Progress Report SP 2010-011

Fire regimes and impacts in transitional woodlands and shrublands

Ecosystem Science

Project Core Team

Supervising Scientist	Colin Yates
Data Custodian	
Site Custodian	

Project status as of Sept. 13, 2016, 5:33 p.m.

Approved and active

Document endorsements and approvals as of Sept. 13, 2016, 5:33 p.m.

Project Team	granted
Program Leader	granted
Directorate	granted

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C Yates, C Gosper

Context

The Great Western Woodlands (GWW) is an internationally significant area with great biological and cultural richness. This 16 million hectare region of south-western Australia arguably contains the world's largest and most intact area of contiguous temperate woodland. The GWW Conservation Strategy and a review conducted by a wide range of scientists with expertise in the region each identified inappropriate fire regimes as a threat to the woodlands and emphasised the need for a science-based fire management regime for the area. Critical gaps in the knowledge of fire ecology for GWW ecosystems are a major hindrance for ecological fire management in the region. The GWW supports eucalypt woodlands at very low mean annual rainfall (250-350 mm). Woodlands require fire to establish but are very slow growing. In recent decades a large part of the GWW has been burnt and concern has been expressed over the ecological impacts of this. Fire ecology research already undertaken in eastern wheatbelt nature reserves will help resolve ecological fire management issues for mallee and mallee-heath communities in the GWW, but similar information for the dominant eucalypt woodlands is urgently needed.

Aims

- Develop a method to robustly estimate stand time since fire in gimlet (*Eucalyptus salubris*) woodlands that have not been burnt during the period covered by remotely-sensed imagery.
- Investigate the effects of time since fire on the assembly and recovery of gimlet woodlands, including on plant and animal community composition and development of ecosystem structure.
- Measure fuel and carbon dynamics with time since fire in gimlet woodland.
- Investigate pathways to weed invasion in the GWW.

Progress

- A multi-century time since fire chronosequence of 76 plots has been established in gimlet woodlands, with sampling of plant composition, vegetation structure, visual fuel assessment, ants and birds.
- Plant data from the chronosequence have been used in national-scale synthesis of: (i) the spatial and vegetation type distribution of fire response traits in woody plants (published in *Science of the Total Environment*); (ii) fire regime and environmental correlates of fire response traits (in preparation); (iii) how Western Australian eucalypt woodlands differ in fire ecology from eastern Australian analogues (*Journal of Biogeography*); and (iv) the composition, biogeography, environmental correlates and ecology of Australia's temperate woodlands (in review for the book *Australian Vegetation*).
- Alien plant records from the GWW were used to identify environmental and disturbance predictors of weed occurrence, and priority weed species for preventative weed management in a climate change context (published in *Biodiversity and Conservation*)
- Gimlet tree size was sampled at 100 plots systematically located across the GWW to estimate stand-class structure, and via linking with models estimating tree age from tree size, woodland age-class distribution.
- Methodology to sample tree and shrub, woody debris and litter carbon pools was tested at pilot sites.

Management implications

- National-scale syntheses of temperate eucalypt woodland fire ecology revealed that Western Australian woodlands are uniquely dominated by taxa that are obligate seeding or recolonise after fire from unburnt populations, and have vegetation dynamics driven by rare, stand-replacing disturbances. These characteristics illustrative a putative vulnerability to decreases in intervals between fires.
- Post-fire succession in plant composition and structure, which in turn determines successional patterns in animals, occurs over multi-century timescales, demonstrating the value of avoiding fire in mature woodlands to maximise future fire management options.

- Changes in vegetation structure, cover and hazard indicate maximum gimlet woodland flammability at intermediate times since fire, supporting the revision of fire behaviour ratings.
- Contemporary invasive plant spread in the GWW could be reduced via: (i) targeting abandoned and current settlements for removal of disjunct weed populations; (ii) minimising new settlement creation in locations currently remote from towns; and (iii) closing water points on conservation estate to reduce disturbance-induced weed recruitment. Considering future climate tolerance in weed species prioritisation results in a feasibly small selection of taxa for pre-emptive regional-scale eradication or containment.
- GWW woodlands have little grass in comparison to other temperate woodlands. If perennial grass weeds (such as buffel grass) become widely established, potentially facilitated by climate change, substantial fire regime shifts and subsequent loss of mature woodlands are plausible.
- Knowledge generated through this project has been incorporated into eucalypt woodland fire ecology training, to be delivered to Department of Parks and Wildlife staff.

Future directions

- Refine models estimating the time since fire of long-unburnt gimlet woodlands through the use of the growth ring increment data.
- Use refined age-size models and stand structure data to generate a robust age-class distribution of gimlet woodland and hence assess whether recent extensive wildfires are unprecedented over the period in which existing gimlet stands developed.
- Complete measurement of carbon pools across the gimlet chronosequence to determine the role of fire management in carbon sequestration.