

The Bushfire Front

“Dedicated to Best Practice in bushfire management in Western Australia”

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Mr. Stuart Ellis OM
Chairman, COAG Bushfire Inquiry
Department of the Prime Minister and Cabinet
3- 5 National Circuit
Barton ACT 2600

Dear Sir,

COAG Inquiry into bushfire mitigation and management

I attach a submission to your inquiry from the Bushfire Front in Western Australia.

I will be very happy to also make a verbal presentation if the panel comes to WA, or to provide any further input, either as elaboration on this submission, or to assist the inquiry in any way. Please contact me if I can assist in any way at all.

Yours sincerely,

Roger Underwood
CHAIRMAN
December 3, 2003

Submission from the Bushfire Front (WA)

**To the inquiry into bushfire mitigation and management by the
Council of Australian Governments**

December 2003

Summary:

The Bushfire Front is an organisation of professional bushfire management and scientists. Our objective is to lift the standard of bushfire mitigation and management in Australia (and especially in the southwest of WA) to meet the requirement of World's Best Practice and to ensure that a management system is put in place that maintains standards over time, rather than responding to crises and disasters.

We welcome this review by COAG, as we believe there is a need for a national approach to this issue, and COAG is the perfect mechanism for achieving this.

World's best practice is readily defined, and all the elements of it are well known to experienced bushfire managers. The difficulty is in getting systems implemented, given the diffusion of jurisdictions, splintering of accountability and poor understanding of bushfire science and management in the community.

In our view, COAG should focus on the policy vacuum which exists both nationally and at State and Federal level, and on the need for State's and Territories to develop a bushfire management system which couples mitigation and prevention to suppression, is cost-effective, and can be independently audited.

In this submission we present the essential elements of a best practice system and six overarching recommendations for action by COAG.

We have attached a copy of a Glossary of Bushfire Terms which we have been developing which it is suggested could form the basis of a new Australia-wide bushfire terminology, sponsored by COAG.

1. The Bushfire Front

The Bushfire Front is a group of West Australians concerned about the risks of bushfire damage to people, lives and forests. We have accumulated several lifetimes of experience in bushfire prevention, firefighting, bushfire science, fire planning, administration and agency operations. We are volunteers, and are not affiliated with any government agency or organisation. Membership is set out in the attachment

This submission to the COAG Inquiry supports the position we have already put to the House of Representatives inquiry, the Premier of WA, the Leader of the Opposition in WA and the WA Auditor General. In each of these submissions we have made the same over-riding points:

- Bushfire management in Western Australia requires a major overhaul to bring it into line with best practice. Unless action is taken, a bushfire disaster is inevitable; and
- The time to tackle this issue is before there is a disaster, not afterwards.

We believe in the past there has been a lack of leadership and coordination with respect to bushfire mitigation and management, at both Federal and State levels. This is demonstrated by the policy vacuum, funding arrangements and lack of progress in the institution of effective fire management systems with emphasis on prevention and mitigation. From the perspective of the COAG, a new approach to policy and funding arrangements in particular can provide an opportunity to require the development of fire management systems by the States which are capable of being audited and publicly reported upon.

2. The WA situation

Inquiries into bushfires can be of two sorts: (i) after-the-event reviews of what went wrong, who is to blame and what needs to be done; and (ii) before-the-event reviews which identify problems and prescribe remedial management and preventative programs. The COAG inquiry is both, because in WA we have not had a recent disaster, certainly not of the proportions experienced in ACT, NSW and Victoria.

However, a number of factors suggest that a bushfire disaster is imminent in WA, e.g.,

- The southwest of WA is bushfire prone, in terms of its climate, weather and vegetation, and has been through an extended dry period over recent years, leading to unusual fuel curing.
- There is no overarching system of bushfire management in WA and no single person in government is accountable for designing, implementing and managing such a system;
- Standards of bushfire mitigation, prevention and pre-suppression work have declined over recent years, especially in southwest forests; in these areas, which co-exist with the main population centres, fuels have been allowed to build up, ensuring larger and more difficult fires, while at the same time fire-fighting resources (especially permanent trained firefighters) are fewer in number;
- As is the case Australia-wide, the WA community is ill-informed about bushfire science and management;
- Environmentalists continue to oppose effective bushfire management practices, irrespective of the impact of high intensity fires on the environment;
- There is no agreement between WA and the Federal government over policy, funding and priorities for bushfire management;
- WA is no longer a centre for excellence in research into bushfire science and management.

3. The bushfire management equation

Bushfire management is complex in a scientific and technical sense, and demands excellent political and social skills, but in essence it boils down to a simple equation:

- On the one hand, action is needed before a fire starts to minimise the risks of ignition and to mitigate the threat of damage to valued assets;
- On the other, there must be the physical capability to detect fires rapidly and suppress them before threatened assets are burnt and with minimum risks to the lives of firefighters.

This so-called “bushfire equation” has been well understood by Australian land managers, foresters and fire scientists for generations. Effective bushfire management systems have been

designed, and in Western Australia such a system was for several decades implemented successfully. Although there have been some advances in technology, in general the trends on both sides of the equation currently are negative.

4. The bushfire cycle

There is a well-recognised cycle in bushfire management across Australia. Disasters are followed by inquiries, commissions, Coronial Courts and litigation, which in turn are followed by better-designed and implemented bushfire management. This leads to fewer bushfires. However, over time the new systems are less rigorously applied. Fire mitigation programs decline. The first unstoppable fires start to occur, and before there is time or the energy to get the system back on the rails there is another disaster and the cycle recommences.

Under this scenario, any progress with research, technology and management systems is regularly undermined, and the costs to the community and to the environment are always expanding.

5. The need for new and well-coordinated policy

As COAG knows only too well, government in Australia is complex, with many levels and jurisdictions and many opportunities for policy to diverge or conflict. This effectively splits the forces which potentially could be focussing on developing and implementing effective fire mitigation and management systems.

Australia does not have a National Bushfire policy and different States and agencies have different policies, or at least different philosophies and priorities. This is exacerbated by the situation at local government authority level, where there is often a different approach to fire management on private land between one councils and the next.

There is a critical need for a national bushfire policy, and for agreed best practice bushfire management systems to be developed at State and Territory level which nest within such a policy. There is also a need for a mechanism to ensure such systems are properly implemented. We suggest that the most appropriate mechanism is as follows:

- Systems are designed and signed off;
- Targets and performance standards are set;
- Actual achievement against targets and standards is independently monitored and reported upon; and
- Continued funding is applied only in situations where good systems are being well implemented.

6. Opportunity for COAG

COAG provides the most appropriate forum in which this issue can be discussed and resolved. The opportunity is three-fold:

- (i) to identify and promote a Best Practice fire management system for the whole of Australia;
- (ii) to oversee a more consistent and better coordinated management approach from the various governments and agencies with land management responsibilities; and
- (iii) to develop a system of federal funding which is tied to bushfire management performance and rewards best practice, not system failure.

7. Best practice in bushfire management

The Bushfire Front has attempted to define the essential elements of a world's best practice bushfire management system. This is:

- There is a National Bushfire Policy, developed through COAG and signed off by all governments, which sets out the overall objectives with respect to bushfire prevention, management, cooperative arrangements and research, and outlines federal and state responsibilities, coordinating mechanisms and funding arrangements;
- Each State and territory has its own bushfire policy or bushfire management strategy, which nests within the National Policy, and establishes accountability at Government and agency level, commits State land management agencies to prevention as well as suppression and which is underpinned by up-to-date legislation;
- Accountability for bushfire management planning and bushfire outcomes at all levels is crystal clear;
- Fire management in forest areas is the responsibility of a single professionally-led land management organisation, capable of designing an effective fire management program and with the resources and political support to implement it on the ground. Accountability at agency level is never allowed to become diffuse;
- System implementation and outcomes will be capable of being properly audited. This means some form of annual independent monitoring and public reporting of actual achievements against targets and performance standards;
- There will be national and locally-based and ongoing research and development programs, with input to research priorities from land managers and firefighters. Research needs to cover fire behaviour, bushfire operations and fire ecology;
- There will be programs of training for bushfire managers applied at both the federal and State/Territory level, aimed at consistent standards and language; and
- All of the above must be accompanied by an affective program of community education, developed according to the rules for successful communication strategies.

No Australian jurisdiction can currently claim to have in place a Best Practice bushfire management system as defined, nor has there been in the past an over-riding force for its development and adoption from the highest levels of government.

The most crucial element of any bushfire management system is that it must be able to cope with the odd bad days in the odd very bad fire seasons. Experience has shown that in forested areas, no system can cope under such conditions unless fuels have been systematically reduced in previous years, by prescribed burning. Thus, best practice system involves work done years in advance of a fire occurring, - i.e., putting in place zones of low fuel where firefighters have a chance of containing fires – in the expectation of multiple fires on a bad day on the tail end of a drought period.

8. Community understanding of fire

In general the Australian public is poorly informed about bushfire management and bushfire science. The European idea that “all fires are bad” is still dominant, supported by environmentalists with a “leave-it-to-nature” philosophy. Research into fire use by Aboriginal people, or natural fire frequencies in pre-settlement times clearly indicates that fire is a natural

part of the Australian environment, but this work is routinely abused by some agency officers and green activists opposed to prescribed burning. As a result there is now a well-embedded mythology about the damage caused to the environment by low and moderate intensity prescribed burns, the result of which is people living in very high risk environments. The poor standard of public understanding about fire has permitted the growing tendency for bushfire policy to be dictated by ideology, mythology and political bias rather than by historical fact, science and actual field experience.

The number and size of damaging high intensity bushfires in forest land all over Australia will always be higher in the absence of effective fuels management. This is because no system of fire suppression can cope with high intensity fires on a bad day, when the fires are spreading through areas of heavy fuel which are generating spotting. This situation is not well understood anywhere outside the small community of Australian bushfire and land managers. This fact leads to opposition to fuel reduction burning, poor planning decisions, and the false belief that if money is poured into firefighting equipment, that is all that is needed to ensure community safety.

A major issue in community education is terminology. It is common in Australia for bushfire terms to be used incorrectly (“back burn” used to mean “prescribed burn) or vaguely (“frequent fire”). To help overcome this problem The Bushfire Front is working on a standard glossary, a copy of which is attached to this submission. There is an opportunity for COAG to take a leadership role in this, and to promote the development and provide custodianship for an Australia-wide bushfire terminology, thus ensuring consistent and accurate use of critical words and terms.

9. Recommendations

- (i) COAG should develop a National Bushfire Policy for signing off at all levels of government.
- (ii) COAG should define a World’s best practice bushfire management system for implementation in the Australian environment. This will demand input from bushfire specialists all over the country, plus review of systems being developed and implemented elsewhere.
- (iii) Flowing from both of the above, COAG should seek to define the conditions under which federal funds will be provided to State and Territory Governments for bushfire mitigation and management. For example, Federal funds should be given when it can be demonstrated (by independent audit) that a State government is implementing a Best Practice fire management system, as defined by COAG. In respect to bushfires, any funding policy must be designed to rewards best practice, not system failure.
- (iv) COAG should seek to ensure the Federal Government continues to provide leadership and funds for bushfire research, and for the transfer of research into operations. From the standpoint of addressing the concerns of people opposed to prescribed burning, a critical research issue is to clarify pre-settlement fire frequency through studies of grass trees and modelling natural fire occurrence and development in the absence of suppression. The most critical operational issue is the development of high quality fire behaviour guides for all forest types.
- (v) COAG should facilitate national officer-level and scientist-level liaison and liaison between Australian and international fire and land management services through the funding and oversight of regular working group meetings, seminars and study tours.

In addition, COAG should review the concept of establishing a national-level bushfire management training facility, which bushfire people from all over Australia can attend, and achieve national-level accreditation.

- (vi) COAG should provide the leadership to ensure development of a public education campaign aimed at informing Australians about the real nature of fire in the Australian environment, and it's natural place as well as its threats. In particular, a well-designed national communication strategy is needed to counter the anti-burning propoganda put out by some political pressure groups. COAG should sponsor a national bushfire terminology for Australia-wide adoption.

Roger Underwood
Chairman, The Bushfire Front
November 30th 2003

Attachment 1 : Members of the Bushfire Front

Roger Underwood, FIFA, MACFA: over 40 years experience of bushfire management in Australia and overseas. Former General Manager of CALM in WA, a regional and district manager, a research manager and bushfire specialist. Directs a consultancy practice with a focus on bushfire management.

George Peet OAM: over 40 years experience in bushfire research, prevention and control. Internationally recognised bushfire scientist and expert. Undertook pioneering research in bushfire behaviour and prescribed burning which led to the development of aerial ignition and many other changes to fire operations in Australia and the USA. Ran Fire Protection Branch in WA for over 10 years.

Don Spriggins, FIFA, MACFA, RPF: over 40 years experience in bushfire management in WA and Victoria. Formerly a regional and district manager, member of the Lands and Forests Commission and long-time Chairman of the Institute of Foresters.

Dr Frank McKinnell, FIFA: over 40 years experience in bushfire research and management in WA, including being responsible for bushfire management in WA forests and national parks in the 1980s, and a research manager overseeing studies into bushfire behaviour and ecology. Has advised overseas governments on bushfire policy and management.

Bruce Beggs ISO JP: over 50 years experience with bushfire prevention and control in WA. Formerly Conservator of Forests and Director General of the Dept of Premier and Cabinet. Experienced the 1961 bushfire disasters in WA and participated in the subsequent Royal Commission. Respected leader, administrator and manager of land management organisations.

Frank Campbell: over 40 years experience of bushfire management in Australia. Formerly Assistant Conservator of Forests in WA, and innovative Fire Operations Officer. Chairman of the WA Public Service Board Represented the Minister for Forests on the Bush Fires Board of WA for 15 years and was responsible for the

rewriting of the WA Bushfires Act in the 1970s. Experienced the 1961 bushfire disasters and the subsequent Royal Commission.

Jim Williamson FIFA: over 40 years experience in land use planning and land management in WA, formerly a Planning Manager and a specialist in mapping and inventory, currently undertaking PhD studies. Was a firefighter at Dwellingup in 1961 at the time of the great fires.

Steve Quain: over 40 years experience as a firefighter and bushfire manager in WA. Formerly a district and regional manager, Chief of Operations and Assistant Conservator in WA. Special knowledge of fire management in the karri forest as well as in the Pilbara and Kimberley regions.

John Evans: over 40 years practical experience as a firefighter and fire specialist in WA, now runs a bushfire consultancy practice. Special knowledge of southern conservation reserves, and has strong working networks with volunteer brigades and Shire councils.

Attachment 2:

Bushfire Management in Australia

A simple glossary of terms associated with bushfire science and management

Prepared by the Bushfire Front

The Bushfire Front is an organisation of professional bushfire scientists and managers, operating from Perth, Western Australia, and with links to all Australian states and overseas. Our objective is to promote best practice in bushfire management, so as to minimise the damage caused by bushfires to human life, community assets and the environment.

We have prepared this simple glossary to assist with public understanding about bushfires, and the underlying fire science. To this end, the glossary is written in everyday language and goes beyond definition to explanation and example. The list of terms explained is not exhaustive, and it is intended that it will be updated. Input is welcomed.

I thank Bushfire Front member Jim Williamson for initiating this project. In preparing the glossary we used a number of published sources, existing glossaries and input from bushfire specialists and fire scientists around Australia.

*Roger Underwood
Chairman, The Bushfire Front
September, 2003
Email: yorkgum@git.com.au*

Terms explained in this Simple Glossary of Bushfire terms

Back burn
Best practice bushfire management
Biodiversity
Burning program
Bush
Bushfire
Bushfire management
Bushfire threat
Controlled burn
Crown fires
Ecology
Extreme (bushfire) conditions
Fire danger
Fire intensity
Fire line
Fire regime

Fire season
Fire suppression
Fire triangle
Flame height
Forest.
Fuel
Fuel reduction burn
Hazard reduction burn
Hop over
Lightning fire
Mild conditions
Mopping up
Plantation
Prescribed burn
Pre-suppression activities
Rate of spread
Regeneration burn
Retardant
Scorch height

Annotated glossary of terms associated with bushfire management

Scrub
Severe conditions
Smoke management
Spot fire
Surface moisture content
Spot fire
Water bombing
Wilderness
Wildfire
Woodland

Back burn (sometimes written ‘backburn’)

A deliberately lit fire to remove the fuel in front of an advancing bushfire or grass fire so that the advancing fire will have reduced levels of fuel and will therefore be more easily controlled. A back burn is generally lit into the wind and thus can be a dangerous manoeuvre. It should only be carried out by experienced fire fighters who understand the risks and the weather. Not to be confused with ‘prescribed burn’.

Best practice bushfire management

Best Practice in bushfire management is defined as a system which

- Delivers protection of community assets and human values from destructive bushfires;
- Avoids or minimises undesirable environmental impacts;
- Ensures, as far as is possible, the safety of firefighters;
- Is based on credible science, and employs protocols and prescriptions continually updated in the light of research and field experience;
- Provides for independent monitoring of outcomes, and public reporting;
- Has community and media support, stemming from strong political leadership and a high level of public understanding of the issues.

Biodiversity

Short for “biological diversity”. The variety of nature, including the number of species and the amount of genetic variation present in an area of interest; the range of native plants and animals found at a particular site. One measure of diversity is the number of different species at a site. This number increases, is sustained or can be reduced by various events or processes, including the passage of time. Examples of natural processes in Australia include fire, frost, flood and drought; in general, native ecosystems recover from such events. Examples of imposed processes include feral predators (e.g. the fox) or herbivores (e.g. rabbits), weeds, clearing of bushland for agriculture or urban development, chemical pollution and salinity. These can lead to “local extinction” of a species, and loss of biodiversity at a site. The interaction between biodiversity and the wide range of *fire regimes* (see below) is a subject of interest to ecologists and land managers.

Burning program

A program that sets out a number of prescribed burns and schedules these for a designated area over a nominated time, normally looking ahead over one fire season (for the coming spring to the following autumn), but can also look ahead 5 years or more.

Bush

General term for all types of forest, woodland and scrub areas. Under the WA Bush Fires Act 1954 the term ‘bush’ is defined to include “trees, bushes, plants, stubble, scrub, and undergrowth of all kind whatsoever whether alive or dead and whether standing or not standing”. Land carrying bush is often referred to as “bushland”, or just bush. In addition, many city dwellers refer

Annotated glossary of terms associated with bushfire management

to all land outside the city as “the bush” irrespective of whether it is native forest, woodland or cleared paddocks.

Bushfire (sometimes written ‘bush fire’)

An unplanned fire in bush. This is a general term, uniquely used by Australians, and includes grass fires, forest fires and scrub fires, i.e. any fire outside the built-up urban environment. Also sometimes known as a wildfire. In the United States always called a wildfire and sometimes a “wildland fire”; in Europe, and Asia usually called a “forest fire”.

Bushfire management

All those activities directed to prevention, detection, damage mitigation and suppression of bushfires. Includes bushfire legislation, policy, administration, law enforcement, community education, training of firefighters, planning, communications systems, equipment, research, and the multitude of field operations undertaken by land managers and emergency services personnel relating to bushfire control.

A “*bushfire management system*” is a calculated, determined and holistic approach to preventing and controlling bushfires. As a minimum a bushfire management system should comprise:

- a stated set objectives;
- a clear statement of who is responsible for system implementation and accountable for outcomes;
- the strategies to be adopted to achieve the objectives (often set out in a stand-alone document called a “Bushfire Management Plan – see below);
- funding arrangements;
- monitoring protocols, to allow actual and planned outcomes to be compared;
- reporting of the results of monitoring;
- a research program directed at unknowns and problems; and
- a communications strategy directed at informing stakeholders about the system and its implementation.

Bushfire threat

A term used to describe and analyse the danger that a bushfire poses in a particular place, or to specified values. There are four aspects: (i) the risk of a fire starting, and of it becoming uncontrollable; (ii) the values which will be lost or damaged if a bushfire starts and gets away; (iii) the extent of damage which could be caused; and (iv) the resources which can be brought to bear on a fire and their efficiency and effectiveness.

Bushfire Threat Analysis (BTA) is a structured approach used to analyse the bushfire threat for a particular area or a nominated set of values and calculate a response or determine priorities for funding or action. It is usually the first step in producing a *Bushfire Management Plan*, which sets out *the actions to be taken* to minimise a threat, mitigate possible damage, ranks actions, allocates responsibility for action, establishes protocols for action in the event of a fire and post-fire monitoring. The Bushfire Management plan should also set up cooperative and command arrangements, and put in place mechanisms for review and updating of the action plan.

Controlled burn

Obsolete term, these days replaced by ‘prescribed burn’.

Crown fires

Occur when a ground fire is so intense that whole trees catch fire and all or parts of the upper branches and crown are consumed. In a crown fire, burning embers are sucked up into the convection column and can be carried down-wind to start new fires called spot-fires. The term Crown Fires is usually only applied in vegetation with both an upper and a lower canopy, as in a forest with trees and a shrub understorey.

Ecology

Ecology is the branch of the natural sciences devoted to the study of the interactions between plants, animals and their environment. Scientists who study ecology are referred to as ecologists. "Fire ecology" refers to the study of the response of and interactions between plants, animals and the environment and various fire regimes.

Ecosystem

An assemblage of plants and animals in a particular environment. A terrestrial ecosystem encompasses a particular biota, the soil, rock outcrops, wetlands and waterways and the atmosphere. Different ecosystems may respond differently to external pressures, for example, a bushfire, a frost, a flood or prolonged drought. The principal focus of the science of ecology is to understand different responses to imposed or natural events, and the many interactions between species and the environment.

Extreme (bushfire) conditions

Extreme bushfire conditions occur when the fuel load is high, the temperature is high, the wind strength is high, the drought index is high, the relative humidity is low, and the fuel moisture is low. These conditions can occur every summer in southern Australia. A bushfire occurring under extreme conditions moves rapidly and generates intense heat and is very difficult or impossible to suppress.

Fire danger

An index which combines all the factors that determine the likelihood of a bushfire starting, spreading and causing damage to identified values, and the difficulty of control. Used for daily preparedness planning by land managers and on signs warning the public of the daily fire danger on a scale from low to extreme.

Fire intensity (Also known as fire line intensity).

The ferocity of a bushfire. Fire intensity is a function of the fuel consumed and the rate of spread of the fire. It is expressed as the rate of energy release per unit length of fire front.

This is defined by the equation: $I = H \times W \times R$ where:

I = fire intensity measured in kilowatts /metre.

H = heat yield of fuel measured in kilojoules/kg of fuel.

W = dry weight of fuel consumed measured in kilograms /square metre.

Annotated glossary of terms associated with bushfire management

R = rate of spread in metres /hour.

A *mild fire* produces up to 350 kilowatts /metre. An *intense fire* produces 2000 or more kilowatts /metre.

Fire Intensity can also be described in terms of rate of spread and flame height.

Mild fires (or low intensity fires) used for prescribed burning have rates of spread generally below 40 metres/hour and flame height less than 2 metres. In a forest, a mild fire will usually cause little or no scorch to tree crowns. Mild fires are easily controlled.

Intense fires (or high intensity fires) can exceed a rate of spread of 3000 metres/hour and flame heights in heavy forest can exceed 70 metres. The following table demonstrates the relationship between fire intensity, fire damage and suppression difficulty.

Fireline intensity (KW /m)	Impact	Suppression Difficulty
20-500	Low intensity, patchy burn (the intensity prescribed for most fuel reduction burns). Rapid recovery of ecosystems.	Direct attack on the headfire is relatively easy
500-1700	Moderate intensity, little damage to ecosystems	Direct attack usually succeeds, but headfire must be “pinched in” from the flanks
1700-3500	Medium intensity, trees are killed, no or few unburnt patches. Very slow recovery of ecosystems	Direct attack not likely to be successful on head or flank fires
3500-7000+	High intensity, extensive and long-lasting damage to ecosystems	Crown fires occur – suppression impossible
20,000-60,000+	Extreme fire behaviour – ecosystems wiped out	Mass fires, firestorms – suppression impossible

Fire Intensity is affected by

- The quantity of flammable fuel, its moisture content and fuel type eg. jarrah litter profiles are more flammable than karri because karri litter usually contains more decomposing material. *Flammable fuel* includes litter on the forest floor [litter increases annually with leaf, twig and

Annotated glossary of terms associated with bushfire management

bark fall], understorey, shrubs[scrub], rough bark and heavy ground-wood such as dry logs which burn behind the main fire front.

- Weather conditions and predisposing climatic factors such as drought.
- Topography. Fires burn more intensely uphill than downhill.

Fire line (Also known as a fire control line or a firebreak)

A natural or constructed barrier such as a graded track or ploughed soil, or treated fire edge free from flammable vegetation, used in both fire suppression and prescribed burning to limit the spread of fire or to provide access for firefighters.

Fire regime

To ecologists, fires can be viewed as “a single event” of which the most important characteristics are size, intensity and season of occurrence, or as part of a “fire regime” which describes a series of fires at the same locality. A regime has many variables, for example the fire frequency (or interval between fires), intensity, season and distribution across the landscape, or patchiness.

Variation in fire regime is regarded as a critical factor in ecological studies, i.e. research into the effects and the interactions of fire on flora, fauna and ecosystems. The reconstruction of *past fire regimes*, e.g. before European settlement, or before occupation of Australia by Aboriginal people, is a subject of controversy between some scientists.

Fire season

The time of the year when a bushfire can start and will spread. In southern Western Australia generally confined to the spring, summer and autumn months (October to April), and lasts about 5-7 months depending on latitude; in northern Western Australia confined to the dry season (April to October). In general a fire season will intensify as rainless months go by. The peak fire season in southern Australia usually coincides with the hottest months at the end of summer (i.e. February and March).

In southern Australia, fire seasons become more dangerous if there is a run of dry winters. Dry winters, leading to “drought” dry out logs, creeks and wetlands, and cause trees and shrubs to shed their leaves, adding to the tonnage of fuel on the forest floor.

Fire suppression

Suppression of a bushfire consists of the many activities connected with restricting the spread of the bushfire, extinguishing it and making it “safe” so it will not flare up later. The principal activities in fire suppression are locating the fire, arranging rapid movement of firefighters to the fire, attacking and extinguishing the fire edge, and then mopping up the edge to ensure it cannot later escape.

Fire attack can take two forms: (i) direct attack, where firefighters work on the very edge of the fire, knocking down the flames with water, hand tools or earthmoving machinery, or perhaps by dropping water or retardant from the air; and (ii) indirect attack, where firefighters drop back to a prepared fireline some distance from the fire edge and light a backburn. Direct attack is only successful on fires of mild or moderate intensity.

Fire triangle

Diagrammatic expression of the three elements that are necessary for a fire to occur: FUEL - HEAT - OXYGEN. The removal of any one of these will extinguish a fire.

Flame height

The average height of the flames, disregarding any occasional high flashes, measured vertically from the ground. Flames are commonly 1 to 2 metres in height in a prescribed burn under mild

conditions and over 5 metres in a bushfire. Flame height can be over 100 metres in an intense forest fire.

Fire scientists also measure “flame length”, which is the horizontal reach of a tongue of flame as it is bent over by the wind. In a grassfire, flame length can be a significant factor, affecting the value of a firebreak, and in other situations will determine how close to a fire firefighters can work.

Forest

Large area of land covered with trees.

Fuel

Fire Fuel. Any material such as grass, leaf litter, twigs, bark, logs and live vegetation that can be ignited and sustain a fire. Measured in tonnes per hectare.

Fuel type. An association of fuel characteristics such as species, form, size, and arrangement that will cause a predictable rate of spread, or difficulty of suppression, under specified weather conditions.

- *Heavy fuel.* Dead woody material in contact with the soil surface, greater than 25mm in diameter. Also called ‘coarse fuel’.
 - *Litter fuel.* The top layer of the forest floor composed of loose dead sticks, branches, twigs and recently fallen leaves little altered by decomposition.
 - *Surface fuel.* The loose surface litter on the forest floor. Can consist of fallen leaves, twigs, bark, small branches, grasses, shrubs, tree saplings less than a metre high, heavier branches, fallen logs, stumps, seedlings and small plants.
 - *Trash.* The component of surface fuel above the leaf litter layer made up of dead twigs, branches and scrub debris of at least 10mm diameter.
- *Fine fuel.* Dead leaves, twigs and bark in the litter layer less than 6 mm thick as well as the green leaves and twigs of shrubs and grasses less than 2mm in diameter, and all less than 1 metre above the ground.
- *Elevated fuel.* Fuels that are suspended above the ground, such as shrubs, bark, seedlings.
 - *Available fuel.* The amount or weight of fuel that will be consumed under prevailing weather conditions during a prescribed burn or a bushfire. Available fuel can be less than total fuel, where part of the fuel profile is still damp from previous rain. Measured in tonnes per hectare
- *Total fuel.* The sum of the fuel quantity of litter, trash, scrub and fuels that are available to burn under extreme wildfire conditions. Measured in tonnes per hectare.

Fuel age. The period of time elapsed since fuel was last burnt, usually expressed in years.

Fuel load. The oven-dry weight of fuel per unit area. Also known as fuel quantity. Expressed as tonnes per hectare.

Fuel quantity. See fuel load.

Fuel reduction burn

A prescribed burn carried out with the intention of reducing the fire fuel so as to minimise the intensity of any subsequent bushfire and to ensure the bushfire is easier and safer to suppress.

Hop over (sometimes written ‘hopover’)

A fire that has started in the unburnt area immediately across a fire line constructed around the perimeter of the main fire. Usually started by sparks or burning embers, carried on gusts of wind. Most *hop overs* start within a few metres of the fire edge. By comparison ‘*spot fires*’ are thrown far ahead of a fire front for distances of up to several kilometres.

Lightning fire

Fire started by lightning striking into dry vegetation. Lightning strikes are a major cause of bushfires in Western Australia each summer. One thunderstorm can generate dozens of lightning strikes over a wide area.

Mild conditions

Conditions of weather and fuel such that if a fire starts it will behave mildly, and can be easily suppressed. For example:

Wind	less than 15km/hour
Temperature	less than 25 degrees
Relative humidity	greater than 50%
Moisture content of fuel	2% to 20%
Tonnes per hectare of fuel –	up to 8 tonnes per hectare.

Mopping up (or Mop up)

The operation carried out by firefighters after a running fire has been stopped. The aim is make the fire edge safe so the fire will not later flare up and escape. Mopping up in forest country requires extinguishing all smouldering logs and trees adjacent to the fire line and sometimes felling trees which are alight in the crown and are throwing hopovers across the fire line. Mop up work should always be accompanied by “patrol”, where a fire edge is closely monitored by firefighters for a period (sometimes weeks) after a fire is out.

Plantation

A forest established by the planting of trees of either native or exotic species. Can also comprise dense plantings of commercial shrub species, for example oil mallees or titree plantations, or horticultural crops such as sugar cane.

Prescribed burn

A general term indicating the planned application of fire to achieve specific land management objectives. ‘Prescribed burn’ replaces the old term ‘controlled burn’ and is preferred to ‘pre-emptive burn’, because it more accurately describes the process and the objectives.

The prescribed burn is carried out under predetermined (or “prescribed”) environmental conditions within defined geographical boundaries, and at the time, intensity and rate of spread

required to achieve the specific land management objectives. Before a prescribed burn is commenced a “burn prescription” is prepared. The prescription details the objectives of the burn, the conditions under which it will be carried out, the precise location, and deals with any specific considerations for the particular burn. It is desirable that burning prescriptions are drawn up a year or more in advance, to ensure all key factors are checked and put in place.

Prescribed burning can be undertaken to achieve any of the following land management objectives:

Fuel reduction A fuel reduction burn is nearly always carried out under mild conditions to ensure that no, or minimal, damage is done to the vegetation and associated environment. The following terms are used interchangeably with fuel reduction burn and mean the same thing: Community protection burn; Environment protection burn; Forest protection burn; Hazard reduction burn.

Regeneration A regeneration burn is lit under prescribed conditions for the purpose of achieving regeneration of a particular vegetation type, in forestry usually seedlings of adjacent trees with viable seed in their crowns.

Site preparation. A burn conducted to clean up a site before undertaking some other activity or converting to a different land use. Examples are stubble burning by cereal growers before sowing the next crop, or burning debris on a minesite before mining and rehabilitation. Site preparation burns are not usually undertaken with a prescription, and are more properly regarded as “burning off” rather than “prescribed burning.”

Pre-suppression activities

Those activities carried out before the fire season to minimise the risk of a bushfire starting, or to ensure that if a bushfire does start there is the best possible chance of suppressing it and preventing it seriously damaging people, the environment and property.

Pre-suppression includes prescribed burning, ensuring an effective detection and communication system is in place, that access tracks are trafficable, that firefighting vehicles, machinery and equipment are in sufficient supply and good working condition and that sufficient personnel are well-trained in command roles, suppression, mop up, safety and other fire management techniques.

Rate of spread (ROS)

The rate at which a fire advances. It is measured in metres/hour. Mild fires used for prescribed burning in forests have rates of spread generally below 40 metres/hour.

A bushfire spreads in four directions: the headfire (which burns downwind, or with the wind behind it), the flank fires (which spread sideways) and the tailfire (where the back of the fire burns slowly into the wind). A fire is usually elliptical in shape, since headfire rate of spread is always at least double flankfire rate of spread. Intense bushfires can have a headfire rate of spread which exceeds 3000 metres/hour or more. The rate of spread depends mainly on wind strength, vegetation type, fuel quantity and slope.

Under the same weather conditions the rate of fire spread is generally greater in grassland and crops than in forest because the wind strength is reduced under forest canopy, but above a threshold of intensity (in the vicinity of 1500 Kw/m), rate of spread of forest fires is also influenced by spot fire development. In dry, heavy fuels, spot fires will be carried downwind ahead of the main headfire, starting new fires, which in turn start new fires. This effect can quadruple the rate at which a fire moves, resulting in bush being “engulfed” by fire. These conditions have led in the past to loss of life of inexperienced firefighters operating in heavy fuel conditions.

Regeneration burn

A burn lit under prescribed conditions for the purpose of achieving regeneration of a particular vegetation type. In forestry the aim is usually to regenerate seedlings of adjacent trees with viable seed in their crowns, but the same burn will also regenerate understorey species present in the forest. In wildlife management, a regeneration burn may be used to create a particular habitat for some selected species of fauna, or to favour a particular plant.

Retardant

A fire retardant is a chemical applied to a fire to reduce combustion rates. Retardant is sometimes delivered by fixed wing aircraft or helicopter, or is applied in the form of foam from a fire truck. Aerial retardant dropping is usually regarded by firefighters as a “holding action” that is, it helps to keep fire intensity and fire spread down until ground firefighters can reach the fire. Most land managers prefer to drop water rather than fire retardant chemicals into native forests and conservation reserves because of uncertainty about after-effects.

Scorch height

The maximum height above the ground to which the leaves of trees or shrubs are browned by a fire. Generally about four times the flame height. In Australia, eucalyptus tree crowns that are merely scorched by a fire tend to recover, whereas trees that are defoliated can take several years to recover or may never recover. Most European and many tropical tree species are not resilient to fire, and even a mild scorching of the crown results in tree death.

Scrub

Vegetation, such as heath and shrubs, that grows either as an understorey or by itself in the absence of a tree canopy. The components of scrub are usually called shrubs. In coastal areas, scrub is often referred to as “heath” or “heathland”.

Spot fire

A new fire occurring downwind of a headfire (up to 10 kilometres has been observed), usually started by a piece of burning bark. Compare with ‘hop over’ which is a new fire that has started immediately across a fireline and not necessarily at the headfire.

Smoke management

Used by land managers and meteorologists planning a prescribed burn, to ensure that smoke does not cause problems downwind of the burn. Bushfire smoke can reduce visibility, and is believed to interact with air pollutants such as vehicle exhausts, and this can irritate some humans. Smoke

management involves prediction of surface and upper wind direction and strength for the day of the burn and subsequent days until a smoke plume has dissipated.

Smoke is also produced by wildfires, but in this situation, smoke management is not a priority concern.

Surface moisture content

The moisture content of the fine fuels in the top 5 – 10 mm of the litter bed. It is expressed as a percentage of oven dry weight of those fine fuels.

Water bombing

The dropping of water onto a bushfire from an aeroplane or helicopter. Waterbombing is most useful to help protect houses threatened by a bushfire. In forest situations it is usually regarded as a holding action, giving time for ground firefighters to get to a fire.

Wilderness

A remote area where the hand of humans is absent or not obvious. Therefore without roads or tracks and so suitable for self reliant recreation activities such as walking, canoeing or climbing. In heavy forest, the lack of vehicle access in a wilderness area can make prescribed burning for fuel reduction, and the suppression of wildfires dangerous, difficult or impossible, especially if water bombing is not permitted.

Wildfire

An American term used to describe an unplanned fire, started by lightning strike, arson or accident. A generic term that may include forest fires, scrub fires and grass fires. Usually referred to in Australia as a bushfire.

Woodland

Large tract of land covered by trees but more open than a forest and often with a grassy understorey.