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FROM HECTARES TO TAILOR-MADE SOLUTIONS FOR RISK MITIGATION: SYSTEMS TO DELIVER EFFECTIVE PRESCRIBED BURNING ACROSS AUSTRALIAN ECOSYSTEMS

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Cover: CFS firefighters conducting a prescribed burning in the Ngarkat Conversation Park, South Australia.

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EXECUTIVE SUMMARY

We are pleased to present the 2015-2016 Annual Report for the Bushfire and Natural Hazards CRC project, *From hectares to tailor-made solutions for risk mitigation: systems to deliver effective prescribed burning across Australian ecosystems*. By undertaking a systematic investigation of the drivers of prescribed burning effectiveness across southern Australia, the project will provide critical support to agency decision makers across the region.

This report describes the project goals, methods and activities since its commencement in July 2015. Naomi Stephens, our End User representative from the NSW Office of Environment and Heritage, provides an insight into the project's progress from a stakeholder perspective.

END USER STATEMENT

Naomi Stephens & Felipe Aires, *National Parks & Wildlife Service, Office of Environment & Heritage, NSW*

Currently NPWS manages around 9% of the land area of NSW and the majority of this land is located in some of the most remote and rugged bushfire-prone landscapes in south-eastern Australia. NPWS recognizes fire as a natural part of the Australian environment and acknowledges that it may pose a threat to human life, property and to the biodiversity and associated values such as tourism. The scenario of climate change and human expansion to areas on the edge of national parks exacerbate the challenge of protecting life, assets and value in an already challenging environment. NPWS is committed to ensure that fire management activities are undertaken with its best current practice, knowledge and expertise.

The use of prescribed burns to mitigate the impacts of bushfires is common practice across many fire management agencies in Australia and across the globe. Currently, there is a move towards changing the bushfire management approach from a hectare-based performance target to a risk-reduction target. The hectare target tactic only determines how much to burn without informing us on the effectiveness of the management. However, a risk reduction target method can focus in areas where we know it will have the greatest impacts.

Projects like this are critical to the strategic burn decision making process. It provides the policy and decision makers with the right tools and knowledge, leading to improved capability and expertise. Ultimately, this project will provide truthful assurance that the hazard reduction activities undertaken by NPWS deliver strategic value during future wildfire events.

So far the papers produced by this research have shown to be of great importance providing insights into how prescribed burn efficacy can change across variable landscapes and how biotical and physical variables are able to influence fire behaviour. It improves the ability of projecting changes to risk for various prescribed burning strategies across a range of ecosystems and bioregions and will certainly improve bushfire management across the state and in other jurisdictions. Once the Prescribed Burning Atlas is completed, the future of fire management in Australia will be supported by a powerful set of tools and knowledge that are able to greatly improve the quality of landscape management decision making.

INTRODUCTION

Prescribed burning in Australia, currently stands at a cross roads. The 2009 Victorian Bushfires Royal Commission recommended an annual treatment target of 5% of public land in Victoria. Subsequently, concerns have been formally raised (e.g. Bushfires Royal Commission Implementation Monitor 2013 Annual Report) that such an area-based target may not deliver the most effective levels of risk reduction for people and property in Victoria. Concurrently, some other States have adopted such a prescribed burning target, but formal attempts to evaluate its effects on risk to people, property and environmental values across different jurisdictions are lacking. Such extrapolation of the 2009 BFRC recommendation pre-supposes that there is a "one-size fits all" solution to the problem. While many agencies are moving toward planning systems supposedly based on risk assessment, knowledge of the best way to use prescribed fire to reduce risk to key values is generally lacking.

General principles need to be developed about how to apply a risk-based approach across widely varying environments, human communities and combinations of key management values. In essence, the use of prescribed fire for risk mitigation involves understanding how risk to any particular management value will respond to variations in the spatial location and rates of treatment. Managers and policy-makers need to know how these fundamental elements of prescribed burning can be tailor-made to suit the environmental and human context of their local jurisdictions. A variety of fundamental problems need to be overcome in order to deliver effective, tailor-made prescribed burning solutions across different Australian environments.

PROJECT BACKGROUND

RESEARCH QUESTIONS

Efficacy in altering fire regimes across differing environments

Fire regimes vary widely across Australian ecosystems as a function of climate, fuel, terrain and ignition variations. Treatment strategies in some parts of the tropics do not yield the same results in some arid and temperate communities. Differences in ignition rates, fuel structure and dynamics and fire weather are crucial determinants of the effectiveness and scope for effective implementation of prescribed burning, but no unified or comprehensive understanding of these constraints exists at a continental-scale. Solutions are therefore piecemeal and likely to lead to ineffective use of prescribed fire without due regard for these constraints.

Resolution of the demands of competing values.

A considerable body of evidence indicates that mitigation of risk to property and residents is best achieved through placement of treatments in close proximity to developments. By contrast, effective reduction of risk to some environmental values, such as catchments, may require different locations and rates of treatment across landscape. Uncertainty surrounding area-based targets versus a risk-based approach arises from the need to address multiple and contrasting management values.

Variation in human and natural values across landscapes and regions

Population density and the mix of key environmental values, along with land tenure and land uses, vary widely across Australia. This not only affects the exposure and vulnerability of key assets to fire but also the capacity to implement effective prescribed burning. Carbon, for example, is not stored at the same rate or maximum levels in arid compared with temperate regions. The mix of values and their relation to biophysical and climatic variation needs to be understood in order to assess any given prescribed burning strategy.

Modelling capacity and constraints

While simulation models are available for exploration of effects of prescribed burning scenarios, their systematic use to explore consequences of environmental, human and climate variation (as outlined above) is lacking. Furthermore, current risk modelling initiatives do not fully incorporate estimates of likelihood (i.e. ignition probabilities in time and space) or comprehensively deal with trade-offs between fire regime components (i.e. fire frequency and intensity) that are fundamental to risk assessment for carbon, water and vegetation structure and composition. Model outputs remain largely unvalidated or poorly benchmarked against empirical evidence.

PROJECT APPROACH

This project will address these problems and deliver a comprehensive:

1. continental-scale, spatially explicit quantitative predictions of the degree to which different rates and spatial patterns of prescribed burning can alter unplanned fire size, fire intensity and frequency across differing Bioregions as a function of underlying variations in climate, fuel, ignitions, topography and human influences;
2. quantitative prescribed burning solutions for effective risk mitigation for multiple, key values (people, property, carbon, water and vegetation structure) to suit characteristics of differing landscapes and regions as a function of their human and environmental context;
3. interface for end-users (i.e. 'Prescribed Burning Atlas'), that will provide quantitative risk-response curves for prediction of the outcome of differing treatment strategies across varied Bioregions;
4. continental-scale, spatio-temporal fuel accumulation and ignition probability models that will provide a dynamic capacity for operational prediction across the nation, accessible via the Atlas;
5. projections of changes to risk for differing prescribed burning strategies under scenarios of climatic and human change, across a representative range of ecosystems and Bioregions, accessible via the Atlas.

Work will build on proven empirical and statistical approaches to assemble an overview of how the effectiveness of prescribed burning in altering fire regime components varies across southern Australia states. Biophysical and climatically-based models of fuel and ignitions will be compiled to support these analyses. 12 to 15 intensive case studies will explore risk mitigation trade-offs for property, carbon, water and vegetation structure under varying prescribed burning strategies. The case studies will be distributed along known environmental and land-use gradients transcending southern Australia and spread across NSW, VIC, Tasmania, SA and southern WA. The case studies will integrate prior empirical analyses (above) with spatially-explicit simulation modelling of fire spread and intensity and the results will be related to underlying climatic biophysical, climatic and human gradients, thereby providing a functional, quantitative basis for extrapolation of the results. These case studies will also quantify how risk mitigation achieved by particular prescribed burning strategies may change in response to future changes in climate and human influences, incorporating future changes to fuel and ignitions via empirical biophysically based models.

The results will be used to explicitly model risk as a function of treatment as a function of underlying biophysical and climatic variation, providing the basis for the "Prescribed Burning Atlas". This will provide a vehicle for ongoing refinement and updating as new case studies, key data layers and underlying analyses and modelling are developed in the future. Thus the project will provide a risk assessment information framework, based on human and environmental determinants, which can harness ongoing research. Such a capability will be able to encompass new data analyses and model outputs (i.e. future extension to northern, tropical Australia).

WHAT THE PROJECT HAS BEEN UP TO

RESEARCH

Data acquisition is a major task in the early stages of the project. It is proceeding well, with stakeholders supplying a range of fire-related, biophysical and human-related datasets. The project carried out an audit of existing data, metadata and storage protocols. Case study areas have been selected for fire spread simulations across southern Australia, based on the need to explore climatic, population and land use variation across the region. Simulations have begun.

RECRUITMENT

The project gathered steam with the appointment of two key positions. Dr Hamish Clarke will be working out of both the University of Wollongong and Western Sydney University. He will be leading the empirical analysis, data management, project management and other tasks. Brett Cirulis is working out of Melbourne University and is leading the case study part of the project, involving simulations using the Phoenix model.

INVITED TALKS

Owen Price was invited to give the keynote talk at the International Conference on Forest Fires and WUI Fires at Aix En Provence, France in May 2016. His talk was titled 'WUI fires in Australia: understanding the risks and optimising the response.'

Trent Penman was invited to speak at the International Society for Ecological Modelling Global Conference in Baltimore, USA in May. His talk was titled 'A probabilistic fire regime risk management tool using Bayesian Networks.'

MEDIA

Owen Price wrote a piece in "The Conversation" in October 2015 about the problem of unplanned fires in the tropical savannas and the effectiveness of prescribed burning to reduce the impact.

http://theconversation.com/huge-fires-are-burning-northern-australia-every-year-its-time-to-get-them-under-control-49431

Ross Bradstock and Hamish Clarke were quoted in the Sydney Morning Herald article by Peter Hannam on May 21 2016, 'Smoke over Sydney: welcome to the autumn of the future.'

http://www.smh.com.au/environment/smoke-over-sydney-welcome-to-the-autumn-of-the-future-20160520-gozrp6.html

Ross Bradstock was interviewed on 'Afternoons with James Valentine' on 702 ABC Sydney on May 23 2016.

MEETINGS

A major two day meeting of the project team was held in April 2016 to allocate tasks and develop a detailed action plan consistent with meeting the formal project milestones. Monthly full project team meeting are occurring, as well as daily interactions among team members concerning the execution of tasks.

PUBLICATIONS

The project team has recently published a synthesis paper (see Publications List) which examines potential effect of prescribed burning on area burned using an established methodology. This provides an initial empirical overview and baseline for validation of relevant simulation output for case studies, based on state agency fire history data. An analysis of the relationship between time-since-fire and fire severity has been conducted for 23 fires across NSW, partly funded by the NSW Office of Environment and Heritage. A paper is expected to be accepted for publication in the International Journal of Wildland Fire in the next few weeks (a requested minor revision has been re-submitted to the journal). This work will be used as a template for large samples of fire severity data from other states covered by the project. Other recent publications, by project team members, that are relevant to the project methodologies, but completed external to the project, are summarised in the Publications List.

END USER INVOLVEMENT

Project staff have been in regular contact with State agency stakeholders from Queensland, the ACT, Victoria, Tasmania, South Australia, NSW and Western Australia. These stakeholders have been positive and keen to see the project develop and succeed. They have actively supplied large spatial data sets dealing with fire history and severity, vegetation, infrastructure and assets, burning blocks and other key inputs for modelling and analyses. Thus key agency stakeholders have direct involvement in the project, which underpins their support.

PUBLICATIONS LIST

FROM THE INITIAL PHASE OF THE PROJECT

1. Price O, Penman T, Bradstock R, Boer M, Clarke H. (2015) Biogeographical variation in the potential effectiveness of prescribed fire in southeast Australia. Journal of Biogeography, 42, 2234-2245.
2. Storey, M, Price, O, Tasker, E (in review) The role of weather, past fire and topography on crown fire occurrence across NSW. International Journal of Wildland Fire

RELEVANT RECENT PUBLICATIONS

3. Boer MM, Bowman DMJS, Murphy BP, Cary GJ, Cochrane MJ, Fensham RJ, Krawchuk MA, Price OF, Resco De Dios V, Williams RJ, Bradstock RA Future changes in climatic water balance determine potential for transformational shifts in Australian fire regimes. Environmental Research Letters 11(6), doi:10.1088/1748-9326/11/6/065002.
4. Bradstock RA, Penman T, Boer M, Price O, Clarke H. (2014) Divergent responses of fire to recent warming and drying across south-eastern Australia Global Change Biology 20, 1412-1428.
5. Collins L, Bradstock RA, Penman TD (2014). Can precipitation influence landscape controls on wildfire severity? A case study within temperate eucalypt forests of south-eastern Australia. International Journal of Wildland Fire 23, 9-20.
6. Driscoll DA, Bode M, Bradstock RA, Keith DA, Penman TD, Price OF (2016) Resolving future fire management conflicts using multi-criteria decision making. Conservation Biology, 30, 196-205.
7. Penman TD, Bradstock RA, Price OF (2013). Reducing wildfire risk to urban developments: simulation of cost-effective fuel treatment solutions in south eastern Australia. Environmental Modelling and Software, 52, 166-175
8. Penman TD, Collins L, Price OF, Bradstock RA, Metcalf S, Chong DMO (2013). Examining the relative effects of fire weather, suppression and fuel treatment on fire behaviour. Journal of Environmental Management, 131, 325-333
9. Penman, TD, Nicholson A, Bradstock RA, Collins LC, Penman S, Price OF. (2015) Reducing the risk of house loss due to wildfires. Environmental Modelling & Software, 67, 12-25.
10. Penman TD, Collins LC, Syphard A, Keeley J, Bradstock RA. (2014) Influence of fuels, weather and the built environment on the exposure of property to wildfire. PLoS ONE 9, e111414. doi:10.1371/journal.pone.0111414.
11. Thomas PB, Watson PJ, Bradstock RA, Penman TD, Price OF (2014) Modelling litter fine fuel dynamics across climate gradients in eucalypt forests of south-eastern Australia Ecography, DOI: 10.1111/ ecog.00445

CURRENT TEAM MEMBERS

Professor Ross Bradstock (Director, Centre for Environmental Risk Management of Bushfires (CERMB), School of Biological Sciences, University of Wollongong

Dr Owen Price (Senior Research Fellow, CERMB, University of Wollongong)

Dr Matthias Boer (Senior Lecturer, Hawkesbury Institute for the Environment (HIE), University of Western Sydney)

Dr Trent Penman (Lecturer, Department of Forest and Ecosystem Science, University of Melbourne)

Mr Brett Cirulis (Research Associate, Department of Forest and Ecosystem Science, University of Melbourne)

Dr Hamish Clarke (Research Fellow, CERMB, University of Wollongong)

Ms Tatiana Mondragon Cortes, PhD Candidate, HIE, University of Western Sydney)