Current trends in ecological research: developing tools for land managers

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Workshop: *The practical application of fire and fuels research in prescribed burning*

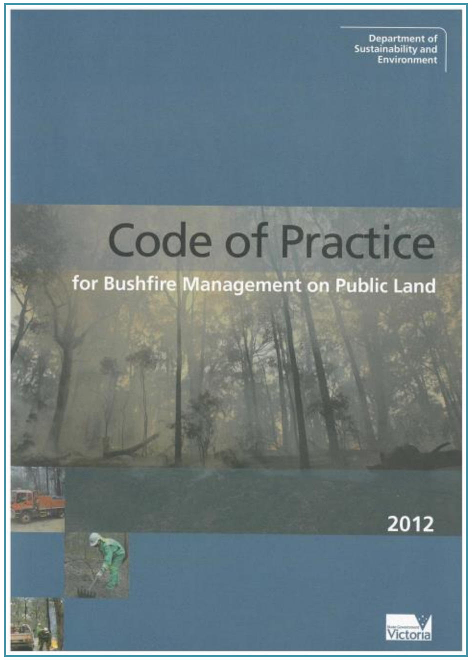
29th April 2019

Background:
Maintaining ecosystem *resilience*

Fire management objectives:

- To minimise the impact of major bushfires on human life, communities, essential and community infrastructure, industries, the economy and the environment.

- To maintain or improve the resilience of natural ecosystems and their ability to deliver services such as biodiversity, water, carbon storage and forest products.



Background:
Victorian resilience metrics - vegetation

- ➢ Tolerable Fire Interval (based on Cheal 2010)

- Proportion of total area (statewide and by EFG) currently:
  - below minimum TFI
  - above maximum TFI
- Annual and cumulative area of each EFG burnt while below minimum TFI
- Variation in inter-fire periods over time

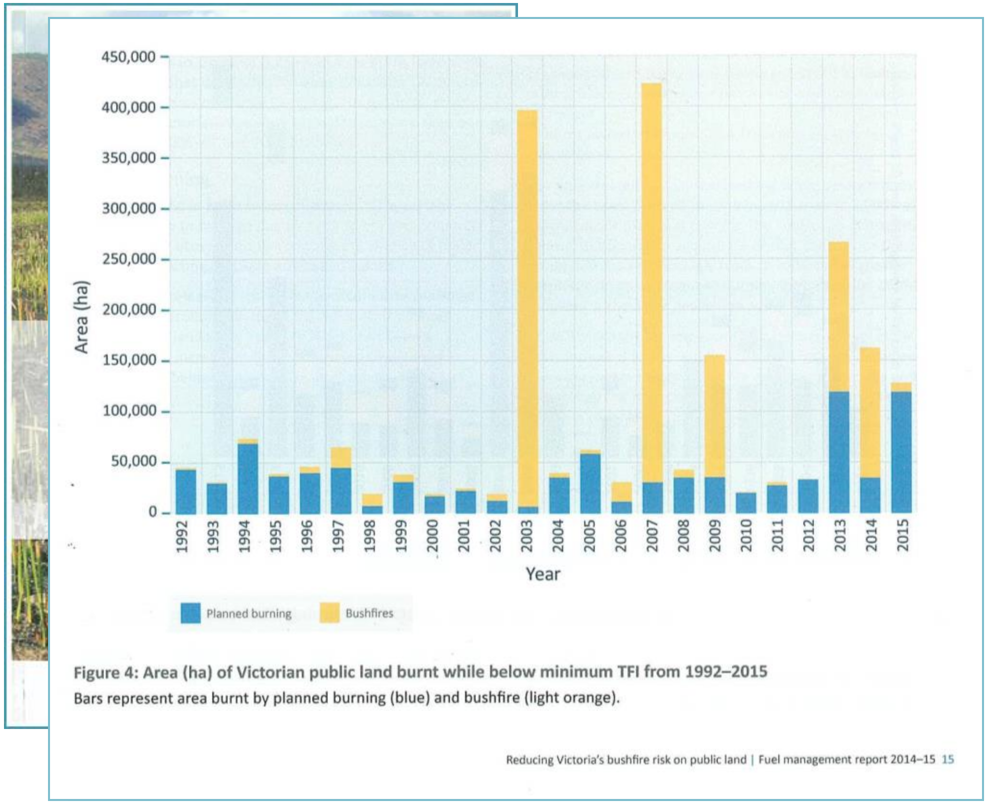
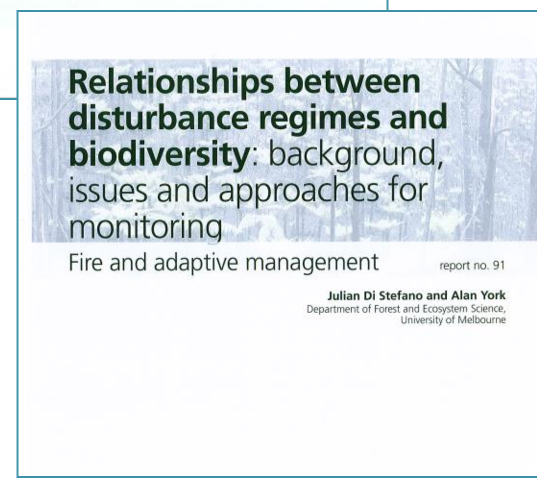


Figure 4: Area (ha) of Victorian public land burnt while below minimum TFI from 1992–2015
Bars represent area burnt by planned burning (blue) and bushfire (light orange).

Recent developments:
Victorian resilience metrics - fauna

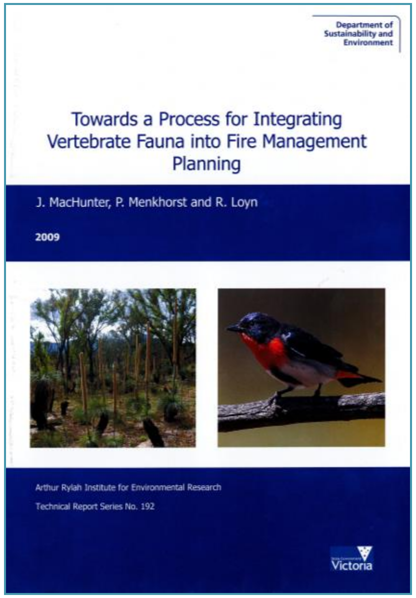
- Geometric Mean Abundance (*G*)
  - A versatile diversity measure
  - An index of community status
    - Track changes over time
  - Can be ‘unpacked’ to estimate impacts on individual species

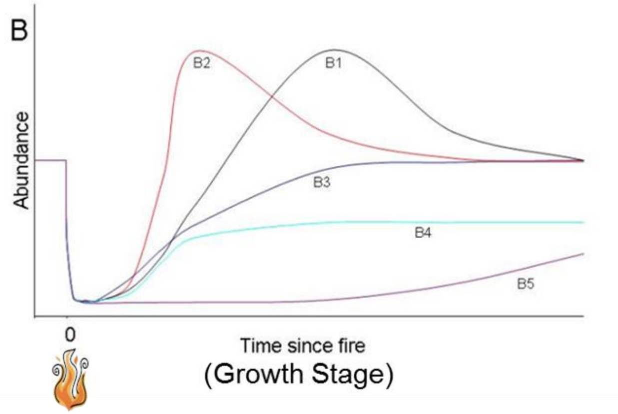


- Vegetation Growth Stage Structure (GSS)
  - Observed vs goal GSS
  - Proportional change in *G* between the ecological goal and the observed GSS
    - Track performance against goals

Growth stage structure and faunal response curves

- Uses conceptual models (response curves) that link the needs of terrestrial vertebrate fauna to vegetation growth stages after fire, via changes in habitat parameters.
- Models based on known relationships between faunal abundance, vegetation type and habitat parameters (expert knowledge), and post-fire vegetation response.
- Currently focussed on a subset of fauna – Key Fire Response Species (vertebrates)
    - KFRS selected based on Wildlife Atlas records and fire response (expert knowledge).





Recent developments:
Growth Stage Structure optimisation

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Defining vegetation age class distributions for multispecies conservation in fire-prone landscapes

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ABSTRACT

The generation of heterogeneous fire mosaics is commonly advocated as a strategy for biodiversity conservation in flammable ecosystems, but it is usually unclear how mosaic properties link to biodiversity outcomes. Here we define a formal relationship between these elements and outline a method for determining the composition of fire mosaics defined by vegetation age classes that maximise species diversity. The method involves 1. quantifying species abundance in each of several previously defined vegetation age classes, and 2. using optimisation to determine the age class distribution that maximises species diversity. We applied the method to 135 species from four taxa in a southeastern Australian heathy woodland. In addition, we quantified the degree to which each taxa could act as a surrogate for others, and assessed how our chosen diversity metric changed with departures from the optimal distribution. Optimal age class distributions differed among taxa, and surrogacy relationships between most groups were poor. Departure from the optimal distribution resulted in an estimated decline in species diversity, a measure that may be used to quantify the biodiversity cost of alternative management strategies. Our measure of departure, relative entropy, was a strong predictor of diversity decline for some taxa but not for others. In cases where predictive capacity was strong, the rate of decline differed among groups. In flammable ecosystems our method can help determine fire management strategies empirically linked to a landscape-scale conservation objective.

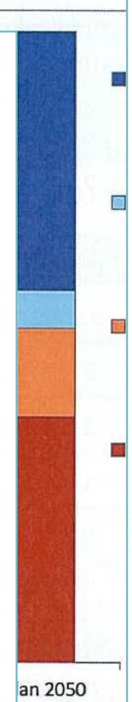


Figure 6. Growth Stage Structures for a range of scenarios for EFG 7 (
Growth Stage Structures (GSSs) are presented for maximising the Geometric
Fire Response Species (optimal GSS), compared with the solution applying th
constraints (ecological goal GSS), and with previous, current and future plann

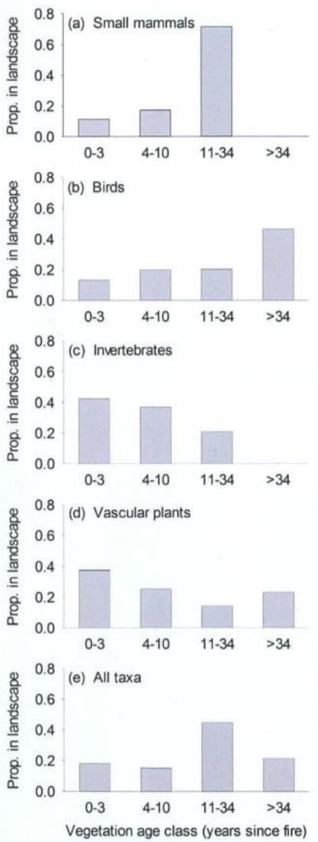


Fig. 1. Vegetation age class distributions that maximised the geometric mean of species abundances for small mammals (a), birds (b), invertebrates (c), vascular plants (d) and all taxa combined (e). Results have been constrained to ensure the distributions are operationally sustainable (see Section 2.3 for details).

From: MacHunter *et al.* 2015 *Initial Growth Stage Optimisation Analysis in the Otways – Building the Ecosystem Resilience Model for Adaptive Fire Management and Planning.* Arthur Rylar Institute for Environmental Research

Utilisation: *Pyrodiversity promotes biodiversity* Optimisation

Sensitivity to:

- Survey design
- Species included
- Allocation of growth stages
- Species weightings (e.g. status)

(Giljohann et al. 2017, Sitters et al. 2018)

Deriving fire response curves from existing presence only data e.g. Biodiversity Atlas (Di Stefano & Sitters 2019)

Models of species' responses to fire history

Optimal allocation of growth stages to maximise overall diversity

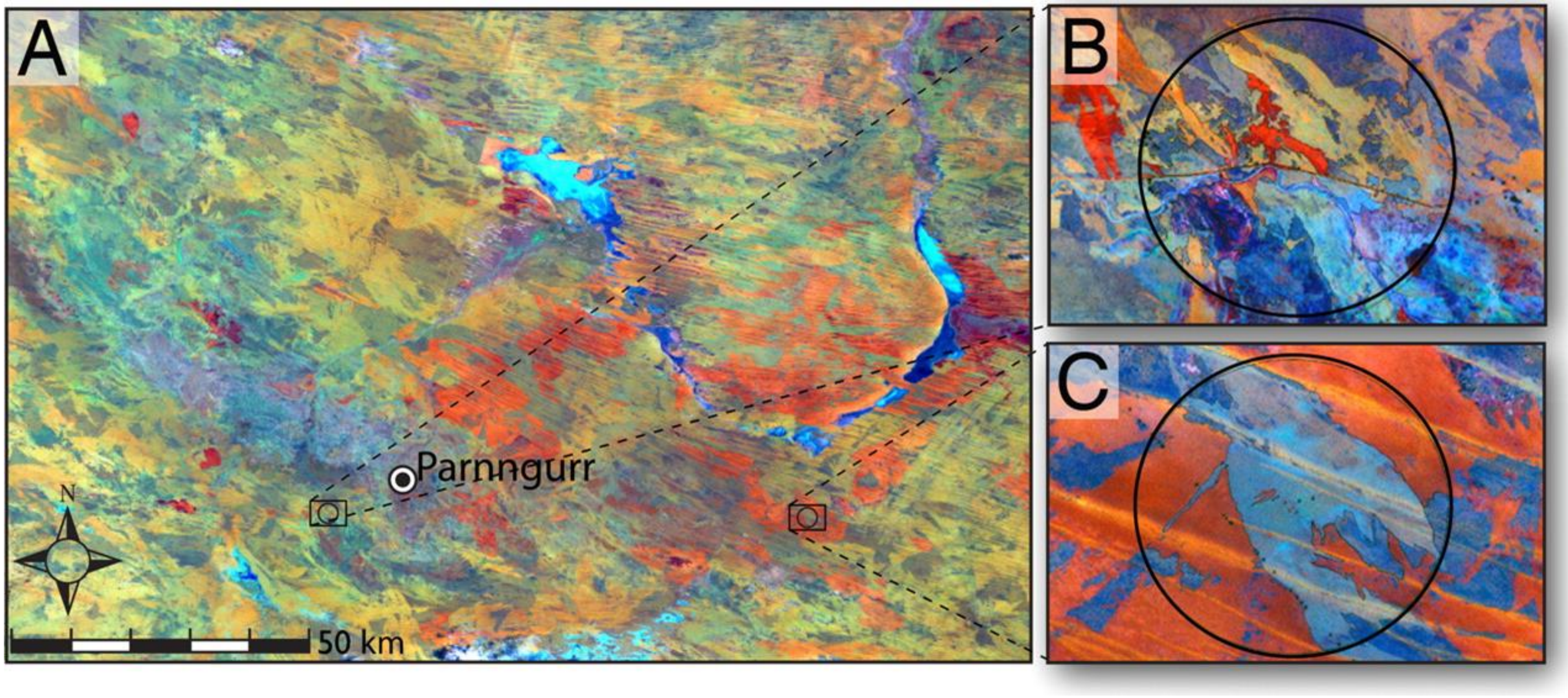
Optimal management strategy

Incorporate targets into decision-theory or modelling framework using fire scenarios (Kelly et al. 2014, Chick et al. 2018)

Management strategy options

Where to next?
Grain and spatial pattern of Growth Stages (fire mosaics)

Indigenous burns



Wildfire

Satellite images of habitat heterogeneity in the Martu homelands.
Bliege Bird et al. PNAS 2008;105:39:14796-14801

Refining management tools: Growth stages and fire mosaics

Landscape scale influences

– lated responses

– et al. 2012)

Taxa-r

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Dispro

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Refinin

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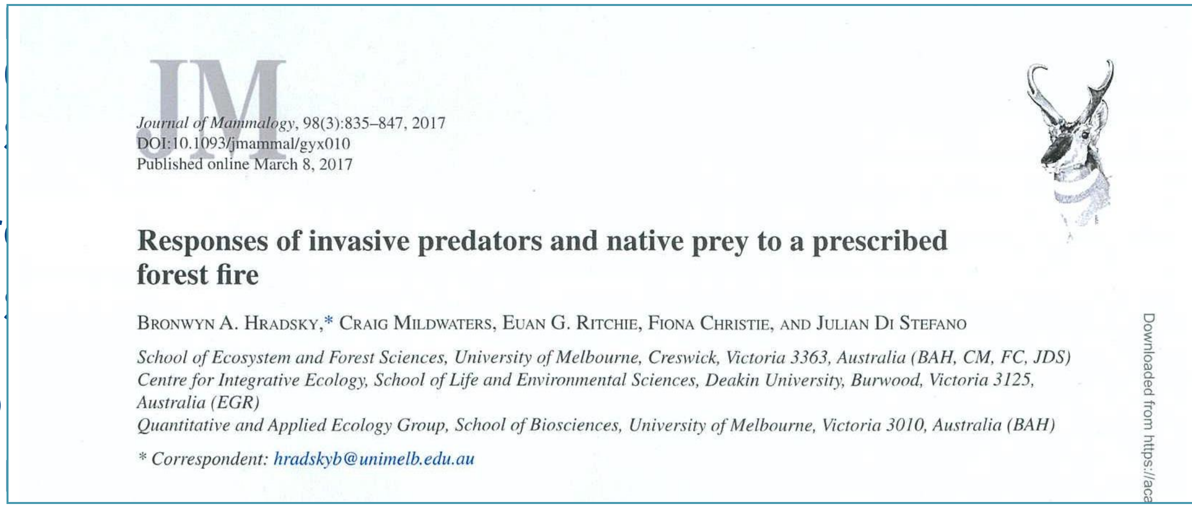

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Responses of invasive predators and native prey to a prescribed forest fire

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Optimising the spatial planning of prescribed burns to achieve multiple objectives in a fire-dependent ecosystem

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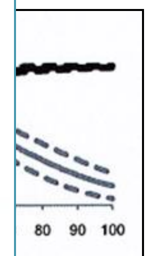

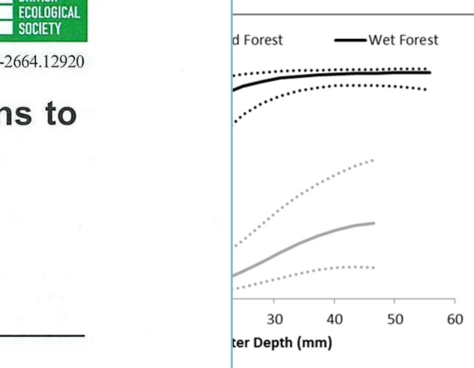

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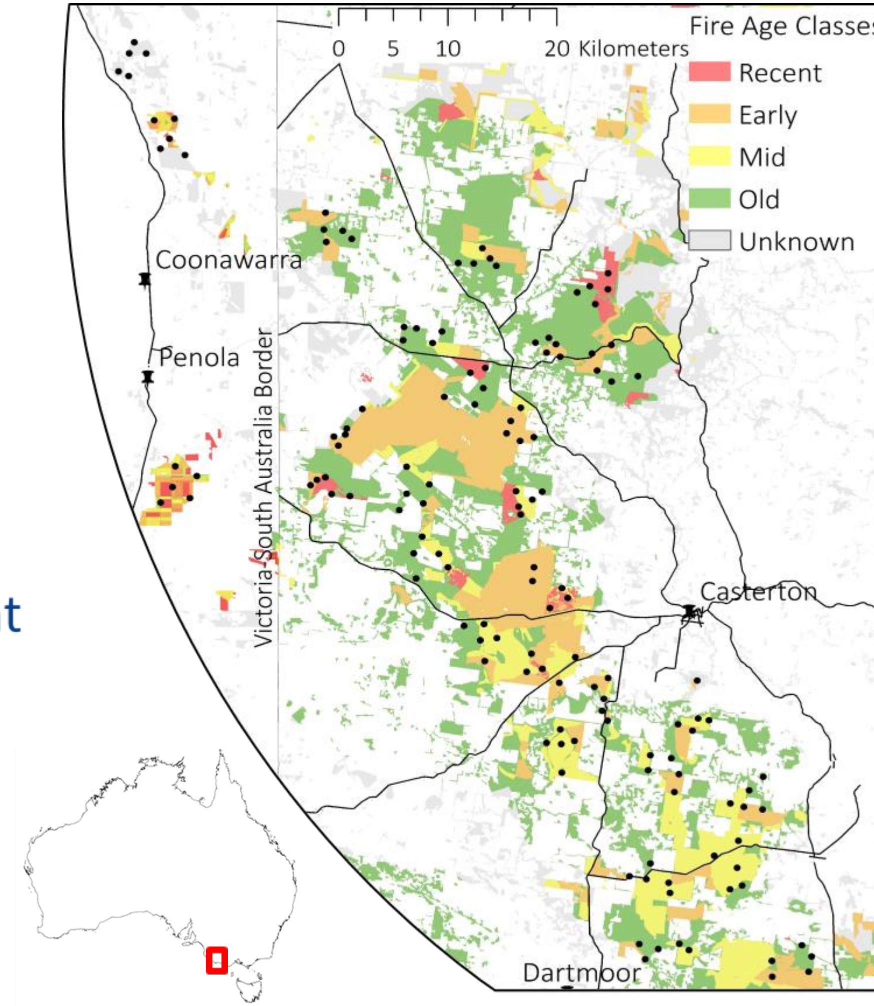
Current Research (ARC Linkage project)
Using fire to manage biodiversity in fragmented landscapes

- 140 sites stratified to cover:
    - Four vegetation types
    - Four fire age classes

- Can we use fire to create mosaics that enhance <u>habitat suitability</u> and <u>connectivity</u> in fragmented landscapes?



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