bushfire CRC

EXIT REPORT

BUSHFIRE CRC 2003-2010

CRC AUSTRALIA


bushfire CRC

1 Introduction

A National Approach to Bushfire Research

The formation of the Bushfire Cooperative Research Centre in 2003 was a major step by the fire and land management agencies and research partners in Australia and New Zealand.

It was a move towards a better understanding of the complex social, economic and environmental aspects of bushfires.

The Bushfire CRC combined the efforts of more than 30 research, fire and land management agencies in Australia and New Zealand in undertaking research on bushfires.

Funded through the Australian Government's CRC program and substantial partner resources for a seven year term from 2003 to 2010, it addressed many of the key research issues raised by the major fires of the past decade.

The research program contained more than 50 projects covering:

- Safe Prevention, Preparation and Suppression
- Management of Fire in the Landscape
- Community Self-Sufficiency for Fire Safety
- Protection of People and Property

The achievements of this Program appear in the following pages of this publication.

Research outputs have been independently assessed as being of "high quality" overall, and on "international benchmark" in the social sciences.

All research outputs have been incorporated into utilisation pathways for use by stakeholders.

The Bushfire CRC has brought about a culture change in the sector with evidence based policy now integral to its systems.

Social sciences are now an essential complement to the physical and natural sciences.

In addition, the Bushfire CRC built a capacity that has enabled multiple, high impact contract research projects to be conducted.

The Bushfire CRC also provided a comprehensive education program to develop the next generation of fire researchers and to inform the public and special interest groups on the latest developments in bushfire knowledge.

This Exit Report is a record of the major achievements of the Bushfire CRC.

www.bushfirecrc.com

2 Report Content

2.1 Performance against the Commonwealth Agreement

Overall achievements

The Bushfire CRC successfully completed the final year of its seven year funding life with more than 90 percent of the key research outputs and activities as defined by the original Commonwealth Agreement achieved.

Where outputs have been unable to be completed alternative products and/or ways to address the issue have been agreed upon between the Bushfire CRC, research partners and industry. Where appropriate, variations to the Commonwealth Agreement have been completed through the CRC Program.

Research output after seven years now totals more than 826 publications. All these publications – reports, journal articles, presentations, posters – are online at www.bushfirecrc.com and most also appear on the AFAC Knowledge Web, a product of the Bushfire CRC now managed by the industry.

The Bushfire CRC Fifth Year Independent Panel Review concluded with a positive assessment of the Bushfire CRC's research quality, performance against agreed milestones, governance and research adoption. The review that concluded, among things, that:

> *The CRC has played a leading role in initiating or further developing a culture of 'improvement by research' evident in all the agency representatives interviewed.*
>
> And that:
>
> "*The Panel has been greatly impressed by the quality of science and by the rate of adoption of research results evident in the Bushfire CRC*."

The major focus for the last two years has been on its *Research Adoption Strategy* and completing the scientific requirements through the submission of journal articles and other academic outputs. This strategy was to ensure that research outputs are founded in rigorous scientific publications and are properly managed through to industry adoption. Industry partners have provided guidance on the optimum way to achieve that adoption. This has lead to a range of easy to digest publications, and online tools and guides, as well as workshops, seminars and field trips.

The Bushfire CRC received an additional three years extension funding from the Australian Government; $15 million for research in the period 2010-2013 as part of the Stimulus Package. This will be used to conduct research into national issues arising from the 2009 Victorian Bushfires Royal Commission.

Further work has begun to identify an appropriate research vehicle and funding sources to secure the future of longer term fire-related research in Australia, in line with the recommendation of both the Royal Commission and the Senate Committee Inquiry into *The Incidence and Severity of Bushfires across Australia*.

For more details on the achievement of milestones and outputs see pages 11 to 42.

Finance

At the end of the seven year funding program the financial performance of the Bushfire CRC was positive with cash and in-kind contributions exceeding original budgets. Cash actuals from all sources were $51 million against an agreed budget of $47 million. In-kind actuals were in excess of $75 million against an agreed budget of $62 million.

The key deliverables in the Commonwealth Agreement for the individual research programs were met within budget, enhanced by a better than anticipated total of in-kind contributions. The

Department of Innovation, Industry, Science and Research has agreed that remaining funds may be carried forward into the extension program.

Overall, this is an excellent result for the Bushfire CRC and is due to prudent financial management and the commitment of partners to the direction and outcomes of the research program. The substantial increase in in-kind contributions by end-user partners, in particular, significantly decreased the demand on budgeted cash expenditure.

On financial performance the Fifth Year Independent Panel Review concluded:

> *The Panel is satisfied that the CRC is financially viable, and that investment is connected directly to research progress.*

Governance and Management

The Governing Board and Stakeholder Council met at all designated times over the seven years to provide strategic guidance to the management of the Bushfire CRC. All key activities of the centre continued amidst several major personnel changes including
a new Chairman and CEO mid-way through the funding period, as well as the addition of several new members of the Board, including a move to include more independent board members to reflect the maturity that had developed within the industry and the Bushfire CRC and in line with the recommendations of the Fifth Year Review. (See Table 1: pages 45-46)

2.2 Outputs of the CRC

Key outputs and details of uptake are listed from pages11 to 42.

2.3 Impacts to Date

Economic value

The Bushfire CRC is largely a public good CRC where most of its outputs are directed to agencies of government that deliver safety and environmental services to the community. Many of these benefits are combined with other policy positions and settings to create an overall benefit to Australia. In part the Bushfire CRC inputs are a necessary but incomplete part of the total benefit, and in many cases these benefits are intangible in nature.

However, the benefits of Bushfire CRC have been seen in a number of areas that were outlined in economic modelling conducted for the Fifth Year Review, which was independently reviewed by Prof David Pannel of the University of Western Australia. This analysis endeavoured to link the outputs from the Bushfire CRC to the following impact areas: Property Loss, Loss of Civilian Life and Injuries, Community Health, Fire fighter Health and Safety, Ecosystem Services, Carbon, Water, Business Losses (Agriculture and Forestry and Infrastructure), Workforce, Marginal Cost of Service Delivery.

The analysis used a conservative methodology and assumptions, based on the total cost of the Bushfire CRC that takes into account Commonwealth and industry cash and in-kind contributions (including the costs of research adoption after the life of the Bushfire CRC). Over a 30 year life at discount rates of 3, 5 and 7% the Net Present Values (NPV) of the research program are $418M, $294M, $210M and over 15 years are $167M, $131M, $102M respectively. This results in a benefit-cost ratio (BCR) over 30 years of 7:1 and over 15 years of 3:1.

In order to address a specific economic requirement of the Bushfire CRC the NPV on the Commonwealth cash contribution only (with agency in-kind as a surrogate for adoption cost) was also calculated. This shows a NPV of the research program over a 30 year life, at discount rates of 3, 5 and 7%, of $438M, $312M, $227M and over 15 years are $187M, $149M, $119M. Based on this a threshold of three times the Commonwealth contribution is reached after 10 years from the start of the CRC.

One of the sensitivities in this analysis is the relatively large value for ecosystem services while also our estimate for the likely impact is uncertain. Consequently, a sensitivity analysis was conducted by excluding the contribution from this element; even though this effectively discounts any benefits from Program B, which carries approximately a quarter of the costs of the Bushfire CRC. These costs were maintained in the analysis. In this case the NPV range reduced to $66M-320M and the BCR for 30 years reduced to 5.5:1 and 2.4:1 for 15 years.

Significantly, the annual benefit derived is approximately 1.8% of the impact of bushfire. The major savings come from a decrease in agricultural and forestry losses, ecosystem services losses and the special funding provided for marginal cost of service delivery for major events.

In other areas the research contributes to a saving of approximately one life and a reduction in the loss of approximately six houses per year.

This analysis was conducted before the Black Saturday fires. A project in the Bushfire CRC extension program is designed at better understanding some of the major issues and assumptions made in disaster economics and it is expected that this will help to revisit this analysis later in the life of the extension of the Bushfire CRC.

Commercialisation

The Bushfire CRC, during its second year, developed a commercialisation strategy as required under the Commonwealth Agreement. This strategy was submitted and subsequently approved by the Department. In part, this outlined the Bushfire CRC's approach to commercialisation and spin-off companies. The key thrust of this plan was that the primary route to use of the Bushfire CRC's Intellectual Property was through the partners of the Centre. Commercial opportunities would be explored on a case-by-case and opportunistic basis, to ensure that the maximum benefit to Australia was achieved.

Social benefits

The Bushfire CRC also accrues substantial social benefits to the nation that do not have a commonly agreed method for determining the economic value. These include the inherent value of life to the families affected, the loss of social infrastructure, networks and personal belongings all of which have substantial value to the owners but cannot be easily valued in dollar terms. The work of the Bushfire CRC is helping agencies and governments build social resilience, to enable faster recovery and lessen the trauma associated with loss from natural disasters.

For more detailed impacts see sections on Volunteers (page 15), Prepare to Stay and Defend or Leave Early (page 19), Vehicle Safety (page 23) and Evidence Based Policy (page 41).

Environmental benefits

Many aspects of the Bushfire CRC's work have an impact on the natural environment. The Bushfire CRC's Program B had as its main focus better management of fire to enhance the biodiversity values of many of Australia's ecosystems. Whilst these have substantial value, it is difficult to place a dollar value on this. The environmental impact of smoke and emissions are also significant, and the CRC's work program is helping the land managers to better manage these emissions.

For more detailed impacts see sections on Managing Prescribed Fire (page 25) and Smoke Management (page 31).

2.4 Impact on Education

A key reason for establishing the Bushfire CRC was the national shortage of bushfire researchers and the absence of a national succession plan for the few fire scientists that remained. The education program was committed under the Commonwealth Agreement to have 20 qualified PhD graduates at 2010. The program has fostered the scientific careers of 42 researchers at PhD level, with 22 submitted by end of October 2010, and several others due to submit by early 2011. When combined with post–doctoral fellows, the Bushfire CRC can claim credit for more than 80 new researchers working in the area, many with international recognition. This will provide a lasting research capability for the industry.
For more details on Education outcomes see Table 2 (page 47)

This capacity was built upon in the Bushfire CRC Research Taskforce that followed the 2009 Black Saturday fires in Victoria. This Taskforce was a team of students, researchers and agency staff from across Australia and New Zealand that could only have been assembled under the banner of a national research body.

By way of comparison, after the Canberra fires of 2003, only a handful of scientists were available to conduct a post-incident analysis, while after the South Australian Eyre Peninsula fires of 2005 the expertise had started to build under the banner of the Bushfire CRC with around 10 scientists able to move swiftly to the scene. By February 2009, the Bushfire CRC Research Taskforce had assembled 50 scientists and agency staff on the fireground within days of Black Saturday, with many of the fires still burning. This collaborative effort lasted three months in the field.
For more details see section on National Bushfire Focus and Capacity (page 35)

Later, this expertise was further evident in the 2009 Victorian Bushfires Royal Commission, where 10 Bushfire CRC people provided expert evidence, and five of the seven experts selected for the panel on prescribed burning were from the Bushfire CRC.

Research into Education into New Processes – case study

The Bushfire CRC has played a critical role of the delivery of the Victorian Department of Sustainability and Environment's educational program for Fire Behaviour Analysts. This is a course that trains new analysts from around Australia to ensure that each state has the capacity and skills during times of need.

This course includes detailed presentations from a range of Bushfire CRC research projects and in many cases is delivered face-to-face by Bushfire CRC researchers. The course has elements from Program A including: fire weather products, fire behaviour modelling, fire spread modelling (Phoenix Rapidfire – developed by the Bushfire CRC and also used by the 2009 Victorian Bushfires Royal Commission), and fuels assessment. This course was recently evaluated by the consultancy GHD for the Bushfire CRC to identify gaps where further Bushfire CRC work could be included to make the course more national in focus. This work is continuing.

2.5 Impact on Collaboration

Evidence of Collaboration

The annual conference is a prime example of collaboration initiated by the Bushfire CRC in conjunction with AFAC across researchers and students, fire and land agencies, small and large industries, and the media and trade publishers.
With the growth and development of Bushfire CRC research, the Australian fire and land management and emergency service sector's biggest event for the year, the annual conference,

Bushfire CRC scholarships – PhD students at Annual Conference, Adelaide 2008

Australia-United States joint research symposium, Fire in the Interface. Field trip to Marysville, June 2010.

has been growing in size and scientific content. From numbers less than 500 pre-Bushfire CRC, in 2008, the *Bushfire CRC International Bushfire Research Conference* in Adelaide attracted 1130 participants. Last year (2009) the *6th Bushfire CRC / 16th Annual Australasian Fire and Emergency Service Authorities Council* conference attracted 1173 delegates to the Gold Coast. In Darwin in 2010, a healthy 907 delegates made it to the Top End.

Sponsors of the conference again included the *International Association of Wildland Fire*, and local conference participants benefited from the presence of a significant number of international delegates and speakers.

Collaboration with the media is also always evident with the ABC, in particular, a regularly broadcaster of interviews during the conference, which are also placed on the ABC website for long term access.

In smaller ways, the same collaboration is evident in seminars and workshops conducted throughout the year for a diverse range of participants in both urban and regional areas.

Furthermore, strong international collaborations have been formed with government, agency and research partners, particularly in the United States, Canada, and southern Europe.

Value of involvement

The most tangible outcome that shows the value participants place on their involvement with the Bushfire CRC is evidenced by the fact that all the end-user partners in the original CRC committed to being a part of both the 2009 Rebid and the three year CRC Extension. Given that the 2002 successful bid for the Bushfire CRC was the third attempt to harness support for a national bushfire research program, this shows the progress that the Bushfire CRC has made in developing a national focus and capacity. *See more details from page 35*.

Furthermore, the Bushfire CRC Extension program has attracted additional partners that see the value in being a part of the CRC – new research organisations (University of South Australia, Deakin University, Canberra University, Geoscience Australia), new small industries (Terramatrix), new industry and volunteer associations (Fire Protection Association of Australia, Australasian Fire and Emergency Service Authorities Council, Municipal Association of Victoria, Rural Fire Brigades Association of Queensland, National Aerial Firefighting Centre).

Case Studies in collaboration

Collaboration was also most evident in two activities – the Bushfire CRC Research Taskforce after the February 2009 Victorian fires, and the US-Australia Joint Research Symposium *Fire in the Interface* in June 2010. In both instances, participants working together through the Bushfire CRC led to an impact that would not have been achievable without the collaborative means of the Bushfire CRC.

See more details on these two case studies on page 37.

2.7 Relationship to the new Commonwealth Agreement

The Bushfire CRC received a three years extension funding for research in the period 2010-2013. As stipulated by the Commonwealth Agreement, these funds will be used to conduct research into national issues arising from the 2009 Victorian Bushfires Royal Commission. As this funding started at the conclusion on the original Commonwealth Agreement, none of the research activities of the 2003-2010 program carryover into the extension research program.

Given the long lead time for full adoption and continued relevance of much of the 2003-2010 program, especially in light of the findings of the Victorian Bushfires Royal Commission, the Bushfire CRC will be collaborating with the industry and its peak body, AFAC, to ensure that the adoption of this critical research continues: a comprehensive strategy for research adoption

using AFAC has been developed to ensure a national approach to maximise the benefits for Australia. As the new extension research moves from a start-up phase into a research phase it has been particularly important to maintain engagement with all Bushfire CRC partners with workshops, seminars, briefing notes and publications that leverage the knowledge and outputs from the earlier research program.

Much of the 2003-2010 research program formed the basis of deliberations of the 2009 Victorian Bushfires Royal Commission, which in turn, is feeding into the operational activities of fire and land management agencies across Australia and New Zealand. Although the active research phase of many projects had ended, the outcomes of these projects were drawn upon in the consideration of major issues before the Royal Commission.

The Royal Commission drew significantly on these outputs of the Bushfire CRC during its inquiries, including signing a Memorandum of Understanding. Some 10 witnesses were Bushfire CRC researchers. Five of the seven scientists who took part on a panel discussion for the Commission on prescribed burning were Bushfire CRC researchers.

The commissioners commended the organisation, saying they had "...benefited from extensive research conducted by the Bushfire Cooperative Research Centre..."

Details on the roll-out of the Research Adoption are regularly added to www.bushfirecrc.com

High Impact Outputs

The areas that have gained the highest impact from Bushfire CRC research are:

Aircraft - Fire and land management agencies are now able to make more informed decisions as to the appropriate type and level of resources for given levels of suppression funding. **Page 7**

Volunteers – Research has resulted in agencies reviewing the way they manage volunteers with enhanced training for better people-management and leadership skills, support services for volunteers and their families, and recruitment campaigns that target a younger and more diverse demographic. **Page 9**

Prepare to Stay and Defend or Leave Early - Following the 2009 Black Saturday bushfires and the subsequent Royal Commission, the breadth of the Bushfire CRC research on community safety and preparedness is underpinning a review of this position including supporting AFAC-lead industry-wide workshops and providing several expert witness testimonies to the Royal Commission. **Page 13**

Vehicle Safety - The research provides up-to-date guidance for people sheltering in vehicles during bushfire events and is promoted by fire agencies and by other associated emergency services and relevant public bodies. **Page 17**

Managing Prescribed Fire - With the growing emergence of a truly national bushfire 'dialogue' it is important to continue to maintain the national focus for prescribed fire related research as coordinated through the Bushfire CRC, while acknowledging the importance of continuing ecosystem-specific research. **Page 19**

Smoke Management - Research on the management of bushfire smoke in the air, on the fire ground and in the community is helping to reduce community and fire-fighter impacts of smoke, both from bushfires and urban fires. **Page 25**

A National Bushfire Focus and Capacity - The establishment of a Bushfire Cooperative Research Centre has been a positive step in the development of a truly national and genuinely cooperative capacity for the management of landscape fire. Through their involvement in this national research effort, State and Territory based agencies are complementing their in-house research and development programs and forming ongoing alliances with a broad network of research providers. **Page 29**

Evidence Based policy - The use of science derived from a genuinely nationally-based research program has set new standards in Australia in terms of the conduct of fire-related Inquiries, including the 2009 Victorian Bushfires Royal Commission. The Commission's final report specifically acknowledged its reliance on scientific research for its recommendations. **Page 35**


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Aircraft in Fire Suppression

1. Aim

- To outline the national benefits of aircraft related research conducted by the Bushfire CRC that has focussed on the engagement of the right type of aircraft for fire suppression effectiveness and cost minimisation.

2. Background

- The role of aircraft in Australian bushfire operations has increased in prominence since the 1960s.
- In Victoria in the mid-1970s for example, bushfire combating agencies had one small contracted helicopter each summer and access to several small fixed-wing agricultural aircraft. Now Victorian authorities have access to more than 40 contracted aircraft covering a range of sizes and types, with an additional 150 aircraft being available on a 'call when needed' basis.
- Nationally, the federally-funded *National Aerial Firefighting Centre*, which was established in 2003/04 to fund 10 aircraft to assist State-based operations, this year funded more than 40 aircraft.
- In the same period, the costs of suppressing bushfires in southern Australia in particular have been rising dramatically and aircraft use comprises a significant component of these increased costs.
- In season 2009-10 the Victorian Government funded a trial of a Very Large Air Tanker: a DC-10 from the US.
- In recent years bushfire related aircraft use has received considerable public attention, particularly when aircraft have been used on significant fires fringing metropolitan areas. This prominence has the potential to distort more considered approaches to the management of bushfire.
- In Australia the role of aircraft is now integrated within the overall task of managing bushfires.

3. The Research Project

- At the time of the establishment of the Bushfire CRC it was clear that while funding for aerial support and the popularity of large firebombing aircraft had increased, the question of how appropriate, useful and effective they were for fighting bushfires remained largely unquantified.
- The Bushfire CRC aimed to assist fire and land management agencies identify the most effective combination of suppression resources for minimising the impact of bushfires. The research was conducted by the Bushfire CRC in conjunction with the CSIRO Bushfire Research Group, RMIT University and fire and land management personnel. An initial report was delivered in 2007.
- A DC-10 air tanker brought into Victoria to help with bushfire operations in 2009-10 was evaluated by researchers at the Bushfire CRC, with the report handed to the Victorian Government in June 2010.

4. The Findings

- Aerial suppression can be effective in providing support to ground crews and can improve the probability of 'first attack' success by up to 50 percent or more if the 'forest fire danger' is in the low, moderate and high classes.
- For an aircraft to provide effective assistance it must be available at call, be able to be rapidly dispatched with minimal travel time and must have logistical support systems in place.

- Air operations must be effectively integrated into the incident management structure and competent personnel must be available to direct the operation.
- The use of ground resources with initial aerial support is the most economically efficient approach to suppression. The use of aircraft for first attack, until ground resources reach the fire, produces the best outcome.
- Large fixed-wing air tankers such as DC 10s are at a cost disadvantage. This is particularly the case for first attack when fires are small and where water drop accuracy is required.
- Researchers have now built aircraft scenarios into a fire management business model to provide fire managers with enhanced decision support tools including an online *Fire Containment Guide and Calculator*.
- An analysis of the results of aerial suppression tests at experimental burns at Ngarkat Conservation Park, South Australia, in early 2008 provided advice on a range of chemical suppressants (retardant, foam and gel).
- The most recent report into the DC-10 trial concluded that the aerial drops had limited effect and presented clear safety issues to personnel and property on the ground. The research concluded that this sort of large aircraft would have limited applications in Victoria in the types of fuel tested.

5. Research Utilisation

- This research was presented at a workshop with Wildfire Aviation Technical Group members, who made suggestions on its development.
- A *Fire Containment Guide* with an online *Fire Containment Calculator* was produced to assist fire managers in making sound decisions about aerial appliances under varied fire danger conditions and geography.
- A *Drop Effectiveness Guide* was produced to assist fire managers in focussing on the key factors that influence the effectiveness of aerial suppression operations.
- The collection of data for research analysis involved many agencies from the beginning – this knowledge is now being directly transferred back to aviation personal from those organisations including the NSW Rural Fire Service, Country Fire Authority, Country Fire Service, Tasmania Fire Service, ACT Rural Fire Service, the Department of Sustainability and Environment (Vic), Department of Environment and Natural Resources (SA), and the National Aerial Fire Fighting Centre (NAFC).

6. Impacts of the Research

- Fire and land management agencies are now able to make more informed decisions as to the appropriate type and level of resources for given levels of suppression funding.

Volunteers

1. Aim

- To outline the national benefits of volunteer related research conducted by the Bushfire CRC to shape volunteer recruitment programs for enhanced community protection.

2. Background

- Australia's rural fire services rely heavily on volunteers. Ensuring adequate crewing levels for brigades is essential for protecting communities vulnerable to bushfires.

- Around 250,000 volunteers across Australia assist paid agency staff in carrying out bushfire mitigation and suppression operations each year. This volunteer effort has been estimated to be worth about $1,200 million to the community annually.

- There are increasing concerns that volunteer numbers are declining in some communities. The average age of volunteers is rising.

- In some rural communities economic and demographic factors result in declining and ageing populations and some new housing developments in previously rural areas have low levels of community participation in voluntary activities.

- Structural changes to employment and social and economic pressures on families are also restricting opportunities for volunteering.

3. The Research Project

- The Bushfire CRC's Volunteerism project has provided fire services across Australia and New Zealand with information to assist with relevant strategic planning and policy development, and has suggested new ways of recruiting and supporting volunteer workforces. The research was conducted by the Bushfire CRC in conjunction with La Trobe University.

- The project team conducted research into factors impacting on the recruitment of future volunteers and the retention of current volunteers. The research utilised surveys, interviews with current volunteers, case studies of best practice brigades, and surveys of employers of volunteers. The project also tracked the experiences of new volunteer recruits as they moved through recruitment, induction, training, and initial deployments to fires and related emergency incidents.

4. The Findings

- In the first survey conducted as part of the longitudinal study, firefighting volunteers 6, 12 and 24 months after recruitment were tracked, an initiative that led to improved volunteer recruitment strategies for Bushfire CRC partner agencies including the CFA and QFRS.

- A preliminary survey of new volunteers in Victoria conducted after six months found that self-oriented motives (career advancement, new skills, new friends, new challenges) were more relevant for younger volunteers (<35 years) compared with older volunteers.

- By September 2008 the project was reporting annual resignation rates for Australian volunteer based fire agencies ranged from 6.7 percent to 8.3 percent of total volunteer membership. The research reported involved two studies of volunteer retention.

- Overall, the findings indicated the need for agencies to:

    - Distinguish unavoidable reasons for resigning (Moved; Age/Health) from potentially avoidable reasons (Work/family; Dissatisfaction);
    - Balance demands on volunteers' time and the needs of their volunteers' work and family life; and
    - Enhance the skills of brigade leaders.

- Research was also conducted into the recruitment and retention of women, who are well under-represented in Australia's volunteer fire services. A number of initiatives based on the findings are now leading to a slow but steady increase in female volunteers and in increased retention rates. However, the research suggests that further work needs to be done to address pockets of bullying and harassment and to improve the inclusiveness of brigades.
- A study with employers of volunteers in NSW has looked at the impact upon employers of volunteers, and had identified ways to better educate and support employers.
- The impact of volunteering on the wider family and how this influences recruitment and retention was the subject of a doctoral study. This study surveyed the families of volunteers and found a critical need for cultural change to provide broader support, to the volunteers and their family.
- How fire agencies respond to issues concerning volunteers and multiculturalism is problematic. This study has provided information to agencies preparing campaigns to recruit and retain volunteers from non-English speaking backgrounds.

5. Research Utilisation

- These findings are increasingly informing rural fire services' recruitment campaigns – most notably those of the CFA in Victoria and the QFRS in Queensland.
- These agencies have reported that those who responded to more recent campaigns were found to be younger overall than those who joined in earlier periods. Younger enquirers made much greater use of web-sites and online download facilities, compared with older enquirers.

6. Impacts of the Research

Research has resulted in agencies reviewing the way they manage volunteers with enhanced training for better people-management and leadership skills, support services for volunteers and their families, and recruitment campaigns that target a younger and more diverse demographic.

Prepare, Stay and Defend your Property or Leave Early

1. Aim

- To outline how national research by the Bushfire CRC is underpinning the evolution of a strategic, national position to enhance community safety.

2. Background

- By the late 1990s it had been generally established that staying with a well prepared home or evacuating/relocating well in advance of the fire threat appeared to be the best survival options during a bushfire.

- History had shown that many of the bushfire-related fatalities which had occurred around Australia when people have been caught on the road, either on foot or in vehicles. The Tasmanian Bushfire (1967), Lara Bushfire (1969), Ash Wednesday (1983) and the Eyre Peninsula Fire in January 2005 had all illustrated this. Eight of the nine people who died on the Eyre Peninsula were found in or near their vehicles.

- With the establishment of the Bushfire CRC in 2003 research commenced to test the anecdotal evidence and to explore the ramifications (legal and otherwise) in relation to the provision of appropriate advice to the community by agencies.

- The 2009 Victorian Black Saturday fires challenged many assumptions in this area. While many people did die on the road, on foot and in vehicles, many also died in their homes, possibly while defending their properties. The 2009 Victorian Bushfires Royal Commission has recommended this policy be reviewed.

3. The Research Projects

Projects undertaken by the Bushfire CRC to help better understand this vital area of community safety were:

- **Project C1 – Understanding Communities**
  This project increased community resilience to bushfires by better understanding how government policy and public perceptions interacted.

- **Project C4 – Effective Risk Communication**
  This project surveyed the information needs of communities before, during and after a bushfire emergency, and suggested how agencies could better communicate with the media.

- **Project C6 – Evaluation of the 'prepare to stay and defend or go early' policy:**
  This project collated and analysed current practices in terms of their legal, organisational, emergency planning and other issues across Australia, using recent fires as case studies. Reports were published on findings and recommendations made. The focus now involves integrating the earlier work with the experiences of Black Saturday to develop plans for enhancing the definition and implementation of preferred approaches for people and property protection.

- **Project C7 - Evaluating Bushfire Community Education Programs:** This project has undertaken a comprehensive analysis of agency based Community

Education Programs regarding bushfires. The effectiveness of these current programs has been assessed.

- **Project D1 – Building and Occupant Protection:** This project has improved the awareness and understanding of issues surrounding building loss in bushfires in order to reduce direct house loss, particularly in urban-rural interface areas. Research has looked at infrastructure such as decking, windows frames and water-tanks, as well as the protection offered by vehicles from bushfire.

- **2009 Victorian Bushfires - Bushfire CRC Research Response**
  This research effort focused on the collection of data across the areas of Fire Behaviour, Human Behaviour and Community Safety, along with building and land-use planning issues.

4. The Findings

- In late 2005, and based on the research conducted by the Bushfire CRC, the national peak body, the Australasian Fire and Emergency Service Authorities Council (AFAC) adopted a national position on the matter. In doing so, AFAC made clear that the research was on-going and that its national position would continue to be based on available evidence and experience.

- The 2005 Bushfire CRC vehicle-related research trials demonstrated that sheltering inside a vehicle can be a high risk strategy. The research highlighted that there were many factors that came into play which can make survival difficult in certain situations. Any members of the public, who found themselves on the road during a bushfire, stood a better chance of survival by taking shelter inside their vehicle, rather than fleeing on foot.

- Research into household and property loss in bushfires has developed risk models to mitigate the hazards in the design, construction and placement of items such as fences, water tanks, window frames, and decking.

- Research confirmed that the key to successful community safety messages is the importance of developing and maintaining consistent and coherent safety messages, while encouraging community self-reliance, engagement and empowerment.

- A range of risk related communication projects identified how agencies can deliver better preparedness and warnings messages to diverse communities.

- Educating children about bushfire risk – this postgraduate study has looked at how children understand bushfire and how they can bring this understanding into their homes.

- Bushfire education, awareness and engagement programs: researchers conducted an evaluation of a range of programs around Australia to assess what is the most cost effectiveness model.

- A review of 100 years of bushfire deaths in Australia to 2008 found that most fatalities occurred in the open when victims fled the flames at the last moment. The study indicated that most deaths in houses were due to inhabitants sheltering rather than actively defending. Women, children and the elderly were particularly vulnerable.

- The Bushfire CRC Research Response into the Black Saturday fires surveyed more than 1300 properties, collected more than 22,000 photographic images and interviewed more than 600 affected residents. In addition, a mail survey was sent to 6000 households to gather information on how the 7 February bushfires

affected people and their property. It included how information and warnings were received and understood; the level of householder planning; and peoples' preparation and response to the bushfires.

5. Research Utilisation

- The Australasian Fire and Emergency Service Authorities Council, the peak body for all fire and land agencies and emergency service organisations has led a national discussion on community safety issues based on this collection of research, over the last seven years and most notably in the aftermath of the 2009 Victorian fires. This has fed into the community awareness strategies for all Australian fire and land management agencies.

- Bushfire CRC research was heavily drawn upon for the Royal Commissioners deliberations – based on a formal Memorandum of Understanding signed early on between the Royal Commission and the Bushfire CRC. This included several researchers as expert witnesses on the matter of community safety.

- The Commissioners commended the Bushfire CRC saying they had: "...benefited from extensive research conducted by the Bushfire Cooperative Research Centre, the Australasian Fire and Emergency Services Authority, and numerous other research bodies."

- It concluded: "As a result of its inquiries the Commission concludes that the central tenets of the stay or go policy remain sound."

6. Impact of the Research

- Following the 2009 Black Saturday bushfires and the subsequent Royal Commission, the breadth of the Bushfire CRC research on community safety and preparedness is underpinning a review of this position including supporting AFAC-lead industry-wide workshops and providing several expert witness testimonies to the Royal Commission.

Vehicles, Bushfires and Shelter

1. Aim

- To outline how research by the Bushfire CRC led to the adoption of a national 'best practice guideline' in relation to vehicle burnovers in bushfires.

2. Background

- It has been generally established, historically, that staying with a well prepared home or evacuating/relocating well in advance of the fire threat are the best survival options during a bushfire.

- History has shown that many of the bushfire-related fatalities which have occurred around Australia have done so when people have been caught on the road, either on foot or in vehicles. The Tasmanian Bushfire (1967), Lara Bushfire (1969), Ash Wednesday (1983) and the Eyre Peninsula Fire in January 2005 have all illustrated this. Eight of the nine people who died on the Eyre Peninsula were found in or near their vehicles.

- Reinforcement of the message that last minute evacuation can potentially be a deadly option is clearly a part of the ongoing education by agencies of communities. However, there are some people who are potentially more likely to be out and about during a bushfire and who may be confronted with the dilemma of what they should do.

- Up until the completion of research carried out by the Bushfire CRC in 2005 the advice provided to the general public by agencies was generally based on the experiences and tests on older style passenger vehicles (written-up in 1972) or fire-fighter vehicle 'burn over' tests.

- In developing guidelines in late 2005, the nation's peak body the Australasian Fire and Emergency Service Authorities Council (AFAC) acknowledged that there were a multiplicity of factors and scenarios that impacted on the chances of survival in a vehicle during a bushfire. These include the size and density of the fuel load, the topography, the type of fire (low intensity grass fire through to high intensity forest fire), the type of vehicle (its exterior and interior design and materials) and the amount of time there is to prepare.

3. The Research Project

The research initiated by NSW Rural Fire Service and conducted by Bushfire CRC with CSIRO scientists, sought to determine the maximum heat load that a vehicle could face while remaining a safe haven for its occupants, both in terms of the air temperature and the air quality inside the vehicle. Support also came from the CFA and the NRMA.

The study of burnovers in civilian passenger vehicles was conducted in January 2007 at the NSW Rural Fire Service Hot Fire Training Facility. Seven used cars with a range of size, age and make, were subjected to burnover conditions with a gas flame front simulator.

Each car was fully instrumented with sensors to monitor for air toxics and heat levels at many points inside the vehicle including above and below the window height, front and rear seats and, above and beneath a woollen blanket. Comparisons were made between having the air conditioner on or off, and by facing the car forwards, side-on or backing to the flames.

4. The Findings

- The Bushfire CRC research conclusively demonstrated that sheltering inside a vehicle can be a high risk strategy. There are many factors which come into play that can make survival very difficult in certain situations - not least the increased use of plastic in vehicle manufacture, which appears to reduce the level of protection afforded by many newer model vehicles.

- Nonetheless research found that any members of the public, who find themselves on the road during a bushfire, stand a better chance of survival by taking shelter inside their vehicle, rather than fleeing on foot.

5. Research Utilisation

- This research supported AFAC in its national 'best practice guideline' in relation to vehicle burnovers in bushfires. Individual agencies, most notably the NSW Rural Fire Service and the CFS in South Australia, based community information materials directly on the findings of the research.

- Bushfire CRC research was heavily drawn upon for the Royal Commissioners deliberations – based on a formal Memorandum of Understanding signed early on between the Royal Commission and the Bushfire CRC. This included several researchers as expert witnesses on the matters of community safety and evacuation in vehicles.

- The Commissioners commended the Bushfire CRC saying they had: "...benefited from extensive research conducted by the Bushfire Cooperative Research Centre, the Australasian Fire and Emergency Services Authority, and numerous other research bodies."

6. Impact of the Research

- The research provides up-to-date guidance for people sheltering in vehicles during bushfire events and is promoted by fire agencies and by other associated emergency services and relevant public bodies.

Managing Prescribed Fire

1. Aim

- To outline the national benefits of prescribed fire related research conducted over the past seven years by the Bushfire CRC.

2. Background

- The fire and land management agencies who are partners in the Bushfire CRC and the Australasian Fire and Emergency Service Authorities Council have identified the use of prescribed fire as one of the most important issues confronting them, both in a technical and scientific sense, and in terms of community perception and understanding of bushfire control and management.

- In the wake of the Black Saturday tragedy the Victorian Government established a Royal Commission to investigate what has been described as the nation's most catastrophic natural disaster with an unprecedented 173 human deaths. The depth of community feeling about the question of prescribed burning is reflected in the fact that it has, reportedly by a large margin, been the most discussed topic in public submissions made to the Commission.

- The use of prescribed fire is one of the more valuable tools available to agencies in their management of landscape fire, and for conserving ecosystem biodiversity.

- Nationally coordinated research undertaken by the Bushfire CRC has considerably enhanced the science that underpins the safe and effective use of prescribed fire. It has also helped improve community understanding of the issue. Related work carried out by the Tropical Savannas CRC and by the Desert Knowledge CRC has also complemented this important research.

3. The Research Projects

- The relevant projects now completed by the Bushfire CRC were:

- B1.1 Managing Forest Fires in South Western Australia

This project analysed the impact of varying fire regimes over the past 50 years. The analysis dramatically improved the capacity to use modelling to predict the sensitivity of bushfire risk to various management strategies, particularly in the light of climate change. Bushfire history in semi-arid southern Western Australia was the basis for the work.

- B1.2 Fire Regimes and Sustainable Landscape Risk Management

This project compared four contrasting regions across Australia (the Sydney Basin, ACT, south-west Tasmania and Central Australia) to enhance and validate key functions in the landscape/fire regime simulation model, FIRESCAPE. It involved measuring the responses of biodiversity to different fire regimes and the sensitivity of fire behaviour to vegetation, fuel moisture, landscape characteristics and fire suppression/prevention activities. The outcomes helped quantify the risks posed by particular fire regimes.

- B2.1 Behaviour of Smoke Plumes and Hazes from Rural or Urban Fires

This project has delivered improved prediction products for agencies. The smoke plume prediction/management model and training module is


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operational and allows agencies involved in bushfires, prescribed burns and in managing smoke from urban and industrial fires to more confidentially manage smoke related impacts. The model has increasingly become part of mainstream planning, and is proving invaluable in terms of the provision of smoke-related community health warnings, and in situations where the prescribed burning season and major community events correspond (e.g. one of its earliest successes was in conjunction with the Sydney Olympics).

- B2.2 Smoke Composition from Prescribed and Wildfires and Health

This project applied new and existing techniques to measure the contribution of prescribed burns and wildfires to particulate matter, classical pollutants, dioxins, irritants and carcinogens, greenhouse gases, photo-chemically active gases and ozone-depleting chemicals in smoke emissions. The project also investigated the impact of smoke on human health through surveys of hospital admissions, patient recovery and more generally through studying community perceptions of smoke events.

- B3.1 Impacts of Fire on Ecological Processes and Biodiversity

This project focused, under different fire regimes, on nutrient fluxes, and on the roles played by mycorrhiza and decomposer fungi on ecosystem health. The related inter-relationships with plants and invertebrates and on the likely impacts of the reactions on ecosystem processes and carbon cycling were also studied.

- B3.2 Tropical Ecosystems

This project investigated fire regimes in the Tropical Savannas of northern Australia using experimental fires. Fuel dynamics, fire behaviour, soil biology and ecological function, grass and tree dynamics, the role of herbivory in vegetation recovery and invertebrate biodiversity were all under investigation. An associated *Burning for Biodiversity* project is now improving the understanding of the effects of fire on biodiversity and increasing public awareness and education of fire in northern Australia. The work has direct application to the fire management issues in Western Australia, Queensland and the Northern Territory.

- B4.1 Synthesis and Integration

This work established the social, political and economic context relevant to the biophysical sciences associated with the use of prescribed fire. It synthesised and interpreted existing data and knowledge with the purpose of positively influencing relevant land management and fire policy.

- B 4.2 Multi-scale patterns in Ecological Processes and Fire Regime Impacts

This project integrated ecological information derived at smaller scale studies with larger scale management perspectives. The outcomes have helped determine appropriate scale for decisions aimed at ecologically sustainable fire regimes.

- B5.1 HighFire – Ecosystem Processes / Living with Fire / Risk Management

The establishment of long-term research sites in the high country of New South Wales, the ACT and Victoria to examine the impacts of climate change on fuel accumulation rates, flammability, fire severity, and the trade-off between fire regimes and water yield was funded by the federal government in the wake of the 2003 fires in south-eastern Australia. Researchers also assembled empirical data on how human communities learn to live with fire;

they gained an understanding of community values and expectations for fire management in high country areas; invested the roles and relationships between relevant land managers; and examined a range of socio-legal governmental, economic, and regulatory and policy issues currently influencing bushfire management in the high country.

- B6 Tree Decline in the Absence of Fire

This project, which was an initiative of land management agencies, examined nationally the hypothesis that tree decline in many situations is caused by reduced frequency or absence of fire. Study sites were established in New South Wales, West Australia and Tasmania where the same forest type occurred as long unburnt stands adjacent to sites where there were good records of fire regimes.

4. The Findings

- Changes in climate will almost certainly result in changes in fire frequency and severity, Bushfire CRC research has increasingly showed. This finding has many implications for fire and land managers in how the land is managed, how resources are allocated and in setting current and future planning priorities.
- Bushfire CRC research is, at a national level, demonstrating how all fires – prescribed fires and bushfires, from the Top End to the Southern Alps – carry implications for biodiversity.
- Building on the few earlier studies, long term research sites across the high country of Victoria, New South Wales and the ACT have already demonstrated the critical impacts of fire on water quality and yield in both the short and long-term. Short-term increases in yield are offset by reductions in quality (for example, the siltation after fire affects rivers and water storages). Long-term reductions in yield from regenerating forests pose considerable risks to flows in major rivers and to residential water supplies (it is currently estimated that, as a result of the 2003 and 2006 fires in the Australian Alps, water flows into the Murray Darling Basin will be reduced by at least 10%, for several decades).
- The same high country research has also shown the critical impacts of fire on both the short and long term carbon balance of ecosystems. The effect of fires on soil carbon is emerging as one of the great unknowns in the global carbon cycle. This research on soil carbon will provide an essential knowledge base for community, industry and government bodies developing possible Emissions Trading Schemes.
- The forthcoming Bushfire CRC publication of a book *Burning Issues: sustainability and management of Australia's southern forests* will bring together all the latest science that is relevant to the maintenance of sustainable fire regimes in forests and woodlands. The book will also look at the likely impacts of climate change on the management of fire. Finally and importantly it will provide guidance for land managers, fire agencies and other decision-makers in this somewhat vexed area of public policy.
- Smoke behaviour from major fires can be reasonably well predicted with atmospheric models – we now know where the smoke will go. However, smoke composition at places removed from the fire front (for example, at distances of 100m to 100km) is almost impossible to predict using current technology. Research has now identified a number of classes of compounds that are common in smoke from eucalypt fires, which have the potential to be used in predictive smoke models in the future.
- Many plants and animals act as 'indicator species' – that is, they can indicate the effects of fires on a wider range of other species and processes. Researchers have looked at a range of soil and litter dwelling invertebrates in

areas that differ in vegetation and climate from around Australia to assess the effect of fires on biodiversity.

5. Research Utilisation

- At the time of the formation of the Bushfire CRC considerable expectations were created in terms of the impact of prescribed fire related research on State and national policy. The reality has proved to be somewhat more problematic, at least in the shorter term.
- More generally and importantly, the impact of Australia's first, nationally coordinated prescribed fire research program should not be underestimated. The use of prescribed fire in 'natural' ecosystems, in a highly urbanised country, continues to be contentious in some quarters. And it also needs to be understood that future specific uses of prescribed fire will need to occur in the context of relevant risk and biodiversity factors.
- Recent bushfires inquiries (Wangary – S.A. Coronial and the 2009 –'10 Victorian Bushfires Royal Commission) have been able to hear evidence about the use of prescribed fire in a more productive way now that the subject clearly has a national focus.
- The 2009 Victorian Bushfires Royal Commission assembled a panel of scientific experts on prescribed burning, five of who were Bushfire CRC researchers. The panel discussed the science and its impact on policy over two days of public hearings – individually they were also called for expert evidence. The Commission's final recommendations were based substantially upon this evidence.

6. Impacts of the Research

- With the growing emergence of a truly national bushfire 'dialogue' it is important to continue to maintain the national focus for prescribed fire related research as coordinated through the Bushfire CRC, while acknowledging the importance of continuing ecosystem-specific research.


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Smoke Management

1. Aim

- To outline how research by the Bushfire CRC has assisted agencies to better manage the impacts of smoke from both controlled and uncontrolled fires.

2. Background

- Smoke from bushfires, and from prescribed fires that may be lit outside the bushfire season to help manage subsequent bushfires, or for ecological reasons, can affect human health.

- Air quality concerns, expressed by people living in cities and towns, provide an added dimension to the management of both prescribed fires and, to an extent, bushfires. So too do concerns about smoke damage to certain agricultural crops such as grapes, and the safety related concerns of motorists and airline operators.

- As well as its impacts on the wider community, smoke can also directly impact on those involved in the management of a fire, such as fire-fighters and aircraft operators.

3. The Research Projects

- The relevant projects established by the Bushfire CRC in 2003 were:

- B2.1 Behaviour of Smoke Plumes and Hazes from Rural or Urban Fires

This project has delivered improved prediction products for agencies. The smoke plume prediction/management model and training module is operational and allows agencies involved in bushfires, prescribed burns and in managing smoke from urban and industrial fires to more confidentially manage smoke related impacts. The model has increasingly become part of mainstream planning, and is proving invaluable in terms of the provision of smoke-related community health warnings, and in situations where the prescribed burning season and major community events correspond (e.g. one of its earliest successes was in conjunction with the Sydney Olympics).

- B2.2 Smoke Composition from Prescribed and Wildfires and Health

This project applied new and existing techniques to measure the contribution of prescribed burns and wildfires to particulate matter, classical pollutants, dioxins, irritants and carcinogens, greenhouse gases, photo-chemically active gases and ozone-depleting chemicals in smoke emissions. The project also investigated the impact of smoke on human health through surveys of hospital admissions, patient recovery and more generally through studying community perceptions of smoke events.

- D2.2 Air Toxics Exposure and Management

This project identified key toxic pollutants in bushfire smoke, evaluating their concentration and providing the tools and techniques to measure, evaluate and control the exposure of fire-fighters (and to some extent communities) to these substances. Research was carried out at bushfires, prescribed burns and at experimental fires across Australia.

- D4 Respiratory Health of Firefighters

This project investigated the efficacy of the standard issue smoke masks in conjunction with FESA, as part of a postgraduate thesis. The study focused on the smoke effects of vegetation fires in eucalypt and savannah. Most previous research in the field had looked at smoke generated by fires in northern hemisphere deciduous and conifer forests. The outcomes from this project are now influencing relevant agency policies in several jurisdictions.

4. The Findings

- The existence of an accessible, reliable smoke management model, supported by the Bureau of Meteorology's real time data, has proved invaluable in terms of the provision of smoke-related community health warnings, and in situations where the prescribed burning season and major community events correspond (e.g. the Commonwealth Games in Melbourne in 2006, the conduct of forest regeneration burns during community festivals in Tasmania).

- Smoke behaviour from major fires can be reasonably well predicted with atmospheric models – we now know where the smoke will go. However, smoke composition at places removed from the fire front (for example, at distances of 100m to 100km) is almost impossible to predict using current technology. Research has identified a number of classes of compounds that are common in smoke from eucalypt fires, which have the potential to be used in predictive smoke models in the future.

- The climate change debate is clearly a complex one and, in the context of bushfires, must also be viewed in conjunction with the nature of much of Australia's native vegetation. Much of this vegetation has a complex evolutionary, and dependent relationship with fire. Fire has been part of these environments for tens of thousands of years and much native flora and fauna remains dependent on it in various ways. The relative contribution of smoke to the atmosphere, from both wildfire and from the use of prescribed fire, has been a theme of Bushfire CRC related research activity. Clearly however, this issue, and the related link between soil carbon and fire regimes, particularly in the light of proposed carbon emissions trading schemes, will need considerable further work.

- Research to further develop meso-scale meteorological modelling, that can be used to predict the likely smoke impacts of prescribed fire, has considerably assisted fire and land management agencies with this important aspect of bushfire and ecosystem management.

- Reliable, site-specific information now sees, for example, agencies igniting a burn a few hours earlier or later than planned with the resultant smoke being diverted from populated areas. Similarly, the lighting of burns under less stable atmospheric conditions (which would see smoke carried aloft and dispersed at altitude by stronger upper winds) is, at times, and despite the 'burn control' problems this can cause, becoming better able to be considered.

5. Research Utilisation

- A software based training module on the behaviour of smoke plumes has been delivered to agencies. The smoke plume prediction/management model and training module is operational and allows agencies involved in bushfires, prescribed burns and in managing smoke from urban and industrial fires to more confidentially manage smoke related impacts. In one high profile example, this model was used by the Bureau of Meteorology and the Department of Sustainability and Environment during the 2006 Commonwealth Games in Melbourne to ensure clean air for the Games.

- *A Field Guide to Smoke Exposure Management* provides advice to fire line supervisors and managers on the fire ground to quickly recognize high exposure risk situations and undertake mitigation strategies to minimise high exposures to air toxics. A more comprehensive *Smoke Exposure Management on the Fire Ground: A Reference Guide* provides detailed information to assist fire agencies in managing smoke exposure on the fire ground.

6. Impact of the Research

Research on the management of smoke in the air, on the fire ground and in the community is helping to reduce community and fire-fighter impacts of smoke, both from bushfires and urban fires.


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Bushfire Panel
Chair – Murray Dudfield
New Zealand Rural Fire Service
Panelists
1. Rob Rogers–Acting Commissioner, NSW Rural Fire Service
2. Euan Ferguson - Chief Officer, South Australian Country Fire Service
3. John Gledhill - Chief Officer, Tasmania Fire Service
4. Rick Sneeuwjagt – Acting Director Regional Services, Department of Environment and Conservation in WA

Developing a National Bushfire Focus and Capacity

1. Aim

- To outline how the work of the Bushfire CRC is contributing to a growing national focus and capacity on the management of landscape fire.

2. Background

- For historical reasons, not least being Australia's federal Constitutional arrangements, there has never been a comprehensive national strategic and associated policy focus in relation to the management of landscape fire.

- A diverse range of ecosystems is found on the Australian continent, from the tropical savannahs across the north, extensive rangelands of the inland to the alpine regions of the south-east and the cool temperate rainforests of Tasmania.

- Despite this ecological diversity, many fire management and related policy issues are similar – from the use of various technologies to the relationships between local communities and land management and fire services, and the management of bushfire risk.

- The 2004 COAG Bushfire Inquiry and to a lesser extent the 2003 House of Representatives report provided some national context to bushfire issues, but both suffered from either limited participation or limited scope to address fire management issues because the responsibility for fire management lay with State and Territory governments. As a result, several commentators, including the U.S. historian and leading authority on the history of fire in Australia, Stephen Pyne, have expressed regret that the national inquiries did not result in more significant outcomes.

- Nonetheless, these Inquiries, and a number of recent State and Territory based ones have variously made recommendations in the following areas:
    - The use of prescribed fire;
    - Resourcing levels for park and forest management;
    - The extent and value of assets in the rural-urban interface zone;
    - Fire fighter safety, risk minimisation and the legal system;
    - The escalating use of technology;
    - Community involvement in bushfire mitigation and management;
    - Meeting community expectations; and
    - Climate Change

- At the national political level policy responsibility for fire management sits with several Ministerial Councils, including Natural Resource Management (NRMC), Primary Industries (PIMC) and to an extent with the Australian Police Ministers (APMC). With the exception of the limited provision of federal funding for bushfire mitigation programs under the APMC, and in recent years toward aircraft use, and the work of the Forest Fire Management Group under the PIMC, there has been minimal bushfire related policy activity by the Ministerial Councils and their related Standing Committees.


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3. More Recent Developments

- The Australasian Fire and Emergency Service Authorities Council (AFAC) has, in recent years, been gradually developing a national presence; a number of now well accepted policies / 'best practice' guidelines being good examples of this evolution. AFAC's successful lobbying of the Commonwealth Government for funding support for the creation of the Bushfire CRC and the National Aerial Firefighting Centre has also assisted the emergence of national bushfire dialogue.

- With the establishment of the Bushfire CRC in 2003, the associated research program established went beyond the traditional (and important) focus on fire behaviour and fire fighter health and safety. Unique to the fire industry, both in Australia and internationally, the Bushfire CRC established a focus on community safety as a key component of bushfire management. The involvement of social sciences in Australian bushfire research only seriously commenced with the establishment of the Bushfire CRC.

- The Bushfire CRC also commenced research in virtually all the areas that had been the subject of recommendations made by bushfire-related Inquiries made around the country in the previous decade (see above).

- In March 2007, the Bushfire CRC held a one day forum in Parliament House, Canberra, to address the issue *Are Big Fires Inevitable?* The forum, which was attended by around 150 invited participants and several politicians, was designed to address several themes including drought and related climate factors, the fire and water relationship, community related 'interface' issues and forest land management strategies. Support from the ABC facilitated widespread national coverage of the forum and this was followed up with a '4 Corners' current affairs program that focussed on the current state of bushfire management in NSW and Victoria.

- In June 2010 a United States-Australasian fire research symposium *Fire in the Interface* was held. Participants with specific expert knowledge were invited to the symposium to discuss the current state of knowledge, issues confronting communities and fire fighters, and the gaps in knowledge for addressing fire within the area that has the greatest threat to life and property – the heavily vegetated residential communities, also known and the rural-urban or wildland-urban interface. More than 40 Australian, New Zealand and United States researchers, practitioners and policy-makers gathered in Melbourne and then in Canberra. The meeting was organised by the Bushfire CRC in conjunction with the departments of Prime Minister and Cabinet, and Attorney General in Australia, and the Department of Homeland Security in the United States.

- The Australian industries' biggest event for the year, its annual conference, has been growing in size and professional content over the past several years. Last year (2009) the *6th Bushfire CRC* / 16th Annual *Australasian Fire and Emergency Service Authorities Council* attracted around 1100 delegates to the Gold Coast. Sponsors of the conference again included the *International Association of Wildland Fire*, and local conference participants benefited from the presence of a significant number of international delegates. Again the ABC broadcast a number of interviews during the conference, and these were also placed on the network's website.

- It is the industries' research effort (conducted through the Bushfire CRC) that is providing a large proportion of conferences' professional content and presumably contributing to their popularity.

- The media, both in Australia and internationally, utilise the Bushfire CRC as a hub of bushfire knowledge. Through direct contact and through use of the website bushfire research is further disseminated into communities via a range of media channels.

- In the immediate wake of the 2009 Victorian *Black Saturday* tragedy, the Bushfire CRC was able to marshal and deploy teams of researchers and agency staff into the affected areas in an unprecedented national effort. This was only possible because of the capacity building strategies of the Bushfire CRC.

- During the subsequent Bushfires Royal Commission, the Bushfire CRC, through a number of its leading researchers, was able to provide considerable expert assistance in key areas relevant to the work of the Commissioners. This is a capacity that did not exist to that extent prior to the Bushfire CRC.

- Over the last eighteen months work has been underway to incorporate the significant research findings that have flowed from the work of the Bushfire CRC into agency-based training and accreditation programs and into relevant tertiary education courses – most notably at RMIT University, University of Tasmania and the Australian National University. This work continues.

- Research institutions are now collaborating on joint projects with industry partners to improve fire fighter and community safety. This did not occur prior to the formation of the Bushfire CRC.

- Fire and land management agency partners are now, through the Bushfire CRC, gaining a high leverage on their research investment through national collaboration. This is better than was ever achieved before the Bushfire CRC.

4. Towards 2020

- In a late 2008 independent 5th Year review of the Bushfire CRC the panel, in its report (page 14) commented:

> *The CRC has played a leading role in initiating or further developing a culture of 'improvement by research' evident in all the agency representatives interviewed.*

- Internationally, Australia, some years ago, signed a formal agreement with New Zealand and with the US for the provision of firefighting support, staff exchanges and joint research. On seven subsequent occasions firefighting support has been provided across the Pacific. This development built on the previous less formal links a few Australian land management agencies had developed with New Zealand, the U.S. and Canada.

- To date the Bushfire CRC has signed a 'Memorandum of Understanding' that provides for the conduct of joint fire research with the U.S Department of Agriculture (Forest Service) and the Canadian Forest Service. The CRC has also signed MOUs with severally overseas based research facilities in the US, Germany, Portugal and Chile.

- The Bushfire CRC has also played a significant role in the development and promulgation of the United Nation's *Voluntary Guidelines for Fire Management*, which were developed following a recommendation of the 3rd *International Wildland Fire Summit* which was held in Sydney in 2003. The Voluntary Guidelines were subsequently endorsed by the 8th Session of the United Nation's FAO Committee on Forestry in March 2007, and by the 4th *International Wildland Fire Summit* in May 2007.

- In 2009, the Bushfire CRC's CEO was invited to participate in an independent review of the US *Joint Fire Science Program*. Since its inception ten years ago, the JFSP has funded some 413 research projects, across more than 90 colleges and universities. The CEO's involvement in the review provided an opportunity to benchmark the current Bushfire CRC's program in terms of its quality, innovation, strategic direction, and its emphasis on producing outputs that meet Stakeholder needs.

- Considering the significant occurrence of large devastating bushfires in southern Australia over the past decade, and particularly in the light of the recent Victorian tragedy, it is timely to:

    - Conduct a truly national and genuinely rigorous trend analysis of fire management strategies and bushfire outcomes;
    - Take steps to ensure that Australia has appropriate national policies and strategies for the year round management of its large, and fire-prone forests, woodlands and range lands; and
    - Ensure that Australia's multi-layered urban planning system does not create the foundations for future catastrophes in the urban interface zone.

- Both the 2009 Victorian Bushfires Royal Commission and the 2010 Senate Select Committee on Agricultural and Related Industries, which held an inquiry into the incidence and severity of bushfires across Australia, recommended that the Commonwealth establish a permanent bushfire research institute.

- The Commission recommended that the Commonwealth of Australia establish a national centre for bushfire research in collaboration with other Australian jurisdictions to support pure, applied and long-term research in the physical, biological and social sciences relevant to bushfires and to promote continuing research and scholarship in related disciplines.

- The proposal for an *Australasian Fire Research Institute* has been developed by the Bushfire CRC with a view to it being a global leader for 'research and development' for emergency services. Operating as an institute for the 'public good' it has been designed to be highly efficient and multi-disciplinary, drawing on independent 'research and development' providers in Australian States and Territories and New Zealand, and internationally where it is beneficial to do so.

5. The impact

- The establishment of a Bushfire Cooperative Research Centre has been a positive step in the development of a truly national and genuinely cooperative capacity for the management of landscape fire. Through their involvement in this significant national bushfire-related research effort, State and Territory based agencies are complementing their in-house research and development programs and forming ongoing alliances with a broad network of research providers.

Evidence Based Policy

1. Aim

- To describe how the work of the Bushfire CRC is contributing to a growing focus among fire, emergency service and land management agencies on ensuring that agency policies and procedures are 'evidence based'.

2. Background

- The sectors that now comprise much of the Bushfire CRC's stakeholder base – the fire, emergency service and land management agencies – had a historically varied approach to the development of policies and procedures.

- The approaches ranged from in-house, 'shop floor to CEO' cultures to ones with varying levels of reliance on universities and educational and training providers to fulfil agency personnel and training needs.

- A commitment to research and development also varied across the sectors with the land management agencies having, historically, the most on-going long-standing engagement in this regard.

- By the late -1980s however Australia's bushfire research related capacity had been considerably diminished and the several remaining researchers with international standing were ageing. No succession plan was apparent.

- By the mid -1990s attempts were underway to put together a fire and land management industry supported bid to establish a research capacity through the Federal Cooperative Research Centre Program. The third CRC bid of this kind was successful and the current Bushfire CRC commenced work in 2003.

- Concurrently, the period 1998-2008 saw an unprecedented level of 'third party' scrutiny of the management of landscape fire in Australia. These Inquiries frequently involved detailed examination of agency policies and procedures, often involving the cross-examination of witnesses - a process that helped focus agencies on the importance of their policies being 'evidence based'.

3. Recent Developments

- With the establishment of the Bushfire CRC in 2003, the associated research program established went beyond the traditional (and important) focus on fire behaviour and fire fighter health and safety. Unique to the fire industry, both in Australia and internationally, the Bushfire CRC established a focus on community safety as a key component of bushfire management. The involvement of social sciences in Australian bushfire research only seriously commenced with the establishment of the Bushfire CRC.

- The Bushfire CRC also commenced research in virtually all the areas that had been the subject of recommendations made by bushfire-related Inquiries made around the country in the previous decade. After an initial seven years of research that was carried out through 13 separate organisations, the Bushfire CRC's 21 core partners and 11 Associate Partners have benefiting considerably in a range of areas including several listed elsewhere in this document.

- The industries' annual conference has been growing in size and professional content over the past several years. Last year (2009) the *6th Bushfire CRC* / 16th Annual *Australasian Fire and Emergency Service Authorities Council* attracted

around 1100 delegates to the Gold Coast. Local conference participants benefited from the presence of a significant number of international delegates. It is the industries' research effort (conducted through the Bushfire CRC) that is providing a large proportion of conferences' professional content and presumably contributing considerably to their popularity.

- One of the key reasons for establishing the Bushfire CRC was to address the serious and growing national shortage of bushfire related researchers. One of the Bushfire CRC's most important achievements to date must be the fact that post-doctorate fellows and post-graduate students now number more than 80. One of the resultant challenges currently confronting the industry is to ensure that a good number of these promising graduates find suitable employment within the Stakeholder agencies, or with the research provider organisations. Early indications in this regard are promising.

- In a late 2008 independent 5th Year review of the Bushfire CRC the panel, in its report (page 14) commented:

> *The Panel heard very positive messages from end users about the need for science to underpin policy and decision making, and about the need for researchers to publish scientific results in the highest quality peer reviewed journals to underpin the validity of their applied outputs……*
>
> *……..The CRC has played a leading role in initiating or further developing a culture of 'improvement by research' evident in all the agency representatives interviewed…..*
>
> *……The Panel has been greatly impressed by the quality of science and by the rate of adoption of research results evident in the Bushfire CRC….*'

- Over the last eighteen months work has been underway to incorporate the significant research findings that have flowed from the work of the Bushfire CRC, into agency-based training and accreditation programs and into relevant tertiary education courses. This work continues and it is complemented by a trend that is seeing a growing adoption of national training and accreditation systems by the industry, as part of AIIMS-ICS and beyond.

4. The Impact

- The use of science derived from a genuinely nationally-based research program has set new standards in Australia in terms of the conduct of fire-related Inquiries, including the 2009 Victorian Bushfires Royal Commission. The Commission's final report specifically acknowledged its reliance on scientific research for its recommendations.


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Images

Cover PhD student Phil Lacy leading the Burning Under Eucalypts, Field Tour and workshop, Casino NSW, August 2009.
Program Leader Prof Mark Adams addressing media from the World Science Journalists International Conference on bushfire science field trip to Anakie, Victoria, hosted by the Bushfire CRC, April 2007.

Page 2 Bushfire CRC Research Taskforce member from Geoscience Australia at Kinglake following the Black Saturday bushfires, February 2009.
Page 12 Eriksen Aircrane being monitored as part of aerial suppression research.
Page 16 New South Wales Rural Fire Service volunteers assisting with the HighFire research burns, Snowy Plains, March 2007.
Page 18 A house that was successfully defended at Strathewen on Black Saturday and later studied by the Bushfire CRC Research Taskforce.
Page 22 Passenger vehicles were burnt in simulated bushfire front, Mogo, New South Wales, January 2008.
Page 26 New South Wales State Forests assisted in the Burning Under Eucalypts field tour and workshop with a live burn on a plantation, Casino NSW, August 2009.
Page 30 Smoke management research assisted agencies in dealing with smoke in urban areas including Melbourne, 2006.
Page 34 *Are Big Fires Inevitable* – a Bushfire CRC national bushfire forum at Parliament House, Canberra, February 2007.
Page 36 *Bushfire Incident Response*, pre-conference seminar at 2008 Annual Conference, September 2008.
Page 40 Phil Zylstra, Bushfire CRC PhD scholarship holder, conducting field work at HighFire research burns, Snowy Plains, March 2007.
Page 43 Fire research in Mallee heath fuels – the biggest fire research exercise undertaken in Australia with more than 100 researchers and fire agency staff from around Australia, at Ngarkat Conservation Park in South Australia, March 2008.

Table 1

CEO, Governing Board and Program Leaders 1 July 2003 to 30 June 2010

Name	Organisation	CRC Position / Role	Term (From 2003 unless stated)
Len Foster	Bushfire CRC	Independent Chairman Strategic Directions Committee (Chair) HR Committee	Director to 18 December 2006. Chairman from 1 April 2007
Ian MacDougall	Bushfire CRC	Independent Chairman	To 31 March 2007
Mark Adams	Dean, Faculty of Agriculture, Food and Natural Resources University of Sydney	Director Research Utilisation Committee	From 12 December 2009
John Baird	Rector, Australian Defence Force Academy	Director Education/Research Adoption Committee (Chair)	From 15 June 2006 to 10 November 2009
Neil Bibby	Chief Executive Officer, Country Fire Authority	Director Audit Compliance Committee	From 18 June 2007 to 7 October 2009)
Joanne Bloch	Independent	Director Audit Compliance Committee (Chair)	To March 2004. Then from 17 July 2007.
Naomi Brown	Chief Executive Officer, Australasian Fire and Emergency Service Authorities Council	Director HR Committee (Chair)	From December 2006
Ray Canterford	Assistant Director, Bureau of Meteorology	Director Users Research Committee	From 15 March 2004 to 20 June 2007 and from 29 May 2008 to 14 June 2010
Murray Dudfield	National Rural Fire Officer, New Zealand Fire Authority	Director Research Utilisation (Chair) Users Research and Education Committee	From 15 June 2007
Shane Fitzsimmons	Commissioner, NSW Rural Fire Service	Director HR Committee Research Utilisation Committee	From 20 November 2009
Anne Gardiner	Director, Head of Compliance, Credit Suisse Asset Management (Aust)	Independent Director	From 15 march 2004 to 30 April 2007
John Gledhill	CEO/Chief Officer, Tasmania Fire Service	Director HR Committee Education/Research Adoption Committee	From 15 March 2004 to 2 September 2009
Phil Koperberg	Commissioner, NSW	Director	From 15 March

	Rural Fire Service		2004 to 17 April 2007
Robyn Owens	Pro Vice-Chancellor Research, University of Western Australia	Director	From 15 March 2004 to 30 April 2007
Brian Richardson	General Manager, Ensis Forest Biosecurity and Protection	Director Education/Research Adoption Committee	From 15 August 2006 to 19 April 2008
Alistar Robertson	Dean, Faculty of Natural and Agricultural Resources	Director Users Research and Education Committee	From 18 June 2007
Mike Taylor	Chair Murray Darling Basin Authority	Director Strategic Directions Committee Audit and Compliance Committee	From 20 November 2009
Timothy Vercoe	Director, Asset Protection Centre, CSIRO Forestry and Forest Products	Director	From 15 March 2004 to 15 August 2006
Ewan Waller	Chief Fire Officer, Department of Sustainability and Environment	Director Users Research and Education Committee (Chair)	From 15 February 2007
Gary Morgan	Bushfire CRC Chief Fire Officer, Department of Sustainability and Environment, Victoria	CEO Director	CEO from 11 September 2007 Director to 15 August 2005
Kevin O'Loughlin	Bushfire CRC	Director CEO	To 22 October 2003. From 22 October 2003 to 11 September 2007
Richard Thornton	Bushfire CRC	Deputy CEO	From March 2004

Program Leaders

Name	Organisation	CRC Position / Role	
Rod Keenan	University of Melbourne	Program A: Safe Prevention, Preparation and Suppression	From 13 September 2008)
Jim Gould	CSIRO	Program A: Safe Prevention, Preparation and Suppression	To 12 September 2008
Mark Adams	University of Sydney	Program B: Fire in the Landscape	
John Handmer	RMIT University	Program C: Community Self-Sufficiency for Fire Safety	
Bob Leicester	CSIRO Manufacturing and Infrastructure Technologies	Program D: Protection of People and Property	
Christine Owen	University of Tasmania	Program E: Education	

BUSHFIRE CRC students – employed – June 2010

	Name	Project title	Status/due date	Employer
1	**Phil Lacy,** PhD	Burning under young eucalypts	submitted	PF Olsen
2	**Madeline Osborn,** PhD	The role of fungi in fire prone forest communities	submitted	DAFF- ACT
3	**Alan Rhodes,** (unfunded) PhD	Evaluation of the "stay or go" policy and community preparedness	2013	CFA -VIC
4	**Phil Zylstra,** PhD	Plant species contributions to fire intensity – towards a total fuels model	submitted	NSW NPWS -DECC- Cooma
5	**Rohan Sadler,** PhD	Long term monitoring and modelling in quantifying the role of fire in grasslands	submitted	UWA
6	**Brendan Pippen,** PhD	Predicting factors affecting fire behaviour in heathland vegetation.	submitted	Dept Climate Change-ACT
7	**Annemarie De Vos,** PhD	Health effects of occupational exposure to bushfire smoke in WA	submitted	Initially Asthma CRC-WA now working in Netherlands
8	**Karyn Bosomworth,** PhD	Does current bushfire risk management policy and practice support community and natural resource resilience to climate change?	2010	DSE - VIC
9	**Adam Leavesley,** PhD	Impact of fire mosaic on birds in mulga woodlands of central Australia.	submitted	Bushfires NT
10	**Paul Fox Hughes,** PhD	A meteorological investigation of the "Springtime Bump" in Tasmania.	2012	Bureau of Meteorology, Tasmania
11	**Laura Kelly,** Ma	Community resilience to and recovery from wildfire in New Zealand	submitted	Working in the UK
12	**Rob De Ligt,** Hons	Patterns in the probability of burning with time-since-fire in the Greater Sydney region	submitted	ANU
13	**Josh Whittaker,** PhD	Adaptive capacity and social resilience to bushfires in southeast Australia	submitted	RMIT
14	**Luke Balcombe,** Ma	The perceptions of bushfire hazard in urban fringe areas of tropical Australia.	submitted	Environmental scientist in private firm - undertaking a PhD, Griffith University
15	**Bevan McBeth,** PhD	Soil, fire and physiological processes and dieback in coastal eucalypt forests.	2011	Southern Cross University
16	**Sonia Whiteley,** PhD (unfunded)	Preparing for the worst: measuring the outcomes of community bushfire safety programs	2012	Department of Justice, VIC
17	**Meaghan Jenkins,** PhD	Carbon budgets and implications for fuel load and flammability of shrub-dominated ecosystems in the high country	submitted	University of Sydney
18	**Tim Prior,** PhD	Community responses to bushfire threat	submitted	UTS - Institute of Sustainable Futures

19	**Jaymie Norris,** PhD	Microbial clues for ecological sustainable management of fire prone landscapes.	2010	DSE - VIC
20	**Ken Scott,** PhD	Fire & savannah grass ecology	submitted	NT Gov - fire management
21	**Matt Phillips,** PhD	Physiological demands of Australian volunteer fire-fighters during bushfire suppression	2010	Dept Defence - ACT
22	**Andrew Edwards,** PhD	An algorithm for mapping burn severity from satellite remote sensing: tropical savannahs, northern Australia.	2010	Bushfires NT
23	**Mae Proudley,** Ma	Reducing bushfire risk through improved household decision making.	submitted	RMIT
24	**Sean Cowlishaw,** PhD	Effects of Fire Service Volunteering on families of volunteers	submitted	Monash University
25	**Julian Black,** PhD	Predicting the dynamic spatial pattern of fire front progress and fire destruction in the rural urban interface zone	2011	Terramatix
26	**Lyndsey Vivian,** PhD	Determinants of variation in fire response types in the composition of montane plant communities.	submitted	ANU
27	**Christine Eriksen,** PhD (project support only)	Local environmental knowledge of bushfire management: a case study of new rural landscapes in NSW	submitted	University of Wollongong

BUSHFIRE CRC students - in study – June 2010

	Name	Project title	due date	Supervisor
27	**Annette Salter,** PhD	Applications of multi-media education strategies in fire behaviour	2011	Dr Christine Owen UTAS
28	**Kerryn McTaggart,** PhD	The effect of fire on soil microbial populations and their processes in Australian alpine ecosystems.	2011	Dr Tina Bell, University of Melbourne
29	**Bryony Horton,** PhD	Fire management and tree decline: mycorrhizal indicators of declining forest health.	2010	Dr Neil Davidson UTAS
30	**Carola Karramotto de Bednarik,** PhD	Relative importance of fir regimes, environmental gradients and climate change for rainforest distribution in the Sydney region.	2010	Dr Geoff Cary ANU
31	**Alison O'Donnell,** PhD	Fire patterns and vegetation structure in semi-arid south-east western Australia	2010	Dr Lachie McCaw, DEC WA Dr Pauline Grierson UWA
32	**Rowena Morris,** PhD	The effect of prescribed burning on sediment movement in the Mt Lofty Ranges	2011	Dr Meredith Henderson SA DEH
33	**Anne Miehs,** PhD	The role of coarse woody debris in fire-prone forests: Achieving both fire management and conservation objectives.	2010	Dr Alan York University of Melbourne
34	**Briony Towers,** PhD	Developmental perspective on bushfire risk communication	2011	Prof Douglas Paton UTAS
35	**Claire Johnston,** PhD	Worst Case Scenarios: their role in safe decision making in bushfire fighting.	2010	Dr Mary Omodei, La Trobe University
36	**Greg Hickey,** PhD	Enhancing effective multi agency operations.	2009	Dr Christine Owen UTAS
37	**Jennifer Hollis,** PhD	Coarse woody fuel availability and consumption in Australian forest fires	2010	Dr Lachie McCaw, DEC
38	**Peter Hayes,** PhD	Do teams that have worked together make better teams than ad hoc teams?	2011	Dr Mary Omodei, La Trobe University
39	**Jenni Raines** PhD	Fatigue and recovery in rural Australian bushfires	2011	Dr Brad Aisbett, Deakin University
40	**Helen Daily** PhD	Development of pasture growth models for grassland fire danger risk assessment	2011	Dr Stuart Anderson, SCION Dr Peter Lane UTAS
41	**Francesca Harris-Spence,** PhD	Catchment management groups - volunteer community organisations and bushfire management	2011	Dr Matthew Tonks (UWA) Dr Marcus Lane (Uni Adelaide)
42	**Colin Simpson,** PhD	Advanced modelling of the interactions between wildfires and the atmosphere	2013	Prof Alan Sturman Uni Canterbury