bushfire&natural HAZARDSCRC

OPTIMISATION OF FUEL REDUCTION BURNING REGIMES FOR FUEL REDUCTION, CARBON, WATER AND VEGETATION OUTCOMES

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Business Cooperative Research Centres Programme

THE UNIVERSITY OF SYDNEY

CURRENT TEAM MEMBERS

University of Sydney Researchers:

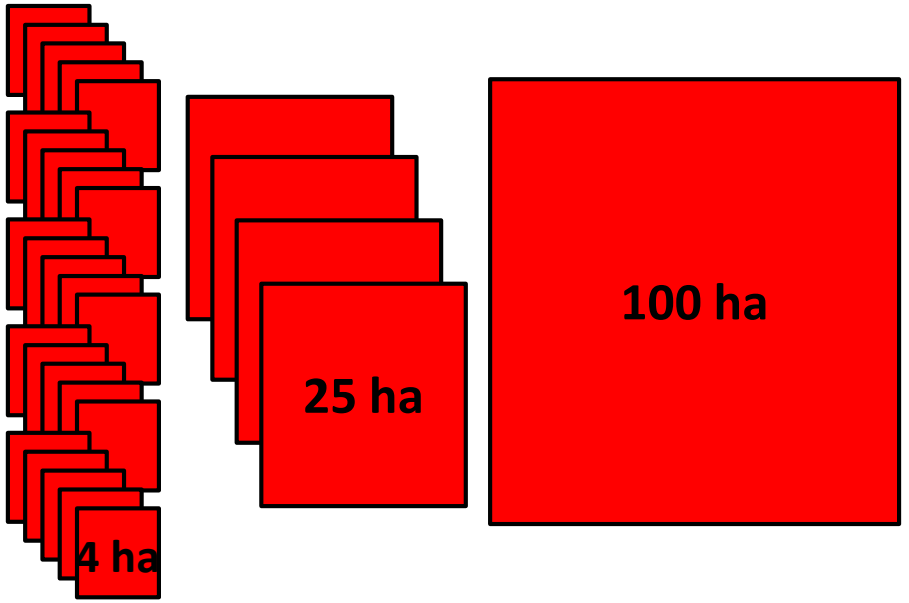
- Mana Gharun – Postdoctoral Research Associate in Spatial Modelling – Biogeochemistry and Fire (since November 2014, BNH CRC funded)
- Ariana Iaconis – Forester/Research Assistant (since October 2014, BNH CRC funded)
- Maggie Norton – Research Assistant (since March 2015, BNH CRC funded)
- A number of in-kind researchers and support staff

End Users include:

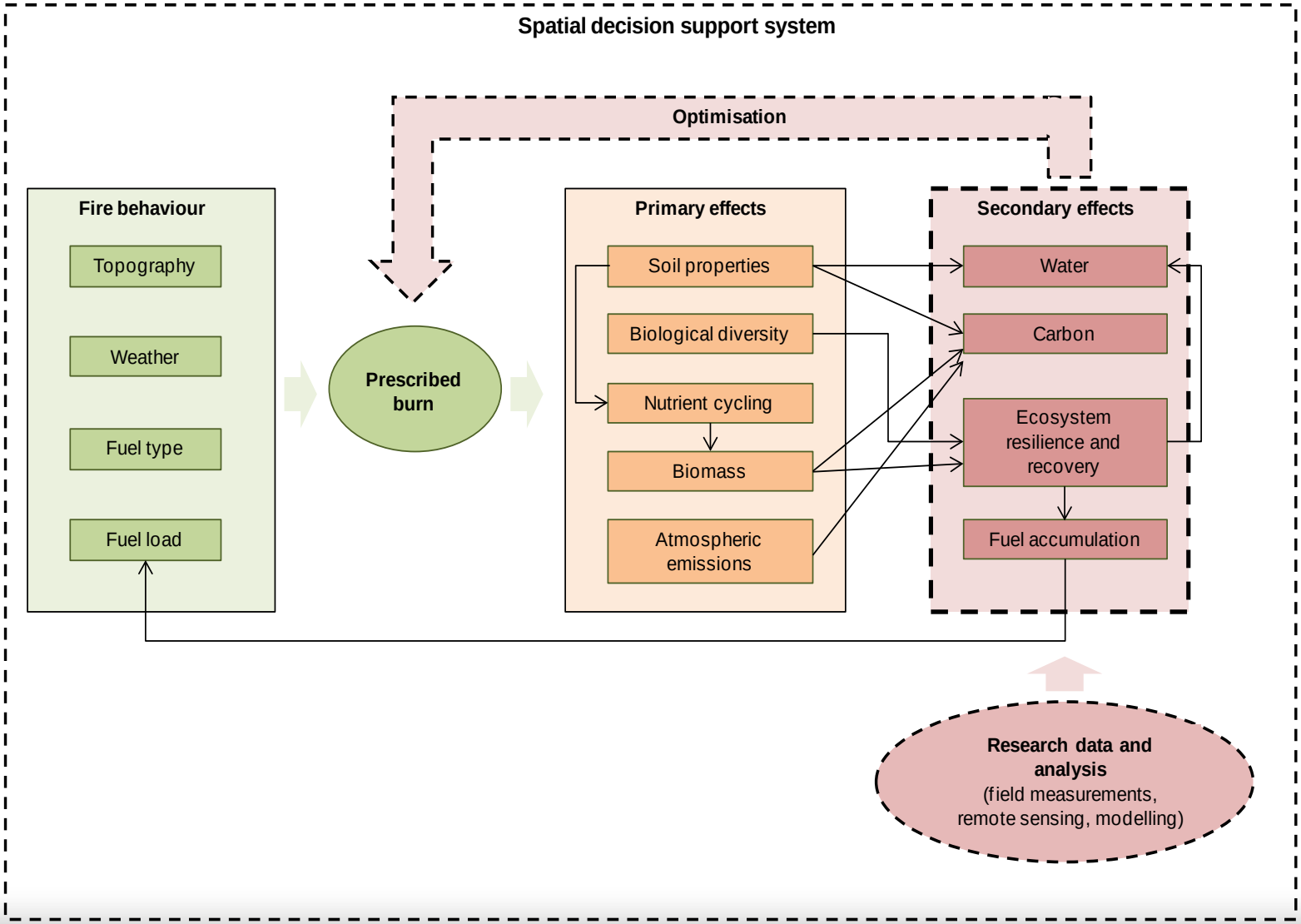
- Naomi Stephens, Office of Environment and Heritage, New South Wales
- Max Beuker, National Parks and Wildlife Service, NSW.
- Mike Wouters, Department of Environment, Water and Natural Resources, South Australia
- Liam Fogarty, Department of Environment and Primary Industries, Victoria
- Neil Cooper and Adam Leavesley, ACT Parks and Conservation Services
- Lachlan McCaw, Department of Parks and Wildlife, Western Australia

LAND MANAGERS WANT TO KNOW

1) What does it cost to implement fuel reduction burns and how effective are they?
2) What is the cost to environmental values for the size of each burn?
   - Carbon outcomes
   - Water outcomes
   - Vegetation outcomes



OPTIMISATION OF HAZARD-REDUCTION BURNING



OBJECTIVES

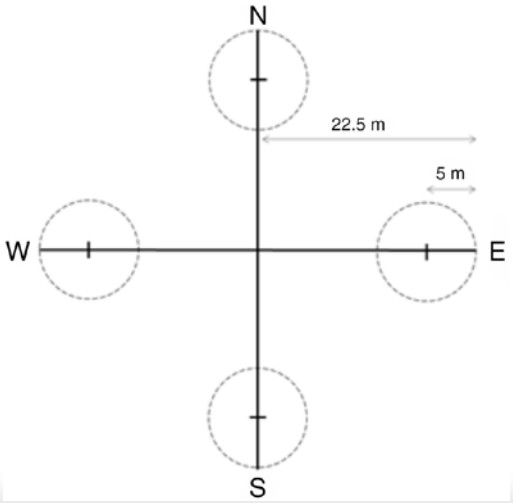
1) Development of a sampling protocol to quantify key variables at fuel reduction fires
2) Design and test a statistical robust sampling scheme for use at range of spatial scales
3) Application of sampling schemes and field techniques at fuel reduction fires
4) Laboratory analysis of soil and plant samples
5) Data analysis and synthesis to assess the effects of size of fuel reduction fires
6) Developing routine and reliable measures of effects of fire intensity on soil carbon
7) Developing spatially accurate measures of soil water storage and dynamics based on soil moisture content

DEVELOPMENT OF SAMPLE SCHEMA

1) Burn units have been developed to measure spatial variability in fires. A burn unit equals a burned area and its control.
2) The schema was circulated to participants prior to field work and protocols were demonstrated while in the field.
3) Our field sampling protocol ("Sampling Schema") was used as a training tool for staff from ACT PCS, NPWS NSW and staff and students from the University of Sydney.
4) The data collected has been analysed and found to be of very high quality.

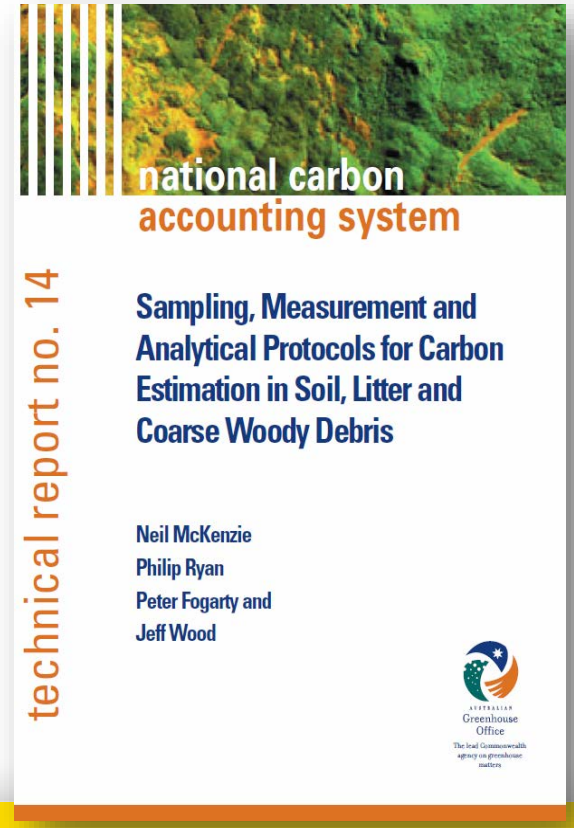
Plot layout for data and sample collection.

Source: Possell *et al.* (2015).



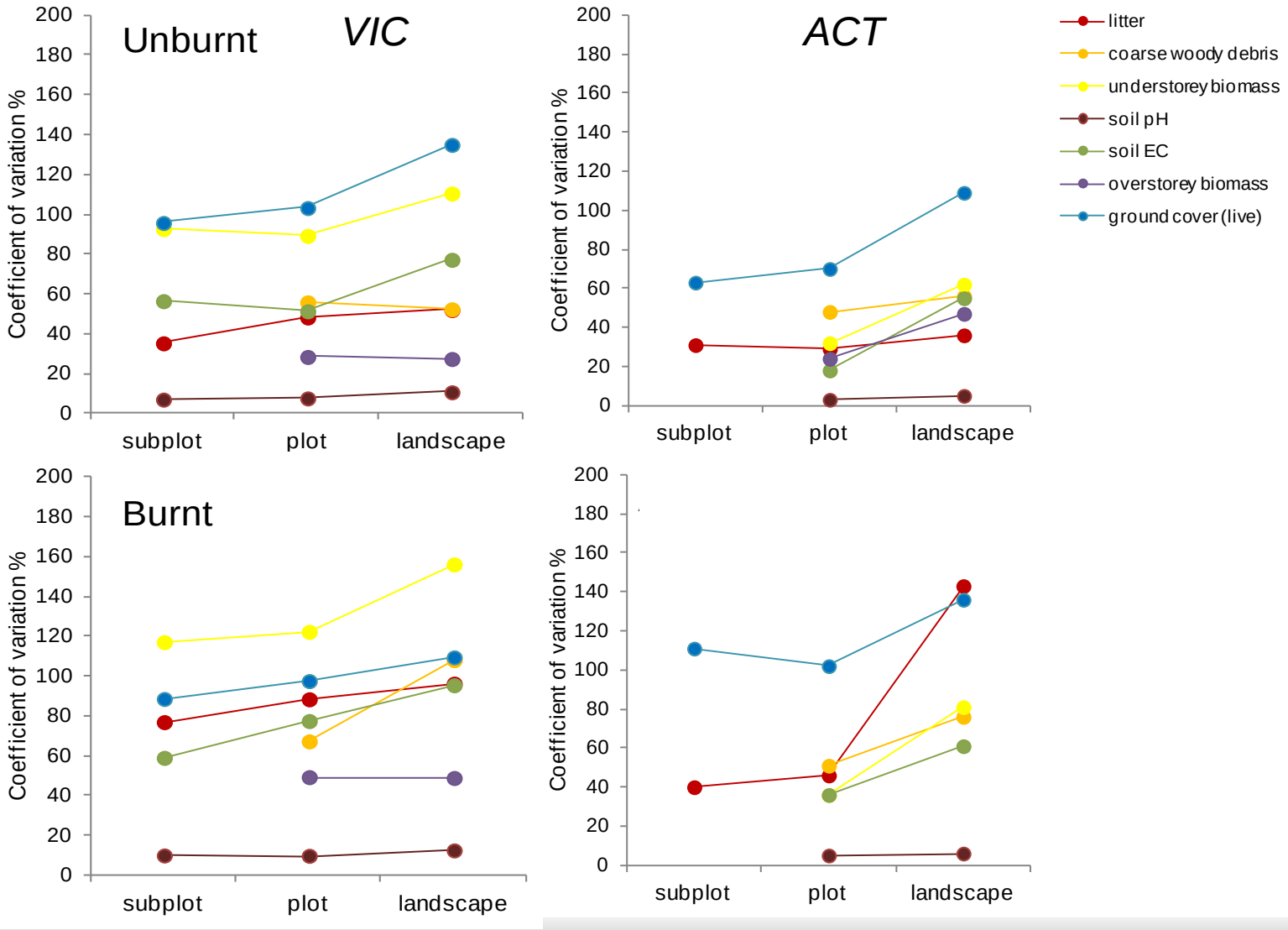
LANDSCAPE VARIABILITY

1) General assumption: variability increases from small (~1 m) to large spatial scales (~1 km)
2) Fire characteristics change with fire size (e.g. intensity, patchiness)



- How much variability is captured in environmental measurements collected at different spatial scales? What is the optimal number of samples required for burnt and unburnt areas? How does fire size affect the accuracy of the measurements?

VARIATION WITH SCALE OF MEASUREMENT

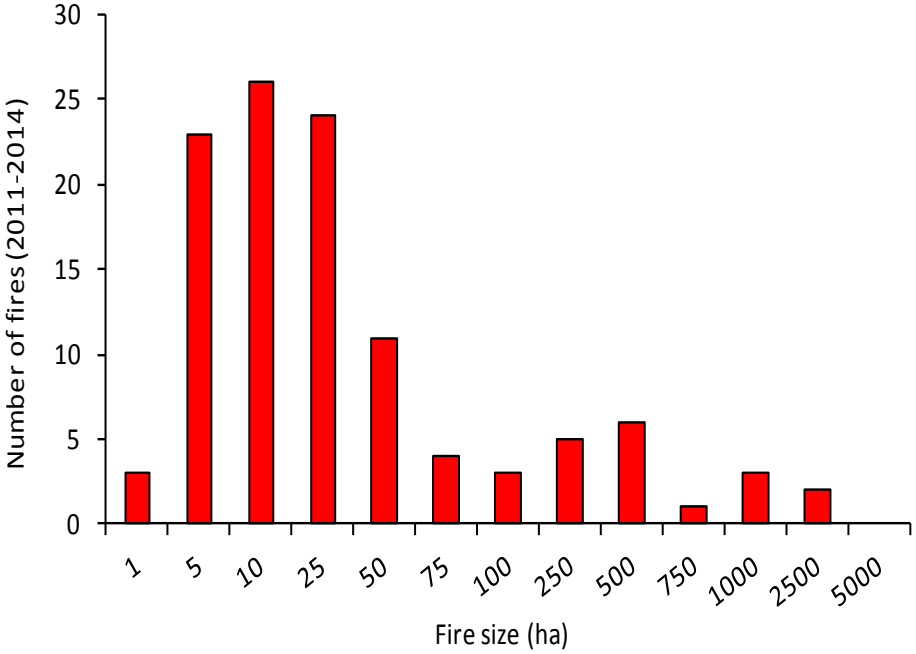


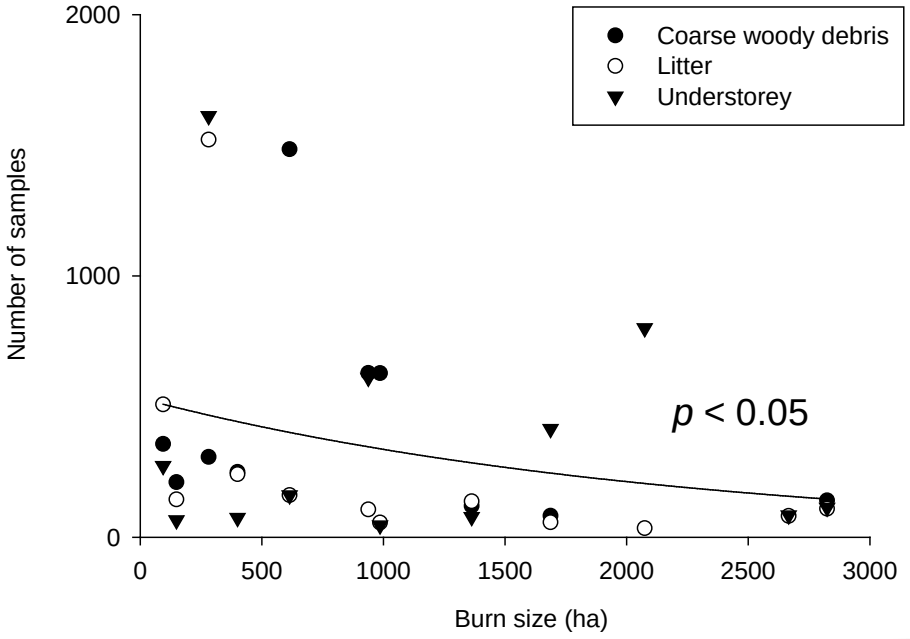
OPTIMAL SAMPLING DENSITY AT THE LANDSCAPE SCALE

Measurement	Before					After				
	mean	SD	$n_{0.05}$	$n_{0.10}$	$n_{0.15}$	mean	SD	$n_{0.05}$	$n_{0.10}$	$n_{0.15}$
Litter (t ha^{-1})	13.6	7.4	474	118	53	3.6	3.8	2306	576	256
Ground cover biomass (live, t ha^{-1})	1.0	1.4	4075	1019	453	0.04	0.1	13696	3492	1552
Understorey biomass (t ha^{-1})	17.9	20.1	1792	448	199	12.7	20.9	3867	967	430
Overstorey biomass (t ha^{-1})	296.6	122.2	297	74	33	335.2	269.8	1326	331	147
Overstorey leaf area index	0.9	0.2	69	17	8	0.8	0.2	146	36	16
Coarse woody debris (t ha^{-1})	46.5	26.3	641	160	71	27.8	26.8	1637	409	182
Soil pH	5.6	0.5	15	4	1	5.6	0.5	14	4	1
Soil EC (µs cm^{-1})	39.5	57.7	3389	847	376	44.3	43.6	1468	367	163

(Following Mollitor et al. 1980)

BURN SIZE AND SAMPLING FREQUENCY





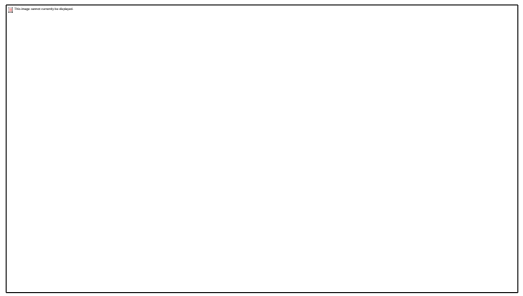
DEVELOPING AN EMPIRICAL METHOD FOR DETERMINING BURN SEVERITY BASED ON SOIL CARBON

AN EXAMPLE OF A VISUAL BURN SEVERITY INDEX FOR SOIL (Jain et al. 2008).

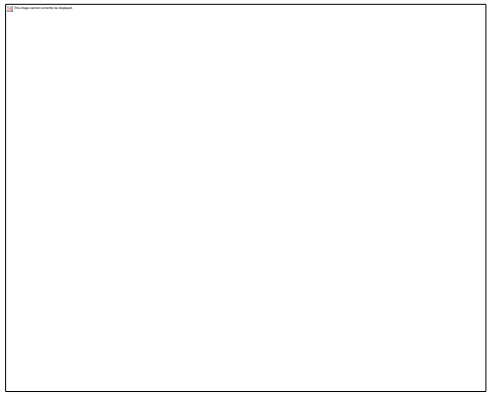
Level of soil burn severity	Indicator characteristic 1	Indicator characteristic 2	Indicator characteristic 3
0	Unburned	No evidence of recent fire	-
1	>40% litter cover	Charred and unburnt litter present	Mineral soil with black char; litter fall since fire
2	2 – 39% litter cover	Mineral soil with black char	Grey char from burnt logs; litter fall since fire
3		Mineral soil with black or grey char	Lines of orange under logs; litter fall since fire
4	<1% litter cover	Mineral soil with black char	Grey and orange-coloured soil under logs; litter fall since fire
5		Mineral soil with black or grey char	Orange-coloured soil under logs; litter fall since fire
6		Mineral soil with orange char	Black ash line present below soil surface

1) Fire severity assessments can be subjective and time consuming
2) Aim is to link unique chemical signatures of soil carbon with measurements of soil temperature and indices of fire intensity and severity to calibrate a quantitative algorithm of intensity or severity.

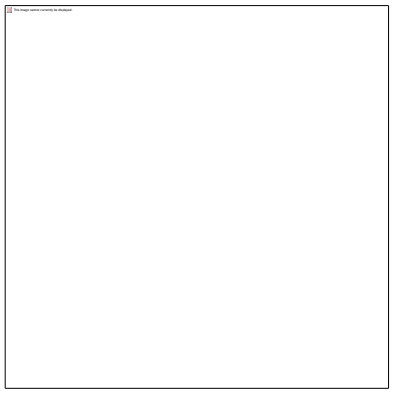
DEVELOPING AN EMPIRICAL METHOD FOR DETERMINING BURN SEVERITY BASED ON SOIL CARBON



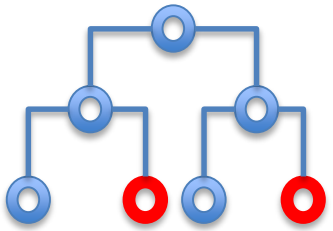
1. Pyrolysis GC-MS



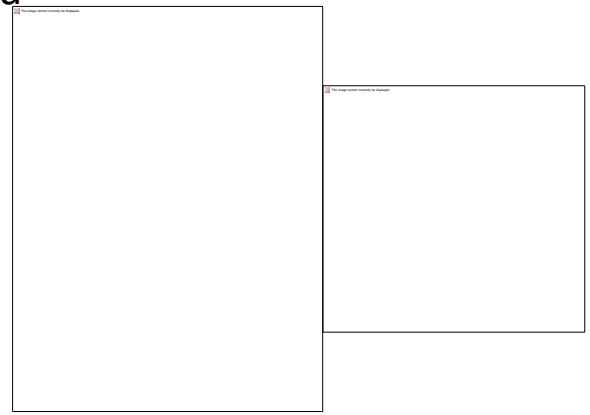
2. Generation of mass-spectral data



3. Cluster analysis and pMANOVA



4. Ensemble learning method



5. Isolating important classifiers

Cluster ID	Importance ($\times 10^{-5}$)	Compound name
117	7.9578	1-methyl-4-(1-methylethyl)-2,3-Dioxabicyclo[2.2.2]oct-5-ene
26	6.7576	Ethylbenzene
29	5.7148	Methylenecyclooctane
43	5.6922	(Z,Z,Z)-9,12,15-Octadecatrienoic acid

6. Identifying important compounds

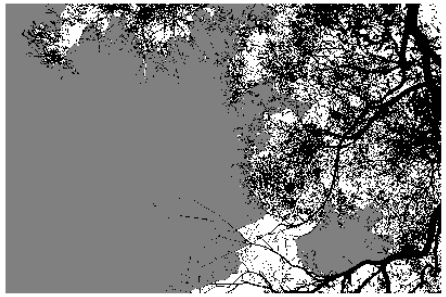
DEVELOPING AN EMPIRICAL METHOD FOR DETERMINING BURN SEVERITY BASED ON SOIL CARBON

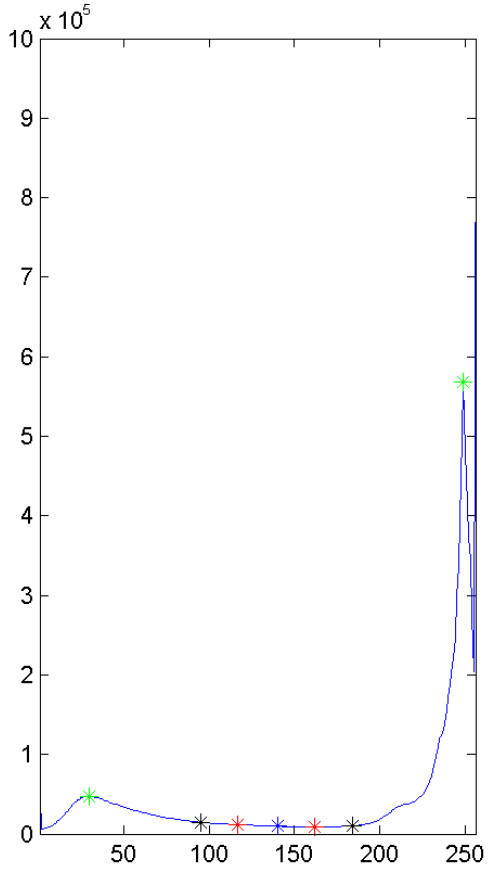
- Still a work in progress:

1. Need to compare potential marker compounds identified from ACT prescribed burn soil with other sites and soil from bushfires.
2. If common set of compounds identified these need to be related to fire intensity and severity parameters to make a predictive algorithm
3. Number of samples needed can be related to spatial variability research

PRESCRIBED BURNING IMPACT ON WATER YIELD

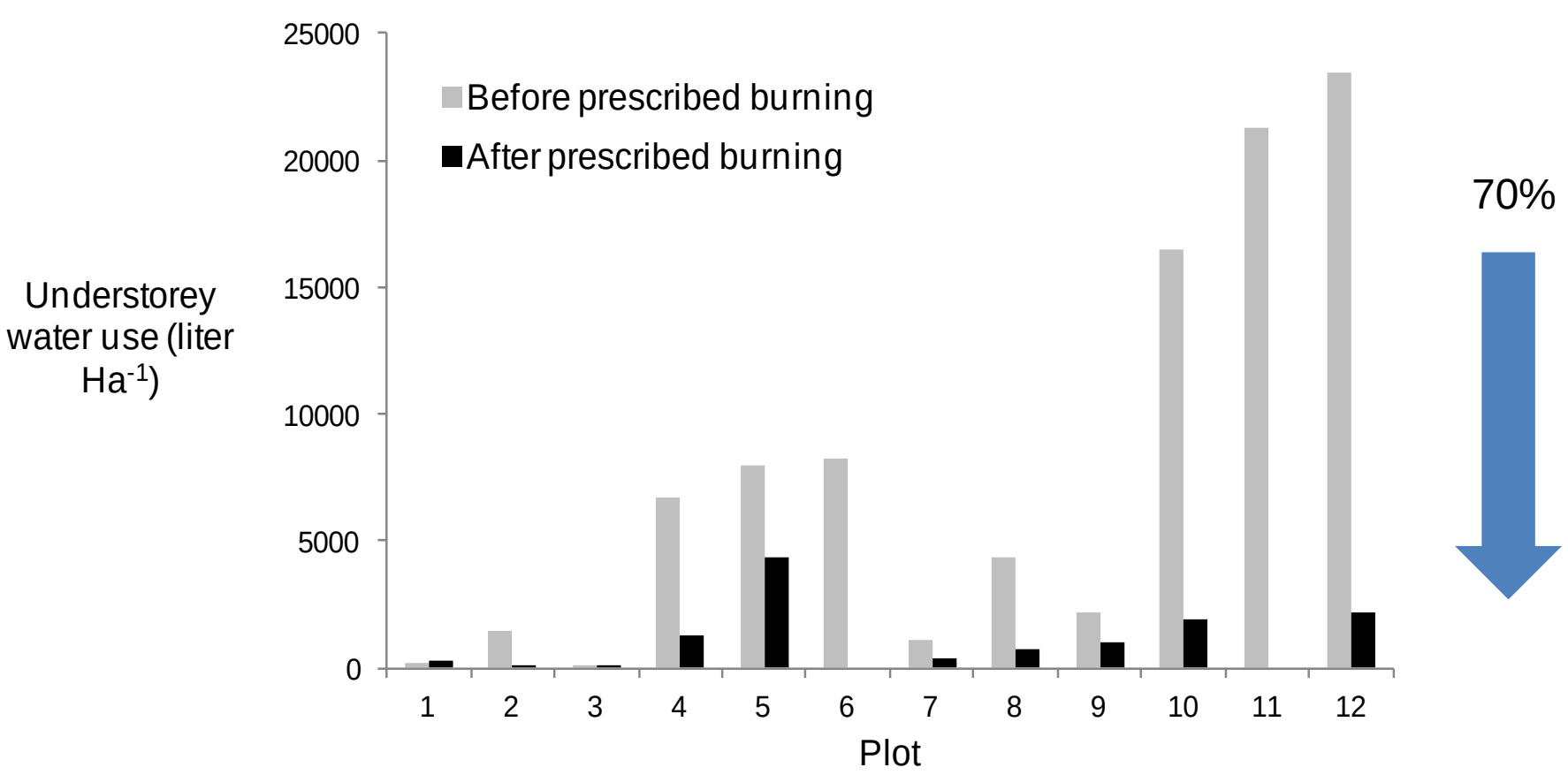
Foliage cover estimation





Tree water use

PRESCRIBED BURNING IMPACT ON WATER YIELD



TEACHING AND TRAINING ASSOCIATED WITH BNH CRC IN 2015

1) Houzhi Wang - Initiation of biomass smouldering combustion (PhD candidate – University of Adelaide; BNHCRC funded)
2) Mengran (Clare) Yu – Modelling the effect of fire on the hydrological cycle (PhD candidate – USyd; BNHCRC funded)
3) Bonnie Cannings – (BEnvSys Honours Project)
4) Erika Sedlacek de Almeida (University of Sydney Internship Program)
5) Amanda Josefsson (University of Gothenberg – Internship)
6) Katharina Leser (University of Bielefeld – DAAD internship)
7) University of Sydney students at RFS HQ

(http://www.bnhcrc.com.au/news/blogpost/tina-bell/2015/next-generation-education)

PROGRESS AND END USER ENGAGEMENT: NEXT 6–12 MONTHS

1. Already met sampling targets for 2016 (54 burn units).

2. Calibration and testing of fuel, vegetation, water and carbon models.

3. Continued development of method to estimate burn severity

4. Fieldwork in places such as south QLD, SA, TAS and northern NSW to validate model development