Bushfire 2016

Connecting Science, People & Practice

Conference Report: Outcomes & Learnings

www.fireandbiodiversity.org.au

SEQ Fire & Biodiversity CONSORTIUM

Contents

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Introduction

Hosted and coordinated by the South East Queensland Fire and Biodiversity Consortium (SEQ Fire and Biodiversity Consortium), **Bushfire 2016: Connecting Science, People and Practice** was a national conference held on the 28 - 30th September 2016, at the University of Queensland, aimed at connecting fire scientists, ecologists and students with onground fire operators, land managers and other fire and environmental professionals.

With a focus on applied fire research, fire management, indigenous fire projects and collaborative fire programs, the objective was to showcase successful partnerships that translate science into practice for beneficial onground fire management and environmental outcomes, whilst supporting land owners, land managers and scientists.

Bushfire 2016 featured three keynote speakers, a panel discussion and 74 presentations across ten themed symposia, over two days of concurrent sessions, with a poster session on Wednesday evening, a dinner on Thursday night and two field trips on the Friday. Bushfire 2016 received substantial support across the sector with ten official sponsors and eight trade and promotional partners. In particular, Gold Sponsors Fireland Consulting, Healthy Land and Water and the University of Queensland are gratefully acknowledged.

Bushfire 2016 was a tremendous success and attracted over 330 people from every state and territory of Australia, including some of Australia's most prominent fire scientists and emergency service fire specialists. The conference had a strong indigenous focus with twelve indigenous fire presentations and a strong indigenous attendance, further highlighted in this report. The response from attendees has been overwhelmingly positive, with 75% of surveyed attendees reporting their experience as "extremely positive", as illustrated by this comment from keynote speaker Dr Neil Burrows from the Western Australian (WA) Department of Parks and Wildlife, *"Congratulations to you and the team on organising a highly successful conference… Thanks for inviting me to be part of it."*

Bushfire 2016 Organising Committee

The success of Bushfire 2016 was in no small way due to the ever-supportive, hard-working and encouraging Bushfire 2016 Organising Committee. Their dedication, good humour, assistance and constructive advice ensured Bushfire 2016 was an overwhelmingly successful and engaging conference showcasing the value of collaborative partnerships with a legacy to be continued in the form of future Bushfire conferences (watch this space).

"I thoroughly enjoyed the conference, one of the best conferences I've attended, in my 20 years of working in the environmental field and attending conferences around the world, this was one of the best well organised conferences."

Bushfire 2016 Organising Committee

From left to right: Dr Geoff Lundie-Jenkins (Queensland Parks and Wildlife Service); Craig Welden (Coordinator, SEQ Fire and Biodiversity Consortium); James Haig (Queensland Fire and Emergency Services); Steve Martin (Powerlink); Chandra Wood (Brisbane City Council); Associate Professor Patrick Moss (University of Queensland); Dr Samantha Lloyd, Chair (Manager, SEQ Fire and Biodiversity Consortium); Cuong Tran (Ten Rivers); Michael Reif (Sunshine Coast Council). Absent: Melissa Walker (Healthy Land and Water) and Annie Keys (Keys Consulting).

Who are the SEQ Fire and Biodiversity Consortium?

The SEQ Fire and Biodiversity Consortium is a network of land managers and stakeholders committed to improving fire and biodiversity management outcomes, supporting and disseminating fire ecology research, facilitating partnerships between key stakeholders and building the capacity of land managers and private land owners in south-east Queensland.

The SEQ Fire and Biodiversity Consortium has three priority areas of delivery:

1. Education and engagement - assisting public land managers and private land holders with information on fire management and biodiversity conservation;
2. Applied research - supporting fire research investigating knowledge gaps in fire ecology and management; and
3. Representation and response - provision of coordinated responses to matters of significant fire management and fire ecology importance.

As the oldest collaborative organisation of its kind in Australia, the SEQ Fire and Biodiversity Consortium has an extensive network of partners, contributors and supporters, both in south-east Queensland and nationally. This includes over 1000 people subscribing to the *Enews*, over 40 members in the Research Working Group and regular over-subscription to training and forums.

Now in its 19th year, the SEQ Fire and Biodiversity Consortium gratefully acknowledges financial support from the following organisations: Healthy Land and Water, local government (Brisbane, Gold Coast, Ipswich, Lockyer Valley, Logan, Moreton Bay, Redlands, Scenic Rim, Somerset, South Burnett, Sunshine Coast and Toowoomba), Powerlink, Queensland Fire and Emergency Services (QFES), Queensland Parks and Wildlife Service (QPWS), the Department of Transport and Main Roads – Darling Downs and SEQ Water.

The South East Queensland Fire and Biodiversity Consortium gratefully acknowledges the support of Healthy Land and Water. Healthy Land and Water is an independent, not-for-profit organisation working to improve the sustainable use of land and waterways in South-East Queensland. This project is supported by Healthy Land and Water through funding from the Australian Government's National Landcare Programme.

For more information, or to subscribe to the *Enews* service, visit: www.fireandbiodiversity.org.au.

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Powerlink Queensland

Scenic Rim Regional Council

Redland City Council

seqwater Water for Life

Somerset Regional Council

South Burnett Regional Council

Sunshine Coast Council

Toowoomba Regional Council

Bushfire 2016 Outcomes and Success

With the theme of 'Connecting Science, People and Practice', Bushfire 2016 set out to provide an environment for professionals to share, engage, learn, partner and network. Overwhelmingly successful, Bushfire 2016 attracted over 330 people from all over Australia and from a diversity of backgrounds. The affordable registration fee "*allowed people from Grassroots to Researchers to attend and learn*" (post conference survey quote). Indigenous travel grants and registration support facilitated a full day of presentations on indigenous fire projects and participation of traditional owners and rangers.

Table 1 below describes the conference outcomes against the intended aims.

"I think the community you guys are creating, continuing and fostering is fabulous."

"Many of us work in remote situations or home offices. The conference brings us together well in a very good atmosphere. The inclusion of the indigenous theme and generous funding of travel was compelling and inspirational. The spirit of dedication of the organizers is infectious."

"Just an awesome conference, especially considering the cost which made it much more accessible than other conferences."

Table 1: Bushfire 2016 aims (as outlined in the Bushfire 2016 Program) and corresponding outcomes.

Aim	Outcome/Performance Indicator
Connect fire scientists and students with on ground fire operators, public land managers and other fire and environmental professionals. Fostering strong partnerships in bushfire management.	• 334 attendees from every state and territory of Australia. • Students delivered 13% of presentations. • Attracted people from research institutions, indigenous groups, local and state governments, fire management agencies, emergency service bodies, utility companies, natural resource management bodies, conservation groups and consultancies (refer to Figure 1 below). • Networking opportunities via a formal poster session, a permanent trade and partner displays, a conference dinner, adequate break time and two field trips.
Showcase indigenous fire projects.	• Theme 2: Cultural Burning and Traditional Custodian Fire Projects showcasing 13 presentations. • 12% of all talks were delivered by, or in partnership with Indigenous organisations. • Travel grants and/or registration sponsorship were provided for all indigenous presenters. • Local Traditional Owner groups were involved with both field trips (refer to field trip section).
Affordable cost	• Strong sponsorship reduced registration costs, in particular Gold Sponsorship by UQ, which provided the venue for free. • Tiered registration with subsidised rates were available for students, Traditional Owners and SEQ Fire and Biodiversity Consortium partner organisations.
Showcase collaborative fire programs and successful partnerships that translate science into practice for beneficial on ground fire management and environmental outcomes.	The event offered: • 74 presentations across ten themed symposia, three keynote talks and a panel discussion. • 61% of all presentations showcased partnership projects (45/74). • Five out of nine posters showcased collaborative projects. • Each of two field trips involved collaborative fire projects on the Sunshine Coast and North Stradbroke Island.
Encourage the resurgence of the biennial Australasian Bushfire Conference.	• Meeting organised to discuss Bushfire 2018. Discussions are underway with potential host organisations. • 95% of participants who answered the post conference survey (115/121) said they would attend subsequent conferences.

Attendees at the opening plenary session of Bushfire 2016, with the opening address given by Professor Hugh Possingham of the University of Queensland.

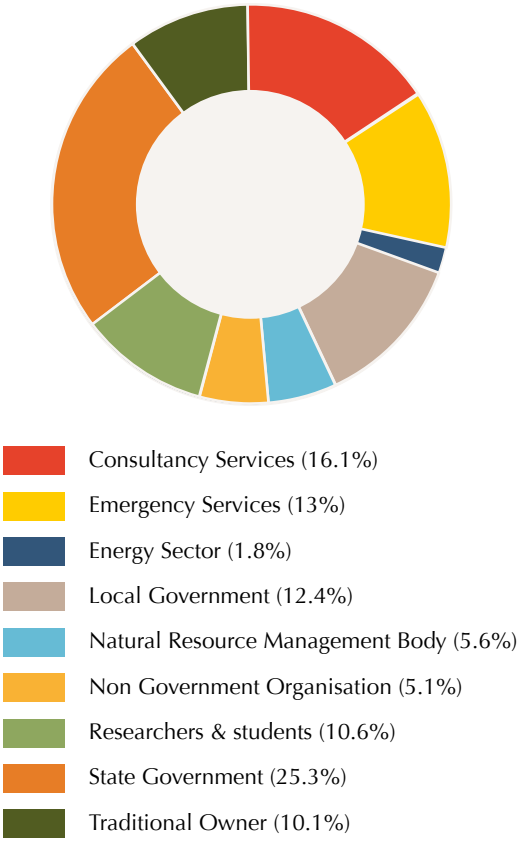

Figure 1: Diversity of attendees based on sector or organisation.

"Seeing integration of scientists and land managers (was a highlight of Bushfire 2016)."

"I liked your approach of reaching out to the grassroots while engaging scientists and academics at the same time."

"The diversity of situations- remote to urban- from which participants attended."

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Results of the Conference Survey

A post conference survey was emailed to all Bushfire 2016 attendees resulting in 36% of attendees completing the survey providing an overwhelmingly positive response. Of the 121 attendees who completed the survey, 75% reported that they were "extremely satisfied" with their experience and another 23% "moderately satisfied". When asked if they would attend another conference if it was offered in 2018, 95% responded positively.

Many people commented on how well organised Bushfire 2016 was.

The survey asked respondents to rate various items on a scale from excellent to fair. Key ratings are provided below in Table 2.

"A well-organised and wonderfully diverse and informative conference."

"Very well organised, great cross section of stakeholders."

"Excellent and well organised conference. Thank you Samantha, Craig, and all that did a great job in putting the conference together."

Table 2: Results of Bushfire 2016 Conference Survey

Question	% of respondents who chose the rating excellent or very good
Relevance of the conference content	93%
Quality of the presentations	83%
Forum provided an opportunity for exchange with others	88%
Registration process	78%
Quality of the information available online	66%
Venue and facilities	69%

Most Valuable

The survey asked participants what they considered most valuable about Bushfire 2016. Analysis of key words from the comments was used to provide the following statistics:

- 40% (45/112) of respondents reported the networking opportunities as a conference highlight;
- 19% (29/112) of respondents found their highlight to be the presentation content, including the panel, posters and trade displays;
- 16% (21/112) reported that the scope, broad range and diversity of presentations and presenters was a highlight;
- 12.5% (14/112) of respondents found the indigenous session and presenters a highlight.

Learnings

The survey respondents were also asked what they considered the least valuable about Bushfire 2016. Analysis of key words from the comments was used to provide the following statistics:

- The greatest proportion of respondents, 20% (24/121) reported that there was "nothing" they found least valuable, which was a very positive outcome;
- Of the people who did provide a response, the greatest proportion, 16% (19/121) sighted the inconvenience and difficulty associated with the distance between the rooms as the least valuable. Initially, the three rooms booked were in closer proximity, but unfortunately the University changed the booking at the last minute. This was out of the control of the Organising Committee who, anticipating some issues, provided walking maps and guides to assist. Part of the issue was that the venue was provided for free as part of Gold Sponsorship by the University of Queensland. It is worth noting that the registration fee would have been substantially greater if a venue fee had been included.
- Five people (5) reported that the panel discussion did not live up to their expectations, sighting issues around the length of time, flow of the conversation and balance of panel members. Certainly, this is something to consider for future events, as many people also responded positively to the panel dicsussion, or the idea of having one. Clearly the idea is well supported but requires further investigation as to how it is best delivered.
- Five people (5) reported that there was too much choice, or found it challenging negotiating three concurrent sessions. The Organising Committee made a deliberate decision to include all the talks as they neatly fell into the ten themes and since it had been ten years since the last conference, the aim was to showcase the breadth of current research and management projects. However, it can certainly be challenging deciding which talks to attend and negotiating a timetable when you need to switch rooms that are not close together. Generally speaking, most comparable conferences (i.e. AFAC, ESA and IAWF Fuels Conference) have up to six concurrent sessions, so it is about finding a balance between offering "too much choice" and not enough and the Organising Committee believe that three sessions provided that balance.

"Just wonderful - content variety, expertise, quality of attendees, food and venue - just everything was tops!"

"The ability to discuss a range of issues with staff from a multitude of different organisations and to be exposed to the diversity of fire research, operations and techniques being undertaken across the country."

"Excellent opportunity to expose fire practitioners to the contemporary thinking regarding bush fire management."

"The opportunity to listen and discuss items with groups I would not normally have an opportunity to interact with (i.e. people with different backgrounds were brought together)."

Presenters, Les Harrigan (Rinyirru Land Trust Corporation, Queensland) and Janie White (Queensland Parks and Wildlife Service) enjoy the trade displays during a break at Bushfire 2016.

Summary of Presentations

Bushfire 2016 offered an extensive range of presentations, including:

- An opening address by Professor Hugh Possingham of the Nature Conservancy and the University of Queensland on the Wednesday and Acting Deputy Commissioner Peter Jeffrey, Emergency Services Volunteers of the Queensland Fire and Emergency Services on the Thursday;
- Three keynote presentations, Professor Ross Bradstock (Director, Centre for Environmental Risk Management of Bushfires, University of Wollongong, NSW), Dr Neil Burrows (Senior Principal Research Scientist, Department of Parks and Wildlife, WA) and Associate Professor Alan York (Head of the Fire and Biodiversity Research Program, University of Melbourne, Victoria);
- 74 presentations across ten themed symposia; and
- A chaired panel discussion with the theme "Intelligent fire – how can fire research and knowledge better connect with drip torches?"

"Highly relevant program with presenters representing scientists and practitioners and stakeholders from across many Australian jurisdictions providing valuable knowledge sharing and networking."

"Great diversity of presenters and attendees."

"Excellent range of presenters and topics."

"Exposure to a wide range of experts and topics."

"I learnt something from every session I attended."

Diversity of Presentations

As illustrated in Figure 2, Bushfire 2016 presenters were well distributed across the broad spectrum of organisations expected to feature at a national bushfire conference and demonstrate the balance of papers from researchers and on-ground operators. Research organisations represented the largest group of presenters with 32% (n = 25) of talks, with local and state government coming in second with 21% (n = 16). Impressively, 14% (n = 11) were delivered by, or with indigenous organisations, which resonated very well with attendees, reporting the dedicated indigenous session as one of the most popular of the conference. Non Government Organisations (NGO) and Natural Resource Management (NRM) bodies were the next most prominent groups with 12% of presentations (n = 9). Consultancies and emergency service organisations offered an approximately equal number of presentations with 9% and 8%, respectively and utility providers delivered 4% of presentations. Collaborative presentations were a feature, with 61% of the talks written and presented as a partnership. Students delivered 13% (n = 10) of presentations.

The diversity of presenters provided a rich environment for information exchange and networking. In the post conference survey, many people noted the diversity of talks as a highlight.

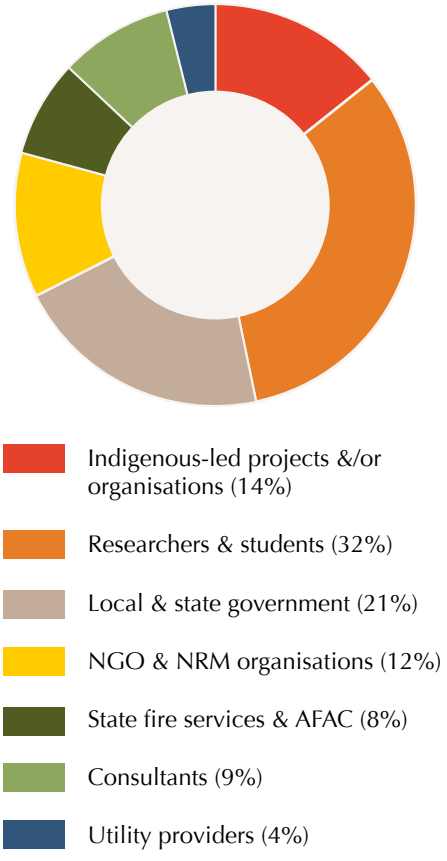

Figure 2: The percentage of presenters as represented by sector or organisational group.

Welcome to Country, Opening Addresses, Keynotes and Panel Discussion

Welcome to Country

Bushfire 2016 opened with a lively 'Welcome to Country' performed by Shannon Ruska. Shannon is a descendant of the Yuggera and Turbul people of the Brisbane, Logan and Ipswich regions, the Nunukul and Nugi people of Stradbroke and Moreton Islands and the Koombamerri people of the Gold Coast area. Shannon spoke of the importance of working together and supporting indigenous organisations to reintroduce traditional fire practices back into the landscape. He recognised the importance of fire in Australia and celebrated the strength of indigenous culture in south east Queensland.

Shannon Ruska delivers the Welcome to Country on the opening day of Bushfire 2016.

Opening Addresses

The first day of Bushfire 2016 was opened by **Professor Hugh Possingham**. Hugh is the Chief Scientist of the Nature Conservancy, a Professor of Mathematics and Professor of Ecology at The University of Queensland, and a Professor of Conservation Decisions, at Imperial College London. He holds an Australian Research Council Laureate Fellow (2014-18) and is Director of The Australian Research Council Centre of Excellence for Environmental Decisions. Hugh spoke about the importance of balancing fire management with ecological function and biodiversity conservation and emphasised the importance of applied fire research.

Queensland Fire and Emergency Services (QFES) **Acting Deputy Commissioner Peter Jeffrey** gave an opening address on day two, and emphasised the importance of collaborative partnerships for effective bushfire management. *"Like many agencies in jurisdictions around Australia and the world, QFES is increasing its focus on mitigation in the prevention and preparation phases of bushfire management. This mitigation effort is not one where QFES is seeking to go it alone, rather we recognise the critical nature of our partnerships with land management agencies, community groups and other key stakeholders and the importance of knowledge sharing at forums such as this."*

QFES Acting Deputy Commissioner Peter Jeffrey delivering the opening address on day two of Bushfire 2016.

Keynote Speakers

Professor Ross Bradstock - Director - Centre for Environmental Risk Management of Bushfires, University of Wollongong, NSW. Address: *"A tale (mostly) of one city: toward a comprehensive understanding of bushfire risks, present and future."* Ross spoke about the discrepancy between the exposure of people and property to recurrent fire and the inadequate perception and quantification of the risk of house and infrastructure loss.

Dr Neil Burrows - Senior Principal Research Scientist - Department of Parks and Wildlife, WA. Address: *"Managing Fire in the New Millenium"*. Neil spoke about changing fire regimes and fire weather with climate change, the challenges facing land managers and the importance of integrating science with traditional aboriginal fire knowledge, onground experience, community engagement and key organisational support.

Associate Professor Alan York - Head of the Fire and Biodiversity Research Program - University of Melbourne, Vic. Address: *"Fire, landscape pattern and biodiversity"*. Alan spoke about research highlights from the Landscape Mosaic Burning Program, which anticipated that mosaic burning at a landscape level would help reduce the size and impact of large-scale fire events.

Attendees at the Wednesday afternoon plenary session, with keynote speaker Dr Neil Burrows of the Department of Parks and Wildlife, WA.

NB: Refer to Appendices 1 and 2 for a full transcript of the presentations of Dr Neil Burrows and Associate Professor Alan York.

From left to right, key note presenters Dr Neil Burrows (Department of Parks and Wildlife, WA) and Associate Professor Alan York (University of Melbourne, Vic) with the Chair of the panel discussion, Dr Simon Heemstra (Rural Fire Service, NSW).

"Really enjoyed the keynotes. Well done for getting speakers who are so prominent in the fire ecology field."

"Plenaries were excellent."

"The depth and informative talks from the inspiring keynote speakers (was a highlight)."

Panel Discussion

"Intelligent fire - how can fire research and knowledge better connect with drip torches?"

In place of a fourth keynote speaker and in response to requests for discussion opportunities, the Organising Committee decided to provide a facilitated panel discussion after lunch on day two. The panel was chaired by Dr Simon Heemstra, Manager Community Planning, NSW Rural Fire Service and featured six world-class fire specialists:

- Mick Blackman, Managing Director, Friendly Fire Ecological Consultants, Qld;
- Oliver Costello, Co-founder of the Firesticks Initiative and Visiting Fellow at Jumbunna Indigenous House of Learning, University of Technology Sydney, NSW;
- Dr Malcolm Gill, OAM, CSIRO, retired fire ecologist, Fenner School of Environment and Society, Australian National University, ACT;
- Dr John Kanowski, National Science and Conservation Manager, Australian Wildlife Conservancy, Qld;
- Dr Leasie Felderhoff, Firescape Science, Qld; and
- Dr Richard Thornton, Chief Executive Officer, Bushfire and Natural Hazards CRC, Vic.

The panel discussion looked at key barriers to communicating and sharing fire science, what sort of information land managers would like to have available, how to make research 'fit for purpose' and how to build effective multi-stakeholder partnerships. The discussion also explored partnerships with Traditional Owners and private land owners, to better tackle fire and land management challenges.

The panel discussion was well received and people were complimentary of the opportunity for further discussion, rather than another talk. Several people listed the panel discussion as the, or one of the "most valuable" parts of the conference. However, feedback was provided around the amount of time allocated to the discussion (i.e. not sufficient) and the balance of panel members (perhaps being too "pro-fire").

"Availability of attendees to answer questions and provide input from personal experiences in particular the panel discussion."

"Open discussion on fire, it's management and learning from practitioners and other experts."

From left to right, Chair of the panel discussion, Dr Simon Heemstra, Dr Malcolm Gill, Dr John Kanowski, Dr Leasie Felderhoff, Dr Richard Thornton and Mick Blackman. Absent: Oliver Costello.

Bushfire 2016 Themed Symposia

Bushfire 2016 talks were organised into ten themed symposia, featuring 74 speakers presenting their talks in three concurrent sessions over the two days. Table 3 (below) provides a summary of each theme and relevant Chair/s.

Included on the following pages are highlights from Theme 2: Cultural Burning and Traditional Custodian Fire Projects, Theme 4: Fire Ecology and Theme 7: Fire Management for Linear Infrastructure from notes provided by the Chairs.

The Program Overview, listing each theme and the Chair, the talks and speakers, including their contact email can be found in Appendix 2. Please note, the full program, with all the speaker abstracts is available from the Bushfire 2016 website: http://www. fireandbiodiversity.org.au/ bushfire-2016-1/program.

Many comments provided in the survey regarding the "most valuable" part of the conference focussed on the calibre, diversity and quality of the program and presenters.

"Presentations by traditional owners, keynotes, in particular, Alan York and Neil Burrows, Red Hot Tips presentation. And some positive stories of good fire management such as AWC."

"Well organised. Amazing program of speakers. Excellent venue. High calibre respected presenters."

"Coherent yet diverse topics, well organized themes."

Table 3: The ten themed symposia and respective Chair/s for Bushfire 2016.

Theme	Chair
1: Fire and Risk	Andrew Sturgess, Predictive Services Unit Manager, QFES and Cuong Tran, Ten Rivers, NSW.
2: Cultural Burning and Traditional Custodian Fire Projects	Oliver Costello, Visiting Fellow at Jumbunna Indigenous House of Learning at the University of Technology, Sydney (NSW).
3: Community Engagement	Craig Welden from SEQ Fire and Biodiversity Consortium (Qld).
4: Fire Ecology	Dr Penny Watson from the Office of Environment and Heritage (NSW).
5: Fire, Soil and Climate	Dr Tom Lewis, Department of Agriculture and Fisheries (Qld).
6: Maps and Models - Intelligent Fire Planning	Joshua Bull, Fireland Consultancy (Qld).
7: Fire Management for Linear Infrastructure	Steve Martin, Powerlink (Qld).
8: Fire and Land Management	Micheal Reif, Sunshine Coast Regional Council (Qld).
9: Fire, Threatened Species and Conservation	Dr Geoff Lundie-Jenkins from the Qld Parks and Wildlife Service (Qld).
10: Fires in the Past: Essential Knowledge for Management	Associate Professor Patrick Moss, University of Qld (Qld).

Ben Twomey and Andrew Sturgess of the Queensland Fire and Emergency Services Predictive Services Unit, who spoke in Theme 1: Fire and Risk.

Theme 2: Cultural Burning and Traditional Custodian Fire Projects

Bushfire 2016 was very pleased to offer delegates a day-long session on cultural fire management - *"Cultural Burning and Traditional Custodian Fire Projects"* chaired by Oliver Costello, co-founder of the Firesticks Initiative and Visiting Fellow at Jumbunna Indigenous House of Learning at the University of Technology, Sydney. Initially, this session was planned for half a day, but due to overwhelming interest and the provision of travel grants and presenter registration sponsorship, the session was rapidly expanded to fill a whole day and was subsequently one of the most popular sessions at Bushfire 2016.

The travel grants were generously sponsored by GHD in partnership with the SEQ Fire and Biodiversity Consortium. Registration was waived for eight indigenous presenters and travel grants were provided to speakers from five presentations to a total of $4460. Many people assisted in promoting the session and travel grants through indigenous networks that the SEQ Fire and Biodiversity Consortium would not ordinarily have access to, in particular Oliver Costello is gratefully recognised. The resulting interest and support allowed for 12 presentations comprising 13 different indigenous and Traditional Owner groups. It is also noted that Qld Parks and Wildlife Service (QPWS) and the Queensland Indigenous Land and Sea Ranger Program featured in three presentations.

Presenters hailed from nearby areas in Northern NSW and south-east QLD, and as far away as Central Australia and Cape York. During this session a number of case studies from around Australia were presented demonstrating how local rangers from areas such as Minjerribah (Quandamooka Yoolooburrabee Aboriginal Corporation of North Stradbroke Island), Bunya Mountains (Bunya Murri Rangers, Qld), Cape York (Rinyirru Land Trust Corporation, Qld), Western Cape (Pormpuraaw Aboriginal Shire Council, Qld) and Minyumai (Minyumai Land Holding Aboriginal Corporation and Jali Local Aboriginal Land Council, NSW) manage fire on their country for improved biodiversity and healthy country outcomes. A number of positive stories were shared from Indigenous Protected Areas (IPAs) including a very special presentation delivered partly in native language with Rangers from the Katiti Petermann IPA in the Northern Territory (NT); an inspiring 'Banbai Fire and Seasonal Calendar' for Wattleridge IPA (featured on page 24) demonstrated that fire management can be creative as well as scientific; and a comprehensive fauna monitoring project coordinated by the Firesticks project, assessing the responses of three vertebrate groups to contemporary indigenous burning in four IPAs in northern NSW. Bunya Bunya Aboriginal Corporation shared their journey to reintroduce traditional burning practices back into the Sunshine Coast landscape. A collaborative project between Awu Laya Kuku Thaypan Green Army (Qld), James Cook University and Cape York NRM promoted how indigenous fire practices utilise a spectrum of fire management techniques at all times of the year for multiplicity of purpose. The Ethnoornithology Research Group spoke about indigenous accounts of birds of prey as propagators of fire in savanna country.

During this session, a number of case studies demonstrated the importance of cultural fire management to protecting and enhancing natural and cultural values. Presentations covered key community and environmental issues that need to be consider when undertaking cultural fire management. A highlight of the day was the undercurrent of cultural obligation these groups had to maintaining and building on their fire stories to enable healthy people and healthy country.

This session featured as one of the most popular of the conference, as illustrated in the post conference survey where 12.5% (14/112) of respondents reported the indigenous presentations as "most valuable". The following comments demonstrate this popularity.

"Presentations about cultural burning and traditional custodian fire projects."

"The indigenous presentations were a highlight, this was an amazing aspect."

"Mobs, sharing knowledge, experience on fire & healing country with best practices, great to catch up."

"There was some excellent presenters with many years experience attending. Also, well rounded perspectives were represented especially from the indigenous attendees."

From left to right, Tracey Guest, Selina Kulitja, Raymond James, Bernard Bell and Jane Blackwood of the Central Lands Council, NT.

From left to right, Les (Junior) Harrigan (Rinyirru Land Trust Corporation, Qld), Brian Wason (Qld Parks and Wildlife Service), Les (Senior) Harrigan (Rinyirru Land Trust Corporation, Qld), Oliver Costello (University of Technology, Sydney) and Mick Smith (Bunya Murri Rangers, Qld).

Oliver Costello (University of Technology, Sydney) with Dominc Adshead (GHD, NSW) who helped facilitate the Indigenous Travel Grants.

Theme 4: Fire Ecology

The Fire Ecology session, chaired by Dr Penny Watson was presented over half a day and sponsored by the Ecological Society of Australia (ESA). The session covered a variety of topics, in habitats from many parts of our diverse and fire-prone continent and most speakers presented collaborative work. Professor Mike Lawes from the Northern Territory outlined research into bark thickness along a gradient from desert to savanna. Bark was thicker where fire was more frequent and was associated with epicormic resprouters; it got thinner as aridity increased and basal resprouting and seed regeneration became more common. Post-fire recovery in the Warrumbungle Mountains, on the boundary between temperate and semi-arid country in north-western NSW was the subject of Penny Watson's presentation. The speed of regeneration in this volcanic landscape, following a major wildfire in 2013, has been remarkable, with grasses, forbs and many shrub species flowering and seeding by three years post-fire. Julian Brown tackled the complex question of fire effects on interactions between pollinators and plants; Julian has developed a model that postulates multiple processes at a range of spatial scales.

Tom Lewis outlined findings on above-ground carbon from the experimental plots at Peachester in south-east Queensland. Carbon stores, which are mainly held in live standing trees, did not differ significantly between treatments in this wet sclerophyll forest ecosystem. Nevertheless, tree density was influenced by fire frequency - to a degree - decreasing slightly in the biennially-burnt area over time, holding steady in the patch burnt every 4 years, and increasing somewhat in the unburnt treatment. South-east Queensland also featured in the next presentation, by Paul Williams and colleagues. Grassy cover in eucalypt forests around Brisbane can be preserved and promoted by judicious use of fire at intervals below six years, under conditions of good soil moisture; obligate seeder shrubs in this ecosystem mature rapidly, flowering by 2-4 years after fire. Boyd Wright rounded off the session with a discussion of fire-plant dynamics in Western Australia's Gibson Desert, where spinifex and obligate-seeder-dominated heath co-exist in a somewhat shifting matrix. Boyd has recently found, and cracked, the mystery of spinifex seed production, which it seems follows the 'mast' paradigm. While flowering events occur quite often, viable seeds are only produced in a subset of these events, a strategy that successfully allows spinifex to persist through seedling recruitment after fire.

Ecological Society of Australia (ESA) Vice-President, Dr Raghu Sathyamurthy speaking with an attendee at the ESA display at Bushfire 2016.

Theme 7: Fire Management for Linear Infrastructure

This theme was presented as a half-day session of six talks chaired by Steve Martin (Powerlink, Qld) who reflected that it was "An essential session from my perspective that brought some different perspectives to the conference. It could be widened to include more of an asset management perspective for future events". QFES Bushfire Mitigation Executive Manager James Haig delivered a presentation with Julian Selke from the Queensland Department of Transport and Main Roads about the Coordinated Agency Model, highlighting a collaborative multi-agency success story for improved roadside fire management. Two case studies were presented focussing on fire management for infrastructure corridors and in particular, Dr Leasie Felderhof discussed the increased complexity and risk associated with corridor fires. Mahogany Gliders featured in a presentation reporting on the relationship between habitat fragmentation, habitat use and close proximity vegetation change within an easement corridor. A presentation on the significance of electrical impacts of bushfires on transmission lines from Tony Gillespie generated considerable discussion from the floor.

James Haig (Qld Fire and Emergency Services) and Julian Selke (Qld Department of Transport and Main Roads) after their presentation on the Coordinated Agency Model for improved roadside fire management.

Dr Leasie Felderhof during her presentation on corridor fires.

Field Trips

Attendees had the opportunity to participate in one of two full-day field trips following the conference. Each field trip examined local fire management and research projects and the impact of fire on various vegetation types.

Field Trip 1: North Stradbroke Island

North Stradbroke Island (NSI) or Minjerribah is the second largest sand island in the world and is home to places of incredible conservation value, including sand dunes, wetlands, endangered heathlands and freshwater lakes. Fire has played a key role in shaping the environment, with the local landscape being dominated by fire adapted sclerophyll vegetation communities. The island also has a long history of human settlement, with the oldest Aboriginal archaeological site (~20,000 years old) in south-east Queensland and one of the earliest European settlements in the Moreton Bay region (1827). This factor, along with the occurrence of several lakes and wetlands that contain palaeoecological records extending beyond 40,000 years, makes NSI uniquely placed to investigate the relationship between anthropogenic and natural fire regimes, as well as how indigenous knowledge can shape fire management. The field trip visited some key sites, highlighting contemporary indigenous fire management techniques, the influence of fire regimes on the contemporary landscape and long records of vegetation and fire change.

This trip was guided by Dr Jan Alden Hoven, NSI resident and biologist; Darren Burns, Quandamooka Yoolooburrabee Aboriginal Corporation; Dave Kington, Queensland Parks and Wildlife Service, Queensland Government; Dr Patrick Moss, Associate Professor, Climate Research Group, School of Geography, Planning and Environmental Management, University of Queensland; and Dr Paul Williams, Vegetation Management Science, Consultant.

Attendees at 18 Mile Swamp, North Stradbroke Island.

"The field-trip was fabulous just could have spent a few more days over there on the beach."

Associate Professor Patrick Moss and delegates at Brown Lake, North Stradbroke Island.

Michael Reif (Sunshine Coast Regional Council) speaks to attendees at Maroochy Bushland Botanic Gardens.

Field Trip 2: Sunshine Coast

The Sunshine Coast field trip presented an ideal opportunity to learn about contemporary indigenous fire practices, the ecological impacts of frequent burning regimes, including an investigation into the responses of litter invertebrate fauna communities to fire-induced litter, managing bushfire risk in linear properties and commercial forestry. The first stop was Wild Horse Mountain Lookout taking in the panoramic views of the ocean, the state forests and the Glasshouse Mountains area, which is of deep spiritual importance for the Kabi Kabi/ Gubbi Gubbi and Jinibara people. Traditional Owners spoke about a new project to reintroduce cultural fires into the landscapes. During a visit to Maroochy Bushland Botanical Gardens participants heard about managing fire risk and ensuring the conservation of twenty rare or endangered species. The field trip also visited the site of one of the longest-running fire experiments in Australia. The site covers a variety of ecosystems types including tall eucalypt and coastal heathlands.

This trip was guided by Orpheus Butler, PhD Candidate, Griffith University; Susie Chapman, Healthy Land and Water; Kerry Jones, Bunya Bunya Country Aboriginal Corporation; Leigh Kleinschmidt, HQ Plantations; Dr Tom Lewis, Qld Dept of Agriculture and Fisheries, University of Sunshine Coast; Steve Martin, Powerlink Queensland; and Michael Reif, Sunshine Coast Regional Council.

Susie Chapman (Healthy Land and Water) and Kerry Jones (Bunya Bunya Aboriginal Corporation) speak to attendees at Wild Horse Mountain Lookout.

Poster Session, Trade Exhibition and Conference Dinner

Bushfire 2016 provided plentiful opportunities for delegates to socialise and network during conference breaks. A permanent poster display was assembled in the exhibition hall, along with displays for sponsors and stallholders. The exhibition hall was also utilised as the main break out space where morning and afternoon tea and lunch was served.

The post conference survey found 40% (45/112) of respondents provided the feedback that the networking opportunities were considered the most valuable aspect of Bushfire 2016.

The poster session on Wednesday night provided an opportunity to interact with poster authors and visit trade display partners. The following posters were on display:

1. The Firesticks Project: Nature Conservation Council of NSW.
2. Economic Evaluation: University of the Sunshine Coast and QFES.
3. Linear Corridor Management: Powerlink Qld.
4. Fire Regimes and Vegetation Change: University of Queensland, James Cook University, Queensland University of Technology and the Australian Nuclear Science and Technology Organisation.
5. Bushfire Fuel Classification: Australasian Fire and Emergency Services Authorities Council.
6. Holocene Fire and Vegetation History: University of Queensland and Forest Practices Authority Tasmania.
7. Information Tools for Bushfire Mitigation Planning in Qld: QFES and CSIRO.
8. Facilitating a Biodiversity legacy for the South Burnett Region: South Burnett Regional Council.
9. National Burning Project: Australasian Fire and Emergency Services Authorities Council.
10. Fire Planning for the Katiti Peterman IPA: Family Fire Country: Central Land Council.

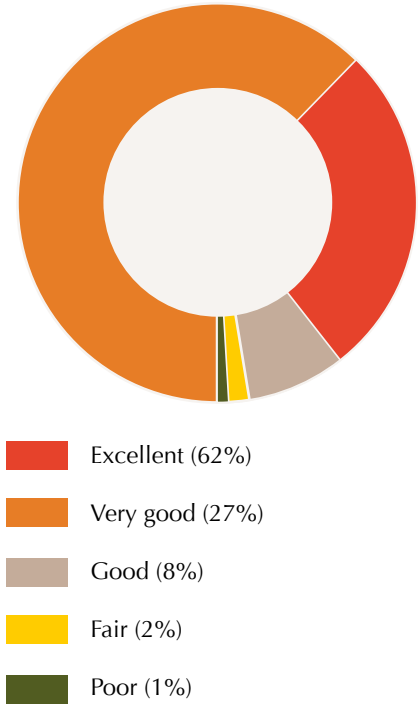

Figure 3: The percentage of participants who rated networking and a "forum for the exchange of information" as excellent, very good, good, fair or poor at Bushfire 2016.

Associate Professor Alan York (Melbourne University) speaks to delegates during a break.

Supporting cultural and contemporary burning practices for healthy communities and healthy landscapes

firesticks

winba = fire

Banbai Fire and Seasons Calendar Wattleridge Indigenous Protected Area

JANUARY

WURUPIL = KOALA, WALE / WOLE = RAIN

Fruits of the **native raspberry** are a delicious snack. Insect populations explode and eucalypts are flowering, with many animals feeding. Many wildflowers are blooming. **Koalas** are breeding. Summer migratory birds visit, including the striated pardalote, **sacred kingfisher**, rufous whistler, satin flycatcher and grey fantail. **Bracken fern** roots were processed and eaten as a staple food, young leaves were rubbed onto skin to relieve insect bites. Bracken fern is abundant after fire.

DECEMBER

AWKENDI / GUGINBIL = WATER

Scarab beetles are swarming. **Black grevillea,** ladies' tresses, buttercup, fairy aprons, crinkle bush, blue bell, native violet **vanilla lily**, native geranium, **fringed lily**, creamy candles, glycine pea and forest goodenia are flowering. Black grevillea is a threatened species found only around the Wattleridge region. Lance beardheath, spiny-headed mat-rush and blackberry are fruiting. The roots of the vanilla lily were eaten raw or roasted. Geranium, glycine pea and fringed lily roots were cooked and eaten. Lance beardheath fruits were eaten. The **native potato** is flowering. The roots of this orchid were roasted and eaten in some parts of Australia. Aboriginal people could find the tubers by digging down where they noticed bandicoots had been scratching. Drooping mistletoe on New England manna gums are flowering, attracting eastern spinebills and New Holland honeyeaters. **Freshwater crayfish** are obvious after releasing their young.

NOVEMBER

BURR, INDYARA = EEL, TUK = FROG

Pink kunzea, lemon dovetail, common buttercup, yellow buttons, native geranium, slender stackhousia, slender teatree, bell fruited mallee and other plants are flowering. The spiny-headed mat-rush is seeding. Mat-rush leaves were used to weave baskets and eel traps. Tea tree was used as an antiseptic and broom. Diurus orchid tubers (like lemon dovetail) were an important food resource in south eastern Australia; in some areas they were 'everyday vegetables for Aboriginal people'. **New England tree frogs,** common eastern froglets, spotted grass frogs, striped marsh frogs, Peron's tree frogs and eastern banjo frogs are calling and breeding. Snow gums are flowering, attracting honeyeaters. A lot of bats are around, catching insects, including the threatened **eastern false pippistrelle**. Magpies are teaching their young.

OCTOBER

KUME = SLEEPY LIZARD, GUNIRUL = FRILLNECKED LIZARD

Geebung are fruiting. Native clematis, lemon dovetail, false sarsaparilla, leafy purple flag, wait-a-while vine, native violet, dusky finger, Australian indigo, beard heath, grass tree and other plants are flowering. **Native clematis** leaves were crushed and inhaled to cure headache or cold. **Australian indigo** roots can be used to stun fish in waterholes. False sarsaparilla stems were used as rope or string for baskets. **Grass trees** were important for food and tools. The flower stalks were used as a base for fire drills and dry material used as tinder to make fire. Whistling tree frogs and eastern sign-bearing frogs are breeding. **Eastern water dragons** are active around Lizard Gully. Bowerbirds are active near the homestead.

SEPTEMBER

TOOLS: ILEMEN = WOODEN SHIELD GANAY = DIGGING STICK, KUMNAI = YAMSTICK, PIKORA = SPEAR, TUA = BOOMERANG, MAWKAW = STONE AXE

Bridal veil orchid is one of the first plants to flower as the weather starts to warm up. The beautiful purple flowers of the **hovea** shrub welcome warmer weather to the bush. Snakes are becoming active, including highland copperheads and **red-bellied black snakes**. Many **wattles** are flowering prolifically. Wattles were often indicator species which were used to let people know when to use fire, move camp or access resources. Wattles have many uses including gum, seeds (ground or eaten green), timber, bark, 'apples', grubs/insects, tools, flowers and medicine.

AUGUST

KUKRA = ECHIDNA
WIR = BLACK COCKATOO

Echidnas breeding – the males form lines to follow a female. Traditionally, echidnas were eaten. This culturally significant species features in rock art at Wattleridge. Day length is increasing which stimulates animals such as antechinus to start mating. Young black cockatoos can be heard begging food from tree hollows. **Glossy black cockatoos** are a threatened species with key habitat found at Wattleridge. She-oak cones are an important food source for them. **Eastern grey kangaroos** come in after a low intensity fire to eat the fresh green pick which made them easier to hunt. Magpies swooping.

FEBRUARY

BEAMBYU = EAT; PHATAE = FOOD

Blackthorn, ladies' tresses and greenhood orchids are flowering. **Native bush rat** juveniles are active. **Wombat berries** are eaten; the roots are sweet tasting when raw; this plant is also used for medicine. Some **bush tomato** (Solanum) fruits were eaten but some species are poisonous- the local solanum fruits are probably poisonous.

MARCH

DULE = TREE

Diehard shinygbarks are flowering, attracting birds such as New Holland honeyeaters and white-naped honeyeaters. **Box mistletoe** is fruiting, attracting **mistletoebirds**. People ate mistletoe fruit, colloquially known as snotty gobbles.

APRIL

BYURNGARRAN = MUSK LORIKEET, BIRIBI = RAINBOW LORIKEET

The **hairpin banksia** is flowering and **wait-a-while vine** fruiting. Banksia nectar can be sucked or dipped in water to make a sweet drink; the banksia cone was used as a comb. The wait-a-while vine was used for rope or string. Broad-leaved stringybarks are flowering, attracting **rainbow lorikeets, musk lorikeets**, eastern spinebills, yellow-faced honeyeaters, red wattlebirds, New Holland honeyeaters, white-naped honeyeaters, noisy friarbirds and silvereyes. Native bush rat females are pregnant.

MAY

GAPI / KUPOAN / KURAKE / GUPE / GURAKAI = POSSUM, BANGGO = SUGAR GLIDER

The **honeysuckle banksia** is flowering, attracting rainbow and musk lorikeets, eastern spinebills, yellow-faced honeyeaters, red wattlebirds, New Holland honeyeaters, white-naped honeyeaters, silvereyes, satin bowerbirds and **sugar gliders**. Bird species are dispersing after breeding, including the fantailed cuckoo, flame robin and silvereye. Banksia cones were used as **firesticks** to assist Aboriginal people to carry fire across country.

JUNE

WINBA = FIRE, BUANG = STRIKE FIRE, BULE = SMOKE

Jam tarts may be known traditionally as mookrum- they produce small edible fruits and nectar. **Prickly moses,** jam tarts, greenhood orchid & mint bush are flowering. **Superb lyrebirds** and bassian thrushes are breeding.

JULY

KARIL = COLD

Greenhood orchid tubers are small but starchy and nutritious. The male **scarlet robin** is busy at this time of year, getting ready for breeding, establishing his territory and looking for food.


BANBAI RANGERS UNDERTAKING POST-FIRE MONITORING AT WATTLERIDGE


WATTLERIDGE IS A 400 HECTARE INDIGENOUS PROTECTED AREA WHERE BANBAI LANDOWNERS LOOK AFTER COUNTRY FOR CULTURE


TO SHOW RESPECT TO TRADITIONAL BURNING CUSTOMS, FIRE USE HAS BEEN BANNED FROM SCHOOLS DURING A FIRE DRILL


SUCCESSFUL LOW INTENSITY CULTURAL BURNING UNDERTAKEN IN AUGUST 2015

BANBAI ACKNOWLEDGEMENT OF COUNTRY

Thanburra una bumanyem ngaia nyem ngenda dungai ngurulami

The members of the Banbai Nation would like to welcome you to learn about our country. This land was walked upon, played upon & hunted upon by our ancestors. As an act of remembrance, honour and loyalty to our ancestors, we ask that you take a moment to remember them.

Our vision for our country is that it is self-sustaining for future generations where our children learn cultural values (such as bush tucker and traditional practices) and understand what healthy country means. Our country is a meeting place for family and community gatherings where knowledge is shared and what we see now, generations will see in the future- healthy country, healthy people and healthy waterways will make our country self-sustaining.

BANBAI LANGUAGE

The Aboriginal language words included in this calendar are the language of the Banbai nation of northern NSW.

SUPPORT

The Wattleridge Fire and Seasons Calendar is supported by the Firesticks project: Banbai Enterprise Development Aboriginal Corporation, University of New England, Rural Fire Service Association & Northern Tablelands Local Land Services (through funding from the Australian Government National Landcare Program).

RESEARCH

This fire and seasons calendar is part of a PhD research project undertaken by Michelle McKemey at the University of New England, under the supervision of Dr Emilie Ens, Mr Oliver Costello, Prof Nick Reid, Dr John Hunter & Dr Hal Ridges.

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PHOTOS

MICHELLE MCKEMEY, DAVID MILLIDGE, PHIL SPARK, GREG STEENBEEKE, MYRNA SPENCER, MITCH PALMER, JOHN HODGE, ROBERT MCCORMACK, MATT CAMPBELL / ROWESWIRD, FIRDOSYS, FLICKR PHOTOS, BERNARD DUPONT, ALPSDAKE, BERNDH, H.HASSELL KRAPF. IMAGES REPRODUCED WITH PERMISSION FROM PHOTOGRAPHER OR UNDER CREATIVE COMMONS BY ATTRIBUTION.

DESIGN

LINDAL HARRIS.

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This draft Calendar is a work in progress and will be updated.
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Winba=Fire Banbai Fire & Seasons Calendar, Wattleridge IPA

An informal dinner at the University of Queensland Pizza Café on Thursday night was well attended, many enjoyed the live music and the relaxed atmosphere. The field trips also provided a chance for delegates to improve their knowledge, see more of south east Qld and network.

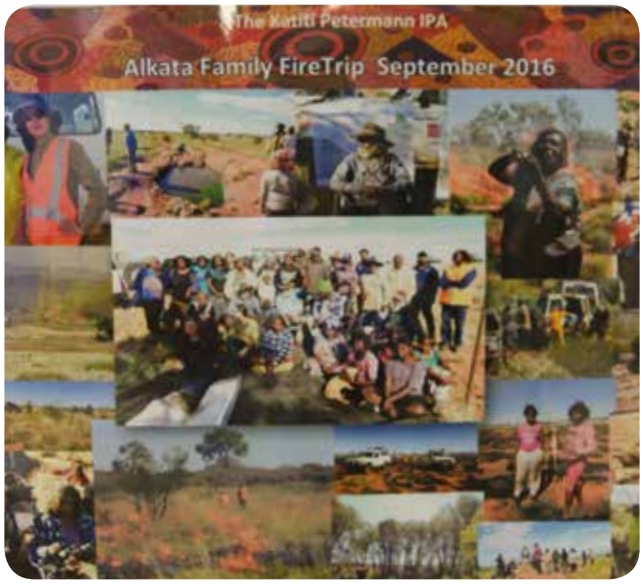
"A great opportunity for scientists, researchers and fire practitioners to talk amongst each other, network and compare notes, ideas and techniques."

"Thank-you so much for the opportunity to present, it was an excellent experience and was incredible for networking."

"There were quite a few people who said to me that these conferences and meetings are very important for them because it helps them connect with people in the fire field."

"The networking and information sharing was invaluable between states and agencies."

'Open relaxed atmosphere. Very conducive to building contacts between presentations.'



Poster presentation entitled "Fire Planning for the Katiti Peterman IPA: Family Fire Country" (Central Land Council).

QPWS staff interacting with attendees at the QPWS display during one of the breaks.

From left to right: Bushfire and Natural Hazards CRC CEO Dr Richard Thornton, QFES Superintentent James Haig, QFES i-Zone Officer Tim Collingwood, Moreton Bay Regional Council (MBRC) Fire Management Officers Bruce Bunkum and Wayne Simpson, MBRC Natural Areas Officer David Horne and QFES Inspector Peta Miller-Rose.

What Next? – 2018/2019

A meeting was held during Bushfire 2016 to discuss the idea of continuing the national bushfire conference every two or three years. Overwhelmingly people were supportive of the concept of Bushfire 2018, provided it remain accessible to people at all levels and continue to connect science and onground action. The post conference survey asked respondents, "Would you attend another conference of this type if it was offered again in 2018? " and 95% of respondents (115/121) answered yes (6 were neutral).

"Very glad to see it was held again after a decade, hoping it's the start of a bi-annual trend, well done to all responsible".

"A great conference over-all, whatever the level of any individual's involvement in the fire industry, there is much to be gained from attending events such as this, again, well done to all responsible".

"A Biannual conference with new developments would be very worthwhile".

For more information on Bushfire 2016 please visit: http://www.fireandbiodiversity.org.au/bushfire-home

Thank you

Sam and Craig would once again like to extend a big thank you to all our sponsors for joining us on this journey, in particular our Gold Sponsors, Fireland Consulting, Healthy Land and Water and the University of Queensland. Thank you once again to the Organising Committee and to everyone who encouraged and assisted along the way, including the team at Healthy Land and Water, Mary Quade and the team at Kingfisher Creative, Abbie Glossop at the University of Queensland Union, our talented photographer Nadine Anderson, our three inspiring Keynote Speakers and panel discussion Chair, our session Chairs and all the wonderful folk who contributed and assisted with the endless tasks including the registration desk, setting up the rooms, recording presentations, directing delegates and the field trips.

The longterm fire research site at Peachester, taken on the Sunshine Coast field trip.

Appendix 1: Keynote Transcript Dr Neil Burrows

Managing Fire in the New Millennium

Thanks for that introduction Sam. As you will have gathered from that introduction, I've been around for quite a while, nearly 40 years as a bushfire scientist working in conservation and land management agencies in Western Australia. I've had the good fortune to not only do some really interesting, exciting bushfire research in a number of landscapes in WA, but I've also worked closely with the fire practitioners, so I've been closely involved with influencing fire policy, planning and operations, and I would take this opportunity, and it's consistent with the theme of this conference I guess, to urge all bushfire scientists to work collaboratively, closely and constructively with your local fire and land management agency.

Now as we know, the fire regime experience in a region is largely determined by climate variability, weather embedded within that and vegetation patterns and it's these fire regimes that give rise to the consequences, impacts or effects of bushfires on the things that are important to us, including our communities, our biodiversity and our environmental services. However, there is one other really important factor influencing regional fire regime and that is people. In addition to climate and vegetation, people can be powerful drivers of fire regimes, particularly, with regard to how much fire they put in to a landscape and how much fire they can put out, and really, that's the key message of my address.

For a very long time, people, have managed or influenced the fire regime on this continent, and we heard some examples of that this morning. And when I say continent, I of course include Tasmania, so if there's Tasmanians here who may be offended when I refer to 'the continent' I include Tasmanian. I consider myself an honorary Tasmanian having bought property down there a few years ago with the intention of spending a large part of my retirement there. So people have influenced fire regime for thousands of years. But it hasn't always been so.

Australia was in fact a wilderness at one time before the arrival of people. And we know from charcoal in the Pleistocene sediment and beyond, so we're going back beyond 5 million years, that there were combinations and fluctuations of vegetation, climate and fire going back millions and millions of years. The primary cause of fires then was probably lightning but there may have been geothermal activity; we can't be sure, but certainly, non-anthropogenic causes were the ignition source for fires - the fire regime before people was pretty much an interaction between vegetation and climate. So, way back then, fire became an evolutionary force acting on our biota and today we see a range of adaptive traits or adaptations to fire that enables our biota to persist and in many cases, depend upon certain fire regimes for its persistence.

That all changed about 50,000 years or so ago; people arrived. People with their fire sticks. Aboriginal people used fire skilfully, purposefully and ubiquitously to make this continent give up things that Aboriginal people needed to live. Fire frequency increased. We can't be certain about what the fire regime looked like across the continent at that time, but certainly, the charcoal record, the sedimentary record shows an increase in charcoal about the time of arrival of people. People became the predominant ignition source; as an ignition source, lightning paled I suggest to you. A new dynamic equilibrium was established as people used fire sticks to encourage food, to encourage medicine plants and for all sorts of other reasons, some of which, again, you heard about this morning.

As I said, we don't know what the fire-prone landscapes might have looked like, but my view is that with so many ignition sources it was probably largely a fine scale mosaic of diverse serial stages or patches of vegetation at different times since last fire.

This is an aerial photograph taken of part of the Western Desert in northwest WA, taken in 1953 during the halcyon days of rocket testing, post-War, and it was taken at a time when Aboriginal people were still living a traditional lifestyle in these areas. At the time of the photograph, they had not been contacted by Europeans. In fact this part of the world was where the last bushman came out of the bush and first made contact with Europeans in 1984 – the so-called Pintupi nine, and that's probably within the lifetime of many of you in the room. So, we are not talking hundreds of years ago; we're talking fairly recent times. I was incredibly fortunate enough to return back to the bush with some of the people that came out, mainly driven by my interest in how they used fire. But this is one of dozens of aerial photographs I have of this part of the desert from which the last bushman came. I'll point out a couple of features - you can see the east/west trending longitudinal or the linear lines. This is sand dune/

sand plain country, covered with spinifex and low shrubs. It is desert country. So, there are sand dunes you can see there. The pale patches are fire scars and most of those were lit by Aboriginal people. If you look closely, you can see a number of places where they've dragged fire sticks to burn country - up here for example. This is not an exceptional photo. I've got, like I said, probably dozens and dozens covering an area of 2500 square kilometres that look similar to this. Having said that, this is one snapshot in time and it's one location, as large as it is, but we can't assume that this is how the entire Western Desert looked. But if you talk with Aboriginal people as I've done, spent time in the bush with them, I got a sense that where they went and where they were camped up, they did a lot of burning like this.

The other feature about this photograph, I should point out, as far as I'm aware, it is the only photographic evidence we have of how flammable landscapes looked under traditional owners or under indigenous people's management. I'm not aware of any other actual photographs revealing that. So, we're pretty fortunate, I think. But the other feature of that photograph is the scale of the patches; they are small. You can see the 1 kilometre scale bar there. Most of those burnt patches are under 100 hectares. When I digitised the fire scars on the 2500 square kilometres covered by these photographs, dozens and dozens of them, the biggest burnt patch I found was about 6000 hectares. So, lots of little burnt patches, which is consistent with what Aboriginal people told me they did in the old days, in the old times.

The people I worked with in the Western Desert were mainly Pintupi and Martu and I gathered lots of information about how and why they used fire, but to try and summarise it, perhaps unfairly so, fire is incredibly important to Pintupi people, both physically and spiritually. They used it for many reasons but primarily to acquire food, either to clear the country to hunt sand goannas or to bring up bush tomatoes or some other source of food or medicine plant. That was the primary use, but there were many uses we documented of why they used fire. Most of the fires were small, but some got large and when they say large, they mean 6000 hectares or so, I guess, because that was the largest fire scar we digitised. They burnt when the spinifex was dense - they recognised five developmental stages in spinifex. Any spinifex older than about 12 or 15 years was considered 'old' whereas prior to interacting with Aboriginal people, I thought 30-40 year old spinifex was old, but they classified anything over about 12 to 15 years as old. They burnt it when it was dense - basically, they burnt it when the cover had developed sufficiently to carry fire. Early growth stages were most valued. They got most resources from the earlier growth stages, they got most of their food and medicine plants, but all growth stages offered something.

You're allowed to laugh at that picture, I think. European colonisation, obviously with the arrival of Europeans, Aboriginal culture across much of southern Australia in particular was displaced. People were decimated by disease and other things. Traditional burning practices basically ceased or were disrupted. The early Europeans were fire phobic; some still are. In fact, the first bushfire ordnance in the Swan River colony in about 1847 stated that minors, children, and Aborigines were to be flogged if caught lighting fires, so fearful where the early settlers of bushfires taking out their farms and their settlements and their towns. So, by the 1860s, traditional Aboriginal burning was virtually extinguished in southern Australia, and by the 1960s, traditional Aboriginal burning in central and northern Australia, had been extinguished or severely disrupted. And we saw earlier, a presentation on Cape York, where today they're trying to bring the traditional fire regimes back from late dry season fires to early dry season fires which is more typically when traditional owners mostly burnt. That's happening right across tropical northern Australia - the top end.

The fire regimes changed with the cessation of Aboriginal burning patterns. The depopulation of the Western Desert was virtually complete by the 1960s, the last handful of people coming into European-type settlements in 1984. As I said, I had the pleasure of going back into the bush with some of them for a few weeks to learn about their use of fire. Very quickly after depopulation, the fire regime flipped and this is how it flipped. So, there's that early black and white aerial photograph, one of dozens I have. You can see the right-hand image on the slide is a recent Landsate satellie image. You can see the fire scars are still there - the yellow colour, light colours are fire scars in that landscape, but what's changed with the depopulation of these landscapes is the scale of the fires, the season in which they are burning and the intensity with which they are burning. While people were in the landscape, the fires were mostly small, mostly frequent, mostly cool - not all fires- there were still some larger hot season fires, but they were less widespread and burnt a smaller area compared with the fires of today. I should point out, in the late 1980s, there was what's been called a homelands movement. A lot of the desert people that had been basically cleared out of that country and herded into towns and other settlements in northwest and central WA, decided to move back onto country in the 1980s. So today around these communities, people are starting to get out and hunt and do traditional burning again, but where the people aren't in the

landscape, lightning rules and fires are huge. On this satellite image, I have superimposed the 1953 aerial photo so you can clearly see the contrasting scale of fire scars between then and now. Today, where there are no people burning, the fires are infrequent, probably 15-20 year cycles depending on rainfall which is a key driver there. They are mostly very large and when I say large, a 200,000-hectare fire is about normal for parts of the Western Desert. In 2012, we tracked one fire by satellite - it burnt 3.2 million hectares. And if you jump in a plane and fly from Perth to Broome and look out the window as you cross the Western Desert, you'll see very large areas of bare, red soil denuded by fire and a few little patches of unburnt vegetation. So, lightning in the absence of people, has taken over and we are seeing this changed fire regime - and it happened quickly, within about 15 years of depopulation.

I've tried to reconstruct what the annual area burnt in the Western Desert might have looked like when people were controlling, if you like, the fire regimes compared with lightning, which is in charge of ignitions across most of the desert country at the moment. I've done this - not so much from the black and white aerial photography - but by looking at the contemporary burning patterns around the Aboriginal communities, the remote communities, resulting from the homelands movement that exist in the Western Desert, where people still go out and hunt, burn the country, dig up sand goannas and so on, and I compared that with areas where people don't go because it's too far away or they can't get access to it because they use Toyotas and guns and things to hunt with these days. They still use fire sticks, but it's often drip torches and what have you, and this is what I find. Within a certain distance of the hunting tracks and the communities, the left-hand side of the graph is a reconstruction of the annual variability in area burnt where people are still firing the landscape. Beyond these areas, in the remote areas where people don't go, the annual area burnt by fire looks like the right-hand side of the graph. So, on the left-hand side, you're getting this fluctuation of proportion of the area burnt ranging from about 5% to 25% per annum, whereas on the right-hand side where people aren't burning, you're getting wild fluctuations ranging from up to 90% burnt in one year, and then not much burnt for the next 5-10 years because there's nothing left to burn, and so on. It is a 'boom and bust' fire cycle under a lightning driven system compared with a much more stable cycle under a people driven system or people ignition system.

Okay so, we've had people arrive then, of course, we had Europeans come along and change things again. Their solution in the early days was to put fire out. As I said, they were pretty much fire phobic, the early settlers. In the early days post-European settlement, most government land management agencies such as forests departments and so on across southern Australia had a policy of fire exclusion and suppression, with some exceptions. That was primarily their policy. Now, how they thought they were going to do that with the gear they had - check out that fire truck. How are you going to put fires out with that? I don't know. Perhaps the early fires were low intensity?

But the fire exclusion and a suppression policy eventually failed. We know that if fuels are allowed to build up over large areas, at some point, they will catch fire and you won't be able to put them out if the fire danger ratings is anything above about moderate. So, we do know that reducing fuel load and fuel structure will reduce the speed and power of a bushfire. That's just science, and if the speed and power of a bushfire is reduced, it means it's going to be less harmful, less damaging, and it's going to give you better opportunities to put the fire out.

Prescribed burning isn't a panacea. It does not prevent fires. It just gives you a better opportunity to control them and it reduces the severity and harm of fires. In southern Australia, hot season summer fires will always be part of the mix and that's probably a good thing because they do serve a purpose, but not at the scales that we have been seeing them recently.

This is a graph of the annual area burnt by wild fire and annual area burnt by prescribed fire in southwest Western Australia from the early 1950s through to 2015. I wouldn't give much credibility to the early data, stuff I've got circled there including the prescribed burn data - the way they mapped fires was pretty rough in the early days, but there's a pattern there. You can see that after the major bushfires in 1961, we had a Royal Commission, as you do, and the Royal Commission amongst other things recommended more prescribed burning, as they do. So, the then Forest Department took that on board and through the 1960s, 70s, 80s, and 90s, supported by a fire research program, they got stuck into broad area fuel reduction burning.

As you can see, it peaked close to 18% per annum in some years, but levelled out through that period at somewhere between around 10% or 12% per annum of prescribed burning. Then you can see, as we moved into the 90s, there's a downward trend in the area burnt by prescribed fire, through to now where we are struggling to meet about 5% or 6% per annum burn. There's a clear downward trend in area burnt by prescribed fire.

Accompanying that, we can see an upward trend in area burnt by wild fire. Is that cause and effect, or is that just coincidence?

Since about 2000, we have seen almost every summer in southwest WA bigger and bigger wild fires, the sort of size of wild fires we have not seen since pre-1960. Around the rest of Australia, and I haven't been able to get a lot of data, we can see on this slide the areas burnt by wildfire and prescribed fire over the last few decades or so by broad regions. For example, over this time period, the annual average area burnt by wildfire in Victoria was about 5.5% and the average area burnt by prescribed fire was about 1.2% per annum. In the southwest forest region of WA, in the last 10 or so years, we've had about 1.8% of the region burnt by wildfire, which is pretty high based on the last 6 decades or so of records. Over the same time period, the annual area of prescribed burning is very low at 5.2%.

The other feature to notice of course is the top end, the tropical savannas. Almost every year, between 20% and 30% of the tropical savannas is burnt, which is not surprising - it's predominantly grassland. I guess the other point to make from that graph is that prescribed burning in terms of area burnt across the continent makes up a relatively small proportion of the total area burnt by fire. Most of the area that's burnt at the continental scale is by wildfire. So, we've got this trend certainly in southwest and southern Australia generally since the late 1990s into 2000 of decreasing area burnt by prescribed fire and an increasing area burnt by wildfire. The top right graph is the same data I showed earlier but it's been simplified into annual decadal means.

So, we're getting this return to the big fires, maybe they are called mega fires, but they are certainly large, destructive fires and there are similar patterns across northern Australia although the pattern there is not so much an increase in the area burnt but a change in the seasons of burning from most of the burning now is done late dry season whereas traditionally, a lot of the burning was done early dry season or late wet season. So, there's been some changes. The recent Waroona fire is an example and a reminder of the return of the megafires. I was involved in this fire as part of the incident management team and also as part of the investigation and reconstruction team. It burnt about 70,000 hectares - fortunately, only two lives were lost - I don't know how we got away with that - more than 150-odd homes lost plus damage to industries and infrastructure. The total cost of that fire according to the Ferguson Inquiry, was 155 million dollars. That's just one fire event.

Now, people have often said to me, well, what does it matter whether it's burnt by prescribed fire or wildfire? Fire is a fire. If you're going to burn 200,000 hectares with prescribed fire, you might as well let it burn by wildfire. Well, there are big differences between prescribed fire and wildfire as I'm sure you'll appreciate. With prescribed fire, we have some control over the time, place and the weather conditions under which we carry out the burning. There is some spatial control over where and how the fire burns. Generally, prescribed fires are cool or low intensity fires. They are relatively frequent, relatively low impact in terms of acute physical impacts on the vegetation in particular and other biota and they are generally patchy in terms of what burns and what doesn't burn. Basically, the opposite applies for wild fires - so they are quite different. On the other hand, wildfires are usually large, intense and mostly uncontrollable. The physical and biological impacts of a wildfire are usually quite different to a prescribed fire.

And prescribed fire ain't prescribed fire. To be effective - and I'm happy to discuss what 'effective' prescribed fire or prescribed burning is - it must be strategic, it must be in the right places - and Ross Bradstock talked a bit about that earlier on today - it needs to be done at the appropriate temporal and spatial scales and certainly, in southwest WA, we know that if we burn small cells, they're pretty well useless for wildfire mitigation. We've got to go to large prescribed burn cells in the order of 2000 to 5000 hectare cells. We've got to treat at least 8% to 10% of the region each year. You can see that graph there showing how the area burnt by wildfire goes up pretty hard when the area burnt by prescribed fire drops below about 6% or 7% - the effectiveness of prescribed burning reduces dramatically and rapidly. We need to keep at least 45% of the landscape - in this case, the forested southwest of WA, less than about 6 years old, and the burning needs to be done to the appropriate standards - so you need the appropriate levels of fuel load reduction and structural changes to the fuel to be effective. If these criteria aren't met, then yes, prescribed burning will be largely ineffective.

I think we're familiar with the cost of bushfires, so I won't dwell too long on this, but they are undesirable to say the least. Whether or not they occurred in the past at the scale they occur at now - and I don't believe they did - but if they did, to some extent, that's irrelevant because we, as a modern society, can't tolerate the impact of these fires on people's lives, homes, communities, infrastructure, environment and just the straight-out monetary cost. This table summarises some of those costs. I won't go through it in detail but most of the impact in terms of on communities and dollar impacts obviously are in southern Australia and I roughly characterise southern Australia as south of a line between Sydney and Perth - this seems to be where we have most of the damaging bushfires probably because of the nature

of the vegetation, the nature of the climate and the fact that it's much more densely populated and that you've got a lot more people living in and around the bush than is the case in the north.

You can see over a 10-year period, 5500 structures mostly homes, gone, over 200 lives lost. Some observers have put the monetary cost of bushfires since 2000 at around $7 billion dollars. I'm not sure how they got to that figure, but that's one estimate. There's a social cost, of course, which is hard to quantify, and a biodiversity cost again, difficult to quantify, and there are environmental services costs to our catchments, air quality, carbon emissions and so on and so forth again, all very difficult to quantify, but they are real.

With regard to biodiversity impacts, we've had a bit of a fright with some of the bushfires we've experienced in southwest WA in recent times. A couple of examples here - one is Gilbert's Potoroo which is Australia's rarest mammal only recently rediscovered a couple of decades ago. We had a bushfire in Two Peoples Bay which decimated the population. We are very concerned about whether or not we will be able to keep this animal on the planet as a result of that bushfire. Similarly, Quokkas which actually occur on the mainland - most people think Quokkas are only on Rottnest Island, but they do occur on the mainland of southwest WA. We had a massive bushfire through the Northcliffe area recently and fortunately, there was a Ph.D student working on the Quokkas in this area leading up to the bushfire, so we got some really good data on the impact of the bushfire on the Quokka populations. And it's reduced them by about 92% according to the Ph.D student, and those that survived the bushfire were living around the edges of the bushfire footprint where the fire intensity was lower.

So nothing good to be said, as far as I'm concerned, about large intense bushfires. So why have we got this sharp increase in area burnt by bushfires, certainly in southwest WA and possibly southern Australia, since about 2000? Well, is it climate change as some have claimed? We can probably blame some of it on climate change. We know the climate's getting hotter and drier. You can see the blue line on that graph; that's the 15 yearly running average rainfall for southwest WA. Southern Australia is suffering climate change, but the southwest is probably suffering more than any other part of the continent with rainfall since the 1970s reducing by between 15% and 18% in that period to now. But that's only part of the story. Is it a reduction in anthropogenic burning? Is that playing a role in this increase in area burnt by wildfire? Is it multifactorial?

It may be a number of things, but I'm suggesting that the reduction in anthropogenic burning has resulted in an increase in the area burnt by wildfire. Similar to the pattern we saw in the Western Desert when people were no longer using traditional fire. Why has there been a decline in the area of prescribed burning? Climate change does play a role. We know it's getting warmer and drier. There are more days of high plus fire danger rating. So, all this combines to reduce the window for safe prescribed burning, certainly in the southwest. I don't know how that formula might apply to other parts of southern Australia, but certainly we have found that the drier winters reduce the number of days where we can safely go out and conduct prescribed burning.

There have been land use changes in the last 20 or 30 years in the southwest of WA, possibly across other parts of southern Australia. For example, where we once had cows wandering around on paddocks, we've got vineyards, kiwi fruit and other crops, and these farmers take exception to smoke tainting their grapes. We have softwood and hardwood plantations established throughout the southwest, they're relatively sensitive to fire so we can't readily prescribe burn them with any confidence that we won't damage them. We have industrial legacies such as bauxite mining in the Darling Scarp. Over the years, the area affected by mining has steadily increased and today we have hundreds, perhaps thousands of hectares of rehabilitated mining pits which are mostly unavailable for prescribed burning. These rehabed areas will burn in a summer bushfire but are difficult to prescribe burn with any confidence that we're not going to damage the rehab. More than 100 years of timber harvesting in native forests has created basically a sea of re-growth particularly in the karri country – young regrowth is fire sensitive and we can't prescribe burn it until it's 25 or 30 years of age. So, there's large chunks of regrowth and mixed age forest that either can't be treated or is very difficult to treat with fire, so we have to sit it out and hope that a wildfire doesn't go through. Unfortunately, there have been a couple of large fires in regrowth forest in recent times. The decline in the native forest timber industry in southwest WA - it is a mere shadow of its former self – has reduced our fire management capacity both in terms of funding through timber royalties and the machinery and manpower that was associated with a significant timber industry in the southwest forest. Many forest tracks that were once maintained are now overgrown which means during a bushfire, these tracks have to be opened up or new tracks constructed.

Other factors such as air quality concerns - Ross again talked about this - so we avoid carrying out burns if the smoke is going to blow over Perth because it might make the washing smell – but there

are more serious reasons of course – smoke can affect people's health and it can be difficult if they have respiratory diseases or problems. Population growth at the peri-urban interface makes prescribed burning challenging, risky and costly and Ross touched on this. We've had one misfortune with the Margaret River fire trying to do prescribed burning in an area that had people living in subdivisions surrounded by flammable bush. We have reduced capacity and resources. There's no doubt in the last 20 or 30 years, the capacity of my organisation in terms of people power and dollars to do any work has declined, although in more recent times measures have been taken to rectify this. We've become risk adverse to some extent. We've had some bad experiences from prescribed burns that have escaped – usually associated with trying to burn long unburnt fuels surrounded by long unburnt fuels – the Margaret River fire is an example. We've had our butts kicked, deservedly so I guess, and that's put some of our people off burning through fear of things going wrong.

A feedback loop begins to develop. When you don't do as much burning, the fuels accumulate and get older and more flammable - you are then confronted with having to burn old fuels which makes you even more fearful of doing it because trying to burn old fuels, surrounded by old fuels, is high risk, difficult – so fuels accumulate until they are burnt by a wildfire.

Onerous bureaucratic risk management processes also dissuade people from burning. And there's sometimes local community opposition to prescribed burning which generally, we can manage to negotiate our way through but there's some patches of bush that people feel precious about and they don't want any prescribed burning in there because they think prescribed burning is going to destroy its values.

Many challenges but what can we do about it? In my view, we need to maintain legitimate anthropogenic burning or prescribed burning in these landscapes if we are to mitigate or lessen the impacts, the effects, consequences of bushfires. Targets such as 8% per annum, 5% per annum, whatever, that you see around the place - I've got a few concerns with those sorts of targets. One, they may be unachievable consistently and that's certainly the case in southwest WA and it is the case in Victoria where they're been set a target of 5%. I think they're going to struggle to achieve that.

So, we need to take a more risk-based approach and I really like what DELWP are doing in Victoria. I've been fortunate enough to be part of an expert group who looked closely at their fire reform program and conceptually, I think it's really a neat piece of work. Now, it will be interesting to see how it works on the ground, but it looks good conceptually.

We, in Western Australia, are not above pinching ideas from others if they're good ones, so we're looking at what DELWP are doing and we're also looking at a zoning concept by increasing or intensifying the fuel mitigation around where communities are and then zoning out from that. I've got a note down there, zoning is not establishing a medieval fortress. That is, we are not just going to try and mitigate or lessen or reduce fuel loads around communities, but we need to do it in the broader landscape for the simple reason that a lot of our fires start out beyond the communities and burn into the communities. Unless you've got at least a 3 kilometre, certainly in our forest, a 3-kilometre low fuel load area around your communities, the fires will push through or they'll throw ambers across. It's going to be incredibly difficult and expensive to treat fuels in these convoluted boundaries at the peri-urban interface where communities are. We have values outside the fortress of communities. We've got critical infrastructure such as power lines, water catchments and transport corridors. There are also conservation values that exist beyond communities that need to be protected from damaging wild fires. There are farms - all that sort of stuff - we have to attempt to protect all these values so we must try and manage fuels around communities as well as in the broader landscape. You just can't fall back to a medieval fortress mentality.

Other things we can do, and I'll flick through these pretty quickly, is increase prescribed burning to get back to where we were in the 70s and 80s with our prescribed burning program which has declined in recent decades. We're exploring things like doing larger burns; a better bang for your buck if you like - widening the prescription window in the light of climate change, winter burning, night burning, adoption of new technologies, drones and so on, better weather forecasting, et cetera, et cetera. But importantly, and an area I think that we've done well enough, is better collaboration and cooperation with other land owners, because we being a public land management agency, don't carry all the fuel, all the risk. We need to work with others who carry some of that risk as well, so we might do as much as we can on our land but that might only reduce the risk by say 20% or 30% if others in that landscape aren't doing something as well. So, we need to work harder and better in those areas.

Most fire and land management agencies have two primary goals and they're worded all sorts of ways but basically, it's about mitigating harmful effects of bushfires which is by and large, recognising the vegetation as fuel and treating it. But we, as a conservation agency have this duality of objective which is to ensure that we maintain healthy

ecosystems, biodiversity and environmental services. Now that's not many words for a hugely complex understanding of what's going on there, but basically that means treating the vegetation as biodiversity in its own right and as habitat, and there's an argument to be said that they are mutually exclusive goals. Well, they're actually not. You can do both. There's trade-offs and compromises along the way, but you can actually do both.

So, in terms of doing both, and I'm running out of time, obviously the second bit, treating vegetation as biodiversity and as habitat, you need to have a basic understanding of fire ecology and how these things respond to fire and fire regimes. We accept fire ecology is complex and that we'll never understand everything. But we don't need to – you've got to start somewhere, so we are focusing on our threatened taxa because we have a legal obligation to our threaten taxa - our endangered species. So, we are looking at what their fire requirements are and we are using fire ecology to understand that. I know single species management is sometimes frowned upon but where they occur, we have an obligation to look after them, so we will manage fire according to their needs.

We can use, and this is pretty common stuff, vital attributes, life histories, particularly of keystone or umbrella species – this information is not that difficult to obtain. Where we don't have good science, or even if we do, knowledge of indigenous fire regimes is really important to us, certainly in our more remote areas such as the Kimberly and Pilbara regions and the Western Desert country where Aboriginal people, traditional owners, still a have profound knowledge of how country was traditionally burnt and they have looked after country long before European arrival. So, we use that – traditional knowledge. It worked for 40,000 years.

Creating diverse serial stages - so that's just punting for structural diversity, a landscape of patches of different times since last fire. And emissions abatement. We're following the lead of Jeremy Russell-Smith, a man I admire enormously for what he's done in the Northern Territory. We're trying to develop similar regimes to reduce emissions in parts of northern and central Western Australia.

With the mosaic stuff, we're trialling if we want a patchwork of different serial stages, what should be the spatial and temporal scales? The picture on the left is pretty much where we are. Each of those blocks or cells are about between 2000 and 8000 hectares, pretty much uniformly burnt although there is some patchiness within those. We've been trialling mosaic burning in the last 10 years near Walpole, breaking up those cells by introducing fire fairly regularly and the right-hand graph shows what we've been able to achieve in a 5000 hectare block just north of Walpole in southwest WA. We've just got this nice fine grain mosaic of fuel or vegetation of different times since last fire as you can tell by the different colours there. Now what we don't know is whether that's good, bad or different for biodiversity, and how good that is in terms of wildfire mitigation, but we're in the process of finding out - we've had that pretty well studied with a whole bunch of different ecologists looking at how effective that is as a landscape in terms of its benefits for biodiversity and hopefully we'll have something published on that in the next year or two.

There is an apparent conundrum - how do fire sensitive species and communities persist in flammable landscapes? There are some examples up there, rainforest and the tropical savannas, rock-out crops in forests, mulga groves in spinifex meadows. Now the reason they persist is because flammability differentials exist between these ecosystems and the surrounding more flammable landscape. So, rainforests are wetter generally than the surrounding landscape, in mulga groves, as you can see from the aerial photo the spinifex is sparser than the surrounds. Similarly, on rock-out crops, the fuels are less continuous compared with the surrounding bush. These flammability differentials only exist when conditions for fire spread are relatively mild or moderate. As soon as we have large, intense wild fires crashing into the systems, they tend to burn.

Two slides to go; Some of the important knowledge gaps - I mean you could go on forever listing research needs - but from a quasi-fire operator, quasi fire manager, being in a position of both doing fire science and also involved in a fire management agency, some of the things we need more info on, and some of these have been around long time, include the long-term fire effects. There's been a lot of short-term studies. We need some work on long-term effects of fire regimes. Not only of prescribed burning, which seems to get a lot of attention - a lot of people are interested in what prescribed burning does probably because it's something we control, but also on fire exclusion and the impacts of large wildfires, somewhat problematic to a study.

I would like see more work on fire response models for vulnerable biota in a changed climate and certainly in our landscapes, the vulnerable biota are those water-loving or moisture-loving things in the landscape. What's going to happen with those in a changed climate in terms of fire interaction? Interactions with other threatening processes including fragmentation, weeds, introduced predators and the like. Fire regimes for emissions abatement, as I said Jeremy Russell Smith has done some outstanding work in the Northern Territory. How far can we push that sort of model or that sort

of approach into other vegetation types? And this whole issue of landscape fire ecology, understanding the patchiness of fire under different conditions of fire danger rating and times since last fire and so on and so forth - how do we create patchy fires and is that good or is that bad depending on what you are valuing?

So, to finish up, I'll leave you with these thoughts. There's my fire triangle; climate, vegetation and people. If you take people out of the equation in terms of ignition sources and legitimate burning in the landscape, you'll end up with large fires; guaranteed. People have been burning for thousands of years and must continue to do so. When people burn less, there's more wildfire. I reckon I'll put my house on that. Large wildfires, whether or not they occurred in the past, today are unacceptable, in my view, for the many reasons I've given - relying on a strategy of fire exclusion and suppression, even with the Americans with their suppression might and hardware, still cannot mitigate or lessen the impacts of bushfires. We must burn smarter though and Ross again, touched on this earlier this morning. It must become risk based rather than area based or percentage of proportion of landscape burnt out each year. A risked-based approach will generate burn area targets, but these should be an outcome of a risk-based approach. We must look at what we need to do to mitigate risk and I would say, yes, obviously, human communities are first but also risk to other values, other things we think are important. We need to work with nature, understand the ecology, understand what traditional owners, Aboriginal people, used to do in the past. If that worked for 40,000 or 50,000 years, it just might work for us into the near future. Again, I implore scientists to work with fire managers constructively to come up with some solutions because that's the only way we'll meet challenges going into the new millennium. Thank you.

Appendix 2: Keynote Transcript Associate Professor Alan York

Fire, Landscape Pattern and Biodiversity

Good morning, everybody and thanks to Sam and Craig and the other organisers for inviting me along. As many of you are aware, in Victoria in 2003 and then again in 2006 and 2007, there were very extensive wildfires and we experienced another severe wildfire in 2009. Land managers were very concerned about the severity and extent of those fires, not just because of the loss of life and property and potential ecological outcomes, but they knew after they'd rebuilt the system and recovered from the inquiries and public scrutiny, they'd be facing it all again in another 10 years time when the ecology of the system had recovered. They would have extensive areas of forested landscape, even age, across much of Victoria again, in a very highly flammable state. So, thinking strategically, they wanted to do something about that.

At the same time, they were questioning some of their strategies with their planned burns. In many areas, the key performance indicator of a successful burn was the amount of black, and crews, doing what they thought was best, were attempting to burn as much of the burn block as possible in order to achieve management outcomes. But that was being questioned from its ecological perspective.

So, in 2008, there was a change in the paradigm in Victoria. There was a release of a document around 'Living With Fire' rather than just fighting it and struggling against it. We've heard a bit about mosaic burning in the last day. They formerly adopted a concept around mosaic burning that would be established across much of the public lands in Victoria. The theory, backed by science, was this would break up this homogenous landscape into a variety of age classes with their different fuel loads, different suppression capabilities. Also, provide a range of ecological outcomes, different habitats for a range of organisms, so achieve the multiple objectives that you might have heard about in the Code of Practice yesterday, would help them manage future fires and potentially increase the resilience of these systems. This involved a commitment to an increased burning effort, increasing the amount of landscape that would be burnt on a rolling average basis. They formally adopted LMB, Landscape Mosaic Burning as a strategy, but coupled with this was a substantive research investment, the adoption of the principle of adaptive management and bringing in the idea of having a monitoring strategy, learning by doing, seeing whether what we have been doing is actually achieving our outcomes and learning and improving, continuous improvement.

This was a substantive research investment. It was derailed in 2009 by the so-called Black Saturday fires and the Royal Commission that followed, but when the dust or smoke had settled, some lessons had been learnt. This strategy was rolled out. There were three main parts of it; they invested in research from Latrobe and Deakin Universities looking at some of the fire refuges, the unburnt areas that had occurred in the 2009 burn areas as a consequence potentially of planned burning activities and what that meant for the ecology of the systems. They invested in the Arthur Rylah Institute to pull together a lot of the fire data that they had over 20 years to retrospectively compare the flora and fauna in areas where mosaic burning had been used at smaller scales.

What I want to talk about today is the substantive investment in our group to look at some experimental work; to test some of the theory that underpinned this new fire and management strategy. The Victorian Government invested in our research group at the University of Melbourne, initially in 2010 to 2013 and then subsequently for another three years. A lot of that research has reached fruition and I thought it was appropriate in the context of this forum that I might report and reflect on some of that work that we've done over that time and also to give a bit of insight into what we've learnt and where we're going next.

It was a big project and I start by acknowledging all the people that contributed financially and logistically to this. We had a bit of a running joke yesterday about the endless name changing of DSE, DEPI and DELWP; I want revisit that. My Faculty and School changed its name several times over that period as well, so it is endemic in agencies. Funding through the landscape mosaic burning program, a research agreement between the Department of Environment, Land, Water and Planning (DELWP) and the University of Melbourne after the Bushfires Royal Commission, the Hawkeye Program chucked in money and local brigades, local research groups and local communities also contributed to our program. Parks Victoria supported student projects, the federal government's Cooperative Research Network also brought in some extra money, students actively went out and sought funds through the Holsworth Research

Endowment and Bird Life Australia and many NGOs provided us with on-ground advice in our work. And of course, when I say "we" over the next 40 minutes, I mean all these guys. The army of students and their supporting staff and technical staff who did all the hard work, some of whom are here today and are presenting.

So, what I want to do is to give a very quick background about the science that underpins the work. Some examples from PhD projects looking at land mosaics and some experimental manipulations and then consider some other processes apart from fire that might be working in these systems, reflect on some management implications and the future work that we're going to be involved in.

So, the science is quite established and quite straight forward. A hypothesis that heterogeneity in the landscape caused by fire or other disturbance mechanisms creates patches that vary in space and time. These patches support a range of species, so at the landscape scale, you might have mosaic patterns as such which are a group of vegetation communities at different post-fire development or growth stages. Those growth stages support different plant and animal communities that reach their maximum abundance at different time in the post-fire succession. By having a range of growth stages supporting these populations, you minimise the risk of extinction of those communities and therefore maximise biodiversity. This approach at the landscape scale is being used in Victoria at the moment to develop a number of resilience metrics and Imogen Fraser is going to talk about them a bit later on and Matt Chick about some of his experimental work around these, so I won't talk much about metrics today.

The other part of it is the smaller scale heterogeneity in the landscape. Within the fire boundary, how patchy was the fire, and even in unplanned fires of high severity, there is often considerable patchiness. Some of these unburnt patches provide refuges for animals and plants during the fire and during post-fire recovery. The scale or grain of the mosaic provides a variety of resources in post-fire recovery which might support a range of organisms; that's the theory. So, in a landscape such as this example, we have a bit of land that varies in its vegetation communities in response to soils, rainfall and topographic gradients. So, we see a mosaic of vegetation types in response to that in the landscape. Applying fire in various ways at various times and places can enhance the complexity of that mosaic and then, when you get down to ground level, which as Sam said working with invertebrates, that's often the scale that I'm working at, you can see fine-scale mosaics that aren't detected in aerial imagery, et cetera.

These hierarchical ranges of complexity in the system create this spatial pattern at a range of scales, they influence behavioural processes which determine the occupancy of the organisms that live there, the diversity and behaviour of them.

The area we selected to test some of this science was in the Otway Ranges in southern Victoria. Best known for the Great Ocean Road, landslips, high-intensity fires, annoyed tourism managers, frustrated backpackers at the moment so in the news all the time, the Anglesea Heath, one of the most diverse heathland landscapes in the world, tall forest systems, so it's got a diversity of environments there and it has a high profile. The public are very interested in management of fire in the Otway Ranges. So, it's got heterogeneity at the level we're interested in. It's got a range of vegetation types and because of planned and unplanned fire over time, it's got a range of growth stages, so it's a good place to test our theory.

There are three phases to the work, the first was to investigate land mosaics which, as I said, capture variability in vegetation type and their post fire growth stage. The second was to work with land managers using planned fire to test some of our ideas and experimental framework. Those two phases have been completed and that's what I'm reporting on today, and the third was in time to go back re-measure, test our models and re-evaluate.

So, the first part, here's our part of the landscape and using spatial layers, we can pick a range of sites. This one is a simple mosaic with just the single vegetation type and growth stage. This is an example of a complex mosaic with multiple vegetation types and growth stages. So, we have 36 of these 100-hectare mosaics across the landscape, each with around five sites to sample within-mosaic complexity and over a couple of years., Our students sampled plant and animal communities and measured a range of supportive information, habitat variables, et cetera.

So, what did we find? The first one is asking this primary question, is there a relationship between environmental variability and species diversity at these landscape scales? So, a graph with bird species richness on the Y-axis and landscape diversity going from the simple to complex mosaic on the bottom, data points scattered around a linear regression line. Yes, there is a relationship. So, land managers can be comforted in the science that underpins their strategy. If they can create complexity across the landscape, that will support a greater range of bird species. But it's a weak relationship, statistically. There's a lot of scatter around that regression line, we need to understand what's driving some of that. I am sorry, the graphs have sort of faded out here a little bit and I'll try and run you through it. So, I've got two birds as an example. Up the top here, we've got the

Eastern Yellow Robin, that's a measure of abundance and activity there, time since fire on the bottom and three different vegetation types and what you see is the Eastern Yellow Robin increases in its activity and abundance with time since fire, pretty much evenly across these types. So, it's more interested in time since fire than it's interested in what vegetation type its in. Down the bottom here, the Whistler, not interested in time since fire, it just cares which vegetation type is available to it. So, these are two examples of why there's a lot of variability around that relationship with heterogeneity. Some birds don't care about fire induced heterogeneity; they're just interested in the background variability in the system, others are more interested in what happens after fire. Overall, as a summary, the vegetation in age class was a stronger driver, so the fire-related stuff was more important for more of the birds but, as you'd expect in a diverse landscape with a diverse bird assemblage, it is quite variable.

When Holly investigated this by comparing the results to the habitat variables, as we expected, it's habitat structure that's driving this and it's well-established in ecology. Fire does contribute to the variation in habitat structure, but it's not the only driver, so understanding habitat structure gives us a better explanation than just fire or vegetation type alone.

Matt Swan investigated the same issue with terrestrial mammals and I give two examples here. For the Southern Brown Bandicoot, we've got its probability of occurrence on the Y-axis and one habitat variable across here which is vegetation cover. Bandicoots aren't in the system until you reach a threshold and then they're happy and they're found there, so they're not too fussed about growth stage per se but they're interested in an aspect of it which is the amount of cover to protect them from predators and they're only found in one veg-type.

Down the bottom, the ubiquitous Bush Rat, varies a bit between the different veg-types but again, it's being driven by the amount of resource that's available to it in the habitat which is only weakly predicted by time since fire, and again, it was habitat structure, that was the best predictor of what we find in these systems which was only weakly related to time since fire and growth stage.

So, those results were useful to the managers because at large spatial scales heterogeneity is good, but at small spatial scales, they need to understand more about what's happening within the burn block than around it.

So, we tested that with an experimental manipulation. We used a planned burn and we had paired catchments, so it's a before/after control impact (BACI) design. You have another catchment that doesn't get burnt, so you can track changes over time that are unrelated to fire and you can try and understand the system a bit better. So, we ask a couple of simple questions during the fire. Where do the animals go? Do they, so in this picture here, the green bits are the burnt bits, the yellow bits are the bits that don't burn. Do the birds for example all go down to the gully and hang out there and avoid the fire and the ones that hang around, die. After the fire, do they leave or do they re-establish? Where do these things go? The local crews lit up the catchment for us. Over a three-day period, we had edges set alight and then some incendiary work done and the fire waxed and waned as it does in these systems over time. When we were allowed back in (that's an issue I'll come back to later on), for safety reasons, we mapped the fire. So the top diagram here shows all the hard work from one of our honour students, John, who traversed this system and mapped the fire extent and just as a comparison, we looked at the aerial imagery that had been done by DELWP using Rapideye so we could get an idea, to advise them, about the reliability of some of the remote sensing work that they were doing.

So, some examples from that experiment and I'm going to go back to the birds and Holly's work and we've got the control results on the left and then the impact and we've got three topographic positions here because we're interested in whether our results were consistent between ridge, gully and mid-slope as well. I draw your attention to the Fairy Wren where we see an increase in activity and abundance after the fire consistently across the landscape in burnt patches. The Fairy Wrens were quite happy with the patchy burn and the fire created open areas that improved their foraging success, so all was well for them. The Yellow Robin showed an opposite pattern, it decreased in abundance and activity in the burnt areas.

What we were saying about small scale mosaics within the burnt area was some birds were being advantaged in burnt areas, some were being disadvantaged, but there were unburnt areas that they could use and across the range of 70-odd species that we looked at, their resource needs were being met at that scale. The diversity of birds within the burnt catchment didn't change, so there was no loss of overall diversity. So, a patchy burn at the burn block scale was sufficient to maintain bird biodiversity in this landscape.

Matt looked at the small terrestrial mammals and two examples again. I draw your attention to the Bush Rat at the top here, in the gullies which by and large didn't burn that much but did burn in parts, the Bush Rats just hung in there and survived, but

on the mid-slopes, we found that the abundance and activity of Bush Rats declined in the burnt areas. We were marking and tracking these animals and so they disappeared from the system and I'll come back in a minute to ask the question, where did they go? This other cute little furry thing, the Agile Antechinus did the opposite. It took active refuge in the gullies to survive the fire. So, we have two different patterns here; the top is called the use of passive refugia which means that you stay put and if things are okay, you survive and if they're not, you don't; and active – there's a lot of humans out there that do this – or active refugia where you make a conscious decision to go somewhere else. So, we're seeing just two examples of behavioural strategies used by these small mammals in the system. So, these guys are alright, but what happened here? Where did these blokes go? As I said, Matt had collars on some of them, little radio-tracking collars, and we found the collars but they weren't attached to the animals. Some of them were in fox scats or found by themselves, so it was suggesting to us that there was mortality of these animals that chose to sit it out in these landscapes and that mortality may have been in part a response to predation.

Another student, Bronwyn Hradsky, who was looking at fox and cat predation, was catching, no mean feat, and radio collaring red foxes and then tracking their activity through the system. I've an example here, these are fixes from foxes moving around the landscape over time. The white is one fox before the fire, the blue is the same fox after the fire, the black-grey is before and the red is the second fox. So, we're seeing two strategies here; sorry, the light green, which is partly obscured but continues over here is the burn block. Before the fire, the foxes had their home ranges quite separate from each other. After the fire, this fox decided to just stretch its home range a little bit across into the burn block and capitalise on what was available there. This fox, very opportunistic, traversed quite a distance and spent a lot of time in the burn block. So, these predators are very opportunistic, if a fire or other disturbance occurs in their general area, it doesn't have to be in their home range, and they take advantage of it; this has been demonstrated with cats and foxes all over Australia.

Bron also looked at the diet and at fox scats before and after the fire to see what they were eating and so this little graphic shows that before the fire, they're eating lots of macropod-size things, a fair bit of bandicoot, ring-tail possum and echidna size, a bit of rat size and this is Bron's pizza sort of thing which says a bit of everything, frogs and whatever; foxes are opportunists. So, we have a fire in the landscape and Bron comes back and goes around and picks up lots of fox poo again and things have changed. So, it's quite evident that foxes are changing not only where they forage but what they eat and they're cutting back on their kangaroo/wallaby-size food and they're eating a lot of these middle-sized things. These are cover-dependent animals, so it's quite clear that the fire is reducing cover in places and making these animals more vulnerable to fox predation.

We're also interested in some of these mid-size animals and their behaviour during the fire, independent of fox predation. Another student, Carolina, who was radio tracking swamp wallabies and it's quite an undertaking, expensive at that time with collars costing $3500 each; they're a bit cheaper now. So, they've have got a GPS on them so you can follow them around the landscape. They've got an activity sensor, so you know what they're doing at various times and they've got a release mechanism at the end so the collar drops off and we can set the collars to record at various times. This is a map of the burnt catchment; the yellowy bits are the bits that I showed in the previous diagram that were mapped as burnt, this was beforehand. There's 11 wallabies and what they do and as you can see, they're variable in the size and spatial patterning in their home ranges. Some of these very extensive ones, the large males, that forage over a large area, were tracked these animals for a period of time before the fire. Over the three days, then we have a smaller data set here, the animals changed their patterns of activity. It was quite clear that they were avoiding the areas that were burnt and it was quite clear that they were relocating to the patches in the landscape that were unburnt.

The data I'm not presenting that are even more interesting than this is what the wallabies did themselves. So, we used Phoenix to model the rate of spread across the landscape and matched that up with the animal tracking records and it appeared that the wallabies just hopped in front of the fire and stopped and looked and assessed what was going on. At night time, when the fire activity died down, they'd go back and investigate and even go into some of the burnt areas that were in their home range before and then move out again. This was last burnt by wildfire in '83. None of these animals had experienced fire before, so it's quite extraordinary I think that their behaviour is so benign in the face of a disturbance like this they hadn't seen. So, really interesting in that regard and we hope to follow that up a bit more.

Then after the fire, as I have said, when we were allowed back into the area and could track again, these animals just went back to business. They moved back out into the area as the grass and cover recovered and they could get shelter and other resources. So, over the period that we studied these animals, there was no loss of life and no apparent ill health from what we could observe. It would appear

that the swamp wallabies were very resilient to this individual planned burn.

To summarise some of those data where we experimentally investigated what was going on during a planned burn, from our mapping, it was quite obvious that the planned burn in this landscape, and I'll come back to that in a minute, did create a range of patches at different spatial scales, so they achieved their management objective. That facilitated the retention of bird species diversity at that scale.

Amongst the animal communities that we studied, there were a couple of strategies and the two that I mentioned were active refugia, so the swamp wallabies and the antechinus actively avoided fire and took refuge, et cetera, whereas the bush rats were passive in their response to that and stayed within the territory that they knew, their home range, and may have suffered the consequence of that, and it looks like there are interactions between the process of fire and habitat variability and predation by foxes.

So, in this landscape, managers have achieved what they set out to do, that at the scale of the burn block, fires self-extinguish in wet gullies, they may burn the ridge tops a bit more severely, so you end up with a mosaic at a range of spatial scales that seem to be supporting the survival, in a short-term at least, of the animal communities that were there. This was problematic in other parts of the landscape, so in the wetter end of the Otways which is what this example I've given you down here, that's achievable, but to the northern end where we're moving into the heath dominated systems, that's hard to do. These colours reflect mapped fire severity and as you see, most of the severity was in the very high category here, and so most of the understory was removed and there were very few refugia. This creates a particular challeng which, if there are any fire managers in the audience, would be very aware of that in these drier, heathy, understory dominated communities, it's very difficult to control fire conditions to create patchy habitat. It requires a lot more resources of all kinds.

So, over the six years we can proudly say we have graduated six Ph.D students which was excellent and two Masters students and nine Honours students, that's good for the University. We've produced a range of scientific material; at the moment, we've got 11 peer review journal articles and four more to come. A lot of land managers, as you know and I don't blame them, don't read journal articles, so we've produced a number of user-friendly DELWP reports that underpin some of the science and interpret some of the work that we've done. For senior managers and for the general public who only read one or two pages at a time, we produced a summary brochure. We have a limited-edition number of these today if people are interested. I can also send you copies of them. I think more importantly, our engagement strategy was one of talking to people rather than just writing stuff down. So, we had a lot of community forums across the landscape, ones that we initiated, ones the community initiated, ones that involved the land management agency and ones that didn't. Many of you will have experienced this, various communities are very suspicious of having land managers in these forums but are happy to talk to the academics, and so you have to do a mix and match of trying to get people together and that's one of the real challenges of effective engagement. I say this with a smile, endless stakeholder meetings and workshops, government agencies, endlessly accountable for the money they spend so you need to keep patting them on the back and reassuring them that it's going well, and I make the point that we had a consistent end-user for the whole project; Gordon Friend who's now retired, unfortunately isn't here today. Having Gordon there from the start to the finish, understanding what we were doing and being supportive was such a plus for this project. Endlessly changing the people that you're talking to, bringing them up to speed all the time, is such a waste of resources for all concerned.

So, the agencies have got good science that underpins what they do and the academics have got good support from the agencies to continue doing what they like to do. What were the outcomes for management? So, as I said, some of this growth stage work underpins the resilience metrics work that's been adopted so we could provide feedback to DELWP about when growth stages were effective surrogates for biodiversity and when they weren't, understanding the limitations of what they were doing. We helped them with some of their fire severity modelling and as part of their monitoring strategy, they need to know which animals and plants they're going to look at, so we could give them some advice around which ones were vulnerable, which ones need refugia during fires, which ones don't mind, which ones can look after themselves, which ones are more vulnerable to predation and we can inform some of their monitoring programmes in this regard.

Victoria has adopted a Risk Landscape Approach which you may have heard yesterday and so they have to produce Strategic Bushfire Management Plans. Our science assisted these guys to develop their management planning because they understood that there was some utility in using this heterogeneity biodiversity model to underpin it and the growth stage approach.

As you may have also heard yesterday, they've adopted a Monitoring, Evaluation and Reporting (MER) framework across these Risk Landscapes, so we now have a series of study sites across the Otway

Ranges with good before data that they can now use in their monitoring program over time.

So, what happens next? We're now planning to go back and remeasure some of these sites, so some of that as I mentioned will be part of the MER that the Barwon-Otways Risk Landscape team are rolling out. The Parks Victoria people are rolling out an ARK (Otway Ark) program which has been used elsewhere in Victoria, they're going to use predator control techniques, so we've got some data that will be useful to them and also, we're going to work with them to develop a research program about the effectiveness of their fox and cat control.

We'll be able to test some of our models, so our landscapes are a mix of vegetation type and times since fire. Vegetation type isn't going to change. Fire has been rolled out across this landscape in the six years we've been there, so we'll be able to try and separate some of the effects of veg-type from growth stage in our physical models.

We've been doing some work with DELWP around their resilience metrics work and a lot of the outcomes that you could get are very contingent upon how you sample the design, how you define an age class and what species you include, so we're investigating that. As most of you will be aware, our natural landscapes are not always big contiguous blocks of land. They're often highly fragmented. So, you need to understand the spatial configuration of your mosaic and how that works. Luke Kelly from Melbourne Uni is working with groups from Latrobe to look at some of this spatialisation in the continuous landscapes and we have an ARC linkage project starting later this year looking at this work in fragmented landscapes. We are working closely cross-tenure, with a range of land management agencies, Trust For Nature, Aboriginal communities and a range of other stakeholders in southwest Victoria, so that's going to be very exciting and I have volunteered my services in a couple of years time to come back and talk about that.

We have learnt a lot in that time and we've learnt a lot about what we don't know, the old Donald Rumsfeld known unknowns. Predation is so important and Gordon Friend always knew this was the case, and it's something we need to understand a whole lot more about.

How do we configure our mosaics? We're going to do some genetic work to try and understand how genes, species at the genetic level, move around the landscape, edges and ecotones. How do you mix and match your mosaics and which ones need to be near each other so that animals can move across? You may have heard Julian Brown's talk yesterday where the wasp-orchid interaction is very contingent upon having a mix of old growth stages that maximise wasp abundance and young growth stages which facilitate orchids' survival. How we do that across the landscape? And of course, the old conundrum of time-since-fire is only one part of it. What about all the other bits? So, better fire severity mapping, better understanding of what constitute a habitat for animals, is the challenge for us all into the future and can we map this habitat. There's some work being undertaken using ground-based Lidar now. Can we map habitat at small spatial scales and understand this a bit better? And the technology is moving forward.

To conclude, we've been involved in strategic research. We deal with the guys in Head Office in Melbourne helping them to do long-term strategic planning. But it only works if we interact with the people in the regions and districts and on the ground and that's a real lesson for us and it's been a challenge for us, as researchers, to understand what's important for them and for them to understand what's important for us; so how we work together, and I think that is a good segue into the discussion this afternoon about how we effectively do that because that's the key to the success or failure of these programs. Thank you very much.

Appendix 3: Keynote Presenter Abstracts and Contact Details

Professor Ross Bradstock
Director - Centre for Environmental Risk Management of Bushfires, University of Wollongong, NSW

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A tale (mostly) of one city: toward a comprehensive understanding of bushfire risks, present and future

Abstract: Sydney is the largest city in the nation (circa. 5 million people in the greater region). The city and its accompanying Bioregion is endowed with spectacular natural assets, including rugged landscapes, picturesque waterways and diverse ecosystems. Fire is part of the furniture, posing both challenges, opportunities and a reminder to the human inhabitants of their interdependence with ecosystems. Exposure of people and property to recurrent fires is relatively high but both the perception and a quantification of the risk of losses is inadequately understood. A similar situation applies to biodiversity and the functioning of ecosystems on which residents directly and indirectly depend. Despite this situation, research progress into this problem has been rapid. Given the state of knowledge, five key conclusions emerge: 1) risks to people and property are low, in quantitative terms, but (paradoxically) are likely to be underestimated by residents; 2) ownership of risk and the responsibility for measures aimed at mitigation is shared; 3) a diversity of fire regimes is 'hard-wired' into many local landscapes which may buffer biota and ecosystems against changes; 4) manipulation of fire regimes to mitigate risks is possible but the scope is constrained by costs, benefits and socio-political will; 5) possibilities for change in the future may be surprising.

Dr Neil Burrows
Senior Principal Research Scientist - Department of Parks and Wildlife, WA

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Managing Fire in the New Millennium

Abstract: The new millennium has brought with it a spate of devastating bushfires across southern Australia; in central and northern Australia, vast tracts of land continue to be blackened by harmful hot fires. Drought and extreme fire weather events attributable to climate change, and the regional build up of flammable vegetation as a consequence of a reduction in area treated by prescribed burning, are key factors giving rise to mega-fires in southern Australia. The cessation of traditional Aboriginal burning practices across much of central and northern Australia has resulted in significantly altered fire regimes. Today, public land managers are required to manage fire for multiple outcomes including reducing the bushfire risk to human communities, conservation and environmental values. While the practice is contentious, prescribed burning is critical for managing flammable fuels to mitigate adverse impacts of bushfires on the things we value. Wise application of prescribed fire is also integral to maintaining biodiversity, ecosystem health and to reducing greenhouse gas emissions. Climate change, changing land use and land owner demographics, industrial legacies, population growth, declining resources, opponents to the practice, and onerous risk management and planning procedures have contributed to a decline in prescribed burning. While fire and land managers can do little about climate change, they can work with the broader community to reverse the declining trend in land treated with prescribed fire. This requires integration of scientific and traditional knowledge, practical experience, community engagement and support, and political and organisational commitment to adaptive management in a changing world.

Associate Professor Alan York
Head of the Fire and Biodiversity Research Program - University of Melbourne, Vic

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Fire, landscape pattern and biodiversity

Abstract: In fire-prone ecosystems, fire, an agent of disturbance, can influence landscape heterogeneity at a range of spatial scales. This heterogeneity varies not only over space, but with time, as successive disturbance events reshape landscape pattern. The range of post-disturbance states and their spatial configuration is expressed as a landscape 'mosaic'; the nature of which in both space and time is thought to have a substantial influence on biodiversity. Because different species have different resource requirements, heterogeneous areas should support a more diverse biota than homogeneous ones, leading to a positive relationship between environmental heterogeneity and species diversity. Heterogenous, species-rich landscapes should be more resilient to disturbances such as fire.

In 2009, following the large and significant 2003 and 2006/7 bushfires, the Victorian Department of Sustainability and Environment, concerned that such extensive fires were reducing landscape heterogeneity, initiated a Landscape Mosaic Burning (LMB) program to increase the amount of planned fire in the landscape. It was anticipated that this 'mosaic burning' undertaken at a landscape scale would help reduce the size, severity and impact of large-scale fire events, and maintain healthy and resilient ecosystems. The LMB program was accompanied by a substantial investment in research with partner institutions. Projects investigated aspects of fire refuges in the Central Highlands, and fire mosaics in East Gippsland and the Otway Ranges.

Outputs from our LMB research program in the Otways have improved understanding of relationships between biodiversity and landscape heterogeneity, identified strengths and weaknesses of using post-fire growth stages as surrogates for fauna habitat and helped refine our understanding of how other aspects of the fire regime and landscape features influence animal populations. In this presentation I summarise our research, highlighting what we have learnt, knowledge uptake by fire managers, and where we are currently going to refine current and evolving strategies.

Appendix 4: Presentations by Theme, Presenters and Contact Details

THEME 1: Fire and Risk

Chairs: Andrew Sturgess, Predictive Services Unit Manager, QFES and Cuong Tran, Ten Rivers, NSW.

Holistic bushfire management at a continental scale: Achieving consistency & improvements
Cuong Tran - Ten Rivers, Qld
tranc@tenrivers.com.au

Wye River Learnings and Recovery
Justin Leonard - CSIRO, Vic
justin.leonard@csiro.au

SABRE Fire - A Stochastic Simulation-based Fire Spread Decision Support System
Ben Twomey - Queensland Fire & Emergency Services, Qld
ben.twomey@qfes.qld.gov.au

Managing ecological risks in prescribed burning
Wayne Kington and Adrian Pyrke - Australian Fire and Emergency Service Authorities Council, Vic
wayne.kington@afac.com.au

Implementing a Risk Based Approach to Fire Management in Victoria
Frazer Wilson - Department of Environment, Land, Water and Planning, Vic
frazer.wilson@delwp.vic.gov.au

The application of economics in US wildfire management
Dr Tyron Venn*, David Calkin and Matt Thompson - University of the Sunshine Coast*, Qld and the USDA Forest Service, Rocky Mountain Research Station, USA
tvenn@usc.edu.au

QFES Predictive Services Team: Planning, preparedness, response & recovery
Andrew Sturgess - Qld Fire & Emergency Services, Qld
Andrew.sturgess@qfes.qld.gov.au

Investigating issues of implementing a strategic tenure-blind prescribed burning program in South Australia
Tim Groves - Department of Environment, Water and Natural Resources, SA
tim.groves@sa.gov.au

Mechanical Fuel Load Reduction Trials
Chris Slade, Dr Fabiano Ximenes and John Samuel - Department of Primary Industry, NSW
john.samuel@dpi.nsw.gov.au

Factors driving flammability in the mountainous forests of Victoria
Dr Jane Cawson, Dr Thomas Duff, Dr Trent Penman & Associate Professor Kevin Tolhurst - University of Melbourne, Vic
jane.cawson@unimelb.edu.au

Law for Resilience to Bushfire in peri-urban Australia: A Tasmanian Case Study
Joseph Wenta (S), Professor Jan McDonald & Dr Jeffrey McGee - University of Tasmania, Tas
Joseph.Wenta@utas.edu.au

Navigating asset protection and biodiversity conservation objectives associated with fire management in Dry Sclerophyll Forest, City of Gold Coast
Brooke Williams (S), Associate Professor Kerrie Wilson, Dr Luke Shoo and Dr Hawthorne Beyer - University of Queensland, Qld
brooke.williams@uqconnect.edu.au

THEME 2: Cultural Burning and Traditional Custodian Fire Projects

Chair: Oliver Costello, Visiting Fellow at Jumbunna Indigenous House of Learning at the University of Technology, NSW.

Cultural Pathways of Fire
Oliver Costello - Co-founder of the Firesticks Initiative and Visiting Fellow, University of Technology Sydney, NSW
Oliver.Costello@environment.nsw.gov.au

Fire Planning for the Katiti Petermann IPA : Family Fire Country
Jane Blackwood, Tracey Guest, Selina Kulitja, Bernard Bell and Raymond James - Central Lands Council, NT
Jane.Blackwood@clc.org.au

Cultural fire landscapes on North Stradbroke Island - Minjerribah
Dave Kington, Darren Burns and Dr Paul Williams - Queensland Parks and Wildlife Service, Quandamooka Yoolooburrabee Aboriginal Corporation and Vegetation Management Science, Qld
Dave.Kington@npsr.qld.gov.au
darren.burns@qyac.net
paul@vegetationscience.com.au

Winba = Fire: Developing a fire & seasons calendar for Wattleridge IPA
Michelle McKemey and Lesley Patterson - University of New England & Banbai Employment Development Aboriginal Corporation, NSW
mmckemey@myune.edu.au

Minyumai Rangers use fire & burning to convert a long-grazed & weed dominated clearing back into coastal forested wetland vegetation
Daniel Gomes, Marcus Ferguson, Justin Gomes, Daniel Wilson, Belinda Gomes, Emma Wilson, Kesha Wilson and Lilly Wilson - Minyumai Land Holding Aboriginal Corporation, NSW and Ngunya Jargoon Indigenous Protected Area, Jali Local Aboriginal Land Council, NSW
gomesdaniel193@gmail.com

Fusing 'Tech' and 'TEK': Queensland's Cape, fire and forging partnerships
Janie White and Les Harrigan - Queensland Parks and Wildlife Service and Rinyirru Land Trust Corporation, Qld
Janie.White@npsr.qld.gov.au

Fire management on the Western Cape: Tradition, science & building economic opportunity
Peter Barker, Gavin Kendall and Eddie Kendall - Pormpuraaw Aboriginal Shire Council & Queensland Indigenous Land & Sea Ranger Program, Qld
Peter.Barker@ehp.qld.gov.au

People, fire and landscape in the Bunya Mountains
Mick Smith - Bunya Murri Rangers, Qld
michael.smith@bmrg.org.au

Cultural fire management on the Sunshine Coast for the first time since traditional times
Kerry Jones and Susie Chapman - Bunya Bunya Country Aboriginal Corporation and Healthy Waterways and Catchments, Qld
kerryjones0108@gmail.com

Preliminary results from monitoring the responses of vertebrate groups to applying contemporary indigenous burning practices in northern NSW IPAs
David Milledge - Landmark Ecological Services, NSW
drmilledge@gmail.com

Ornithogenic fire – Birds as propagators of fire in the Australian savanna
Bob Gosford and Associate Professor Mark Bonta - Ethnoornithology Research Group and Penn State University, USA
bgosford@gmail.com

The Angel in the detail - diverse burning for cultural and environmental outcomes in Australia
Peta-Marie Standley[1] and Lewis Musgrave[2] - 1 James Cook University and Cape York Natural Resource Management, 2Awu Laya Kuku Thaypan Green Army, Qld
pstandley@capeyorknrm.com.au

THEME 3: Community Engagement- Building Partnerships and facilitating change

Chair: Craig Welden, SEQ Fire and Biodiversity Consortium, Qld.

Connecting Community and Koala using Phoenix Rapid Fire
Phillip Patterson - Rural Fire Service, NSW
phil.paterson@rfs.nsw.gov.au

Landholders linking through Landcare for landscape fire planning in the Queensland Murray Darling Basin for carbon, production & biodiversity
Rhonda Toms-Morgan, Col Paton, Peter Thompson, Lynda Hardwick, Roxane Blakley and Donna Hurley - Queensland Murray Darling Committee & EcoRich Grazing, Qld
rhondat@qmdc.org.au

Capacity Building in the Surat Basin
Murray Abel - Powerlink, Qld
mabel@powerlink.com.au

CFA Fire-Scape: Social factors in Community Fire Management
Mike McStephen - Wellington Shire Council, Vic
mike.mcstephen@wellington.vic.gov.au

Can citizens accurately report on fuel hazard?
Dr Ernst Kemmerer and Mark Wisniewski - Cradle Coast NRM, Tas
ekemmerer@cradlecoast.com

Building Partnerships and Facilitating Change for Improved Fire Management: The South East Queensland Fire and Biodiversity Consortium Model
Craig Welden - South East Queensland Fire and Biodiversity Consortium, Qld
Craig.W@hlw.org.au

THEME 4: Fire Ecology

Chair: Dr Penny Watson, Office of Environment and Heritage, NSW.

Evidence for bark thickness as a fire resistance trait from desert to savanna in fire-prone inland Australia
Professor Mike Lawes and Dr Catherine Nano - Charles Darwin University and The Department of Land Resource Management, NT
Michael.Lawes@cdu.edu.au

Tracking recovery and vital attributes of flora species after severe wildfire, Warrumbungle National Park, north-western NSW
Dr Penny Watson and Dr Elizabeth Tasker - Office of Environment and Heritage, NSW
pennyw@efa.com.au
Liz.Tasker@environment.nsw.gov.au

Fire effects on pollinators and pollination
Julian Brown (S) and Associate Professor Alan York - University of Melbourne, Vic
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Long-term effects of frequent fire on above-ground carbon stocks and vegetation structure in a wet sclerophyll forest in south-east Queensland
Dr Tom Lewis and Professor Chenrong Chen - Department of Agriculture and Fisheries and Griffith University, Qld
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Fire ecology of Brisbane's eucalypt forests
Dr Paul Williams, Dave Kington, Michelle Nash, Chandra Wood and Eleanor Collins - Vegetation Management Science, Queensland Parks and Wildlife Service and Brisbane City Council, Qld
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Vegetation boundary dynamics and relationships between fire severity and recruitment in a fire-sensitive heathland in the Gibson Desert
Boyd Wright - Northern Territory Herbarium, NT
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THEME 5: Fire, Soil and Climate Change

Chair: Dr Tom Lewis, Department of Agriculture and Fisheries, Qld.

Comparing smoke pollution from prescribed and wildfires: do we have a problem?
Dr Owen Price, Bronwyn Horsey and Phil Purdam - University of Wollongong and the Bureau of Meteorology, NSW
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Combating wetland burning – The ability of carbonate to suppress combustion of organic soils
Valerie Densmore - Department of Parks and Wildlife, WA
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Interactive relationships between fire frequency, insects and elemental cycling in Peachester State Forest
Orpheus Butler (S), Professor Chenrong Chen, Professor Brendan Mackey, Dr Tom Lewis and Professor James J. Elser - Griffith University and the Department of Agriculture and Fisheries, Qld
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Environmental determinants of grass and shrub cover across a transitional climate region: Implications of climate change on fuel dynamics
Dr Rebecca Gibson and Professor Ross Bradstock - Office of Environment and Heritage and the University of Wollongong, NSW
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Estimating air emissions for natural fires in south east Queensland
Rhiannon Tooker and Robin Smit - Department of Science, Information Technology and innovation, Qld
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Initial findings on the Bushfire Convective Plume Experiment: Examining Pyroconvection with Portable Radar
Nicolas McCarthy (S) - University of Queensland, Qld
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THEME 6: Maps and Models - Intelligent Fire Planning

Chair: Joshua Bull, Fireland Consultancy, Qld.

Can thermal imagery help inform landscape fire management and planning?
Shannon Mooney and Mik Petter - Healthy Waterways and Catchments, Qld
Shannon.M@hlw.org.au

TERN: Data Infrastructure that enables fire management
Associate Professor Nikki Thurgate, Dr Siddeswara Guru and Professor Tim Clancy - Terrestrial Ecosystem Research Network and the University of Queensland, Qld
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Science in practice: application of ecological metrics in strategic bushfire management planning
Imogen Fraser and Andrew Blackett - Department of Environment, Land, Water and Planning, Vic
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Modelling optimal growth stage distributions for biodiversity observation and ecosystem resilience
Matthew Chick (S) and Associate Professor Alan York - University of Melbourne, Vic
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Fire is not fire – The next generation of TERN fire remote sensing datasets
Stefan Maier - Terrestrial Ecosystem Research Network and the University of Queensland and Maitec, Qld
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Playing with fire: The disparities with observed and model predictions of fuel loads
Dr Diana Virkki - Ten Rivers, Qld
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THEME 7: Fire Management for Linear Infrastructur

Chair: Steve Martin, Powerlink, Qld.

Lines Through the Bush - Infrastructure Corridors and Fire Management: An SEQ Case Study and Factors to Consider
Dr Mark Shuster & Paul Veivers - Meandu Mine, Qld
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The Coordinated Agency Model for Improved Roadside Fire Management
Julian Selke and James Haig - Department of Transport and Main Roads and Queensland Fire and Emergency Services, Qld
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James.Haig@qfes.qld.gov.au

Corridor fires: What's different?
Dr Leasie Felderhof - Firescape Science, Qld
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Mahogany Glider movements near linear infrastructure
Ben Saal - Powerlink, Qld
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Electrical impacts of bushfires on transmission lines
Tony Gillespie - Gillespie Power Consultancy, Qld
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The Tasmanian Bushfires of 2013 - An Environmental Response
Michael Emmett - Tasnetworks, Tas
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THEME 8: Fire and Land Management

Chair: Micheal Reif, Sunshine Coast Regional Council, Qld.

Reflections on the NSW Bush Fire Environmental Assessment Code since 2006: Continuing to meet the need
Dr Simon Heemstra and Jennie Cramp - Rural Fire Service, NSW
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National Burning Project
Deborah Sparkes and Greg Esnouf - Australian Fire and Emergency Service Authorities Council, Vic
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Using prescribed burns to achieve biodiversity outcomes through weed management
Dr Kirsten Abley and Anthony Abley - Department of Environment, Water & Natural resources, SA
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Ecological ignitions: Suggestions on how to ignite ecologically beneficial fire in subtropical and tropical eucalypt forests
Dr Paul Williams - Vegetation Management Science, Qld
paul@vegetationscience.com.au

Red Hot Tips: Building capability & capacity of private landholders to conduct planned burning
Leanne Sherriff & Justin Cashion - Macquarie Franklin & Ground Proof Mapping, Tas
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Fire behaviour in buffel grass dominated mine site rehabilitation in central Queensland, Australia
Dr Phill McKenna & Dr Peter Erskine - University of Queensland, Qld
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The effect of fire and rainfall in gross primary productivity in northern Australian savannas
Barbara Bernal (S), Dr Andrew Edwards and Professor Lindsay Hutley - Charles Darwin University, NT
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THEME 9: Fire, Threatened Species and Conservation

Chair: Dr Geoff Lundie-Jenkins, QPWS, Qld.

Fire management for conservation: Outcomes of AWC's fire programs across northern Australia
Dr John Kanowski - Australian Wildlife Conservancy, Qld
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How long is too long: The response of woody plants to inter-fire intervals in grassy forests of the Border Ranges, NSW
Dr Penny Watson and Dr Elizabeth Tasker - Office of Environment and Heritage, NSW
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Planning, Implementing and evaluating fire management-Recurrent issues and responses in a range of environments
Murray Haseler - Bush Heritage Trust, Qld
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Managing fire to help prevent the extinction of the Coastal Emu: A successful collaboration between Hotspots and a more traditional NRM project
Mark Graham - Nature Conservation Council of NSW
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Relative effects of fire on fauna in fragmented grazing landscapes
Dr Teresa Eyre - Queensland Herbarium, Qld
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Overcoming critical ecological thresholds in fire-excluded ecosystems: Restoration of an endangered heathland in rapid transition to forest
Andy Baker - Southern Cross University, NSW
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Burning an endangered species: importance of understanding habitat dynamics for Northern Eastern Bristlebird conservation
Zoë Stone (S), Associate Professor Martine Maron and Dr Elizabeth Tasker - The University of Queensland, Qld and the NSW Office of Environment and Heritage, NSW
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THEME 10: Fires in the Past: Essential Knowledge for Management

Chair: Associate Professor Patrick Moss, University of Qld, Qld.

Late Quaternary fire regimes of Moon Point, Fraser Island
Philip Stewart (S) and Associate Professor Patrick Moss - University of Queensland, Qld
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Satellite imagery interpretation of current & past fire history information in the Upper Maranoa area of southern inland Queensland
Peter Thompson and Rhonda Toms-Morgan - Queensland Murray Darling Committee, Qld
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The influence of time since last fire on the soil seedbank and woody understorey of temperate eucalypt forests
Helen Vickers (S), Dr Craig Nitschke, Dr Thomas Duff and Dr Sabine Kasel - University of Melbourne, Vic
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A late Quaternary fire history of the Kimberley region, northwest Australia: new records from the Northern Kimberley Bioregion
Emily Field (S), Associate Professor Patrick Moss and Professor Hamish McGowan - University of Queensland, Qld
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Fires in the past: An overview of late Quaternary burning patterns for eastern Australia
Associate Professor Patrick Moss - University of Queensland, Qld
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A 150-year fire history of mulga dominated vegetation in semiarid Queensland, Australia
Dr Bradd Witt, Dr Jennifer Silcock and Dr Rod Fensham - The University of Queensland and Queensland Herbarium, Qld
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