



Fragmentation but not fire facilitates weed invasion in mallee

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Background

Weed invasion is a significant threat to native plant communities in fragmented landscapes. Remnants are vulnerable to weed invasion due to the combination of changed natural disturbance regimes (e.g. lack of fires allowing plant communities to senesce), altered environments at edges (e.g. nutrient enrichment from adjacent agricultural activities) and high seed input from nearby weed populations. Fragmentation by interior roads within remnants could also enhance invasions by altering roadside environments (e.g. water run-on) and increasing seed input via movement by vehicles. Fire potentially facilitates invasions by stimulating germination of dormant seed, increasing resource availability and reducing competition. Yet, in landscapes historically subject to recurrent fire, exclusion of fire is also likely to result in loss of biodiversity. Hence, the potential for weed invasion after fire presents a conundrum for land managers. We hypothesized that invasion in intact mallee communities of the Western Australian wheatbelt is limited by lack of seeds and low soil nutrient levels, and that fire and/or fragmentation may disrupt these limits. We tested these hypotheses in a field experiment of three treatments (fire, post-fire seeding with the locally invasive *Avena barbata* (Bearded Oat) and three landscape positions with respect to remnant edges; mallee adjoining paddocks, adjoining interior roads and in reserve interiors).

Findings

Landscape position had a much greater impact on soil properties and weed performance than fire.



- Paddock edge soil contained much more total nitrogen, potassium and organic carbon, irrespective of fire, than interior road edges or reserve interiors. Phosphorus and ammonium was also greatest at paddock edges, but fire elevated levels above those at unburnt paddock edges (Fig. 1a). Interior roads and fire away from paddock edges had minimal effects on soil nutrients.
- *Avena* abundance was limited by seed availability, as there was always more *Avena* in seeded than unseeded plots. *Avena* growth was substantial only at burnt paddock edges (Fig. 1b)
- Growth of weeds other than *Avena* (mostly other annual grasses) was substantial only at unburnt paddock edges, indicating that fire suppressed these species (Fig. 1c).

- Away from paddocks, neither fire nor fragmentation by interior roads enhanced weed seed availability or weed biomass.
- At paddock edges, increased seed availability, sowing with *Avena* seed and elevated nutrient levels strongly enhanced weed biomass; however fire had a neutral to negative effect.

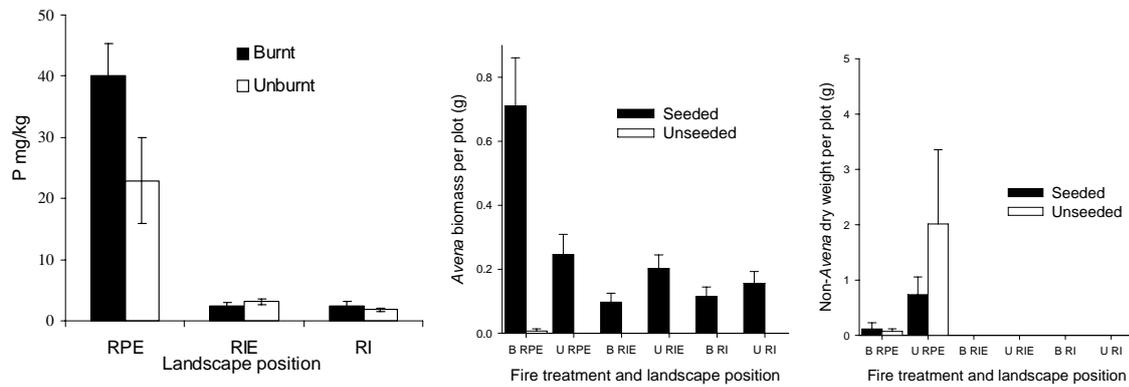


Figure 1. Effects of fire, landscape position and seeding with *Avena barbata* on (a) soil phosphorus levels; (b) *Avena* biomass; and (c) biomass of weeds other than *Avena*. Fire treatments: B = burnt, U = Unburnt; landscape positions: RPE = reserve paddock edges, RIE = reserve interior edges (roads), RI = reserve interiors (away from edges).

Management Implications

- **Fire did not exacerbate invasions in intact mallee.** Consequently, fire is a viable disturbance option for biodiversity conservation in mallee remnant interiors. This conclusion is tempered by the following qualifications: no plots were overwhelmingly dominated by weeds prior to fire, invasive perennial grasses were absent and no mechanical disturbance of the soil preceded or was coincident with fire; different outcomes may follow if any of these scenarios occur.
- **Nutrient enrichment at paddock edges enhances invasions with or without fire.** It may be appropriate for land managers to take a precautionary approach and avoid fire on paddock edges if resources are not available for post-fire weed control. If resources for weed control are available, however, fire may offer a weed management opportunity. Fire appeared to reduce the seed bank of weedy annual grasses, and because many weeds are known to germinate more rapidly post-fire than most native species, weed control could be applied after weed, but before native, seedling emergence/sprouting.
- **Neither soil changes, nor vehicles acting as vectors for weed seeds, facilitated weed invasion along interior roads.** The use of strategically placed fire management trails, combined with current vehicle hygiene protocols and levels of use, appears to be a low risk of facilitating invasions.



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