PROGRAM B

Eucalypt decline in the absence of fire

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Contributors to the project

1. Project Leader Neil Davidson (UTas)
2. Project Manager Dugald Close (UTas)
3. Forest Fire Management Group (national)
   a) Department of Environment and Conservation (WA)
   b) Forests NSW
   c) Forestry Tasmania
   d) Department of Sustainability and Environment (Vic)
   e) Department of Environment and Heritage (SA)
   f) Department of Arts, Environment and Heritage (Tas)
4. Tuart Health Research Group (Murdoch University, WA)

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Tasmanian Midlands: pre-European fire management

John Glover, Mills Plains 1834 C/O TMAG

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Tasmanian Midlands: recent fire management (in the absence of grazing)

Photo: Fred Duncan, Forest Practices Authority

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Coastal *E. gomphocephala* (Tuart) woodlands south of Perth, WA

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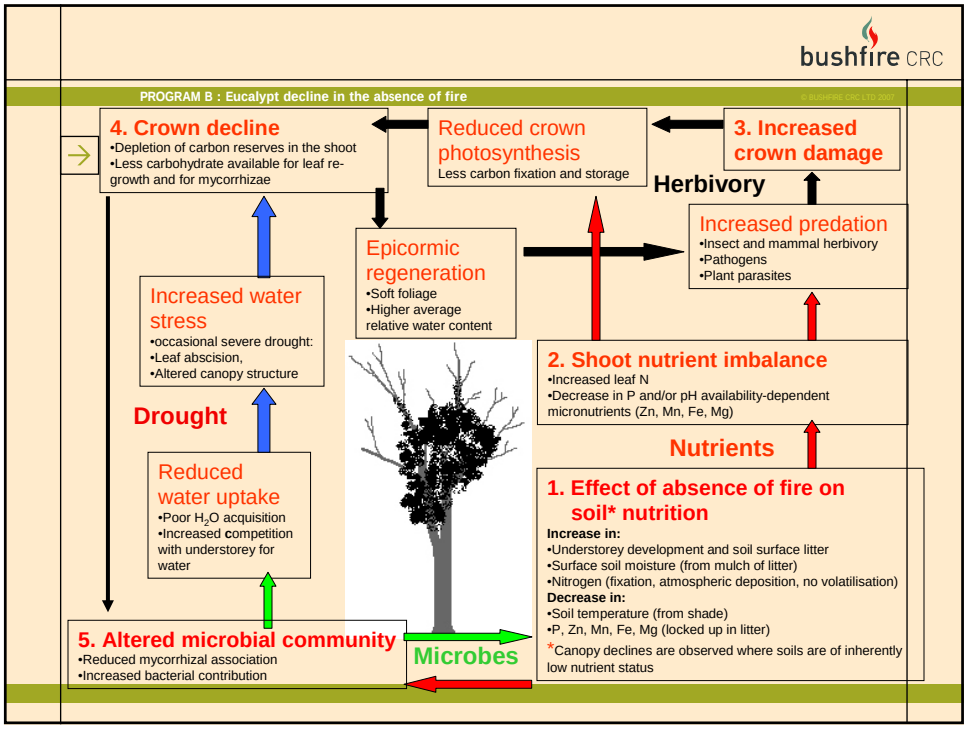
High Altitude *Eucalyptus delegatensis*: north-east and north-west Tasmania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4. Crown decline
•Depletion of carbon reserves in the shoot
•Less carbohydrate available for leaf re-growth and for mycorrhizae
Reduced crown photosynthesis
Less carbon fixation and storage
3. Increased crown damage
Herbivory
Increased predation
•Insect and mammal herbivory
•Pathogens
•Plant parasites
Epicormic regeneration
•Soft foliage
•Higher average relative water content
Increased water stress
•occasional severe drought:
•Leaf abscision,
•Altered canopy structure
Drought
Reduced water uptake
•Poor H_2O acquisition
•Increased competition with understorey for water
2. Shoot nutrient imbalance
•Increased leaf N
•Decrease in P and/or pH availability-dependent micronutrients (Zn, Mn, Fe, Mg)
Nutrients
1. Effect of absence of fire on soil* nutrition
Increase in:
•Understorey development and soil surface litter
•Surface soil moisture (from mulch of litter)
•Nitrogen (fixation, atmospheric deposition, no volatilisation)
Decrease in:
•Soil temperature (from shade)
•P, Zn, Mn, Fe, Mg (locked up in litter)
*Canopy declines are observed where soils are of inherently low nutrient status
5. Altered microbial community
•Reduced mycorrhizal association
•Increased bacterial contribution
Microbes


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Experimental sites: E. gomphocephala, WA

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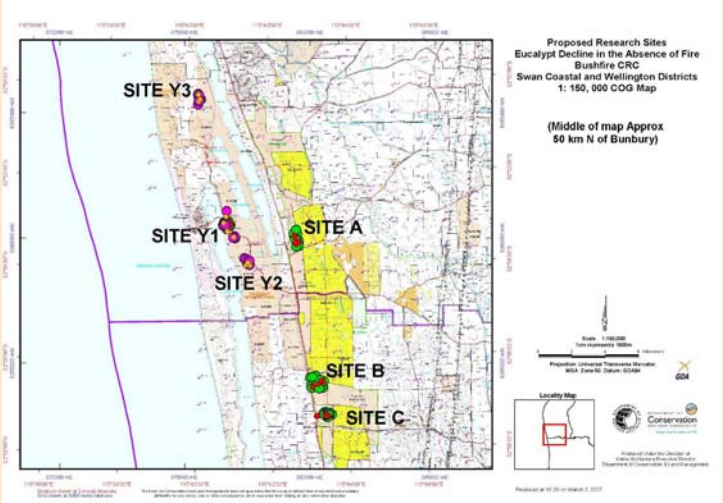
Experimental design: WA



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Experimental sites: *E. delegatensis*, Tas

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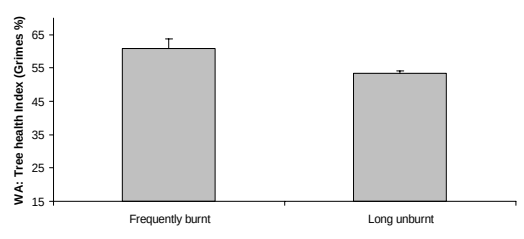
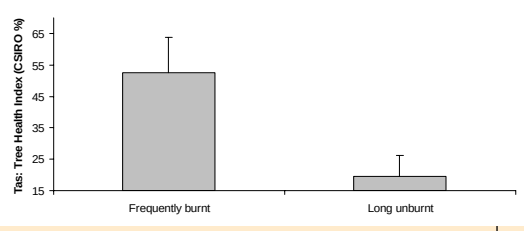
Tree condition: WA and Tas

1. Tree health index of Tuart in WA was significantly higher (p = 0.0724) (ie less decline) in frequently burnt state forest (approx every 10-15 years for past 6 decades) relative to infrequently burnt National Park (unburnt for approx 4 decades).
2. Tas: Tree health index of *E. delegatensis* in Tas was not significant but higher (i.e. less decline) in sites burnt in 1967 relative to sites last burnt by aboriginals approx 120 years ago.





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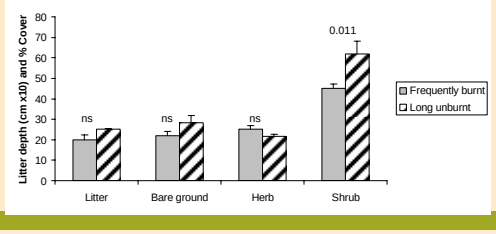
Understorey vegetation and litter: WA

1. Ten 2x2 m vegetation plots per site
2. Some difference in floristic composition
3. Long unburnt had greater % cover of shrubs than frequently burnt sites (p = 0.011)



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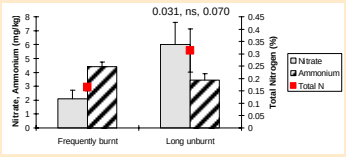
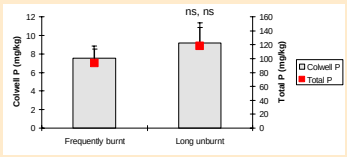
Soil nutrition

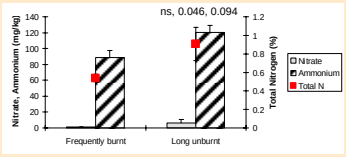
1. n = 6 sites, 10 trees per site, for each tree 4 sub-samples from top 5 cm of soil were bulked
2. WA: Long unburnt had higher nitrate and total N
   Tas: Long unburnt had higher ammonia and lower total P
3. No differences in Zn, Mn, Fe or Mg

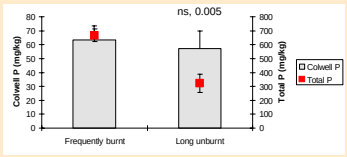
WA





Tas





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Tree foliar sampling

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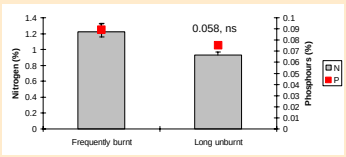
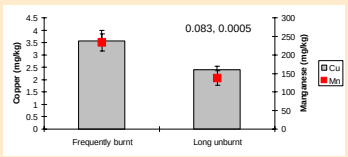
Tree foliar nutrition

1. n = 6 sites, 10 trees per site,1 sub-sample per tree
2. WA: Long unburnt had lower N and (not significant) P and lower Cu and Mn

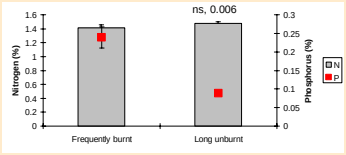
   Tas: Long unburnt had lower P
3. No differences in other micronutrients

WA





Tas



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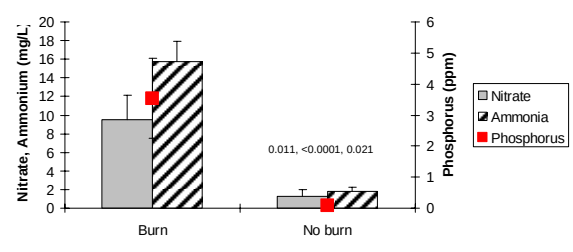
Effects of prescribed fire on soil nutrition (by ion exchange resin and seedling bioassay)

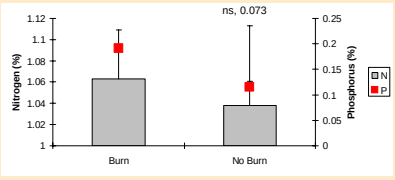
Effects of prescribed fire on plant nutrient availability: WA

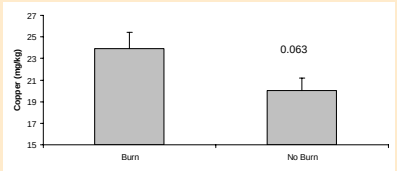
1. Plant nutrient availability by ion exchange resin
2. n = 10 trees, 4 resin sacks (N-S-E-W under dripline) buried at 5 cm depth per tree
3. N, P and all micronutrients (except Mn and Fe) higher in burn than no burn



Effects of prescribed fire on plant nutrient availability cont: WA

1. Plant nutrient availability by Tuart seedling bioassay
2. n = 8 trees, 4 seedlings planted per tree
3. Sampled early after 3 months due to kangaroo browsing
4. P and Cu higher in burn than no burn seedling bioassays





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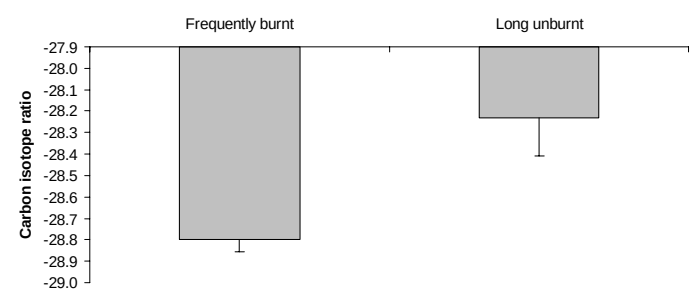
Tree water use efficiency (by carbon isotope ratios): WA

1. n = 6 sites, 10 trees per site, 1 sub-sample per tree
2. Less negative (p = 0.0379) in long unburnt due to less water availability. Via competition with understorey?



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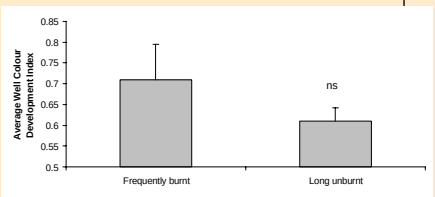
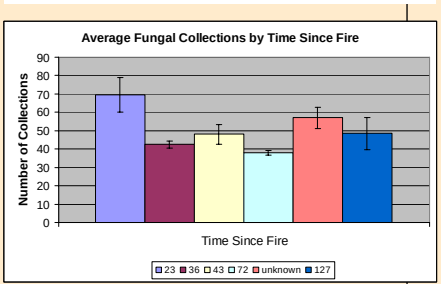
Soil Microbial/Fungal Ecology

1. Average Well Colour Development (by Dr Yanfei Cai) as a measure of the functional diversity of the microbial communities (Garland and Mills 1991). Not a significant difference but trend toward higher functional diversity in state forest.
2. Tas: Sporocarp surveys of high altitude *E. delegatensis* sites (by Bryony Horton)
3. Observation indicates greater biodiversity in recently burnt compared to long unburnt sites. Molecular analysis being conducted in future.





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Summary

1. Eucalypt decline – increased in the long absence of fire in some forest types (WA and Tas).
2. Decline is associated with the development of understorey, litter and decreased fungal diversity (WA and Tas).
3. Soil and Plant nutrition

   WA

   a) Increased N in long unburnt soil but lower N in long unburnt trees.
   b) Micronutrients same in soils but Mn and Cu lower in long unburnt trees.

   Tas

   a) Increased N in long unburnt soil but same N in long unburnt trees.
   b) Lower P in soil and far lower P in trees at long unburnt sites.

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Summary cont.

4. Prescribed fire and plant nutrient availability (WA)

   Resin exchange:

   Increased N, P and micronutrient (except Mn and Fe) availability.

   Seedling bioassay:

   Increased P and Cu uptake on burn site, N and micronutrient uptake the same.
5. Trees have greater water use efficiency and are probably more water limited on sites with a long absence of fire (WA).

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Conclusions - preliminary

1. Fire history is significantly associated with plant understorey and litter development, soil microbial diversity and activity, and tree health (decline) in some forest types in WA and Tas.
2. WA: Mn and Cu deficiency and limited water availability and;
   Tas: P deficiency;
   are potential factors in eucalypt decline in the absence of fire.
3. Prescribed fire renders a large increase in plant nutrient availability (WA).

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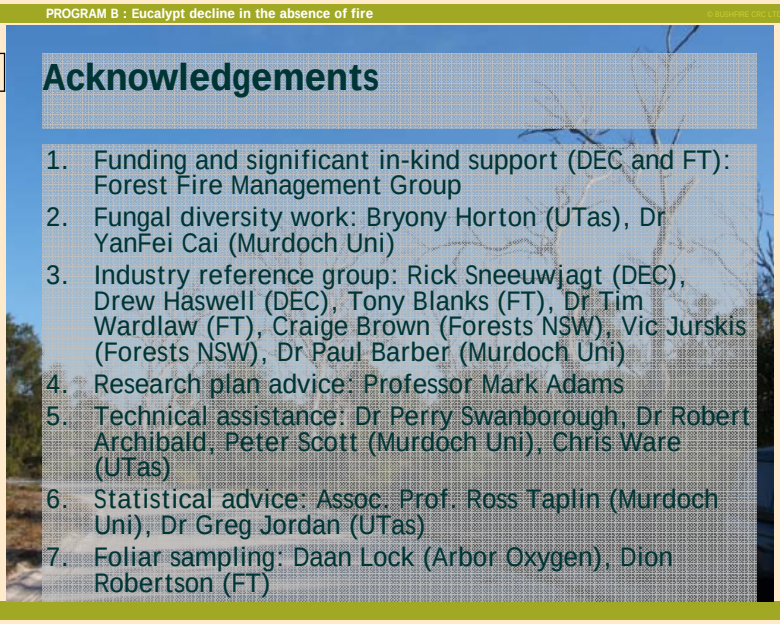
Future activity

1. Manipulative treatments of:
2. prescribed burning and;
3. understorey vegetation clearing
4. → for the restoration of tree health

5. = Conclusions from treatments (not correlations) on ecological processes that underpin eucalypt decline in the absence of fire



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2. Fungal diversity work: Bryony Horton (UTas), Dr YanFei Cai (Murdoch Uni)
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