational, Environmental and Political Considerations in achieving the Prescribed Burning Program Target

112. The application of a large and comprehensive prescribed burning program on DEC-managed lands requires a very significant investment by DEC through the allocation of staff time and operational funds. The Department allocates a

significant proportion of its annual budget on the planning, preparation, implementation, monitoring, research and reporting on prescribed burning programs.

113. The permanent fire fighting crews that number about 180 personnel are augmented by about 100 seasonal fire fighters that are hired from spring to autumn. These crews, who are essential to the achievement of the large prescribed burning programs in spring and autumn, are well prepared and trained to combat summer wildfires. The crews are highly mobile and are frequently moved between Regions to assist with burns whenever conditions are suitable in different locations within the south-west of WA.

114. The Department leases up to 3 aircraft (fixed-wing and helicopters) during the peak burning months to enable multiple burns to be conducted at the same time when the weather and fuel moisture conditions meet the burn prescriptions.

115. Maintaining air quality in population centres is a major challenge in the execution of approved burn programs. The risks of impacts of smoke and ash on residents, water catchments, wine growing areas, road traffic and recreationists, is minimized through the use of smoke prediction models and weather forecasts during the planning and implementation of prescribed burns.

116. The smoke management constraints are particularly onerous in the forest within 200 kilometres east and south of Perth, as well as in the wine growing regions near Pemberton, Manjimup and Margaret River.

117. The coincidence of the most suitable period of prescribed burning of the karri forests (December to April) and the maturation of the wine grapes (January to March/April) has severely restricted the window of opportunity for safe and effective burning in these forests. There is a significant backlog in the karri prescribed burning program due to the very limited number of suitable days for prescribed burning when smoke impacts on neighbouring vineyards can be minimised.

O. Political and Corporate Support

118. DEC's fire management policy and practices, including prescribed burning, has been intensively reviewed and scrutinized by several external organisations and agencies that include the Environmental Protection Authority (2005), the Office of the Auditor-General for Western Australia (2004),and the Ministerial Fire Review Panel (1994). These reviews have supported CALM/DEC's prescribed burn program and its importance to the protection of the communities and state's natural assets.

119. The current State Government and the previous Labor Government have strongly supported DEC's prescribed burn target and the approach taken to achieve the program with minimal impacts on air quality in Perth metropolitan area. This

bipartisan support has been important to DEC staff in undertaken planning and implementation of prescribed burns that may be contentious to some members of the community.

120. The Department has responsibility for fire management across most state public lands outside of the Perth metropolitan area, and this includes the state's national parks, conservation parks, regional parks, State forests and timber reserves, and plantations. DEC is also responsible for management of lands that contain WA's surface water catchments and some of the ground water catchments. As an agency with integrated responsibilities, DEC is able to plan and implement the fire program and prescribed burns across all these land purpose tenures. This provides significant flexibility to fire planners in achieving strategic protection as well as achieving biodiversity outcomes across the entire landscape. Unlike some other states where responsibilities for management of different public land tenures are variously allocated to separate agencies, Western Australia is able to streamline the bureaucratic process associated with approvals, planning, implementation, prioritizing, monitoring and resourcing for fire and land management programs across different purpose tenures.

P. Relationships between Fire Suppression and Land Management

121. As a result of the significant investment by DEC (and its processors) in staffing and operating prescribed burning and fire research programs over the past 50 years, the costs of fire suppression and loss of assets from wildfires have been kept at very low levels when compared with other jurisdictions in Australia and Northern America.

122. For the 2008/09 financial year, the total budget for the planning and implementation of prescribed burns in the south-west was approximately $7 million. The annual direct cost of suppression of wildfires on DEC-managed lands in the south-west has varied in the past five years from $7.7 million to $15 million. These suppression costs are relatively small when compared with those incurred in Victoria in the 2002/03, 2006/07 and 2009 fire seasons. It is DEC's understanding that the direct fire suppression costs for the 2009 Victorian bushfires will exceed $350 million.

123. A study undertaken by the University of Melbourne in 1997[18] on the economic evaluation of bushfire prevention and suppression[(1)] found that Victoria gained $24 of benefit from averting wildfire costs and losses for every $1 spent by the DNR (now DSE). It is highly likely that this benefit would be even greater for the DEC burn program today which is much more comprehensive and effective than that undertaken by DNR in the 1990's. There are no other comparable economic studies in Australia that I am aware of that provide a reliable estimate of the cost-benefit of prescribed burning.

[18] Benneton, J and Cashin, P (1997). "An Economic Evaluation of Bushfire Prevention and Suppression". Paper No. 598. Department of Economics, University of Melbourne