



National Research Priorities to 2020 and Beyond

National Bushfire Management Policy Statement for Forests and Rangelands



Australia and New Zealand's Forest Fire Management Group

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Cover photograph:

2009 fuel reduction burn in high elevation, long unburnt native forest, Namadgi, ACT
(photo: Neil Cooper, ACT Parks and Conservation Service).



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Purpose

1. To identify the research needs required to fundamentally underpin the implementation of the *National Bushfire Policy Statement for Forest and Rangelands*.
2. To list priority landscape fire management research themes for managers of Australia and New Zealand's public lands to meet the identified needs, to 2020 and beyond.
3. To identify the related specific research questions (which are summarised in Appendix 1).



Fire killed Alpine Ash in Victoria (photo: Bushfire CRC).

Background

Australia

Occupying an entire continent of some 7.6 million square kilometres, Australia is the sixth largest country in the world. Nearly seven million square kilometres, or 91 per cent of Australia, is covered by native vegetation.

According to the *National Forest Inventory*, Australia has 149 million hectares of forest. Of this, 147 million hectares is native forest, dominated by eucalypt (79 per cent) and acacia (7 per cent), and 1.82 million hectares of plantations; while Australia's Chief Scientist records grassland as covering around 440 million hectares of land.

Fire has been significant in shaping the distribution and composition of much of Australia's flora and fauna. Many native species have developed specific mechanisms to survive periodic fire; some are fire dependent for critical life stages.

The long term effect of fire on plants and animals varies according to sequences of fire events rather than to a single fire event. Sequences of fire events are known as 'fire regimes'. Fire regimes are determined by: intensity, frequency (how often fires occur at a place), season (the time of year fires occur), extent (how large the fire is and its spatial pattern), and type (e.g. solely above ground or also consuming the organic layer of soil).

Ecologically appropriate fire regimes across the landscape are important for the protection of Australia's biodiversity. Plants and animals are adapted to different fire regimes. For example, the planet's tallest flowering plant, Mountain Ash (*Eucalyptus regnans*) regenerates from seed, and therefore may not survive if fires are too frequent, as the plants need to reach maturity and produce sufficient seed before the next fire episode.

Conversely, excluding fire from some landscapes for long periods and over large areas can threaten ecosystem health. For example, there can be negative consequences if a species is no longer able to reproduce or if heavy fuel loads accumulate resulting in large, very intense and ecologically damaging bushfires.

Equally, some species and/or ecosystems, such as rainforests, require long fire-free intervals to ensure their continued presence.

'Ecologically appropriate fire regimes across the landscape are important for the protection of Australia's biodiversity.'

Indigenous people were integral to the development of Australian fire regimes which shaped the landscapes flora and fauna. Following the movement of non-aboriginal people into this landscape resulting in gradual changes in land tenure and the creation of built assets on a significant scale, bushfires came to be seen as Australia's most ubiquitous natural hazard. In more recent decades, south-eastern Australia has come to be viewed, within the international wildland fire community, as one of the three most fire-prone regions on Earth.



Fuel reduction burn ACT (photo: Brian Levine).



Fuel reduction trials in New Zealand (photo: NRFA NZ).

New Zealand

Every year areas within New Zealand experience or are threatened by wildfire, and the risks from rural fires are growing. Conversely, over the last 30 years the damage caused by wildfire has declined significantly, with the area burnt dropping by approximately a third. The major reason for the decline has been changes in management of both the areas in which wildfires occur and the techniques used to manage them once they start. Changing technology has played only a minor role in this trend. Decreasing damage, while risks are rising, has been a significant achievement and a major gain for all stakeholders. Applied research, both in New Zealand and internationally, has been the single largest determinant of the changes in management. Research into the impacts of climate change, land use change, use of fire, carbon emissions, health and safety, and the retention of volunteers – are all areas where a better understanding to assist fire management are necessary.

'...support of applied research to further our understanding of the wildfire environment and how it can be managed.'

For this reason all stakeholders within the rural fire sector are in support of applied research to further our understanding of the wildfire environment and how it can be managed. The aim of the forest and rural fire research program is to assist in the protection of life, property, economic and conservation resources in New Zealand's forest and rural land management environments. The research provides land managers, policy makers and rural fire fighters with both information and tools to help reduce the number and consequences of wildfires.

Landscape Fire



Heavy smoke from a plantation fire in Western Australia (photo: WA DEC).

In the wider Australian community, fire is increasingly regarded as a part of the environment with large forest and woodland fires being understood to occur periodically, both prior to and since European settlement.

In northern Australia, few years pass without large areas being burnt. These fires generally have a comparatively low economic impact due to the limited population density and the dispersed nature of built assets. The potential environmental impacts from poorly planned or executed fire regimes are however, significant (negative impacts can include the loss of natural biodiversity, and increases in pest plants and animals). The greenhouse implications of extensive burning in northern Australia are also slowly being better understood.

In southern Australia large fires often have significant economic and social impacts. The 2002–03 and 2006–07 fire seasons in south-eastern Australia, and most particularly the 2008–09 season were bad, with very significant areas of forest burnt, major asset losses occurring, very high suppression costs incurred and complex incident management arrangements being required. The tragic 2009 Victorian *Black Saturday* fires and the early 2013 Tasmanian, New South Wales and Victoria events again highlighted the negative economic, social and environmental impacts that bushfires can have.

'The greenhouse implications of extensive burning in northern Australia are also slowly being better understood.'

It has been estimated (Russell-Smith *et al.* 2007) that between 30 million and 70 million hectares of Australia are affected by fire annually, with seasonal fluctuations being largely responsible for the considerable variation.

Over 90 per cent of the area of Australia burnt by fire each year is found north of the Tropic of Capricorn, with burning occurring during the 'dry season', generally between April and November.

Most of the remaining burnt area is found in the temperate, more densely populated southern region of Australia with high fire danger generally occurring between December and March.

There are significant differences between the types of fires that occur in northern, and in southern Australia. Northern Australian fires tend to occur in savannah woodlands and in hummock grasslands. The amount of fuel in these environments is generally limited and the weather conditions in the dry season are generally stable. Maximum fire intensities in these situations rarely exceed 20,000 kilowatts per metre.

During bushfires in the mountain forests of southern Australia maximum intensities can reach up to 100,000 kilowatts per metre. (Tolhurst, 2004).

At these high intensities which, coincidentally, are ecologically necessary for the renewal of the 'ash' type higher altitude single species eucalypt forests, built assets and human lives can be put severely at risk.

From a New Zealand perspective 3,000–4,000 wildfires occur each year that burn around 6,000 hectares of New Zealand's rural vegetation and land (grasslands, scrublands and forests). This is in addition to the more than 100,000 hectares burned annually by prescribed fire.

Over the last 16 years the areas affected by fire in New Zealand have ranged from 1,183 hectares in 1991–92 to 17,698 hectares in 1998–99, mainly due to fluctuations in seasonal weather conditions. Changing demographics, land-use activities and climate change will continue to adversely affect New Zealand's fire hazardscape.

The average economic cost of New Zealand wildfires from 2002–2007 has been estimated at \$97.7 million per annum (BERL, 2009). This figure does not capture the full costs of indirect fire impacts, for example on farming production, biodiversity and tourism.

The National Rural Fire Authority (NRFA) is the national co-ordinating body for the 76 rural fire authorities (Local Government, Department of Conservation, NZ Defence, forestry companies) and others (e.g. Federated Farmers of NZ), whose focus is to manage and minimise the impact of rural fire in New Zealand.

'...average economic cost of New Zealand wildfires from 2002–2007 has been estimated at \$97.7 million per annum (BERL, 2009).'

The mission of the NRFA is to '*minimise the social, economic and environmental impacts of fire in the forest and rural landscape*'. Together with other stakeholders, the NRFA has two broad objectives for rural fire management in New Zealand: reducing the number and consequences of wildfires, and facilitating the use of fire as an effective land management tool.



Soil erosion following 2003 fires (photo: Bushfire CRC).



The Policy Context

The United Nations' Food and Agriculture Organisation (UN-FAO) Ministerial Meeting on Forests and the 17th Session of the FAO Committee on Forestry, March 2005 called upon FAO, in collaboration with countries and other international partners, including the office of the *United Nations International Strategy for Disaster Reduction* (UNISDR), to develop a strategy to enhance international cooperation in fire management, that advanced knowledge, increased access to information and resources and explored new approaches for cooperation at all levels. It also requested preparation of voluntary guidelines on the prevention, suppression and recovery from forest fire. The need for such tools to assist in international cooperation had also been highlighted at the *3rd International Wildland Fire Conference* and the *International Wildland Fire Summit* (Sydney, Australia 2003) as a consequence of the increasing incidence and severity of impacts of major fires globally.

'...build on the work of the existing Bushfire CRC and expand research efforts into other natural hazards...'

An international expert consultation in wildland fires (Madrid, May 2006) agreed that a non-legally binding *Strategy to Enhance International Cooperation in Fire Management* would include an overarching framework and four components:

- i. Fire Management Voluntary Guidelines (which were published in 2006);
- ii. An Implementation Partnership;
- iii. A Global Assessment of Fire Management; and
- iv. A Review of International Cooperation in Fire Management.

From an Australian perspective, the recently released *National Bushfire Management Policy Statement for Forests and Rangelands*, that was developed by the Forest Fire Management Group (FFMG) and subsequently endorsed by the Council of Australian Governments¹ (COAG), linked Standing Councils of both Primary Industries, and Environment and Water, states:

'...A strategic approach to research, monitoring and learning aimed at supporting the use of fire in the landscape will lead to an improved understanding of the relationship between fire regimes (and individual fires) with risk, biodiversity, ecosystem health and resilience, natural resource management and production, catchment water yields and water quality and greenhouse gas storage and emissions...' (pg. 12)

In terms of current federal government research priorities, the then Minister responsible for the 'cooperative research program' listed, late in 2012, innovative manufacturing, social innovation, and sustainable regional communities. More recently, the Prime Minister has announced, as part of the implementation of COAG's 2011 *National Strategy for Disaster Reduction*, federal funding toward the establishment of a *Bushfires and Natural Hazards CRC*. The PM stated that the new CRC would *'...build on the work of the existing Bushfire CRC and expand research efforts into other natural hazards...'*

1 COAG includes the New Zealand Government

Toward a Research Agenda

In late 2012/early 2013, the FFMG sought, within the context of the recently endorsed *National Bushfire Management Policy Statement for Forests and Rangelands*, to identify both the 'drivers' and the research priorities confronting the nation's land managers to the year 2020 and beyond.

Identified policy/research 'drivers' included:

- Global warming;
- Population growth and the movement of people and assets into the bushland 'interface';
- Risk management considerations;
- Water catchment threats;
- Budget limitations;
- Ecosystem complexity;
- Growing demands for services including:
 - Tourism and recreational opportunities;
 - Water;
 - Timber;
 - Carbon storage; and
 - Food production and grazing on range lands.

'...few communities in fire-prone areas around the country believing that they are successfully managing their forests, woodlands and rural areas and the inherent fire threat associated with them.'

This work by the FFMG followed an earlier, somewhat similar analysis undertaken by the *Australasian Fire and Emergency Service Authorities Council (AFAC)*. During a process that was designed to help define more general future research needs, fire agency CEOs acknowledged that they did not have the tools and knowledge to meet the future needs of the industry and the community it serves.

The future research program directions developed as part of that process acknowledged a context that sees few communities in fire-prone areas around the country believing that they are successfully managing their forests, woodlands and rural areas and the inherent fire threat associated with them. Changes in philosophical and organisational approaches to wild land areas over the last 40 years, the expansion of urban populations into the hinterland, and more recently the uncertainties associated with climate change were seen as presenting current decision-makers with considerable dilemmas.



*Burnt infrastructure Coonabarabran 2013
(photo: Dr Margaret Kitchin).*



Research Priorities

The four strategic objectives set out in the *National Bushfire Management Policy Statement for Forests and Rangelands* are to:

- Effectively Manage the Land with Fire;
- Develop Involved and Capable Communities;
- Facilitate Strong Land, Fire and Emergency Partnerships and Capability; and
- Actively and Adaptively Manage Risk.

The Statement also commits land managers to:

'...continue to improve links with cooperative research centres, universities and other research providers by:

- *developing a comprehensive research strategy to support the implementation of this statement (this will include assessing the value of long term ecological research sites in supporting bushfire management across the landscape)...'* (pg. 15)

The members of FFMG develop twelve National Research themes relevant to land managers:

- [Climate Change](#)
- [Appropriate Fire Regimes](#)
- [Risk Management](#)
- [Water Catchments](#)
- [Fires Role in Flood Mitigation](#)
- [Indigenous Involvement](#)
- [Social Issues](#)
- [Aircraft](#)
- [Research Infrastructure](#)
- [Workplace Health and Safety](#)
- [Legislation and Policy](#)
- [Research Implementation](#)

The issues facing FFMG member agencies and the priority tasks for each of these twelve themes are listed as follows.

Climate Change

Issues Facing the FFMG

Land managers clearly have much work to do if they are to sufficiently understand the impact of climate change on both the ecosystems they are responsible for, and on the nation's level of bushfire risk.

Australia's Climate Commission, in its most recent report (April 2013), notes that fire prone conditions and associated vulnerabilities are increasing.

'...scientific issues associated with climate change science are complex...'

The scientific issues associated with climate change science are complex and, in the context of bushfires, must also be viewed in conjunction with the nature of Australia's native vegetation, much of which has a multi-faceted evolutionary relationship with fire.

The relationship between climate change and vegetation/ecosystem changes has major implications for fire management and risk assessment. Changes to biota and ecosystems will, at a minimum, affect fuel accumulation and distribution in forest and woodlands as well as affecting the biodiversity and ecological outcomes required from fire management programs. The location and extent of fire prone and fire sensitive ecosystems is likely to change in relation to climatic changes, presenting new challenges for land management and fire suppression operations.

'...developing a comprehensive research strategy to support the implementation of this statement (this will include assessing the value of long term ecological research sites in supporting bushfire management across the landscape)...' (pg. 15)

A related consideration sees smoke from bushfires, and more particularly smoke from the use of prescribed fire, as being increasingly viewed in some quarters as further adding carbon dioxide and other Greenhouse gases to the atmosphere. As with much of the science associated with climate change however, the story is complex. New vegetation that establishes following a fire invariably grows vigorously, generally sequestering considerable quantities of carbon. Similarly, any contributions to global warming that may result from prescribed fires must be balanced against the global warming effects of more frequent and more intense bushfires that will occur in the absence of the strategic use of prescribed fire in many ecosystems.



Heavy smoke from Grampian fires 2013
(photo: Patricia D'Abrera).

More specifically, it has been estimated that a change in only 10 per cent of the carbon stored in the soil would be equivalent to all the anthropogenic CO₂ emitted over 30 years (Kirschbaum, 2000). The influence of fire on the carbon balance of montane and sub-alpine ecosystems in Australia is virtually unexplored but is clearly of importance given the extent of the ecosystems concerned, their carbon density, and their sensitivity to both fire and climate. Current Bushfire CRC research is designed only to provide baseline data on carbon cycling from key vegetation types in the sub-alpine region of NSW, and to further elucidate the drivers of carbon flux in soils.

Other implications that flow from a changing climate and consequential more extreme weather events include:

- Changes to the distribution and extent of ecosystems under management, changing fire risk profiles, planning and mitigation actions;
- The likelihood of increasing event 'cross-over', such as more frequent and more intense heat waves leading to conflicts between advice to vulnerable people to rest and to stay indoors, while at the same time remaining alert to the threat of bushfires;
- Heat wave impacts on the availability and efficacy of volunteer fire fighters;
- A possible greater occurrence, nationally, of simultaneous bad floods and serious bushfires is a possibility recently raised by the BoM, fragmenting emergency response;
- A merging of northern and southern hemisphere fire seasons leading to a lessening of the effectiveness of the current mutual support arrangements (particularly between North America and Australia);
- Possible changes in the pattern of dry lightning storms; and
- Changes in the amount and seasonality of rainfall which can affect fuel dynamics in native ecosystems.

'...influence of fire on the carbon balance of montane and sub-alpine ecosystems in Australia is virtually unexplored...'

The FFMG is Seeking

- A much greater understanding of the way global warming will impact on ecosystem health and viability, at a regional level;
- The impact of climate change on the criteria used to produce fire danger ratings in specific areas;
- A greater understanding of carbon storage options available for forests, woodlands and rangelands, and a related improved understanding of the relationship between vegetation age, fire regimes and carbon fluxes (involving soils, vegetation, smoke and the atmosphere); and
- Ways to integrate applied research with adaptive management to increase the rates of response to ecosystem changes.

The Identification and Maintenance of Appropriate Fire Regimes

Issues Facing the FFMG

This continues to be a fundamental task if land managers are to adequately fulfil their *raison d'être* in relation to the ecosystems for which they are responsible. Ecosystem specific research however is generally conducted at the jurisdictional or local level, issues beyond the identification of frameworks and benchmarks rarely being national in nature.

The planning and implementation of fire regimes is long term in nature and requires predictive capacity, with understood levels of uncertainty, to underpin decisions in the present.

Over time, it is likely that at least some ecosystems will move across the landscape with changes to climate, becoming either larger, smaller or of similar extent but changing geographical location. Current knowledge of fire management in these ecosystems will form the basis for future management across different areas.

However, the development of a national data base, describing the distribution of existing ecosystems; predictions of where they will be in the future (with defined uncertainty); and setting out the appropriate fire regimes (with appropriate burning prescriptions) necessary for future management will need to occur as part of the implementation of the *National Bushfire Management Policy*.

'...new ecosystems will arise, and these will need research into fire risk and appropriate fire management needs.'

Using current climate projections it would seem possible that new ecosystems will arise, and these will need research into fire risk and appropriate fire management needs. Similarly, it appears a range of sensitive ecosystems may disappear and a range of (fire-dynamic) ecosystems will become more widespread. It is currently suggested that fire managers will experience conditions that exist already but more widely across the landscape.

The FFMG is Seeking

- The development, and on-going maintenance of a national data base of current and projected distributions of existing ecosystems under a range of climate change scenarios (the size of this task is acknowledged, and priorities and strategic collaboration with other interested stakeholders would need to be established);
- Development of models to assist in determination and management of appropriate fire regimes;
- Agreed indicators of landscape biodiversity health and fire risk management, for assessing the adequacy and effectiveness of landscape management approaches;
- The identification of a suite of appropriate fire regimes for each major Australian and New Zealand ecosystem; a data base that is informed by the needs of threatened species of flora and fauna, by the requirement to manage pest plants and animals, and that uses agreed measures (and indicators) of ecosystem health, vitality and productive maintenance capacity; and
- Parameters for evaluating biodiversity trade-offs when designing burning programs for human life and property protection which can be readily applied in a risk assessment and mitigation context.
- Ways to integrate research with adaptive management in defining and managing appropriate fire regimes; and
- A better understanding of how climate change will interact with fire seasons (length, dryness), fire weather, dry lightning and bushfire risk across all regions of Australia and the time frames involved.

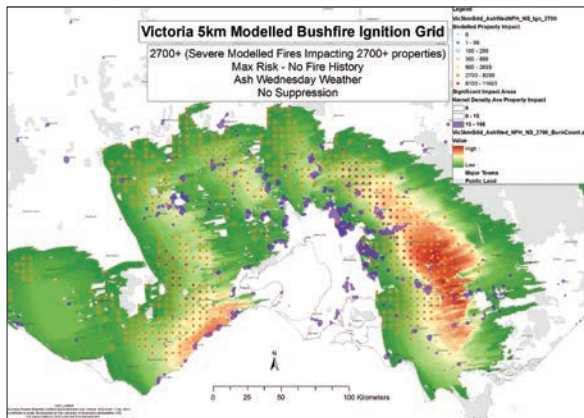
'Tool(s) which standardise risk assessment across different vegetation types, management objectives, agencies and communities would be useful to ensure threats are recognised and treated in the same way.'

Risk Management

Issues Facing the FFMG

The work that has been conducted in this area in recent years has contributed significantly to improvements in the management of landscape fire and prescribed burning. However, public and professional expectations of land managers have risen considerably and a greater, more transparent understanding of the trade-offs involved is required.

Tool(s) which standardise risk assessment across different vegetation types, management objectives, agencies and communities would be useful to ensure threats are recognised and treated in the same way. This approach is essential in the training of new fire managers and to transfer experience and knowledge between generations of fire management professionals.



Model output of predicted fire spread of Ash Wednesday fires (photo: Vic DSE).

The FFMG is Seeking

- Refinement of the currently available models, and of the underlying fire behaviour and fuel accumulation simulations in a form that can be readily utilised in risk assessment and management;
- A more refined analysis of the effectiveness of prescribed burning in meeting both ecosystem and risk management objectives – including delineating and identifying trade-offs between social and environmental outcomes;
- Enhanced tools for the assessment of fuel characteristics across the landscape;
- Methods for quantifying the severity of seasonal and multi-seasonal drought and its effects on fuel availability and potential fire behaviour;
- Enhanced resource preparedness models that include fire danger indicators and more realistic indicators of the differing levels of risk associated with various vegetation types; and
- Predictive resourcing guides (crew, machines and aircraft) for fire-line construction in a range of vegetation types and topographies.

Water Catchment Management

Issues Facing the FFMG

Maintaining catchment water quality and quantity in response to changing fire and climate regimes is a key challenge facing many land managers. Community expansion and projected water shortages in some jurisdictions place additional pressure on fire managers to secure water infrastructure and availability.

'Maintaining catchment water quality and quantity in response to changing fire and climate regimes is a key challenge facing many land managers.'

Balancing responsible approaches to the management of landscape fire, the use of prescribed fire in water catchments for the protection of water quality, water yield and human safety, and including water yield and quality parameters in fire risk models all present challenges.



Hazard reduction around ACT's main water supply 2013 (photo: Odile Arman).

The FFMG is Seeking

- A better understanding of the relationship between fire regimes, risk management, water quality and yield; and
- A practical way of integrating water yield and quality objectives into fire risk models and fire regimes.

The Role of Forests and Woodlands and Fire Regimes in Flood Mitigation

Issues Facing the FFMG

Forests and woodlands play a vital role in moderating water movement over the landscape. Although forested landscapes cannot prevent large floods outright, they do minimise the frequency, intensity, and extent of all flooding events, which in turn significantly reduces the damage to life and property that serious flooding can cause. Forests also minimize soil erosion and landslides, and improve stream channel stability and water quality.

As global warming intensifies hotter, dryer conditions are predicted as, in some locations, are more intense storm, wind and rainfall events. The influence of

fire regimes on the ecosystems ability to withstand these events and contribute to community resilience is key knowledge required to underpin planning and implementation of controlled fire.

'...influence of fire regimes on ecosystem ability to withstand these events and contribute to community resilience is key knowledge required to underpin planning and implementation of controlled fire.'

The FFMG is Seeking

- A better understanding of the relationship between fire regimes, flood events and the level of risk to life and property.

The Role of Indigenous People in Land Management

Issues Facing the FFMG

Agencies are increasingly working with indigenous people, particularly in natural resource management and heritage related activities.

'...need for improved dialogue and information flow between Aboriginal and non-Aboriginal land managers is acknowledged, as is the need for appropriate research to underpin this relationship.'

Aboriginal attitudes and perceptions of land management issues can sometimes differ considerably from those of other land managers. Explanations for the nature and condition of land and resources can have their root in Aboriginal culture rather than in the western scientific paradigm. This is an issue of great importance when looking at any of the activities which take place on Aboriginal land. The need for improved dialogue and information flow between Aboriginal and non-Aboriginal land managers is acknowledged, as is the need for appropriate research to underpin this relationship.

The FFMG is Seeking

- A better understanding of the scientific and cultural basis for indigenous burning strategies in different ecosystems and how that might be integrated into fire management plans and objectives;
- A better understanding of the drivers of indigenous participation in land and fire management; and
- A better understanding of indigenous aspirations and objectives for land and fire management with indigenous land owners as key stakeholders.

Maintaining a Land Management 'Social Licence'

Issues Facing the FFMG

In recent years the term 'social licence' has come to be more widely applied, and used by a broader range of stakeholders – beyond the earlier more localised company and community context. There has also been increasing debate in the academic literature over how to define 'social licence obligations' and what (if any) value the concept brings to an understanding of the social aspects of sustainable development.

In the highly urbanised social and political climate in which land management agencies must operate, an understanding of, and support for management activities (such as the use of prescribed fire, and the management of pest plants and animals) among the wider community cannot be assumed. Achieving a better understanding of these matters within society is also essential if community education and information programs are to be effectively designed and delivered.

'...an understanding of, and support for management activities (such as the use of prescribed fire, and the management of pest plants and animals) among the wider community cannot be assumed.'

The FFMG is Seeking

- Logical, nationally consistent and easily recognised indicators of fire program effectiveness and goal achievement for reporting to Governments and other stakeholders;
- Consistent and regular assessment of community attitudes and expectations for fire management with links to the risk assessment and community education programs of the fire and land management agencies; and
- A better understanding of the changing levels of community resilience and what that means for education and awareness programs; and
- A better understanding of the impacts of smoke on health, community services and viticulture, and develop tools and methods to manage these impacts.

The Use of Aircraft

Issues Facing the FFMG

The role of aircraft in the management of landscape fire has increased in prominence considerably since the 1960s.

'...the costs of suppressing bushfires have been rising dramatically and aircraft use comprises a significant component of these increased costs.'

Nationally, the federally-funded *National Aerial Firefighting Centre*, which was established in 2003–04 to fund ten aircraft to assist State-based operations, now, routinely, funds in excess of 52 aircraft, a significant percentage of which are large, heavy-lift machines.

In the same period, the costs of suppressing bushfires have been rising dramatically and aircraft use comprises a significant component of these increased costs.

In recent years bushfire related aircraft use has received considerable attention from the media, particularly when aircraft have been used on significant fires fringing metropolitan areas, and when large machines have been used. This aircraft prominence has the potential to distort more considered approaches to the management of bushfire.



Helicopter use in Hazard reduction – Corin dam ACT (photo: Scot Farquhar).

Equally however, aircraft use is now integrated within the overall task of managing landscape fire and the benefits and limitations need to be understood. Similarly, the use of retardant and suppressant chemicals needs to be understood in the context of fire management and the ecological footprint.

The FFMG is Seeking

A better understanding of questions including:

- The relative effectiveness of aerial fire suppression – exploring the niches where aircraft have a distinct advantage either as front line assets or as support resources and similarly understanding their limitations;
- The relative cost effectiveness of aerial assets in a range of roles compared with other assets – the right tool in the right place;
- The most effective strategies for the integration of aircraft use in a range of roles – bombing, intelligence gathering, mapping, transport, aerial ignition etc;
- In what situations does aerial management have the greatest net benefit? (i.e. which locations-remote/interface etc./fuel types/phase of operation – first-attack?);
- The relative effectiveness of a range of aircraft and equipment types (i.e. which class of aircraft/aircraft type/suppression equipment/suppression medium);
- Indicators and parameters in risk models which guide the appropriate use and level of investment in aircraft for a given event;
- The most important pre-conditions for effective/cost effective aircraft use (i.e. what else needs to be in place to make sure a positive return and optimum returns on investment are achieved?);
- Understanding the trade-offs between fire and the ecological impact in the use of retardant and suppressant chemicals;
- Understanding the optimal role and use of unmanned aircraft for uses such as monitoring fire behaviour through dense smoke, low cloud or darkness, or for aerial ignition in remote areas; and
- Define the role of radar imaging in fire planning and suppression?



Protective clothing at safety briefing (photo: Simon Butt).

Developing and Maintaining 'Research Infrastructure'

Issues Facing the FFMG

Much of the information required for informed decision making and policy development is derived from long-term monitoring and research programs. This involves sustained investment in infrastructure such as ecological reference sites (long-term ecological research sites), longitudinal human community studies, and research data, such as detailed fire history, both regionally and nationally. This infrastructure investment also underpins shorter-term projects, and third-party Inquiries, and enables researchers to move quickly on urgent high priority projects. It also facilitates the use of common underlying data sets to generate specific outputs and provides a unifying framework for complementary contract or agency-based research, which is usually shorter-term, state/territory-based and which, in many cases, builds on broader knowledge bases.

'...establishment and maintenance of long-term fire management related ecological study sites, and longitudinal human community studies.'

The FFMG is Seeking

- The identification, collection and on-going management of appropriate landscape fire data including fire history and intensity, carbon impacts, ecosystem health and risk level monitoring; and
- Monitoring of the need for and, as appropriate, the establishment and maintenance of long-term fire management related ecological study sites, and longitudinal human community studies.

Workplace Health and Safety

Issues Facing the FFMG

Land management agencies already have a strong focus on safety. Pressures for even safer working conditions will continue and both the risks and the risk management options clearly need to be understood to ensure appropriate protection for personnel, the communities they serve, and the wider society, while at the same time maintaining first-class agency response and general management capability.

Many aspects of fire management remain 'hands ons activities but with the increasing use of prescribed fire in many jurisdictions and potentially increased exposure to extreme fire events, there is a new imperative to look at the working conditions of fire managers and fire fighters.

'...increasing use of prescribed fire in many jurisdictions and potentially increased exposure to extreme fire events, there is a new imperative to look at the working conditions of fire managers and fire fighters.'

A key focus will remain on identifying alternatives to placing people in the more hazardous situations. Importantly also, is the need to understand the full impact modern emergency response has on other aspects of the lives of responders.

The FFMG is Seeking

- An understanding of the impacts of climate change and prescribed burning on fire behaviour as a guide to the level of risk exposure by fire fighters;
- The development of fire fighter specific risk assessment tool(s) and mitigation strategies;
- The enhancement of training programs for fire fighters, volunteers and land owners through incorporation of improved fire behaviour knowledge generated in other parts of the research program;
- The development of tools to extend WH+S knowledge and strategies to individual private landowners to assist with the development of personal fire plans; and
- An understanding of changes that could be made in fire fighter equipment to address more stressful operating environments, improve field communications and enhance the transfer of relevant knowledge from an incident control centre to fire ground.

'...achieving and maintaining an appropriate balance between workplace safety and threats to life and property posed by landscape fire.'

Legislation and Policy

Issues Facing the FFMG

Land management (and related) agencies are increasingly grappling with the impact of third-party Inquiries of various types. These invariably require considerable time and effort and do not always consider the most productive use of resources. It is believed the increasing frequency of such Inquiries, and the related personal accountability for the management of inherently high-risk and often very dynamic situations they bring, may be leading to behavioural change and risk-averse agency cultures, thereby reducing the effectiveness of some management undertakings, including response.



Victorian fire-fighters (photo: Parks Victoria).

Scientific knowledge and carefully evaluated experience are essential foundations for the production of good policy and legislation. Fire in the landscape affects many stakeholders and the policy framework governing the agencies' and communities' response to fire will be tested repeatedly, deeply and thoroughly in the future. Any flaws will be exposed and in the worst cases, lives may be lost as a result. It is critical to have the best information to support policy direction in this field and that information must come from a carefully constructed and reviewed process to ensure its veracity.

A good scientific basis for policy will provide land managers with the confidence to proceed in an inherently high risk environment and do what needs to be done in the safest and most effective way.

It is also clear that in many aspects of the industry, from land-use planning through to incident management, the role of supportive policy and legislation is crucial. What form good policy and legislation should take requires constant monitoring and innovative thinking, backed by relevant research.

The FFMG is Seeking

- On-going monitoring and analysis of current policy settings and legislation, and related community and agency cultures, with a view to achieving and maintaining an appropriate balance between workplace safety and threats to life and property posed by landscape fire.



Night time burning (photo: Simon Butt).

Research Implementation

Issues Facing the FFMG

In order to reap the maximum benefits from investing in research it is important to regularly and systematically review the position of agencies in relation to the utilisation of the findings of completed research, and also to understand how individual agencies and the wider industry can best capitalise research outcomes.

The scientific study of methods to promote the uptake of research findings can sometimes be useful. Research projects generally focus on specific issues or field based experiments, and assume that findings can be generalised to roll out into strategic and/or operational practice. 'Implementation research' explores the challenges that are faced when generalising research findings in the 'real world', for example in fields such as fire or flood management.

'...continued conversion of research outcomes to operationally useful tools;'

The FFMG is Seeking

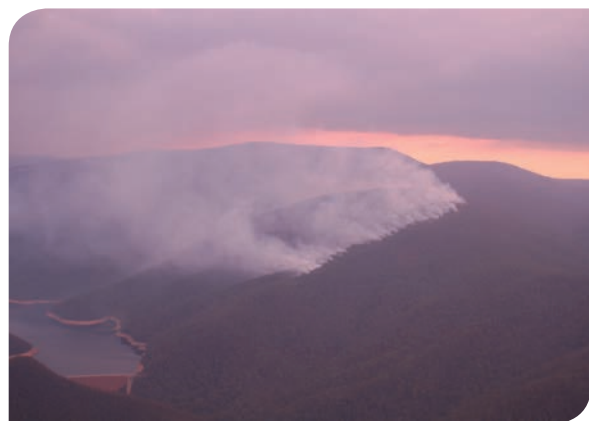
- The continued conversion of research outcomes into operationally useful tools;
- Novel ways of distributing research outcomes for different stakeholders including agencies, communities, policy makers and others; and
- The maintenance of effective research utilisation and related monitoring programs in general.

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High fuel loads (photo: Simon Butt).



Fuel reduction in water catchment (photo: Brian Levine).



Fixed wing aircraft (photo: Bushfire CRC).



Appendix 1 – FFMG Research Themes/Issues/Research Questions

Research Theme	Issues	Research Questions
Climate Change	<ul style="list-style-type: none"> • The impact of climate change on both ecosystems and the level of bushfire risk; • The Greenhouse gas consequences of varying prescribed and bush fire regimes; • The complexities of the relationships between fire regimes, carbon cycling, carbon balances and ecosystem health; • Possible changes in the pattern of dry lightning storms; and • The need to better understand the impact of extreme weather events on the vulnerability of communities, and on fire fighter fitness/effectiveness. 	<ul style="list-style-type: none"> • Do existing fire danger and risk models adequately cover the range of predicted 'new' ecosystems? • What impact will climate change have on ecosystem fuel accumulation and dynamics? • What impact will predicted increased 'dry lightning' storms have on bushfire risk? • How do the Greenhouse gas emissions from prescribed fires compare with the background carbon flux from 'natural' fire regimes in priority landscapes? What are the emission trade-offs between different fire regimes? • What easily measurable (i.e. that can be routinely monitored by land managers) indicators of carbon flux can be incorporated in hazard reduction fire prescriptions? • What modifications are necessary to existing fire behaviour models to account for climate change? • How does predicted climate change affect existing fire behaviour models and fire risk analysis? • How do current fire fighter fatigue management processes cope with increased extreme events and temperatures? • How can predicted climate change scenarios be incorporated into community preparedness planning and individual 'Prepare, Leave Early or Stay and Defend' plans? • How will climate change affect fire seasons (length, dryness), fire weather, dry lightning (frequency and spatial distribution) and bushfire risk across targeted regions of Australia and what are the time frames involved?

Research Theme	Issues	Research Questions
The Identification and Maintenance of Appropriate Fire Regimes	<ul style="list-style-type: none"> • A need to be able to better plan for and implement fire regimes in the longer-term, requiring predictive capacity with known uncertainty to underpin decisions in the present; and • The current absence of comprehensive national data bases that can underpin future analysis of climate change impacts on ecosystems. 	<ul style="list-style-type: none"> • What are the natural fire regimes for ecosystems of interest and how will they change? • How do managed fire regimes need to change to keep pace with climate change? • What are the uncertainty levels associated with fire regimes and can these be reduced? • What general principles and benchmarks for fire regimes apply across the landscape – regardless of ecosystem and location? • What indicators of ecosystem health reflect appropriate fire regimes? • How to deal with trade-offs between community safety and biodiversity protection in designing and implementing fire regimes? • What prescribed fire ignition patterns should be used in protected areas for fuel reduction?
Risk Management	<ul style="list-style-type: none"> • A need to further refine current risk management models to provide greater understanding and transparency in relation to the associated trade-offs; • A current absence of tools which standardise risk assessment across different vegetation types, management objectives, agencies and communities that would help ensure that threats are recognised and treated in the same way; and • A need to examine whether scenario modelling, as a tool for use in Incident Management Team training, has a role to play. 	<ul style="list-style-type: none"> • How can existing fire danger and fire spread models be refined and better integrated with risk management tools? • What additional parameters and indicators are needed to improve risk assessment for environmental outcomes? • Where are the conflict points for environmental and community safety risk management and how might they be resolved? • Is there a role for scenario modelling in Incident Management Team training? • What science is required to underpin a national Bushfire Risk assessment standard and how would this standard deal with localised differences in landscape, vegetation and community resilience? • What is the effectiveness of various risk mitigation strategies including community preparedness and prescribed fire? • How does the impact of concurrent disaster events affect risk assessment and management? • Can we develop models and or tools that assist in quantifying the costs and benefits (social, financial and environmental) of prescribed burning across different landscapes?

Research Theme	Issues	Research Questions
Water Catchment Management	<ul style="list-style-type: none"> Increasing pressure to maintain water quality and quantity, at a time of changing fire and climate regimes; and Better ways of including water yield and quality parameters in fire risk models. 	<ul style="list-style-type: none"> What are the trade-offs between fuel reduction and water yield in catchments close to the urban interface? What is the impact of demographic change on the trade-offs between water yield/quality and fuel reduction? What is the impact of climate change on trade-offs between water yield/quality and fuel reduction? What indicators or parameters of water yield and quality are best suited to inclusion in risk assessment and management models?
The Role of Forests and Woodlands, and Fire Regimes in Flood Mitigation	<ul style="list-style-type: none"> The need for a better understanding of the influence of fire regimes on ecosystem ability to withstand more intense storm, wind and rainfall events. 	<ul style="list-style-type: none"> What parameters relating to flood mitigation should be incorporated into risk models and planning for fire regimes?
The Role of Indigenous People in Land Management	<ul style="list-style-type: none"> A need to better understand the scientific basis for indigenous cultural approaches to fire management; and The need for a better understanding of the drivers of indigenous participation in land and fire management. 	<ul style="list-style-type: none"> What are the driving factors behind indigenous fire management and do they have an identifiable scientific basis? How can we parameterise indigenous cultural factors into fire management and fire behaviour models?
Maintaining a Land Management 'Social Licence'	<ul style="list-style-type: none"> A need to better understand community attitudes to fire in the landscape, as a means to better underpin community education and information programs; and The importance of maintaining the trust of the community through transparency and accountability. 	<ul style="list-style-type: none"> What are the logical and easily recognised indicators of success in the management of fires in the landscape and how should these be integrated in triple (quadruple) bottom line reporting to stakeholders? What are the indicators of community satisfaction with fire management by land managers and how are these best monitored? How can these indicators and feedback be incorporated into risk management and planning? What are the most effective means for communicating key messages about fire in the landscape and how do these change for different messages? How can we better quantify the impacts of smoke on health, community services and viticulture and further develop tools and methods to assist in minimising and managing the impacts of smoke?

Research Theme	Issues	Research Questions
The Use of Aircraft	<ul style="list-style-type: none"> • With costs rising, a need for a greater understanding of the effectiveness, and of the optimal roles for aircraft in the management of landscape fire; • The need to constantly improve the integration of aircraft with other fire management tools; and • A need to examine possible roles for UAVs (drones) and radar in fire fighting/ fire management. 	<ul style="list-style-type: none"> • What are the optimum and most effective roles for different aircraft types in a range of fire scenarios? • What is an appropriate set of parameters by which to compare the effectiveness of a range of fire fighting assets – including aircraft? • What is the relative effectiveness of different aircraft and role equipment combinations in a fire fighting sense and in a cost effectiveness sense? And are these the same thing? • What parameters should be used in risk models and decision support tools to ensure the appropriate use and level of investment in aircraft for a given event? • Development of tools to evaluate strategies for aircraft involvement in a range of roles? • What are the fuel break construction rates for different types of ground and aerial assets which can be used in decision support and comparison studies? • How do we measure the impacts of retardant and suppressant chemicals on fire suppression and ecosystems to determine the most appropriate use? • What are the risks and advantages of using UAVs and/or radar in fire management roles?
Developing and Maintaining 'Research Infrastructure'	<ul style="list-style-type: none"> • A current absence of an adequate network of longer-term monitoring and research programs (such as ecological reference sites, human community studies) and research data bases. 	<ul style="list-style-type: none"> • What are the key existing long term resources available for fire research and what are the gaps affecting progress? • Are there key indicator communities (and where are they) for mapping medium-long term changes to community attitudes and preparedness for fire in the landscape? • How can other research groups and communities be incorporated into the overall bushfire research framework on a 'self-nominating' basis? • What are the guiding principles to be used for the establishment of long term research studies? • What information from actual bushfire and prescribed fire events should be captured to contribute to the larger data pool available for research?



Research Theme	Issues	Research Questions
Workplace Health and Safety	<ul style="list-style-type: none"> • Continuing pressure for safer working conditions; • The difficulties associated with balancing safe working environments with the need to maintain first-class agency response and general management capability; and • A need to continue to explore alternatives to placing people in hazardous situations. 	<ul style="list-style-type: none"> • What are appropriate fatigue management systems for fire fighters and how should they be changed to account for climate change and increased hazard reduction? • How can agency WH+S principles and practices be extended to individual landowners and people instigating their own property fire management plans? • What equipment, strategies and practices can reduce the WH+S risk to fire fighters in bushfires?
Legislation and Policy	<ul style="list-style-type: none"> • A need to continue to ensure that legislation and policy have a sound scientific basis; • An increasing incidence of third-party inquiries; • A need to counter tendencies toward extreme risk aversion and subsequent poor landscape management; and • The variety of stakeholders involved in the management of landscape fire and the need for a multifaceted approach to policy development. 	<ul style="list-style-type: none"> • What are the current gaps and priorities in research to underpin policy development?
Research Implementation	<ul style="list-style-type: none"> • Effective and timely conversion of research results into operational tools and knowledge; • 'Generalisation' of specific research outcomes; and • Packaging of research outcomes to increase uptake by a range of stakeholders with differing skills and objectives. 	<ul style="list-style-type: none"> • What planning and review processes are needed to ensure knowledge is delivered in an appropriate and usable form? • What are the best ways of integrating individual research projects to deliver broader and more general operational outcomes? and • What are the most effective modes of delivery of research outcomes to different stakeholders?

