



BUSHFIRE CRC 2003 - 2010

OUR MISSION

The Bushfire CRC's mission – to enhance the management of the bushfire risk to the community in an economically and ecologically sustainable manner.

It includes the following objectives:

- **To develop an internationally renowned centre of excellence to lead bushfire research in Australia.**
- **To provide a research framework that will improve the effectiveness of bushfire management agencies.**
- **To increase the self-sufficiency of communities in managing the risks from bushfires.**

BUSHFIRE CRC 2003 TO 2010

4 broad research programs **37** partners across fire and land management agencies and research organisations
42 postgraduate students providing a new generation of researchers **111** research briefs distributed to industry as Fire Notes and Fire Updates **100** booths filled at annual conference trade expo by small and medium enterprises
130 researchers collaborating across Australia and New Zealand **4702** monthly average of visitors to www.bushfirecrc.com in 2010 **600** residents interviewed on their Black Saturday experiences **826** publications including reports, presentations, journal articles and posters **1000** participants on average at our annual conference **1300** properties examined after Black Saturday **22,000** photographs of Black Saturday documenting fire behaviour and property damage.

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.

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.

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-led industry-wide workshops and providing several expert witness testimonies to the Royal Commission.

House and Vehicle Safety – The research provides up-to-date guidance for people, constructing houses, preparing properties and 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 – 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.

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.

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.

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.

INDEX

INTRODUCTION

RESEARCH IMPACT

EDUCATION AND CAPACITY BUILDING

RESEARCH ADOPTION

OUTPUTS FOR INDUSTRY

A PROMINENT PUBLIC ROLE

CONFERENCES

BLACK SATURDAY RESPONSE

2013 AND BEYOND

PROGRAM A

PROGRAM B

PROGRAM C

PROGRAM D

PARTNERS IN THE BUSHFIRE CRC 2003 TO 2010

CEO, GOVERNING BOARD, 2003-2010

PROGRAM LEADERS

BUSHFIRE CRC STUDENTS – EMPLOYED – JUNE 2010

BUSHFIRE CRC STUDENTS – IN STUDY– JUNE 2010

5

7

8

9

10

13

14

17

18

19

27

37

45

54

56

57

58

59



INTRODUCTION



By Len Foster AO, Chairman, Bushfire CRC

The formation of the Bushfire CRC in 2003 was a major initiative by the fire and land management agencies in Australia and New Zealand, and their research partners. For the first time there was a coordinated approach to fire research.

The Bushfire CRC was a collective move towards the achievement of a better understanding of the complex social, economic and environmental aspects of bushfires. The Bushfire CRC partners were fire and land management agencies, universities, CSIRO, Australian Federal Government agencies and New Zealand fire and forest agencies.

Funded by a combination of partner resources and the Australian Government’s CRC program grant for seven years, the Bushfire CRC was a substantial investment in ongoing research into bushfires.

Between 2003 and 2010, this industry-focussed research and collaboration, together with strong education and knowledge transfer programs, delivered practical benefits to the fire and land management sector and to the wider community.

PARTNERS IN A NEW RESEARCH FOCUS

From the outset the challenge for the Bushfire CRC was large – how do we best manage the bushfire risk; how do we use fire as a land management tool; what are the key issues that require further understanding; how do we balance the complex trade-offs between social, cultural, environmental and economic values?

Fire and land management agencies worked closely with researchers on a broad research program to help answer this challenge.

Importantly, the research went beyond the traditional focus on fire behaviour and firefighter 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. Later, the 2009 Victorian Bushfires Royal Commission specifically acknowledged its reliance on Bushfire CRC research for its recommendations.

INTRODUCTION

COLLABORATION AND INNOVATION

The Bushfire CRC initiated ways for researchers and fire and land management agencies to work together to ensure that the research was adopted across the fire sector.

These included:

- Educating the next generation of fire researchers to work closely with those in the sector.
- An enormously successful annual conference where researchers and students mixed with fire industry management and operational staff, volunteers, and the small to medium enterprises.
- Publications that included peer-reviewed scientific journals, research briefing notes, books, DVDs, and field guides.
- A regular program of seminars, workshops and public forums.



GOVERNANCE

The Bushfire CRC operated through an incorporated not-for-profit company, Bushfire CRC Ltd. The Bushfire CRC Ltd was registered in March 2003 and began formal CRC operations in July 2003. Participating parties were members of the company, which is limited by guarantee.

The Bushfire CRC's Stakeholders Council consisted of representatives of each of the participating agencies.

The Stakeholders Council met twice a year to review and receive updates on the progress of research, education, communication and other activities, and to provide strategic advice to the Governing Board. The final incarnation of the Governing Board had nine members including two independents. The Governing Board and Stakeholder Council met 54 times over the seven years.

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 will 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.

RESEARCH IMPACT



RESEARCH IMPACT

The use of science derived from a genuinely nationally-based research program has set new standards in Australia in terms of fire management and in 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, much of it from the Bushfire CRC, for its recommendations.

The broad research program of the Bushfire CRC contributed to better fire management across a range of topics including fire behaviour and suppression, fire as part of the natural landscape, fire weather, community self-sufficiency, firefighter safety and building protection.

The Bushfire CRC successfully completed its seven-year funding life with more than 90 percent of the original research outputs and activities related to these areas achieved. Where outputs were unable to be completed, alternative ways to address the issue were agreed upon between the Bushfire CRC and research and industry partners. Where appropriate, variations to the Commonwealth Agreement were completed through the CRC Program.

Research output from the seven years totalled more than 800 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 large number of participants at the annual conferences of the Bushfire CRC, conducted in partnership with the peak industry body the Australasian Fire and Emergency Service Authorities Council, was an indication that the broader industry clearly sees the value in gathering to participate in the research process, from concept through to utilisation.

The Bushfire CRC's 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 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."

EDUCATION AND CAPACITY BUILDING

EDUCATION AND CAPACITY BUILDING

The Bushfire CRC's education program addressed the chronic shortage of bushfire research skills in Australia. The program supported more than 40 postgraduate students in topics spread across the Bushfire CRC's four program areas – with the prospect of more students joining in future years.

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. At the end of the funding period the program had fostered the scientific careers of 42 researchers at PhD level, with 22 submitting by end of 2010, and several others due to submit in 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 is providing a lasting research capability for the industry.

This capacity was built upon in the Bushfire CRC Research Taskforce that followed the 2009 Black Saturday fires in Victoria. This Taskforce gathered a team of researchers, students 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. 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.

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 ADOPTION



RESEARCH ADOPTION

Through the development of education and training, technology transfer and knowledge networking programs the Bushfire CRC has supported its industry partners to better manage bushfire risk. Research outputs have been transformed into tangible outcomes for the agencies and for the community.

A research adoption strategy has ensured that research outputs are founded in rigorous scientific publications and are properly managed through to industry adoption. Industry partners provided ongoing guidance on the best way to achieve that adoption.

The approach combined product development with stakeholder engagement. It drew heavily on the existing AFAC consultative networks and provided considerable ongoing opportunities for interaction between researcher and stakeholders.

This has led to a range of publications and online tools and guides, as well as workshops, seminars and field trips.



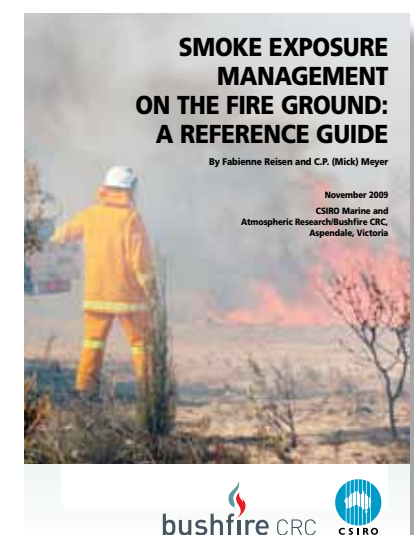
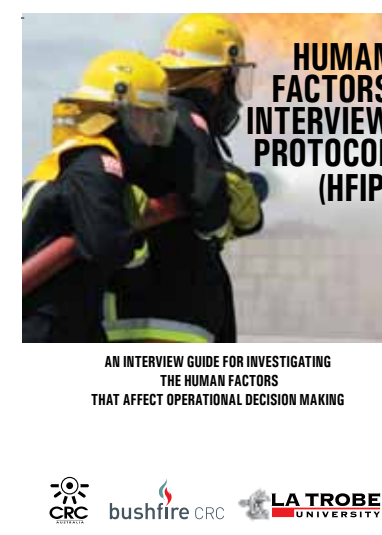
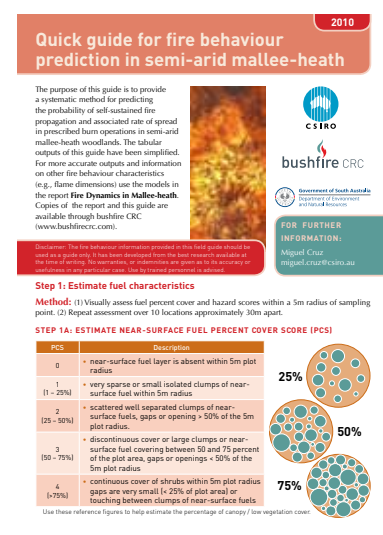
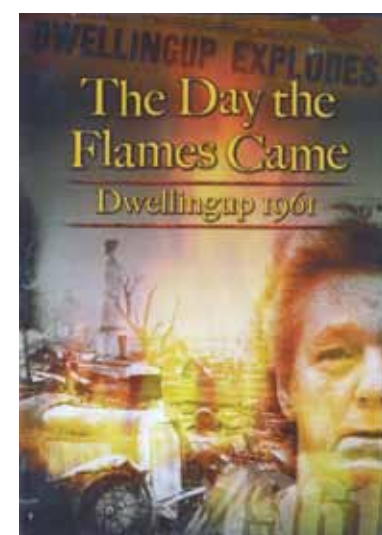
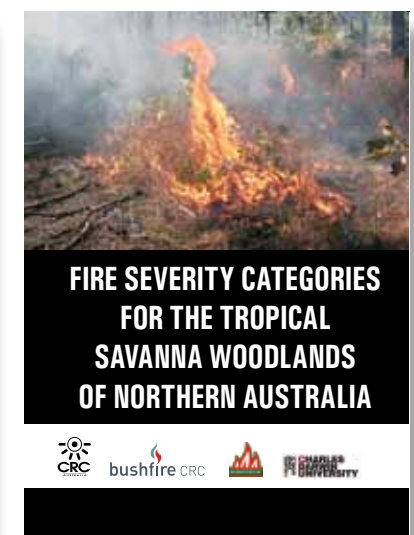
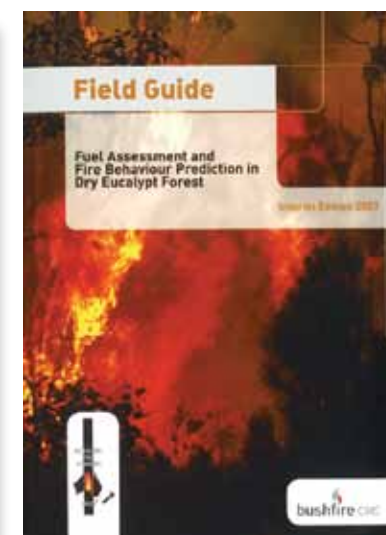
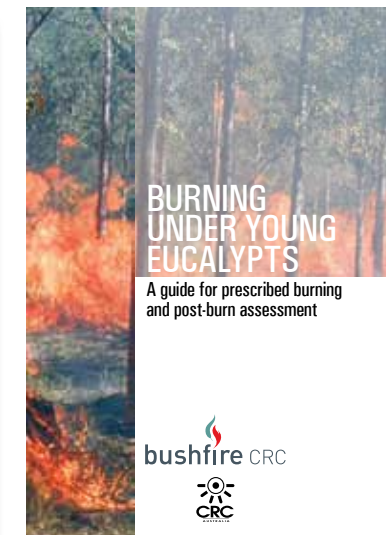
OUTPUTS FOR INDUSTRY

OUTPUTS FOR INDUSTRY

A range of products suitable for industry and the public is a lasting legacy of the Bushfire CRC research program. These are prominently displayed at conferences and are available from either the Bushfire CRC website or the AFAC Shop.

These include:

- The research outputs of Program C: Community Self Sufficiency for Fire Safety, compiled and published in a book *Community Bushfire Safety*, which proved to be an essential publication for the fire and emergency management sector. Other books that drew from this Program include *Handbook of Disasters and Emergency Policies and Institutions*, and *Communities Living with Hazards*.
- Field guides on research that impact upon a range of operational issues including smoke management, human factors interview protocols and fire containment, and guides for burning in eucalypt forests, plantations, mallee heathlands, and in tropical savanna woodlands.
- Two high quality DVDs on the lessons learnt from key historic bushfires – 1967 in Tasmania *Black Tuesday*, and 1961 in Western Australia *The Day the Flames Came*.
- Presentations and interviews on DVD from key researchers at the 2009 and 2010 annual conferences
- A DVD case study on fire management in south-west Western Australia
- A quarterly magazine *Fire Australia* that profiles fire research and developments to more than 5000 readers in the broad fire and fire protection sector. This publication is a collaborative effort in partnership with the Australasian Fire and Emergency Service Authorities Council, the Fire Protection Association of Australia and the Institution of Fire Engineers Australia.
- 70 *Fire Note* briefing papers on major findings of all the research projects.
- The use of new media formats including *You Tube* and *Facebook* to communicate with a new and wider audience.



OUTPUTS FOR INDUSTRY



A PROMINENT PUBLIC ROLE

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

The Bushfire CRC was in particularly high demand during annual conferences and other events, during fire events in North America and southern Europe, and over the extreme fire seasons across southern Australia, both before, during and after the 2009 Black Saturday fires, then subsequently the 2009 Victorian Bushfires Royal Commission.

During this latter time the Bushfire CRC was called upon to provide comment and opinion for news media around Australia and internationally. In doing this the Bushfire CRC provided much needed support for our partner agencies handling media demands. Internationally, interviews were conducted with media from countries and regions including China, Japan, Ireland, United States, United Kingdom, the Middle East and New Zealand.

Most of the queries were on complex issues where the media were looking for a more in-depth discussion than could be provided by the agencies. Issues included climate change, fire weather, the "Prepare to Stay and Defend or Leave Early" position, house protection, bunkers, community education and warnings, arson, and an historical perspective of where the 2009 fires sat with Australia's history of bushfire.

The Bushfire CRC annual conferences attracted considerable media coverage. Each year, from 2007 to 2010, several members of the national media based themselves at the conference for the duration of the event. In addition the ABC did live radio broadcasts of *The Country Hour* and hosted the TV show *Landline* from the floor of the conference.

Over the seven years of the Bushfire CRC, researchers were regularly called upon by media for comment and program content. In particular, the ABC *Catalyst* science program did several specials on Bushfire CRC research, including alpine fire research, car and house fires, and fire modelling. The ABC television special series *Bushfire Summer* profiled the work of several researchers, as did other natural hazard documentaries by the Weather Channel, the BBC and the Discovery Channel. A Pulitzer Prize winning series on wildfire in the *LA Times* featured Bushfire CRC research and commentary.

In alpine plains, savannah forests, mallee scrubland, town halls and brigade sheds, Bushfire CRC researchers shared their research with communities across Australia. The Bushfire CRC supported the community-led publication *Wildfire in the High Country*, as part of the recovery effort of those affected by the 2006 alpine fires.



CONFERENCES



CONFERENCES

ANNUAL CONFERENCE

The Australian, and possibly the world's, biggest fire industry event, the Bushfire CRC annual conference in partnership with AFAC, has grown in size and professional content over the past seven years. Each year the conference attracted around 1000 delegates, with the 2009 conference on the Gold Coast exceeding expectations with 1132 delegates from around Australia and 13 other countries over the three days. Each capital city hosts the conference in turn, with Adelaide in 2008 hosting the International Bushfire Research Conference.

The conference offers industry delegates the opportunity to participate in two to three days of discussion on research and innovation, plus a day dedicated to pre-conference specialist workshops.

This is a prime communications event for researchers. All Bushfire CRC postgraduate students and most of the researchers attend each annual conference – many get the opportunity to present their work on the conference or workshop program, and all get to present their work on a poster, which is prominently displayed.

Importantly, the conference, the workshops and the posters are prime communications vehicles for ensuring the research of the Bushfire CRC is transferred into agency partners. The presence of so many people from across the industry – from the many CEOs to those in day-to-day operations – is an acknowledgement that the industry has seized the opportunity to be informed of the latest research developments in its field.

The trade exhibition associated with the conference had as many as 85 organisations occupying 133 exhibition spaces displaying the latest in technology. This exhibition allows researchers and partners to interact with representatives of various enterprises, including large corporations and SMEs. Business representatives have expressed their gratitude for the opportunity to hear about the latest Bushfire CRC research outputs and the industry's anticipated technical needs based on this new knowledge to address the future.

CONFERENCES

NATIONAL FIRE FORUM

In February 2007, the Bushfire CRC hosted a one-day forum at Parliament House, Canberra, to address the issue *Are Big Fires Inevitable?* The forum was attended by around 150 invited senior people from research, fire and emergency service management, forestry, community organisations, all levels of government, plus several Federal politicians. Three Federal Ministers spoke at the event and the keynote address was by Jerry Williams, former National Director of Fire and Aviation at the USDA Forests Service and now a Senior Advisor at the Brookings Institution.

It was designed to address several themes, including drought and related climate factors, the relationship between fire and water, community related 'interface' issues and forest land management strategies.

Support from the ABC assisted with widespread national media 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 Australia.



FIRE IN THE INTERFACE

In June 2010, more than 40 Australian, New Zealand and United States fire researchers, practitioners and policy-makers gathered in Melbourne and Canberra for high level discussions on joint issues.

The event 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. It included field trips to the areas burnt in the 2003 Canberra fires and the 2009 Black Saturday fires in Victoria.

This fire research symposium gathered participants with specific expert knowledge on bushfires at the urban-rural interface. They discussed 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 at the interface.

A suite of potential bushfire/wildfire research projects were identified for further investigation into how they relate to fire management before, during and after a bushfire or wildfire. The joint proposals focus on the areas of community safety and situational awareness, building planning and fire behaviour.

BLACK SATURDAY



BLACK SATURDAY

BLACK SATURDAY RESPONSE

In the immediate aftermath of the 7 February 2009 fires in Victoria, the Bushfire CRC assembled a taskforce of researchers and fire agency staff from across Australia and New Zealand. The task was to gather vital data on fire behaviour, property loss and community behaviour, from the fire affected areas.

Only five days after Black Saturday, the 50 taskforce members in the first teams were in the field. Three months later, the daily field work was complete. The Taskforce assessed more than 1300 homes, interviewed more than 600 residents face-to-face and received completed mail surveys from a further 1350. More than 22,000 photographs were taken.

A report was presented to the Victorian fire and land management agencies and the 2009 Victorian Bushfires Royal Commission. This large quantum of data is a unique resource available for all Australian and international agencies and research organisations for many years to come.





2013 AND BEYOND

The founding aims that secured seven years of funding to the Bushfire CRC in 2003 were shaped by the priorities of the times. This publication on the full seven years of our operations summarises the gains made on the original aims embedded in the research program.

By 2010, the priorities had changed in ways unforeseen by our industry at the start of this decade. The key drivers of change in our society today are centred on climate and extreme weather, demographic shifts, new demands with workplace health and safety, and emerging technology.

To this mix we can add the multitude of issues arising out of the tragic Black Saturday bushfires in Victoria in February 2009.

It is with these new priorities that the Bushfire CRC looks ahead and plans a long-term research agenda.

The Bushfire CRC in 2009 received an additional three years funding from the Australian Government; \$15 million for research in the period 2010-2013. The Bushfire CRC is using this to conduct research into national issues arising from the 2009 Victorian Bushfires Royal Commission and will begin to identify research to meet the industry's needs by 2020.

Our partners are working closely together to better understand and prioritise the research issues arising from the 2009 Victorian Bushfires and to place these in the context of the broader research needs of the industry.

The new program is grouped around the themes of Understanding Risk, Communicating Risk and Managing the Threat.

Further work has begun to secure funding beyond 2013 for the ongoing research projects.

Most importantly, work is well underway to build on the success of the Bushfire CRC seeking to establish an ongoing research institute. This institute will conduct research across a range of fields for the benefit of our broad industry. The institute will work closely with similar bodies internationally and will collaborate with organisations with an association with fire in areas such as building, planning, local government, health, media, risk management, insurance, water and power, and telecommunications.

The fire industry and research sector has come a long way over the past seven years. A broadly-based, nationally coordinated research program with international links is now a worthwhile focus for our future.



PROGRAM A: SAFE PREVENTION, PREPARATION AND SUPPRESSION

Bushfire management seeks to prevent a fire starting, to prepare in case it does, to suppress it once started and to enable rapid recovery afterwards. Fire managers need reliable tools and the best technologies to support them before, during and after a bushfire. This Bushfire CRC program provided new understanding of such key issues as fire behaviour, fire weather, bushfire danger rating and strategies for aerial and ground suppression.





A1.1 Fire behaviour modelling

This project addressed the need to better understand the interactions between fire, fuel, weather and topography.

Factors include rate of spread, flame height, intensity and spotting for both wildfires and controlled prescribed fires. The research included experimentation and validation of fire behaviour models, documentation, training and the production and delivery of fire behaviour systems to end users.

Research work included field validation of the findings from Project Vesta results in south eastern fuels. Project Vesta was a comprehensive research project between CSIRO and Department of Environment and Conservation in Western Australia, investigating the behaviour of bushfires in different fuel ages and structures during dry summer conditions.

According to project leader Jim Gould, of CSIRO: "As a result of this research we have developed a new bushfire spread model for summer wildfires that will provide the basis for a national fire behaviour prediction system for dry eucalypt forests."

A new model for crown spread in pine plantations was developed out of observations of a plantation fire in Tumut, New South Wales.

Large scale experimental burning and the collection of fire behaviour information from at the Ngarkat Conservation Park in South Australia led to a new guide for burning in Mallee heath and scrubland, a vegetation type that covers large parts of southern Australia. This output was led by Dr Miguel Cruz, of CSIRO, and followed up with field clinics and a handy field guide to assist fire managers.

This was well received by fire managers with one corresponding after the clinic: "It was a really interesting presentation and the field guide reference is a very valuable tool. We actually used it to determine if we had a 'go' or 'no go' burn day when we started our burning campaign and despite some staff believing fuel moistures would be too high we had sustained propagation due to reasonable wind strengths."

A PhD project by Phil Lacy developed a field guide for the often difficult task of prescribed burning in young eucalypt plantations. A workshop and field trip in northern New South Wales for plantation industry staff reinforced these learnings in a hands-on way.

A study on how educational multi-media programs may improve the delivery of fire behaviour training was the focus of postgraduate student Annette Salter, at the University of Tasmania.

A1.3 Fuel classification and availability

The aim of this project was to develop fuel assessment tools for use in fire behaviour models. It was led by Dr Peter Ellis, of CSIRO, with Dr Wendy Anderson, of the University of New South Wales, Australian Defence Force Academy, and Dr Kevin Tolhurst, of the University of Melbourne. Understanding fuel types is critical for the improved control of bushfires.

Initial work for this project focused on revising and improving a fuel classification system developed by David Sandberg and colleagues in the United States. This is a universal classification and hierarchical in structure, with the advantage of providing the necessary parameters for fire behaviour, smoke emission, ecological and other possible models regardless of the amount of detail known about fuels at any particular point in the landscape. The classification system was applied to the fuels in an experiment at Tumbarumba, NSW, in February 2004.

The project's second component related to fuel consumption. This research aimed to predict the extent of fuel consumption under different fire, fuel and weather conditions so that fire behaviour and smoke emission models can be improved.

Initial research was undertaken in Tumbarumba, NSW, in February 2004, when a methodology was developed and initial results obtained. The high level of fuel moisture variability in coarse woody debris in natural forests is a significant problem for fuel consumption modelling. A significant difference in fuel moisture was found between woody material in contact with the ground and material suspended above it, suggesting that the modelling of fuel moisture and availability in natural forests is likely to be more complex than has been indicated by previously published research (predominantly relating to recently logged forest).

This project contributed to the Project Vesta field guide to fire in dry eucalypt forests.

Two postgraduate student projects based at the University of New South Wales, Australian Defence Force Academy, produced new knowledge in this area. Brendan Phippen identified factors affecting fire behaviour in heathland vegetation. Jennifer Hollis looked at woody fuel consumption and fire intensity and is developing a field guide for fire managers. "The log and branch material on the ground can contribute to as much as 80 percent of what is burnt in the bush," said Hollis. "This research will allow fire and land management agencies to better predict the total fuel consumed in prescribed fires and wildfires and assist planning for expected fire behaviour, smoke emissions and the various impacts of the fire."

A1.4 Improved methods for the assessment and prediction of grassland curing

Curing describes the annual or seasonal cycle of grasses dying and drying out. The proportion of cured material in grassland fuel (indicated by a "curing value") is a critical input into both Australian and New Zealand grassland fire behaviour models and fire danger rating systems.

This project developed improved methods for the prediction of grassland curing as an input into fire danger rating systems and fire behaviour models in Australia and New Zealand.

Scientists at the Bureau of Meteorology in Australia and at Scion in New Zealand utilised remote sensing technology and pasture/grass growth models to assess curing levels in grasslands.

The outcomes from this research have provided improvements to current remote sensing methods. It also developed new information on the use of thermal imagery and moisture relationships. Many of these outcomes are being validated and trialled in the field by fire and land management agencies both in Australia and New Zealand.

Danielle Martin, of RMIT University, worked on developing satellite vegetation indices to assess grassland curing for her PhD. Helen Daly's PhD through the University of Tasmania adapted agricultural modelling tools to predict curing rates across temperate grasslands of southern Australia and New Zealand.





A2.1 Fire weather – fire danger

Meteorological data is fundamental to predicting fire danger and fire behaviour on timescales from seasonal to very short range. Seasonal factors affect fuel moistures and fuel availability while the variability on the very shortest time and space scales can cause marked variations in fire behaviour over very short distances or time intervals. Accurate fire weather forecasts can make all the difference to a community's safety and to the overall success and wellbeing of firefighters and fire authorities in preparing for adverse fire weather.

This Bushfire CRC project, led by Dr Graham Mills of the Bureau of Meteorology, aimed to improve the operational utility of fire weather forecasts and outlooks, by providing better knowledge and understanding of wind, temperature and humidity structures and distributions, on the very short term (one to 12 hours), short to medium term, and seasonal time scales.

The outcomes provide a range of forecast products tailored to the fire weather forecaster and based on hourly mesoscale numerical weather-prediction model output. These are available to forecasters nationally. These have included gridded weather and soil indexes for better fire weather forecasting; a better understanding of wind changes and links to “blow up” days; a better understanding of atmosphere stability impacts on fire behaviour with the Continuous Haines index; and breakthrough work on the nature of dry lightning.

A significant piece of research on climate change impacts on fire weather in south-east Australia for the Climate Institute has been extensively used in strategic planning and risk assessments by industry and governments.

The Bushfire CRC's annual Bushfire Seasonal Outlook developed from this project. Each year before the northern and southern Australian fire seasons the Bushfire CRC brought together fire managers from all jurisdictions with Bureau of Meteorology scientists for a workshop.

The Queensland Fire and Rescue Service contributes considerable resources and importance to the workshop. Fergus Adrian, the manager of planning and research in Rural Operations, said climate and fuel data gathered for the workshop is used in pre-season readiness activities, including the timing of community awareness programs, briefing government, other fire and support agencies and contracting firefighting aircraft. “Importantly, on both a state and national level it provides an opportunity for fire agencies to appreciate resource demands such as intra and interstate assistance and to identify potential safety issues over the duration of the fire season,” he said.

In 2010, for the first time, a similar workshop was held in New Zealand. The final agreed seasonal outlooks are communicated in a *Fire Note* format and used by fire managers to harness resources for the upcoming seasons.

A3.1 Evaluation of air suppression techniques and guidelines

The number of aircraft used in fighting bushfires in Australia rose from just a few in the mid-1970s to several dozen by 2010, with some, especially the large Erickson Airplane helicopters, attracting wide public attention with nicknames such as Elvis and Elsie.

The National Aerial Firefighting Centre, funded by the federal, state and territory governments, was established in 2003 to fund a growing national fleet.

Despite the significant role of aircraft in firefighting by the time of the establishment of the NAFC, there was no significant research into how appropriate, useful and effective they were. One of the first big tasks

undertaken by the Bushfire CRC after its establishment the same year was to initiate that research.

The research was conducted by the Bushfire CRC in conjunction with the CSIRO Bushfire Research Group, RMIT University and fire and land management agencies, with an initial report, *The Effectiveness and Efficiency of Aerial Firefighting in Australia*, published in 2007. The lead author was Dr Matt Plucinski, of CSIRO Sustainable Ecosystems.

The research looked at many scenarios, including such issues as single or multiple “drops” on fires and whether and when to drop water or chemical-based retardants. It found that aerial suppression drops were of limited value without timely follow-up by firefighters on the ground, but when used properly, could enable ground firefighters to contain fires more quickly.

Field work was conducted in Tasmania and at the Ngarkat Conservation Park in South Australia, where a combination of water, chemical and gel drops were compared. Drop data from aircraft at real bushfires in several states was also obtained.

Among other things, the research led to the production of a *Fire Containment Guide*, an online *Fire Containment Calendar* and a *Drop Effectiveness Guide* to help fire managers assign and use fixed-wing aircraft and helicopters effectively.

In the wake of the 2009 Victorian Black Saturday bushfires and publicity about large jet airliners being used to fight fires in the United States, the Victorian Government funded the trial of an American DC-10 firefighting jet during the 2009-10 fire season. On behalf of the Bushfire CRC, a team led by Dr Plucinski evaluated the effectiveness of the DC-10 in Victorian conditions. It was found that the DC10 had a number of issues that deemed it unsuitable for use in Victorian conditions.

A4.1 Fire management business model

The Bushfire Management Business Model project – led by Dr Kevin Tolhurst of the University of Melbourne – was born out of the recognition that while bushfire management has been a major enterprise in Australia for many years, there has been to date, no formal risk management model developed.

This project developed a risk management decision support system for fire agencies and land managers through interviewing a large number of fire managers from a range of different agencies and types.

The Fire Management Business Model underpins a risk management model. The model is used to calculate the probability of ignition and spread of fires across a landscape.

This outcome allows for a better understanding of how changes in one aspect of management can affect other aspects of management. The models may assist fire agencies in better deciding where to allocate resources during a fire event.

While developing the Fire Management Business model, Dr Tolhurst realised a fast, operational, fire-spread model was also needed. The existing ones did not suit his need, so he developed his own with his colleague Derek Chong.

Known as Phoenix RapidFire, the program predicts the movement of fire and helps determine which communities need to be warned and where to send resources to minimise the impact. It generates a map with a visual representation of the bushfire moving across the landscape with input from environmental details such as the height and slope of the land, vegetation type, road proximity and fire history of the area.





The fire’s impact is then estimated based on fire characteristics and the values and assets of the landscape, such as houses and agricultural areas.

The state of Victoria began using it operationally for the 2010-2011 fire season.

“The program should allow us to provide hours of warning of a fire approaching within just minutes of it being discovered,” DrTolhurst said.

“It’s designed to show the progression of fire across an entire state, and not just a local area, and therefore the firefighting resources can be most effectively allocated. Although other fire behaviour models exist, Phoenix RapidFire is unique in the world because of its ability to respond to changing factors in the environment such as weather and fuel. We aim to implement Phoenix RapidFire right across Australia in the future.”

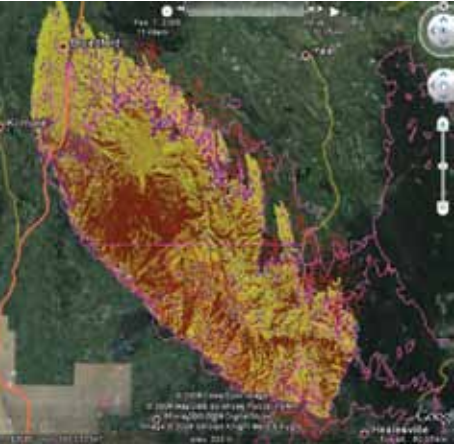
Fire managers can now use Phoenix RapidFire to simulate the positive effects that a fuel reduced zone can have on the progress of a wildfire. It has the potential to be used for fire management planning and to inform land use planning decisions.

A5.1 Computer simulation modelling

Modelling bushfire spread improves decision-making in critical scenarios. This project developed reliable bushfire spread simulation and animation technology to support a wide range of fire management activities, including risk analysis, prescribed burning, wildfire suppression and incident control training.

A computer-based environment permits rapid and repeatable execution of bushfire simulations under a wide range of conditions, assisting with real-time decisions and “what if” scenarios. Simulations are based on the latest understanding of fire behaviour captured within a computer model. Simulations inform predictions of fire behaviour and the effectiveness of containment strategies.

Led by Professor George Milne, of the University of Western Australia, this model is being used by the Fire and Emergency Services Authority and that state’s Landgate agency as part of its state alerting system and was a main feature of a successful Digital Regions initiative grant.



PROGRAM B



PROGRAM B: THE ROLE OF FIRE IN THE LANDSCAPE

Fire has long contributed to the nature of the Australian landscape, like rain, drought, heat, snow and human activity. Fire can be beneficial and destructive. Too much or too little can have a profound effect on ecosystems. This Bushfire CRC program helped firefighters, land managers and the broader community to learn to manage fire and understand its importance as a land management tool. From the tropical savannas of the north to the forests of the south, Bushfire CRC scientists undertook research of fire as an integral part of the landscape.





B1.1 Managing fires in forested landscapes in south Western Australia

South-west Western Australia is one of the most fire-prone regions in the world due to the combination of a Mediterranean-type climate with hot dry summers and the presence of large areas of flammable native vegetation. It is also a biodiversity hotspot where the role of fire is key. Prescribed fire has been used extensively in forest landscapes since the 1960s to mitigate the impacts of bushfires on the community and on environmental values including biodiversity. The ecological implications of prescribed burning, however, remain contentious.

Bushfire CRC researchers Dr Lachie McCaw, a principle research scientist with the Western Australian Department of Environment and Conservation (DEC), and Dr Roy Wittkuhn, a research scientist with the DEC, set out to evaluate the resilience of plants, vertebrates, invertebrates and fungi to different fire interval sequences over the last 35 years in the Warren bioregion in the far south of south-west Western Australia. Their aim was to guide the management of fire interval regimes for biodiversity conservation.

They used accurate fire history information to determine the impact of different fire interval sequences over the last 35 years on the composition and abundance of vascular plants, ground-dwelling invertebrates, vertebrates and macrofungi in the forests and shrublands of the region. This was achieved by using a space for time methodology that included extensive digitisation of hand drawn maps from historical fires.

Their research found that the forests and shrublands they investigated were more resilient to the effects of burning than may have been previously believed.

They surveyed species composition and the abundance of ants, beetles and vascular plants at all the sites. In addition, forest sites were surveyed for macrofungi and vertebrate fauna. Surveys for most groups were conducted over two years, and often twice in a single year to account for seasonal variation in species composition.

The study found that none of the groups displayed significant differences in species composition as a result of contrasting fire interval sequences in either forest or shrubland. The data showed that varying fire intervals had no persistent effect on the richness and composition of biota associated with open forests and shrublands of the Warren bioregion, and demonstrated that these ecosystems are highly resilient to fire.

“The periodic occurrence of fire in these ecosystems from pre-human to more recent times is likely to have pre-conditioned the biota to persist across a range of fire intervals varying from long (at least 30 years) to short (less than five years) fire intervals,” said Dr Wittkuhn. “This suggests that the variability that has occurred at the study sites makes an important contribution to observed resilience, whereas repeated short intervals over the longer term would likely lead to substantial ecological change.”

A DVD has been produced of the work done by Dr Wittkuhn and Dr McCaw and is available from the Bushfire CRC through the AFAC Shop. The research has also been captured in a teaching resource *Fire and the Environment*, which is suitable for undergraduate students in environmental science, land management and geography.

The work of two University of Western Australia Phd students complemented this project. Alison O'Donnell investigated the spatial and temporal dynamics of wildfire in the shrublands and woodlands of the Lake Johnston region in southern Western Australia, while Jaymie Norris looked at how fire intensity affects the microbes in the soil that make the forest productive.



B1.2 Fire regimes and sustainable landscape risk management

Human population and climate changes directly affect fire regimes and associated risks. Risk management now emphasises assessment, measurement and mitigation of risks to a wide range of values, including property and ecosystem services, water, air quality, indigenous values and biodiversity.

This project focused on four contrasting regions across Australia – the Sydney Basin, the Australian Capital Territory, South West Tasmania and Central Australia. A core tool was the FIRESCAPE landscape/fire regime simulation model. It was led by Professor Ross Bradstock, at the University of Wollongong, supported by Dr Geoff Cary and Dr Malcolm Gill, at Australian National University.

The modelling was supported by two major strands of on-ground investigation aimed at measuring the responses of biodiversity to different fire regimes and the sensitivity of fire behaviour to vegetation, fuel moisture, landscape characteristics and fire suppression and prevention activities. Outcomes from the research have enhanced and validated key functions in FIRESCAPE, allowing explicit quantification of risks posed by particular fire regimes.

Major findings have included an extensive evaluation of the effectiveness of prescribed burning strategies in the World Heritage listed button grass in Tasmania. This modelled the effects of climate change on the fire impacts on fire sensitive species and informed the Tasmania Parks and Wildlife Service Management Plan.

Work in Central Australia has included studies of the impacts of fire regimes on sensitive flora and fauna using various bio-indicators. Adam Leavesley's PhD work out of the Australian National University was on the impact of fire on the birds of Central Australia. This better informs burning practices in Central Australia.

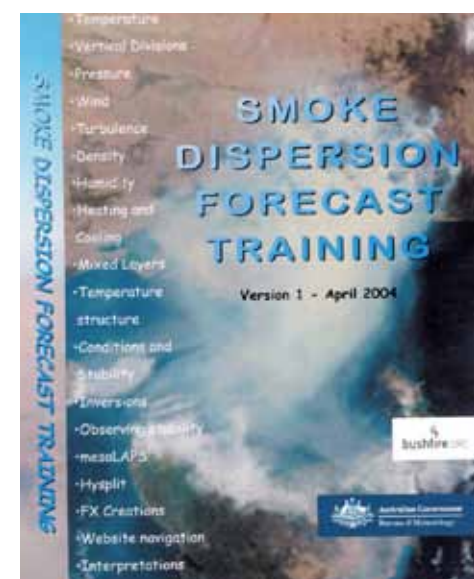
Other postgraduate work from ANU students included Lyndsey Vivian's ACT-based work on how fire controls where different types of sprouting and seeding plants live. Fire impacts on the rainforest regions of the Sydney Basin were the focus of a PhD study by Carola Kuramoto de Bednarik. Both aim to inform prescribed burning plans.

Phil Zylstra (UNSW/ADFA) was based in the high country of New South Wales and looked at the flammability of the forest – how a fire burns in the bush and why some plants thrive and other plants die after a fire. This work has assisted the New South Wales Parks and Wildlife Service in their scheduling of prescribed burning. Rowena Morris, University of Adelaide, completed her PhD thesis on how prescribed burning impacted upon sediment traps in the waterways of the Adelaide Hills.

B2.1 Behaviour of smoke plumes and hazes from rural or urban fires

The impact of smoke from prescribed and fuel reduction burns and wildfires on community health is an area of growing public interest. To minimise the impact of smoke on the community from planned burns, a predictive model was sought by fire managers.

The project enhanced the Bureau of Meteorology's operational high-resolution prediction models to provide forecast wind and temperature fields and the location and strength of the smoke plume. A self-paced, computer-based, interactive training package was produced to aid in the training and use by fire managers.





The predictive model is now delivered online, and includes operational capabilities for users to interactively specify the ignition sites. This tool is routinely used by fire managers across southern Australia to plan prescribed burns, and was also used during the 2006 Commonwealth Games in Melbourne to ensure smoke from autumn burns did not impact on the events.

This research, led by Dr Graham Mills and colleagues at the Bureau of Meteorology, assists the prediction of transport and dispersion of smoke from an urban or rural fire. It predicts concentrations of smoke particulates at locations affected by the smoke plume. Outcomes are helping fire management planning, by modelling smoke movement from potential sites of controlled burns.

B2.2 Smoke composition from prescribed and wild fires and health

A key issue for this project was to resolve whether smoke from prescribed fires differs from smoke produced by wildfires.

Dr Tina Bell, at the University of Melbourne, led this project which 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, photochemically active gases and ozone-depleting chemicals in smoke emissions.

The project worked towards a system for predicting the concentration and composition of smoke from a given vegetation type and condition. It quantified this in order to assist fire managers to better manage the intensity of a fire to improve the impact from smoke on human health.

B3.1 Impacts of fire on ecological processes and biodiversity

For land managers, understanding the impacts of fire on the environment is important. The ecologically sustainable management of forest ecosystems depends on understanding the processes involved in carbon and nutrient cycling, involvement of organisms in these processes, and how they contribute to biodiversity conservation.

Forests also play important roles in Australia's carbon budget, through accumulation of carbon, above and below ground. Low intensity fires are used extensively in managed forests in Australia and there is a need to better estimate the impacts of repeated fire on plant and animal communities.

This project focused on nutrient fluxes under different fire regimes, investigated the roles played by mycorrhiza and decomposer fungi; their inter-relationships with plants and invertebrates and likely impacts on ecosystem processes and carbon cycling.

Researchers, led by Dr Alan York at the University of Melbourne, analysed and documented the main findings from a series of long-term fire effects sites around Bulls Ground and Eden, in New South Wales, and in the Wombat State Forest, in Victoria. They found that many fuel reduction burns are conducted too cool to have an effect on recruiting a new generation of plants. Also, they analysed the quantity and the role of decomposers on the fuel loads in forests and the impact of different fire regimes on these, providing advice to Victorian and New South Wales land management agencies on prescribed burning plans.

Further significant contributions to prescribed burning plans were made by University of Melbourne based PhD students. Anne Miehs looked at the role of coarse woody debris on the forest floor and how it could be managed for fire



and conservation objectives. Kerryn McTaggart used the Bogong High Plains as a base to look at how fire affected the uptake of methane in the soil of alpine ecosystems.

The knowledge is helping land managers to protect life and property while maintaining ecological processes essential to ecosystem health and productivity, and improving awareness and understanding of the role of fire in biodiversity management.

B3.2 Burning for biodiversity in tropical ecosystems

The vast majority of Australian bushfires occur in the savannas of the tropical north. While the Aboriginal tradition of landscape burning has waned, prescribed fire remains the key landscape management tool across vast areas. Half or more of the monsoonal tall grass landscapes of north-western Australia are burnt each year.

The "Burning for Biodiversity Project" covered a range of projects across Northern Australia.

An ongoing project at the Territory Wildlife Park, near Darwin, features an experiment for fire research, integrated with the delivery of public information and education programs. Eighteen hectare-sized plots are subjected to one of six fire regimes. Research activities cover fuel dynamics, fire behaviour, soil biology and ecological function, grass and tree dynamics, the role of herbivory in vegetation recovery, invertebrate biodiversity, and the population dynamics of small lizards. The work has direct application to the fire management issues in Western Australia, Queensland and the Northern Territory.

The researchers have also worked with traditional Aboriginal owners in Kakadu National Park to examine the cultural benefits of Aboriginal fire management. This project was based in the floodplains of the South Alligator River. Results showed that the re-application of traditional fire management dramatically enhances biodiversity and the cultural values of these wetlands. As a consequence of this research, prescribed burning practices have been changed in the wetlands of Kakadu National Park.

This project established a graphical web-based interface for integrating Indigenous and Western knowledge systems in the conservation of biodiversity and traditional resource use. This graphical approach illustrates how the nature and appearance of wetlands change with seasons and different management interventions. An Aboriginal manager's understanding of wetlands includes factors such as sights, sounds and smells, and these have been included into the model.

At a community level, this has enhanced the cultural benefits of biodiversity and increased public awareness about the role of fire in northern Australia.

Andrew Edwards, based at Charles Darwin University, produced the field guide *Fire Severity Categories for the Tropical Savanna Woodlands of Northern Australia* from his PhD research that combined ground measurement with satellite sensing to map the fire severity of burns in the northern part of Australia. Ken Scott's PhD study looked at how native grasses responded to fire regimes. This is being used by field staff in tropical savanna woodlands of northern Australia for better data collection and future research analysis, prescribed burning planning, and a wildfire abatement program.





B4.2 Multi-scale patterns in ecological processes and fire regime impacts

Most studies of impacts of fire on ecological processes have dealt largely with single fire events, examining fire at localised scales without reference to the variability of fire in the landscape. The lack of an appropriate landscape context for fire management may lead to management decisions that are contrary to the intent of ecologically sustainable fire regimes.

The patterning observed after a single fire event is often a consequence of the effects of previous fires, yet the concept of dynamic models that take into account impacts of preceding fires is often missing. Understanding the consequences of 'ecological memory' on local and landscape patterns, is key to predicting the likely effects of future prescribed burning regimes.

This project was led by Dr Pauline Grierson, at the University of Western Australia, with Dr Matthias Boer. Part of the study looked at 50 years of active fire management in south-west Western Australia. It sought to measure to what extent the annual area burnt by prescribed fire reduced the annual incidence and extent of unplanned fires. A key finding was that prescribed burning for reduce fuels ceased to have significant effects on annual wildfire numbers after six years. Meanwhile, the length of time a site remained unburnt by wildfire had doubled since the early 1960s to about eight to nine years by the early 2000s.

The PhD work of Rohan Sadler developed mathematical and modelling approaches to quantifying the impact of ecosystem events (such as fire, flood, drought) on semi-arid grasslands in the Pilbara region of Western Australia.

B6 The High Fire Project

This project, led by Professor Mark Adams, of the University of Sydney, was a significant extension to the work of the Bushfire CRC. Following the devastating alpine fires of 2003, public debate around land management intensified with many opposing views, much of this unsupported by scientific research. The HighFire project created an evidence base for ongoing research that can be drawn upon by land managers in formulating future policy and practice.

It established a three-year national project on fuels and fire issues in Australia's high country under three sub-projects:

1. The effects of disturbance (such as grazing and fire) and a changing climate on ecosystem processes (greenhouse gas emissions, water use and carbon emissions, biodiversity) on the flammability of high country landscapes, and on fuel and fire management.
2. Understanding human and community resilience in the high country.
3. Managing the risk of fire across the landscape for the protection of people, property and ecology.

Crucial to the success of HighFire was the network of relationships with the sector and the community. Partners in HighFire included the New South Wales Rural Fire Service, Parks NSW, Parks Victoria, Country Fire Authority, the ACT Rural Fire Service, and researchers from the University of Sydney, University of New South Wales, the University of Melbourne, RMIT and CSIRO. In addition, many residents of high country properties made significant in-kind contributions to the research.

"This research is the only integrated effort to understand the impacts of land management policies, climate and fire on water yield from the high country," said Professor Adams.

The first project established new, long-term research sites and experiments



across alpine areas of Victoria, New South Wales and the Australian Capital Territory. These sites provide data to underpin efforts to model the impacts of climate change on fuel loads and the trade-offs among fuel management and water yield. The project also addressed issues raised in major reports, such as the Nairn Inquiry and Council of Australian Governments (COAG) reports on the 2003 fires.

Important new work by PhD student Meaghan Jenkins revealed that sub-alpine vegetation types in Australia significantly influence soil chemistry and rates of carbon release as CO₂. Meaghan developed an approach for accurately measuring gas exchange from soils. Soils hold about double the carbon that is stored in the atmosphere. Changes in carbon release rates from soils are largely determined by patterns of vegetation, which are determined by patterns in fire and temperature. Bushfire, this study concluded, is at least as important as temperature, in its effect on both plant growth and release of CO₂.

Furthermore, this project assessed the combined impacts of grazing and burning on fuel accumulation in sub-alpine grasslands and woodlands with a series of experimental plots. Over the three years of research by Dr Maria Taranto and Dr Stephen Roxburgh, the impact of fire on the vegetation was able to be measured, but the effects of grazing were much more gradual. Hence, the combined effects of fire and grazing may take decades to be fully apparent.

An important element in HighFire was the social research that provided an understanding of community experiences and attitudes on fire management in the high country. This research looked at how fire and land agencies and communities manage the risks involved with both prescribed burning and with bushfires.

Led by Professor John Handmer, from RMIT University, the Living with Fire component of the project documented local experiences of fire in the high country in order to share this knowledge to improve resilience among communities. Details of this research were documented in the Program C book *Community Bushfire Safety*.

The third component of HighFire, Management of Bushfire Risk, was led by Rick McRae, of the ACT Emergency Services Authority and Professor Rod Weber, of the Australian Defence Force Academy at the University of New South Wales, with colleague Dr Jason Sharples.

This team recognised that several processes are known to influence fire behaviour in mountainous regions, ultimately determining the size of a bushfire and the level of risk to assets. These processes include the interaction of terrain features, climatic conditions and local weather patterns. Portable weather stations were erected to examine the unique weather patterns of high country ACT and NSW.

Although the same processes influence fire behaviour elsewhere, new understandings on the unique nature of the interactions in the high country is contributing to better management of fires in these areas.

In addition to several public and industry field days and forums, a major gathering of agency staff, community and researchers was held in Albury, New South Wales, in 2010 to share the research findings and to consider their implications and applications. The HighFire Risk work has immediate applications to firefighting agencies. Educational learning materials focussing on fire weather and firefighter safety are under development.

B7 Tree decline in the absence of fire

This project represented the first national study of tree decline caused by reduced frequency or absence of fire. In New South Wales, Victoria, Western Australia and Tasmania, there are large tracts of native moist-to-dry forest in



PROGRAM B



advanced stages of decline. In some instances, there is strong evidence linking this decline to change in fire management, from historically frequent low intensity burns to a current management of fire exclusion.

Suitable study sites were identified in NSW, WA and Tasmania, where the same forest type occurs as long unburnt stands adjacent to sites where there are good records of frequent burning.

The research was led by Dr Neil Davidson, from the University of Tasmania, in partnership with State Forests NSW, University of NSW, Conservation and Land Management WA, Murdoch University WA, Tasmanian Fire Service, Forestry Tasmania, Department of Tourism, Parks, Heritage and the Arts Tasmania, and University of Melbourne.

This project hypothesised that an absence of fire leads to the increased development of woody mid-storey that out-competes eucalypts for soil water and/or alters tree nutrient availability.

The project took a 'space-for-time' approach of paired sites with a history of either being long unburnt or relatively frequently burnt. The sites were established in *E. gomphocephala* woodland in Western Australia and in *E. delegatensis* forest in Tasmania.

It found that in the long unburnt sites in both WA and Tasmania there was a greater percentage cover of midstorey (tall shrub layer) and that eucalypts were exposed to greater water stress (measured as higher water-use efficiency). Also, in WA eucalypts of long unburnt sites were deficient in foliar copper (Cu), and in Tasmania eucalypts of long unburnt sites had lower levels of foliar phosphorus (P).

Using an index of tree health with crown cover as the measure, the project showed that tree decline was correlated with increased midstorey shrub cover, and water stress and nutrient deficiency in eucalypt trees.

It concluded that the midstorey that develops in the long absence of fire alters ecological processes, leading to premature eucalypt decline. A decision support tool for fire managers was developed.

The Manager of Fire Management at Forestry Tasmania, Tony Blanks, stressed the importance of this work. "This is a project of national significance. The research report will be of value to all managers of natural and long rotation eucalypt forests," he said.

"The possibility of the premature decline and loss of the overstorey eucalypts from even a proportion of the southern Australian forests is of major concern aesthetically and ecologically, but also for the effect this process will have on carbon sequestration.

"It is important that forest managers understand the processes which affect the longevity of eucalypts, as a step in finding ways to protect the massive quantities of carbon stored in the stems of our eucalypt forests."

Bryony Horton's PhD study at the University of Tasmania explored the links between ectomycorrhizal fungi, fire and eucalypt dieback in forests with different understorey vegetation.

Fire managers now have a decision support tool to aid in their management of the forest's health.

PROGRAM C



PROGRAM C: COMMUNITY SELF-SUFFICIENCY FOR FIRE SAFETY

The choice to live and work in places of bushfire risk makes us more vulnerable. It also demands that we become self-sufficient in dealing with that risk. This Bushfire CRC program helped communities to become more resilient in the face of the threat of bushfires. It looked at what communities needed to manage the risk, which varied from community to community across Australia and New Zealand. Central to the program was what drove human behaviour before, during and after bushfires.





C1 Understanding Communities

To increase community resilience to bushfires, people need a better understanding of how government policy and public perceptions interact. There is a need for a better understanding of how the expectations of service providers, communities and agencies agree or differ.

Using the urban community living in a forested environment at Thuringowa in Townsville as a case study, this project developed methods to enhance agreement and resolve differences that resulted from different expectations within bushfire prone communities. They were then evaluated for their effectiveness in meeting the needs of communities and service providers for bushfire mitigation, response and recovery.

The project developed a better understanding of community perceptions and attitudes to bushfires and incorporated research from other hazard studies that can be successfully adapted to these communities. This was evident in the 2007 book *Communities Living with Hazards*, co-edited by project leader Dr Alison Cottrell at James Cook University, which included much of the work of this project. Regular bulletins kept research colleagues and agencies up to date with the progress of this project.

The project also helped agencies to profile their at risk communities – a *Know Your Patch, Grow Your Patch* guide was produced for this task. It worked on developing guidelines for working with disadvantaged communities, including Indigenous communities in Cape York, and Sudanese communities in Townsville.

C3 Bushfire arson

The bushfires that threaten Australian homes and lives on a regular basis originate with a small number of common causes. One is arson, or the deliberate criminal setting of fires. The Bushfire CRC worked to reduce the number of fires by learning more about the incidence of bushfire arson.

The project collated, reviewed and assessed current juvenile arson prevention practices. It developed a better understanding about arson in Australian bushland environments.

A literature review on bushfire arson showed the current state of knowledge; its links to urban arson, the age and background of arsonists, and the times and places of offences. This review is essential reading for fire agencies and law enforcement authorities attempting to combat arson in bushfire areas.

More than 50 *Bushfire Arson* bulletins were published and are publicly available for discussion and advice. These publications build the knowledge of all aspects of bushfire arson; who lights fires, why they do it, and what the authorities can do about it.

A comprehensive review of trends in deliberately lit vegetation fires across Australia was distributed to AFAC Groups and individual agencies to better understand the nature of bushfire arson.

Bushfire CRC funding fostered this specialist field at the Australian Institute of Criminology, with researchers including Matthew Willis, Damon Muller, Colleen Bryant and Warwick Jones helping investigators, prosecutors and land management agencies to work on prevention strategies.

“By understanding why someone commits a particular criminal act, you can start to look at ways of stopping them,” Willis said. “Our work on the motives and patterns behind bushfire arson produced practical information that police, fire services and land managers can use to target investigations and prevention campaigns. By knowing where and when bushfires are most



likely to be lit, and who is likely to be lighting them, stakeholders can more effectively target their resources.”

This important Bushfire CRC research into understanding the trends in deliberate vegetation fires and using crime prevention strategies to reduce deliberate fires in Australia were used as the source documents by the Commonwealth Attorney-General in a national workshop aimed at greater national collaboration to reduce deliberate bushfires in Australia.

C4 Effective risk communication

Risk communication is an ongoing difficulty for fire and emergency services. Official reports continue to refer to the need for better, timely warnings and advice on safe action during fire events. This is because a significant proportion of the population in many communities fail to respond appropriately or adequately to fire weather and fire emergency warnings. The failure of pre-event safety messages, fire warnings, post-event communications and the associated action advice results in lower standards of safety and increased property, heritage or cultural, environmental and social losses.

This project provided a better understanding of community engagement with the media to facilitate better communication by agencies and more effective use of the media. A series of reports from La Trobe University researchers on better engagement between fire agencies and the media were used by agencies to better plan their media communications during bushfire incidents.

Work by project leader Professor Douglas Paton, at the University of Tasmania, identified ways in which communities and individuals respond to warnings and prepare in advance of a fire event. Substantial research was undertaken around high fire risk areas in Canberra and Hobart to gauge how people interpret community safety messages from agencies.

For warning messages to be heeded, the community needs to recognise it is at risk, and this study found this is strongly influenced by community psychology, and personal experiences and beliefs.

This data was used to construct a bushfire preparedness model for fire services to better deliver preparedness and warning messages to communities. These findings were also presented by Professor Paton to the 2009 Victorian Bushfires Royal Commission.

Damien Killalea, Director of Community Fire Safety at Tasmania Fire Service, said the research is now being applied: “This research identifies the essential need to understand the psychological motivations and other reasons behind an individual’s decision to act or not to act, sometimes despite their best intentions.”

Two postgraduate projects at the University of Tasmania reinforced this research. Tim Prior identified the key factors that most influenced residents when deciding whether or not to prepare their homes for bushfire. Tim’s work highlighted the importance of different information for different people, and that the notion of “preparedness” differed between agencies and residents.

Educating children about bushfire risk was the focus of a postgraduate study by University of Tasmania student Briony Towers. Her work looked at how children understand bushfire and how they can bring this understanding into their homes. Briony was selected as a top four finalist in the Early Career Scientist Award to present to the CRC Association Annual Conference in 2010 on how this work was taken up by fire agencies. The CFA in Victoria and Ettamogah Productions worked with Briony to develop a series of 30-second animated cartoons that were repeatedly shown on three free to air television networks across southern Australia over the 2009-10 bushfire season, with plans to extend the series further.





C5 Bushfire economic costs

Accurate numbers on bushfire impacts – the economic, social and environmental costs – are difficult to quantify. Estimates often ignore economic principles and are of limited value in dealing with governments that increasingly require fire agencies to justify their actions with economic and other quantitative indicators. Much work on bushfire economics is being conducted overseas, especially in the US, although much of this work concerns forestry rather than urban interface issues. Considerable loss assessment work has also been conducted for other hazards like flooding. This project drew on this work where appropriate, and built collaboration with experienced overseas fire economists.

The project was led by Professor John Handmer, at RMIT University. Through a number of journal articles and book chapters, the project expanded the scope of what is normally included in bushfire loss assessment, to ensure that coverage is comprehensive, taking into account the costs of arson, the impact of error and uncertainties, carbon accounting, additional impacts of mega events, volunteers, and intangible losses.

One of the first priorities was to establish the cost effectiveness of aerial firefighting through a joint project with Program A. Professor Handmer and colleague Gaminda Ganewatta assessed the relative economic merits of different types of fixed-wing aircraft and helicopters for suppression tasks conducted with and without various combinations of ground resources.

A guide to estimating non-market values for improved fire management has been developed, targeted at government and other organisations for creating business cases.

C6 Evaluation of the “Stay or Go” policy

Over many years, experience showed that many people who died in bushfires across Australia perished when caught by fires on the road, whether in their cars or on foot. By the late 1990s, it was generally accepted by fire agencies that staying to defend a well-prepared home, or leaving for a safe place well before a fire threat appeared, were the two best survival options for a bushfire.

This led to the formal development of the “Prepare, stay and defend your property or leave early” policy, often shortened by the public and in the media as “stay or go.”

With the establishment of the Bushfire CRC in 2003, research led by Professor John Handmer, at RMIT University, was begun to test the anecdotal evidence underpinning “stay or go,” as well as the legal and other implications of fire and other agencies giving advice on the policy to communities.

A key piece of work that underpinned the policy was the review by Dr Katharine Haynes of 100 years of bushfire deaths in Australia to 2008. Dr Haynes found that most fatalities occurred in the open when victims fled the flames at the last moment, highlighting the fact that last minute evacuation was the highest risk strategy. 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.

A review of the legal underpinning of this policy analysed the shift in risk and responsibility between the homeowner and the authorities. This legal analysis was an essential complement to the broader research project on this policy aimed at managers responsible for implementing the policy into practice.

Josh Whittaker’s PhD study at RMIT University examined what made some communities vulnerable to bushfire. Using the communities affected by

the 2003 East Gippsland fires, Josh identified the factors that made some communities more resilient than others. This was conveyed to the 2009 Royal Commission and directly to fire agencies.

“By developing an understanding of the underlying causes of vulnerability to bushfires, the research can inform strategic planning and policies that build the capacity of rural communities to cope with bushfires,” he said.

Francesca Harris-Spence’s PhD at the University of Adelaide looked at how local communities and organisations plan for and manage bushfires. This research examined two volunteer firefighting brigades and their communities; the first in the Adelaide Hills and the second in the hills suburbs to the east of Perth.

Mae Proudley’s postgraduate study focussed on the January 2005 Wangary bushfire on the Lower Eyre Peninsula in South Australia. Her study looked at the bushfire experience from a domestic perspective by exploring, through face-to-face interviews, how families respond and recover from a severe bushfire event.

The outputs of this project and numerous other related Bushfire CRC projects were compiled in the book *Community Bushfire Safety*. This important book was launched in 2008 at a high profile event to senior representatives of the fire and emergency management sector. It has a wealth of information for communities and fire agencies aiding in the transfer of social science research outputs into changes in community behaviour.

The February 2009 Victorian Black Saturday bushfires seriously challenged many of the assumptions behind the policy of staying and defending or leaving early. Of the 173 people who died, 113 perished inside their homes and a further 27 just outside them. Just 11 died in cars fleeing the fires, with a further 10 dying on roadways, while many people successfully escaped approaching flames by car.

Professor Handmer’s Bushfire CRC team undertook extensive research into the Black Saturday deaths for the Royal Commission established after the fires. Both Professor Handmer and Dr Haynes presented evidence on Bushfire CRC research outputs to the Royal Commission.

Among the findings of their research, they highlighted a significant unawareness of the general fire risk, a lack of appreciation that 7 February required a different approach due to the extreme conditions, and limited knowledge about what to do. Some were dismissive of the risk. Many had limited capacity to undertake preparation and property defence.

The research found: “Although nearly half the fatalities had a fire plan, these were of very variable quality. Few fire plans were comprehensive addressing all issues necessary to cope with the conditions experienced on the day. There appear to be few cases of fatalities having a contingency plan for when their preferred course of action ceased to be viable. A significant proportion of fatalities were taken by surprise by the fires. Others appeared to be waiting for an official warning before activating their plans. Many falsely assumed that they would receive a specific warning or that they could obtain help by calling 000.”

As a result of the research, the final report of the Royal Commission called for a revision of Victoria’s bushfire safety policy. And Bushfire CRC researchers aided AFAC in its new position statement “Bushfires and Community Safety”.



PROGRAM C



C7 Evaluating bushfire community education programs

Fire agencies recognise that public safety and protection of assets during bushfires depends to a large extent on the community's capacity to respond effectively to the risk from bushfire events. This project focused on the development of an evaluation framework and its application to a range of community safety and education programs. It asked the questions – how well do agencies educate communities? How do we measure this? Are there ways that agencies can learn from other jurisdictions across Australia?

The project aimed to help fire agencies evaluate the effectiveness of community safety and education programs and facilitated the application of the evaluation framework to a range of programs and initiatives that are undertaken by agencies.

The team was led by Associate Professor Gerald Elsworth, with his colleagues at RMIT University, Dr Helen Goodman, John Gilbert and Professor John Fien, and postgraduate student Alan Rhodes.

Project researchers contributed to a survey and report of householders on South Australia's Eyre Peninsula, for a Coronial Investigation after the January 2005 fires.

The researchers used a technique known as "Concept Mapping" to identify outcomes for community safety programs that stakeholders consider important. The results identified a number of themes related to community safety outcomes. It provided a useful tool to evaluate the effectiveness of community safety programs for bushfires. This evaluation framework is now in use in a number of agencies in Australia.

The methodology has been consolidated into professional development resources, including a workshop, online resources and a postgraduate course offered through RMIT University.

PROGRAM D



PROGRAM D: PROTECTION OF PEOPLE AND PROPERTY

Living, working and playing in the bush grows ever more popular, and with it comes the recognition that this lifestyle carries the risk to safety of regular bushfires. At the same time, people in bushfire-prone areas increasingly expect the risk will be better assessed and managed by fire and land agencies. This Bushfire CRC program studied ways to increase the safety of people and property. It focussed on the health and wellbeing of the community and firefighters through research as diverse as building protection and ways to improve the retention and recruitment of volunteer firefighters.





D1: Building and occupant protection

The 2003 Canberra bushfires were noted for very high levels of house loss deep into suburban areas. Fire jumping from house to house was a major issue.

Project leader Justin Leonard, of CSIRO Sustainable Ecosystems, set out to look at what aspects of house construction contributed to such losses. He also looked at the safety of wooden power poles – many of which caught fire and fell, blocking roads, in the Canberra fires – as well as the critical issue of surviving in a car if caught by fire on the road.

In an effort to understand the role of critical elements in and around the home the research team conducted a series of experiments over several years. The team subjected typical home fences, decks, windows, water tanks and fences to flames typical of bushfires, at the New South Wales Rural Fire Service Hot Fire Facility at Mogo.

The tests found, for example, that metal fences survived the best. Hardwood fences, though they would burn, acted as a barrier to radiant heat, helping to protect a home. Softwood fences such as treated pine had the worst performance – as well as burning, the resulting ash, containing arsenic, was a potential health issue.

Steel water tanks proved the most reliable, though their plastic liners needed replacing after a serious fire. As a result of this research, several Small to Medium Enterprises (SMEs) have developed highly modified steel water tanks and water delivery systems that are commercially available for use in bushfire areas.

“Ideally this research will also help provide advice to property owners on the level of risk to their homes and businesses and help develop education programs for local communities,” said Leonard.

Fire agencies have long advised against being caught on the road in a bushfire, but there had been little detailed research in how a bushfire affects cars and how best to survive if you are in a car and confronted by a bushfire. In an experiment that placed seven common vehicles under the bushfire simulator, this research identified key issues that influenced survivability, including the orientation of the car to the fire, the relative temperatures in different areas of the car, the adverse influence of an air conditioner or recirculating air systems, and the toxic chemicals produced inside a car subject to intense heat.

The project’s postgraduate student, Julian Black, of RMIT University, worked on developing a Geographical Information System tool to allow for various residential scenarios – such as different types of windows, doors, or walls – to be developed and visualised, based on building and planning requirements. This tool could assist in developing building and planning regulations that enable residential areas to perform better under bushfire attack.

Overall, this project has led to significant national policy changes, as well as the development of new products, especially windows, and has fed through in the update of Australian Standard 3959 – Construction of buildings in bushfire-prone areas.

After the 2009 bushfires in Victoria, researchers from this project examined more than 1300 properties in the fire areas. They documented in detail the extent of damage to properties, made conclusions on why some houses burnt and others did not, and compared the merits of different types of construction materials. This examination combined with other Bushfire CRC work as evidence before the 2009 Victorian Bushfires Royal Commission.

D2.1 Firefighter health and safety

Firefighter safety is a high priority for fire agencies. Battling fires in hot and smoky conditions is at times unsafe and unhealthy. Firefighters are subject to stressful conditions, in which fatigue and work capacity is affected by the erratic nature of work and rest cycles and the need for food and liquids.

Work environment issues plus physiological and psychological pressures are a constant factor. The ageing population, demographic variety and physical condition of the Australian volunteer firefighter presents a significant challenge to firefighting agencies in improving safety conditions on the fire ground.

This research was led by David Nicholls, at the Country Fire Authority, and Dr Brad Aisbett, at Deakin University.

“Despite a heavy reliance on volunteer firefighters in Australia, there has been limited research into the physical demands that they experience during bushfire suppression,” said Dr Aisbett. “Similarly, before this project the health and physical fitness of these volunteers has received little research attention.”

The project provided a quantified picture of the total fireground environment. Importantly, it provided a unique insight into the level of fitness of current firefighters and made scientifically based recommendations on the level of fitness required by bushfire fighters over a range of common tasks. This has been communicated to Australian and New Zealand firefighters at several annual conferences and national workshops.

To investigate the physical demands of bushfire suppression, the research measured volunteers’ heart rate, limb movement, and oxygen consumption during standard fireground activities, including unreeling and reeling fire hoses and advancing charged hoses. To measure the health and fitness of volunteer firefighters, the research also measured important health indicators, including resting blood pressure, blood cholesterol and glucose levels, and body fat levels, and cardiovascular fitness.

Sub projects were undertaken by PhD students at Deakin University. Matt Phillips’ research work comprehensively quantified the physical demands of Australian tanker-based bushfire suppression and identified the minimal level of physical fitness required to safely complete this work. This work earned Matt a top four placing in the 2009 CRC Association Early Career Scientist Award for innovative science.

A study by Jenni Raines investigated the effect of hydrating firefighters before, during and after live bushfire fighting shifts. Data was gathered from firefighters at several bushfires and also at the large burning experiments conducted by researchers in Program A at the Ngarkat Conservation Park in South Australia. This ground breaking work is now the basis for agencies to provide scientifically valid fluid consumption strategies for bushfire fighters.

D2.2 Air toxics exposure and management

Previously, there was little knowledge of bushfire firefighters’ exposure to such toxic air pollutants as carbon monoxide, respirable particles, polyaromatic hydrocarbons and dioxins.

This project tackled this important occupational health and safety issue by identifying key toxic pollutants, evaluated their concentration and provided the tools and techniques to measure, evaluate and control the exposure of firefighters (and to some extent communities) to these substances. The main researchers were Project Leader Dr Mick Meyer and Dr Fabienne Reisen, both of CSIRO.





The outcomes of the research, including a detailed *Reference Guide* and a *Field Guide* to smoke exposure management, have improved the management of air toxics exposures of Australian bushfire firefighters. The aim of the guide is to provide advice to fire line supervisors and managers on the fire ground so they can quickly recognise high exposure risk situations and undertake mitigation strategies so that their firefighters remain safe.

RMIT University student Dane Hansen conducted his PhD research on particulate matter, which has been linked to acute or chronic cardio-respiratory disease. It is also an eye and respiratory irritant. His research aimed to characterise the volatile organic components and heavy metals adsorbed to particulates generated in bushfires by looking at firefighter exposures in both the lab and in the field, and the differences between particles collected under different conditions.

D2.3 Safe behaviour and decision-making

Why do good firefighters sometimes make poor decisions? This research – undertaken by a LaTrobe University team led by psychology lecturer Dr Mary Omodei, in collaboration with firefighting agencies – sought the answers.

Firefighting, despite heavy reliance on fire prediction, hazard models, fire control and suppression technologies, is ultimately a human activity. It requires individual firefighters to form risk assessments and initiate courses of action. It requires that individuals be aware of, and give adequate attention to, the safety implications of any decisions they might implement.

The researchers interviewed many firefighters coming off the fire ground in Victoria and New South Wales over several fire seasons, conducting detailed post-incident debriefings of firefighting personnel (across all levels of rank) involved in incidents, conducted controlled experimentation using computer-generated safety threats (using a simulator, Networked Fire Chief), and developed and tested methods for presenting fire related information and for training to reduce safety-compromising behaviour.

The project team developed the Human Factors Interview Protocol to help firefighters recall and recount their experiences on the fireground as accurately as possible.

They identified around 20 individual and 10 small group human factor issues that appeared to be relevant to safety on the fire ground. This included the issue that firefighters were reluctant to change a decision once it was made, even though something else – such as moving fire trucks elsewhere – might be more effective. Other issues involved mental overload, underestimating the situation, role confusion, and inconsistencies in trusting a range of information sources.

Research specifically looking into how bushfire firefighters think about worst case scenarios was conducted by PhD student Claire Johnson. These kinds of extreme events are rare and so the possibility of them occurring can be overlooked, with tragic consequences. Claire looked at how worst case scenarios are currently considered, how and when they should be considered and how training might develop these skills.

And PhD work by Peter Hayes explored the differences in the decision-making quality between pre-formed teams and those teams pulled together at short notice, that is, ad hoc teams.

This project is greatly improving the ability of fire agencies to amend and develop processes and to train their firefighters, increasing the likelihood of safe decisions, particularly under stress. These researchers have been in particularly high demand as speakers and experts and have participated in



many agency-based workshops and seminars, in addition to making key presentations at community forums and the Bushfire CRC/AFAC annual conference.

D3 Enhancing volunteerism

Rural fire services rely heavily on volunteers. Ensuring adequate crewing levels for our brigades is essential for protecting the environment and communities vulnerable to bushfires. Around 250,000 volunteers across Australia engage in bushfire suppression and mitigation work.

In some rural communities, economic and demographic factors result in declining and ageing populations. 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 also restrict opportunities for volunteering.

The Volunteerism project – led by LaTrobe University psychology professor Jim McLennan with researcher Adrian Birch – has provided fire services across Australia and New Zealand with information to help strategic planning and policy development concerning volunteer numbers, and suggested new ways of recruiting and supporting volunteer workforces.

The project team conducted research into factors affecting the recruitment of future volunteers and the retention of current volunteers. The researchers used 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.

As part of a longitudinal study, volunteers were surveyed six, 12 and 24 months after recruitment, an initiative that led to improved volunteer recruitment strategies for Bushfire CRC partner agencies such as Victoria's Country Fire Authority and the Queensland Rural Fire Service.

The project reviewed the annual resignation rates for volunteer-based fire agencies. The findings indicated the need for agencies to distinguish unavoidable reasons for resigning (such as moving, age and health) from potentially avoidable reasons such as work, family and dissatisfaction, to balance demands on volunteers' time including their family and work needs, and to enhance the skills of brigade leaders.

An important input was the doctoral study of Sean Cowlshaw that looked at the impact of volunteering on the wider family and how this influenced recruitment and retention. 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. "What I have found is that families are often not as prepared to deal with these conflicts and pressures as we might hope," said Cowlshaw. "My research has informed interventions that agencies can use to support families and volunteers and to minimise the conflicts between volunteers and family life."

The combined research of this project has led to agencies reviewing the way they manage volunteers, with enhanced training, support services for volunteers and families and recruitment campaigns that target younger and more diverse sections of the population. The Queensland and Victorian agencies in particular have reported that younger people than previously have responded to recent campaigns, noting younger inquirers were making much greater use of online information than older inquirers.





D4 Respiratory health of firefighters

Two types of masks are used by Australian firefighters. One mask (P2) is designed to protect from particulates only, and the other (P2+Organic) from particulates and organic volatiles.

This study, based on the PhD work of Annemarie De Vos, at the University of Western Australia, was a finalist in the 2007 Early Career Scientist Awards at the CRC Association Annual Conference. The work evaluated the effectiveness of these different masks as compared with using no mask. To do this, a random sample of volunteers was selected from the Perth metropolitan area.

It found that the types of face masks available for those at the fire front vary greatly in their ability to shield the firefighter from particulate matter and the gases present in bushfire smoke.

The results of this study led directly to the formulation of recommendations on maximising firefighter safety in Western Australian conditions. The research was conducted with the Fire and Emergency Services Authority (FESA) of Western Australia.

D5 Enhancing emergency Incident Management Team effectiveness and organisational learning

Led by University of Tasmania education senior lecturer Dr Christine Owen, this project has studied communications among members of incident management teams working under the Australasian Inter-service Incident Management System (AIIMS).

How best is an Incident Management Team established when its members come from a variety of different agencies, each with its own mindset and viewpoint about making decisions? The project sought to gain a sound understanding of communications flows through the AIIMS structure. The researchers conducted many observations of IMTs in action, looking at, for example, how best to lay out an Incident Control Centre.

Timely interactions and collaborations within and between both same-site and geographically isolated teams are crucial for achieving seamless information flow and coordinated effective action. Communication breakdowns in such teams of even a minor nature can easily lead to unnecessary and unacceptable property loss at best, or life threatening consequences at worst.

The research has led to a better understanding of the ways in which incident management teams work together, a better understanding of how information flows through organisations and the way knowledge is managed before, during and after incidents, and a better understanding of what enables and constrains successful IMT operations and information flow.

The research indicated that the current incident control systems work well under routine emergency events but are strained under escalated conditions, when emergencies are complex, where there are high numbers of people involved, and where there are multi agencies involved. Changes to various parts of AIIMS were suggested.

Dr Owen says the work has led to improved training strategies in communication, teamwork and coordination of incident management operations, with enhanced reliability and responsiveness of IMT operations at times of fire. Several industry workshops and presentations have taken place.

“The application of the findings will lead to improvements in preparedness and collective action that will mitigate the effects of future disasters in Australia,” she added.



This project had several University of Tasmania postgraduate projects associated with it. Greg Hickey looked at how information flow is conducted when many organisations suddenly respond together in a bushfire incident. Jan Douglas investigated teamwork effectiveness in incident management teams undertaking simulation training. Ian Dwyer examined communication strategies and collaborative work practices in IMTs.

The breakthrough findings of this project have significantly raised awareness in partner agencies of the need for more research in this area. Consequently, further research is being conducted under the new Bushfire CRC Research Extension program and several related studies have been commissioned under contract arrangements with individual agencies.



PARTNERS IN THE BUSHFIRE CRC 2003 TO 2010

CORE PARTNERS

- ACT Emergency Services Agency
- ACT Parks, Conservation and Lands
- Bureau of Meteorology
- Country Fire Authority of Victoria
- CSIRO - Divisions of Manufacturing & Infrastructure Technology, Forest Biosciences, and Sustainable Ecosystems
- Emergency Management Australia
- Fire and Emergency Services Authority of Western Australia
- Melbourne Metropolitan Fire and Emergency Services Board
- New South Wales Fire Brigades
- National Parks and Wildlife Service of New South Wales
- New South Wales Rural Fire Service
- Queensland Fire and Rescue Service
- State Forests of New South Wales
- Tasmanian Government – Tasmania Fire Service, Parks Tasmania, Forestry Tasmania
- University of Melbourne, School of Forestry and Ecosystem Science
- University of Tasmania
- University of Western Australia
- University of New South Wales
- Department of Sustainability and Environment, Victoria
- Department of Environment and Conservation, Western Australia
- New Zealand Rural Fire Service and University of Canterbury

ASSOCIATE PARTNERS

- ACT Department of Justice and Community Safety
- Australian National University
- James Cook University
- La Trobe University
- New Zealand Forest Research
- RMIT University
- South Australian Country Fire Service
- South Australian Department for Environment and Natural Resources
- South Australian Metropolitan Fire Service
- Charles Darwin University
- WA Department of Industry and Resources, Chemistry Centre
- University of Wollongong

FORMAL COLLABORATIONS

- Association for the Development of the Industrial Aerodynamics, Coimbra University, Portugal
- Spatial Information Cooperative Research Centre
- CRC for Tropical Savannas Management
- National ICT Australia Limited
- University of California, Berkeley – College of Natural Resources – Center for Fire Research and Outreach
- University of Chile
- US Department of Agriculture, Forests Service



BOARD, PROGRAM LEADERS

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

BOARD, PROGRAM LEADERS

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

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

BUSHFIRE CRC STUDENTS – IN STUDY– JUNE 2010

Name	Project title
Annette Salter, PhD	Applications of multi-media education strategies in fire behaviour
Kerryn McTaggart, PhD	The effect of fire on soil microbial populations and their processes in Australian alpine ecosystems
Bryony Horton, PhD	Fire management and tree decline: mycorrhizal indicators of declining forest health
Carola Karamotto de Bednarik, PhD	Relative importance of fire regimes, environmental gradients and climate change for rainforest distribution in the Sydney region
Alison O'Donnell, PhD	Fire patterns and vegetation structure in semi-arid south-east western Australia
Rowena Morris, PhD	The effect of prescribed burning on sediment movement in the Mt Lofty Ranges
Anne Miehs, PhD	The role of coarse woody debris in fire-prone forests: Achieving both fire management and conservation objectives
Briony Towers, PhD	Developmental perspective on bushfire risk communication
Claire Johnson, PhD	Worst Case Scenarios: their role in safe decision making in bushfire fighting
Greg Hickey, PhD	Enhancing effective multi agency operations

STUDENTS

Jennifer Hollis, PhD	Coarse woody fuel availability and consumption in Australian forest fires
Peter Hayes, PhD	Do teams that have worked together make better teams than ad hoc teams?
Jenni Raines PhD	Fatigue and recovery in rural Australian bushfires
Helen Daily PhD	Development of pasture growth models for grassland fire danger risk assessment
Francesca Harris-Spence, PhD	Catchment management groups - volunteer community organisations and bushfire management
Colin Simpson, PhD	Advanced modelling of the interactions between wildfires and the atmosphere

