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A RIPPING YARN: THE EFFECT OF RABBIT WARREN RIPPING ON PLANTS AND SOIL

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BACKGROUND

The European rabbit (*Oryctolagus cuniculus*) is one of the most damaging environmental pests in Australia. Over much of their range, rabbits live in large underground warrens. Large amounts of soil are excavated to form an elevated mound, and warren excavation leads to extensive and prolonged soil disturbance (Eldridge and Simpson 2002). Rabbit activity also destroys woody vegetation (Lange and Graham 1983), and continuous grazing results in increased grazing pressure, reduced pastoral productivity and eventually landscape degradation. While the ripping of rabbit warrens is a popular technique for controlling rabbits, little is known about its effect on the vegetation and soils. We report here the results of a number of studies to assess the impact of ripping on soils and vegetation, and the degree of invasion on ripped and unripped warrens.

METHODOLOGY

The study was undertaken at Yathong Nature Reserve in western NSW. Five microsites were examined along a gradient through each of ten ripped warrens (centre, mid centre, edge, near control, far control). Soil cover (litter, plants by species, cryptogam cover, bare soil) and microtopography were assessed, and soil samples taken for germination in the glasshouse to examine soil seed banks. Two-hundred warrens (100 intact, 100 ripped) were surveyed, and plant cover, number of active and inactive entrances, and warren area measured. Multi-variate analysis (Multi-Dimensional Scaling, PRIMER; Indicator Analysis; PCORD) was used to examine relationships between seed banks and ripping status and warren microsite. Analysis of variance and non-parametric statistics were used to look for differences in reinvasion of ripped and unripped warrens, and to test for differences in soil cover and species diversity between ripped warrens and non-warrens.

RESULTS

The cover of bare soil declined and cryptogam cover increased with increasing distance from the warrens. Ripped warrens had a more degraded soil surface (more scarps and bare soil) compared with control surfaces ($P<0.001$).

There were substantial differences in plant species composition between the warren centre, edge and non-warren control sites ($P<0.019$). Significantly more species were recorded at the warren edge followed by the control sites (Table 1). Three (weedy) species (*Schismus barbatus, Salsola kali* var. *kali* and *Chenopodium melanocarpum*) were highly indicative of degraded warren surfaces (Indicator Value 56-72%, $P<0.007$). *Austrostipa scabra* was a strong indicator of non-warren surfaces (IV=63%, $P=0.008$). The structure of the soil seed bank differed significantly between the warren microsites and the controls (Global $R=0.713$, $P=0.001$). Ripped and unripped warrens differed significantly in their complement of plant species (Global $R=0.815$, $P=0.001$). Forty-four species (30,188 individuals) emerged from the soil seedbank, with two species (*Crassula sieberana* and *Schismus barbatus*) accounting for 66% of all germinants.

Unripped warrens contained approximately ten-times more active warren entrances ($F_{1,98}$= 328.18, $P<0.001$) and reduced plant cover ($F_{1,198}=63.58$, $P<0.001$) compared with ripped warrens. Larger warrens generally had more burrows ($F_{1,198}=73.21$, $P<0.001$, $R^2=0.26$)

Table 1. Diversity of seeds germinating from the soil seed bank in relation to warren microsite. SE is standard error of the mean; different subscripts within a row indicate a significant difference in that component at P=0.05.

Component	Warren centre		Warren edge		Control	
	Mean	SE	Mean	SE	Mean	SE
No. of species	12.8^{a}	0.65	17.1^{b}	0.86	15.8^{c}	1.5
No. of individuals	278.0^{a}	59.0	339.0^{a}	50.0	317.0^{a}	65.0
Richness	2.19^{a}	0.15	2.84^{b}	0.13	2.62^{b}	0.20
Evenness	0.50^{a}	0.06	0.58^{a}	0.03	0.53^{a}	0.04

DISCUSSION

Our results demonstrate marked biotic and abiotic differences between rabbit-disturbed and adjacent rabbit-free woodland. Taken together, these results reinforce the view that rabbits have a negative impact on surface soils and vegetation in semi-arid woodlands. Differences in the composition of the plant community were reflected in marked differences in the germinable soil seedbank between the warren and non-warren microsites.

The germinable seed bank on ripped warrens was dominated by weedy exotic species (e.g. *Schismus barbatus*), and our results indicate that ripped warrens are not likely to regenerate in the short-term given the paucity of desirable plant species in the soil seed bank. Restoration of the vegetation is highly depended on reinstating the natural surface morphology, which is primarily an intact biological crust.

Our results indicate that there are likely to be large differences between ripped and unripped warrens in their complement of plant species, although results are based on only five years of recovery after ripping. Little is known about post-disturbance succession of plants on ripped warrens, but anecdotal evidence suggests that it is at the scale of many tens of years. Active intervention may therefore be necessary to hasten recovery in good years. Our work reinforces the need to destroy warrens, which will only continue to act as harbour for rabbits if left intact.

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