

Trial of Sen-Tree Browsing TM Deterrent on shrub plantings on escarpments at Bababi Marning Grassland, Campbellfield.

Merri Creek Management Committee

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Reinforcing Grassland
Ecological Values
in the Merri Valley
North of Melbourne



CARING
FOR
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COUNTRY



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Acknowledgements.

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Summary

Sen-Tree™ browse deterrent was applied at recommended intervals (4 per year) to a planting of five species of indigenous shrubs on an escarpment on the Merri Creek at Campbellfield, north of Melbourne between May 2011 and February 2013. The relative intensity of browsing (primarily by Swamp Wallabies, *Wallabia bicolor*) on different species of shrub was recorded on these treated plants and a subset of plants that remained untreated.

Sen-tree™ appeared to improve early establishment of indigenous shrubs on escarpments along the middle reaches of the Merri Creek, however its capacity to reduce browsing pressure differed between species. For some species, a high proportion of treated plants continued to be browsed to a degree that prevented planting goals being achieved. Implications for tree and shrub establishment are suggested.

These plantings were not established as a pure research trial and compromises in experimental design reduce the confidence in some results. Recommendations for improving design of future trials are included.

2 Background

For over twenty years, Merri Creek Management Committee (MCMC) crews have reported suppression and mortality in planted shrubs due to intensive browsing at peri-urban and rural sites. The severe impact may be evident for several years after planting. In extreme cases, mortality results from newly planted stock being dislodged or exhausted as browsing exceeds a plant's capacity to re-grow. Swamp Wallabies (*Wallabia bicolor*) appear to be the main browser of new plantings on escarpments in the peri-urban and rural stretches of the Merri Creek, north of Melbourne.

The consequences for ecological restoration of severe browsing includes; delays in achieving ecological objectives of planting, increased weed control costs due to delays in vegetation achieving a competitive weed-suppressing cover and, in extreme cases, an obligation to re-plant.

MCMC routinely install plastic tree-guards on shrub plantings that (when properly installed) resist rabbit browsing and most early browsing by Wallabies and Hares. However, the effectiveness of these guards does not continue once plants grow to within a few centimetres of the guard's rim (approximately 45 cm). Wallabies browse plants at the top of the tree-guard, 'pruning' the plants and promoting dense, branching growth within the triangular cross-sectioned tree-guard. When shrubs and trees develop a larger, woody structure, most appear to become less attractive to wallabies and/or capable accumulating growth in spite of browsing.

Tall fencing or tree-guards (over a metre) needed to prevent wallaby browsing are relatively expensive (eg. \$12.00 per guard, Deppler 2007). In the Merri Creek escarpments, shallow rock and steep slopes often limit the capacity to install fences and guards of this type.

A spray-on browsing deterrent offers a possible solution to establishing trees and shrubs in areas where installation of physical guards is unfeasible. The recommended frequency of re-application (approximately three-monthly) fits well with the usual establishment maintenance regime MCMC plans for new plantings.

Deppler (2007) advises that "There is no exact strategy for combating wallabies as their behaviour is difficult to predict and site conditions vary. Land managers need to trial a variety of approaches

to see what works best for them and their particular location”. Although the effectiveness of Sen-tree™ has been assessed in trials by the developers and by other organisations doing restoration (Walsh 2008; Miller *et. al* 2009), locally, anecdotal reports of its value have been mixed so further investigation under local conditions is warranted.

3 Aim

To evaluate the whether application of the Sen-Tree™ browsing deterrent will improve the establishment of shrubs of escarpment shrubland along the Merri Creek, north of Melbourne by;

- preventing catastrophic browsing when used in conjunction with ‘standard’ tree-guards
- preventing ‘moderate browsing’ intensity which prevents shrub expansion

4 Method & Materials

4.1 Site

Cooper St Grassland, Reserve (Bababi Marning¹) in Campbellfield, north of Melbourne, protects approximately 50 hectares of Volcanic Plains Grassland. Its eastern border is formed by the Merri Creek, with escarpments clothed in remnant Escarpment Shrubland Ecological Vegetation Class (EVC).

After a previous history of cattle grazing, no active maintenance occurred for over fourteen years between 1996-2010. Soon after the escarpment was added to the reserve in 2009-10, Parks Victoria, undertook a major program of control of dense stands of woody weeds and Serrated tussock (*Nassella trichotoma*). The weed control left patches of bare ground suitable for revegetation with shrub and tree species characteristic of the Escarpment Shrubland EVC.

Sen-Tree™

Sen-Tree™ Browsing Deterrent is a three-part product; whole egg solids and acrylic polymer adhesive are mixed together with water and sprayed onto foliage of the trees then, before the mixture dries, silicon carbide grit is sprinkled onto the foliage to produce a double deterrent effect of unfamiliar smell and gritty texture. Re-application is essential when the product has weathered off and where new growth occurs beyond the treated foliage.

4.2 Planting

Three-hundred plants of five species characteristic of Escarpment shrubland were planted as ‘forestry tubes’;

1. 30 x *Allocasuarina verticillata*, Drooping Sheoke
2. 30 x *Bursaria spinosa*, Sweet Bursaria
3. 180 x *Acacia paradoxa*, Hedge Wattle
4. 45 x *Melicytus dentatus* (syn. *Hymenanthera dentata*), Tree Violet
5. 15 x *Myoporum petiolatum* (syn. *Myoporum* sp. 1, ‘*Myoporum viscosum*’), Sticky Boobialla

The proportion of each species reflects densities seen in remnant populations of these species.

¹ Bababi Marning (‘mother’s hand’) is the name proposed for this reserve by a representative of the descendents of the traditional owners of this area, the Wurundjeri-Willam. As of writing, this name has yet to be officially adopted.

Planting commenced on 21st June 2011 and was completed in July when an assessment of all plants was conducted. The initial months assessment therefore includes some data where plants had not been subjected to a month in the ground.

4.3 Setting out

Six planting ‘plots’ were identified along 2 kilometres of the the escarpment at Bababi Marning. (See Appendix 2)

Plots were broken into ‘zones’ with the exception of the relatively small Plot 4. A ‘star’ type steel picket was placed in the centre of each zone and in the centre of Plot 4. Each star picket was labelled with a metallic tag, attached with wire, identifying Plot number and, zone number if applicable. A GPS reading of the location of each star picket was taken.

A variable number of each shrub species were planted in each zone, reflecting the proportions of shrubs and plot characteristics. One of each of the five shrub test species was chosen as a control in each plot. Control plants were marked by stapling a metallic tag to the tree guard stake facing up the slope of the escarpment with the location recorded by measuring the distance and noting the direction to the closest star picket. Refer to the ‘location of control species’ sheet for the control plants position identification when on site. (See Appendix 3)

4.4 Treatment

Instructions for mixing a solution and application of Sen-Tree™ Browsing Deterrent, are as follows for a 5ltr mixture;

1. Add 2.5 ltrs of water to the spray equipment/knapsack
2. Add approximately 240g (1/6) Part A, whole egg solids, and stir
3. Add 1.25 ltrs of Part B, Acrylic Polymer Adhesive, and stir
4. Use the white sprinkler unit to dispense Part C, Silicon Carbide Grit, evenly over foliage after each plant is sprayed with the liquid solution

Sen-Tree™ treatment was applied at the time of planting and on or around the assessment dates. Herbicide application to treat weeds in the plots was generally carried out on the same date.

4.5 Assessment

Browsing intensity will appear different in different species of plants at different stages of growth. Four classes of browsing were formulated based on their perceived impact on plant survivorship and growth.

<i>None</i>	No sign of any browsing at all
<i>Light</i>	Light tip pruning, young/soft/new growth missing, less than 25% height reduction
<i>Moderate</i>	Mature growth eaten, including hardened twigs
<i>Catastrophic</i>	Plant absent, eaten back to main stem down to 25mm from ground, few/no leaves

A visual guide, simulating the appearance of plants browsed at different classes, was provided to help assessors allocate the correct browsing intensity. This is reproduced in Appendix 1. Visual Estimation of Browsing Intensity.

Plants undergoing ‘Moderate’ or ‘Catastrophic’ browse intensity will not be expanding in size and are deemed to be ‘failing’ as regards the planting goals.

4.6 Competitive cover

To evaluate that the routine weed control treatment was sufficient to prevent checks on plant growth due to competition, a one metre diameter circle from each plant was inspected for the cover of; native vegetation, exotic grasses and exotic broadleaf species. These were categorised, according to the following ratings:

None	No vegetative cover of native vegetation, exotic grasses or exotic broadleaf species
< 30% cover in plot	Less than 30% vegetative cover
30 < cover < 70%	Greater than 30% cover and less than 70% vegetative cover
> 70% cover	Greater than 70% vegetative cover

If the tally of competitive cover for ‘exotic grasses’ exceeded 0% and that of ‘exotic broadleaf’ species exceeded 30%, weed control was deemed to be failing to prevent competition.

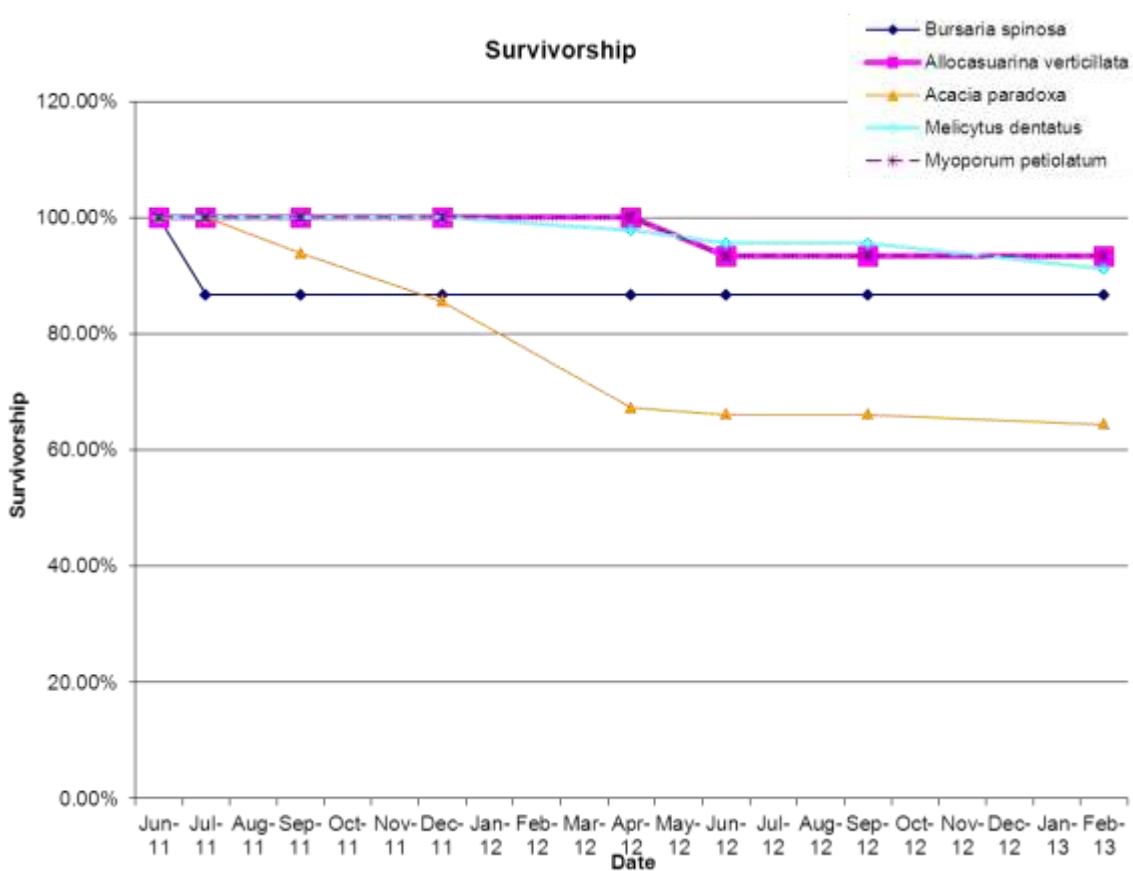
5 Results

Assessments were carried out on 19th July 2011, 26th September 2011, 9th December 2011, 12th April 2012, 19th June 2012, 12th September 2012 and 6th February 2013.

5.1 Survivorship

Survivorship remained high for all plant species for the duration of the study, with over 85% of plants surviving for all species except *Acacia paradoxa*, which nonetheless still had a survival of over 60% at the end of 20 months. (See Figure 5-1 Plant Survivorship).

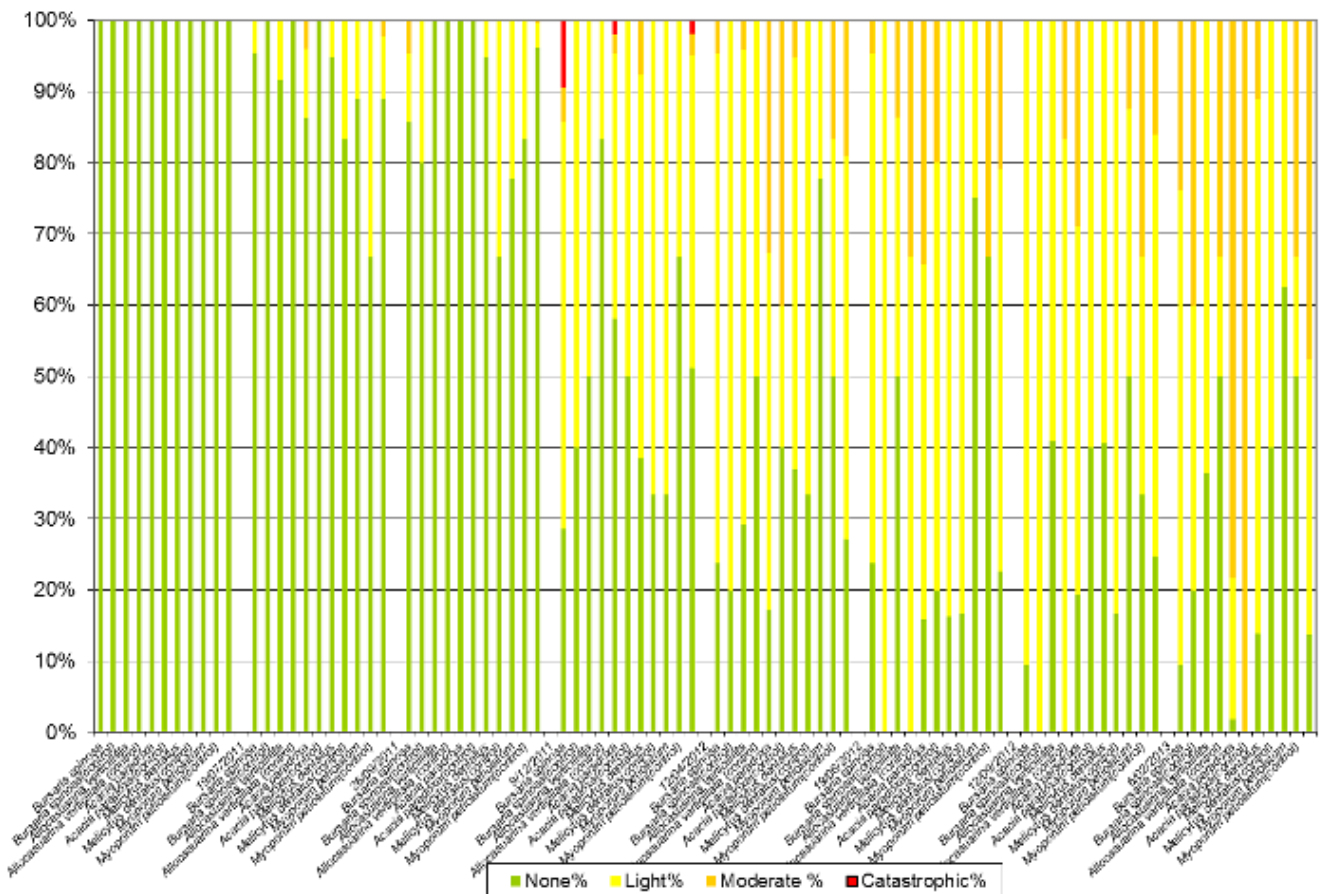
Figure 5-1 Plant Survivorship



5.2 Browsing

A trend of increasing browsing level was apparent throughout the period of the trial. This can be seen in Figure 5-2 Browsing Intensity over time.

Figure 5-2 Browsing Intensity over time



5.3 Species-specific trends

Species specific trends were apparent. These are summarised in Table 6 1 Species-specific trends. Calculations on browsing were based on assessments of surviving plants.

Because of the different proportions of species in the trial (in particular the high number of *Acacia paradoxa*) and different trends evident between species, combined figures for all species are unable to give a useful impression of effectiveness of the Sen-tree™ treatment and have not been calculated.

Table 5-1 Species-specific trends

Species	Browsing to Spring 2011	Browsing 2012	Browsing at end of trial	Control vs treated	
<i>Bursaria spinosa</i>	Plants showed little browsing in the first 3 months,	60-100% of plants were browsed, with the proportion browsed increasing with time	Moderate browsing had become evident in a proportion of the plants at the end of the trial.	Browsing intensity was similar to 'treated' with slightly more intense browsing on control. 40 % of plants 'failing' compared with 23 % of treated plants.	Bursaria spinosa Bursaria spinosa (control)

<i>Allocasuarina verticillata</i>	Plants showed little or no browsing in the first 3 months of the study.	Between 40-70% of treated plants were 'lightly browsed' and a small proportion moderately browsed.	No treated plants 'failed' at end of trial although a high proportion had light browsing evident.	From the second year of the trial, browsing of control plants appeared consistently higher with 30 % of control plants 'failing' at end of trial.	<i>Allocasuarina verticillata</i> <i>Allocasuarina verticillata</i> (control)
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Acacia paradoxa	Some browsing of treated plants occurred soon after planting. It is possible the application was successful in preventing browsing as none was apparent on the September observation.	60% of treated plants lightly browsed for most of the study period, and 40 % moderately browsed, preventing plant expansion.	80% moderately browsed in the final year, and only 20% lightly browsed and (‘succeeding’).	Although control plants, consistently had less browsing than the treated group; on the final visit 100% of A. paradoxa controls were moderately browsed and thus deemed to be ‘failing’	Acacia paradoxa <table border="1"><caption>Acacia paradoxa Browsing Data</caption><thead><tr><th>Date</th><th>None %</th><th>Light %</th><th>Moderate %</th><th>Catastrophic %</th></tr></thead><tbody><tr><td>Jun-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Jul-11</td><td>0</td><td>0</td><td>85</td><td>15</td></tr><tr><td>Aug-11</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Sep-11</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Oct-11</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Nov-11</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Dec-11</td><td>0</td><td>0</td><td>58</td><td>42</td></tr><tr><td>Jan-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Feb-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Mar-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Apr-12</td><td>0</td><td>0</td><td>18</td><td>82</td></tr><tr><td>May-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Jun-12</td><td>0</td><td>0</td><td>16</td><td>84</td></tr><tr><td>Jul-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Aug-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Sep-12</td><td>0</td><td>0</td><td>19</td><td>81</td></tr><tr><td>Oct-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Nov-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Dec-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Jan-13</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Feb-13</td><td>0</td><td>0</td><td>2</td><td>98</td></tr></tbody></table> Acacia paradoxa (control) <table border="1"><caption>Acacia paradoxa (control) Browsing Data</caption><thead><tr><th>Date</th><th>None %</th><th>Light %</th><th>Moderate %</th><th>Catastrophic %</th></tr></thead><tbody><tr><td>Jun-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Jul-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Aug-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Sep-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Oct-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Nov-11</td><td>0</td><td>0</td><td>0</td><td>100</td></tr><tr><td>Dec-11</td><td>0</td><td>0</td><td>50</td><td>50</td></tr><tr><td>Jan-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Feb-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Mar-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Apr-12</td><td>0</td><td>0</td><td>40</td><td>60</td></tr><tr><td>May-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Jun-12</td><td>0</td><td>0</td><td>20</td><td>80</td></tr><tr><td>Jul-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Aug-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Sep-12</td><td>0</td><td>0</td><td>40</td><td>60</td></tr><tr><td>Oct-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Nov-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Dec-12</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Jan-13</td><td>0</td><td>0</td><td>100</td><td>0</td></tr><tr><td>Feb-13</td><td>0</td><td>0</td><td>100</td><td>0</td></tr></tbody></table>	Date	None %	Light %	Moderate %	Catastrophic %	Jun-11	0	0	0	100	Jul-11	0	0	85	15	Aug-11	0	0	100	0	Sep-11	0	0	100	0	Oct-11	0	0	100	0	Nov-11	0	0	100	0	Dec-11	0	0	58	42	Jan-12	0	0	100	0	Feb-12	0	0	100	0	Mar-12	0	0	100	0	Apr-12	0	0	18	82	May-12	0	0	100	0	Jun-12	0	0	16	84	Jul-12	0	0	100	0	Aug-12	0	0	100	0	Sep-12	0	0	19	81	Oct-12	0	0	100	0	Nov-12	0	0	100	0	Dec-12	0	0	100	0	Jan-13	0	0	100	0	Feb-13	0	0	2	98	Date	None %	Light %	Moderate %	Catastrophic %	Jun-11	0	0	0	100	Jul-11	0	0	0	100	Aug-11	0	0	0	100	Sep-11	0	0	0	100	Oct-11	0	0	0	100	Nov-11	0	0	0	100	Dec-11	0	0	50	50	Jan-12	0	0	100	0	Feb-12	0	0	100	0	Mar-12	0	0	100	0	Apr-12	0	0	40	60	May-12	0	0	100	0	Jun-12	0	0	20	80	Jul-12	0	0	100	0	Aug-12	0	0	100	0	Sep-12	0	0	40	60	Oct-12	0	0	100	0	Nov-12	0	0	100	0	Dec-12	0	0	100	0	Jan-13	0	0	100	0	Feb-13	0	0	100	0
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<i>Melicytus dentatus</i>	Both treated and controls were lightly browsed from an early stage.	Light browsing was prevalent for most plants	12% of plants were moderately browsed and thus 'failed' in the final assessment	The controls appeared to receive less browsing attention than the treated plants for most assessment period although this did not appear to be a strong trend.	Melicytus dentatus Melicytus dentatus (control)
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<i>Myoporum petiolatum</i>	Light browsing commenced at an early stage of the trial on both treated and control plants.	Variable light browsing was recorded in the second year of the trial	Browsing of <i>M. petiolatum</i> controls was, more intense (35% moderate browsing in the second half of the study).	In the final assessment, over 30% of controls were deemed to have 'failed'.	Myoporum petiolatum Myoporum petiolatum (control)
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5.4 Competitive Cover

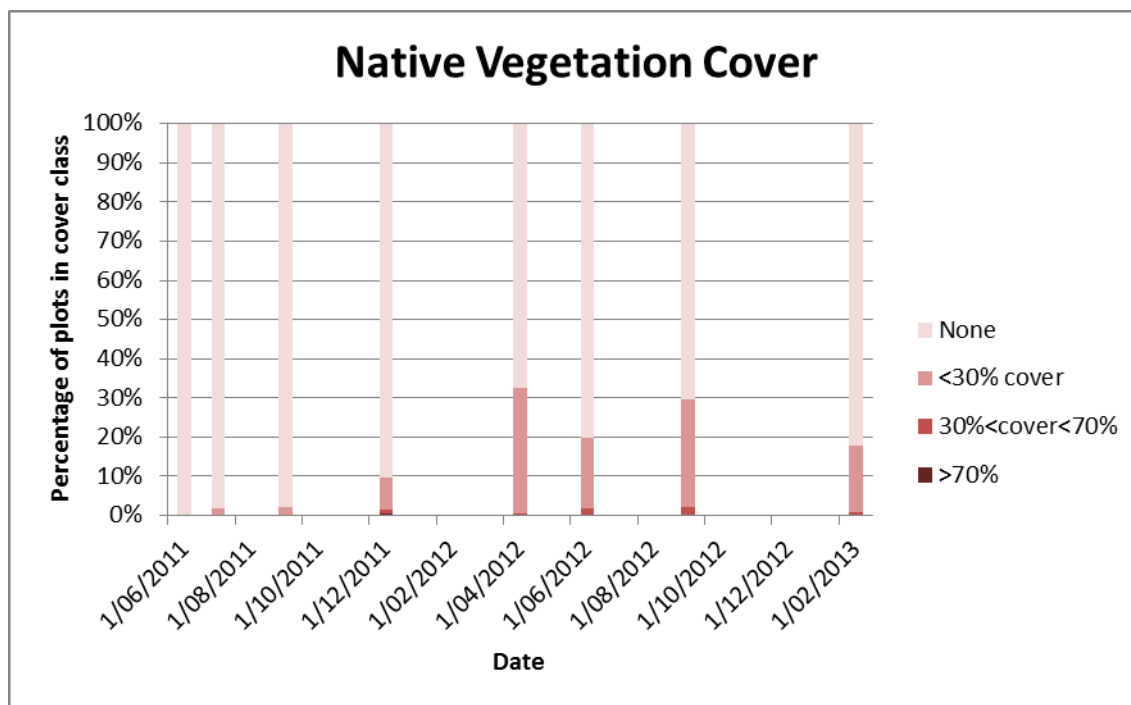
Charts showing the percentage of plots with cover of Native vegetation, exotic grass and broadleaf weed are included as Figure 5-3 Native Vegetation Cover, Figure 5-4 Exotic Grass Cover and Figure 5-5 Exotic Broadleaf Cover.

5.4.1 Native Vegetation Cover

From a starting point where no indigenous plants were detected, small amounts of native plants re-established, reaching a peak of being present in over 30% of plots approximately 12 months following planting. Native cover was primarily made up of short-lived colonising broad-leaf species (*Senecio quadridentatus* and *Senecio hispidulus*) with smaller quantities of native grasses (*Rytidosperma*). The long-lived perennials *Lomandra filiformis* and *Dichondra repens* were noted re-establishing from plants that had presumably survived the competition of Serrated tussock and subsequent herbicide applications.

The trend was generally towards increasing cover of native plants under the regular weed control regime where these species were protected. However, this ‘assisted natural regeneration’ is slow and by the end of the assessment period, less than 20% of plots had native plants at a level of <30% cover and only 2 plots had cover greater than 30%.

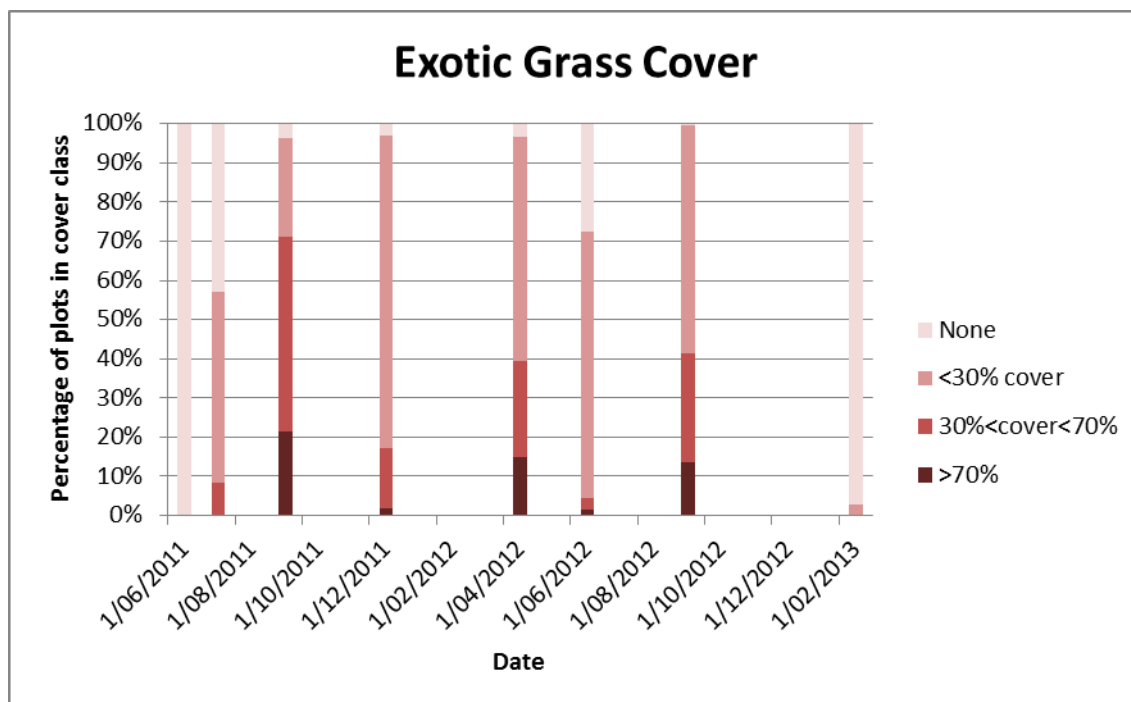
Figure 5-3 Native Vegetation Cover



5.4.2 Exotic Grass cover

From a totally weed free starting point, exotic grassy weeds rapidly established in the plantings, reaching a peak in the first spring. Primary exotic weed grasses noted included *Phalaris aquatica*, *Nassella neesiana*, *Nassella trichotoma* and *Dactylis glomerata*, especially in the first year, later figures are made up primarily of annual grassy weeds. Weed control did not achieve the goal of avoiding all grassy weed competition until the final assessment period. The very low cover level reported for this period may be partly attributable to the absence of annual grasses following a severely dry summer.

Figure 5-4 Exotic Grass Cover

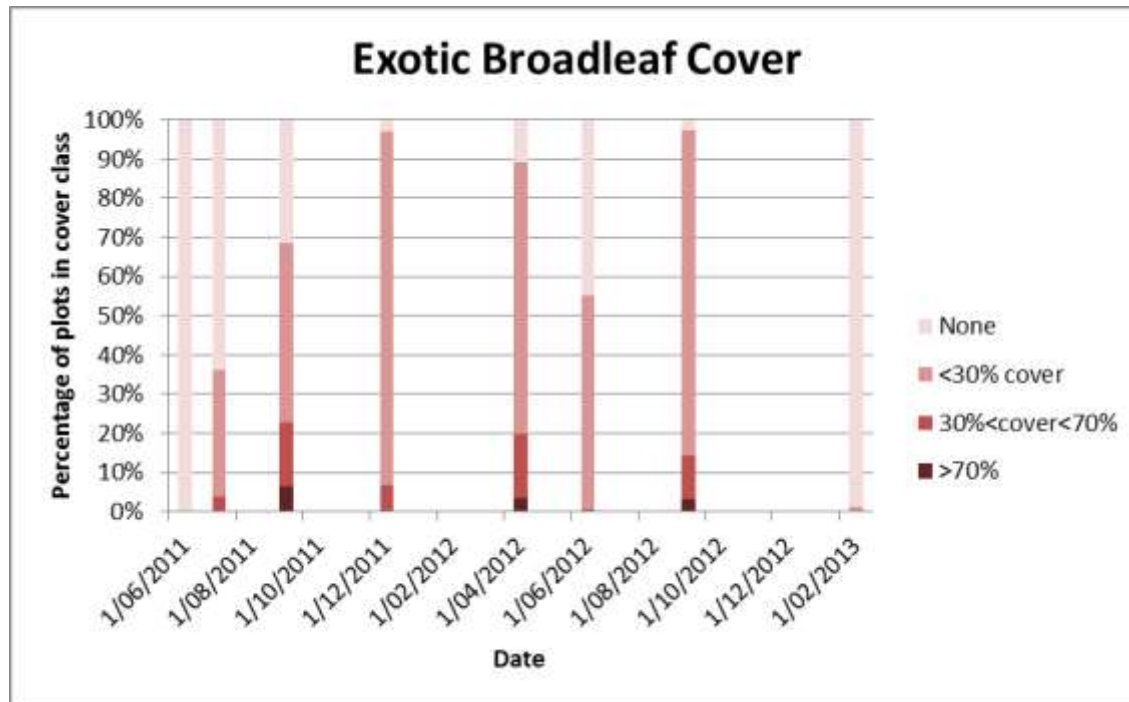


5.4.3 Exotic Broadleaf Cover

Exotic Broadleaf weed species present a lower competitive threat to shrub and tree establishment than grasses however they may impact on young shrub and tree plantings through fostering high populations of slugs, mites, bugs and possibly allelopathic effects. The main component of broadleaf weeds around the plantings were Brassicaceae (esp. Twiggy Turnip, *Brassica fruticulosa* and Buchan Weed, *Hirschfeldia incana*).

From a planting site with no exotic broadleaf weeds, these increased rapidly, reaching a peak in the first spring when over 70% of plants had between 30 and 70% cover of exotic broadleaf and 20% had greater than 70% cover. Thereafter, weed control appeared adequate to reduce cover of exotic broadleaf weeds. In the final late-summer assessment, broadleaf weeds were almost absent, suggesting a high proportion of the remaining broadleaf weeds are winter-growing annuals.

Figure 5-5 Exotic Broadleaf Cover



6 Discussion

6.1 Scheduling re-application of deterrent

Some gaps in re-application exceeded the recommended range, in particular the 4 month gap between December 2011 and April 2012 and the 5 month gap between September 2012 and February 2013. These delays reflect the competing priorities in an organisation where research is not the primary occupation. However, scheduling is not an insurmountable hurdle and it is recommended that greater emphasis be placed on this aspect of the treatment for future uses.

These delays have compromised the reliability of results of this project, producing an unintentional additional variable in the design – interval between re-treatment. The possible effects of the delays on the results are detailed under the notes on ‘browsing’ below.

During the assessment, observations were made that the quantity of vulnerable new growth beyond treated foliage varied widely with the season, species and rainfall. During times of rapid growth, re-treatment intervals shorter than the standard three-month period might have had more impact on preventing browsing and hastened the establishment of plants for some species.

6.2 Survival

No mortality was attributable to browsing itself, plants that survived the initial period of establishment tended to persist, even when heavily browsed.

The most vulnerable time for survival of plants from herbivore activity is in newly planted stock guards on where dislodging and catastrophic browsing may have most impact. It is possible that the tree-all plants provided sufficient protection from this disturbance and that application of Sen-Tree™ was redundant for the first 3 month period.

The primary reasons for mortality were;

- The mortality observed in the first post-planting assessment of *Bursaria spinosa* may have been attributable to planting shock or poor planting technique.
- High rainfall with associated high soil moisture and localised poor drainage is most likely to have caused the higher death rate observed in *Acacia paradoxa*. Symptoms of waterlogging (yellowed foliage) were noted in this species by field staff. Locally, the species appears to be highly sensitive to impeded drainage and this scale of mortality appears to be normal.
- Damage from vandalism (illegal ‘joy-riding’ by a four-wheel drive vehicle) was recorded for Plot 5 on 26/9/11 and contributed to the deaths of several plants.

6.3 Browsing

Based on; the results of the assessment, comparison between controls and treatments and field based observations, there were species specific differences between the efficacy of the deterrent.

- Sen-tree TM application appeared helpful in allowing treated *Myoporum petiolatum* and *Allocasuarina verticillata* plants to establish compared to ‘control’ plants, the treatment apparently preventing browsing from reaching ‘moderate’ levels. By the end of the trial, the plants appeared to be reach a point where browsing was no longer affecting growth on untreated vegetation, perhaps indicating that these species’ own defences (perhaps unpalatability) were becoming sufficient to deter serious browsing.
- Sen-tree TM application did not appear to significantly reduce browsing pressure on *Bursaria spinosa* or *Melicytus dentatus* plants compared with control plants (slight positive effect in *Bursaria*, no or negative effect in *Melicytus*). Observations by field staff were that foliage to which the deterrent was applied did persist across subsequent visits. New growth beyond the treated foliage was frequently browsed. These observations suggested that a more frequent regime of deterrent application may have achieved a positive result.
- There appeared to be little difference in the browsing intensity on *Acacia paradoxa* between treated and controls, suggesting the treatment had little effect. However two strong jumps in the intensity of browsing correspond with assessments following the unintended delays in application. Similar jumps might be discerned in the results for the treated *Melicytus* and *Bursaria* plants. This suggests that the deterrent was having an effect and that more consistent application may have achieved a positive result.
- By the end of the trial, almost all surviving *Acacia paradoxa* plants continued to be heavily browsed where wallabies were able to reach. Even treated foliage was repeatedly browsed when within reach. This suggested such a high level of palatability of this species to Swamp Wallabies that browse-deterrent may not be adequate for establishing this species.
- A single plant of *Acacia paradoxa* grew rapidly to a large size as, for reasons unknown, it escaped being browsed throughout the study. This indicated that *A. paradoxa*, can establish successfully on escarpments where browsing is excluded.
- In remnant areas of the Merri Creek valley, *Acacia paradoxa* appears to be absent on escarpments (where wallabies are common), while being frequently found on Stony Knolls where wallabies are scarce. This raises the possibility that the current absence of *Acacia paradoxa* on escarpments of the Merri Creek is a natural consequence of their palatability to Swamp Wallabies. If this is the case, then attempts to establish naturally-reproducing populations of the species on escarpments in the presence of Swamp Wallaby are probably doomed. Further examination of remnants and historical records for *Acacia paradoxa* and Swamp Wallabies might determine whether the species should be excluded from Escarpment Shrubland planting lists for the middle and upper Merri Creek. (eg, Wigney et. al. 1994)

6.4 Competition reduction

Levels of native plant competition appeared to be low and it is unlikely it provided any check on planting establishment. Re-colonisation by indigenous plants was therefore fostered in this project through careful spot application of herbicide.

Although overall exotic weed cover was high at times, no mortality or substantial check on growth could be attributed to weed competition. This was presumably due to;

- regular weed control rounds preventing weeds (in particular perennial weeds) reaching a state of maturity capable of severely impacting growth of adjacent plantings.
- The high and regular rainfall (including summer rainfall) in the first 15 months from planting prevented competitive effects from weeds causing serious competitive problems.
- Of the exotic grasses and broadleaf weeds, a high proportion were annual species which would have provided minimal competition during periods of high drought stress in late summer.

Exotic grass cover presents the most serious threat to plant establishment as the vigorous grasses are capable of causing severe water stress, especially in summer. Winter-growing annual weeds pose a lower long-term risk to tree and shrub than rank perennial weeds as they will generally not be extracting soil water during the period of most severe moisture stress in mid to late summer. Locally, summer-growing annual weeds are generally poor competitors in sites that remain dry through summer. No separate figures for perennial versus annual weeds were maintained during the project.

6.5 Limitations

- The period in which this trial has taken place has coincided with a relatively high rainfall which has promoted relatively rapid growth. Browsing pressure may have been less relative to average or drought years. The effect of such seasonal variation could only be identified with repeated trials across several years.
- Control plants were located among treated plants in each plot. The action of the Sen-TreeTM includes a smell deterrent which might provide protection to surrounding untreated plants. Animals may also avoid a general area (including the control plants) due to the low density of palatable plants. In event of future trials of this product, it would be important for controls to be located at a distance from the treated plants. Leaving an entire plot untreated may provide a more definitive comparison of treated and untreated plants.
- The incidence of extended intervals between treatment resulted in periods where abundant untreated new growth was present among the plantings. The continuing high prevalence of palatable browse may have prevented wallabies developing a pattern of avoidance of these plantings that the regular application is supposed to foster.
- The ecologically relevant distinction between perennial and winter-growing and summer-growing annual weed species was not recorded, lowering the capacity to interpret competition and weed control parameters.

7 Conclusion

For areas along Merri Creek where Swamp Wallabies are abundant, it appears as though Sen-treeTM will improve establishment of all species if applied regularly.

Some shrub and tree species appear to be able to withstand browsing adequately after 20 months application of the product while others continue to suffer high levels of browsing that prevent plantings achieving ecological goals. However, delays in application and inadequacy in the design of the controls in this study mean we were unable to conclusively determine this.

Acacia paradoxa appears to be highly palatable to Swamp Wallabies to the extent that application of the deterrent may not be sufficient, even at the recommended level in allowing plants to expand

The effectiveness of Sen-treeTM application is negatively affected by delays in re-application.

Sen-treeTM application at the recommended rate is unlikely to maximise establishing the structure of shrubs (eg. when good rainfall and warm weather coincide).

8 Recommendations

- 1) It is recommended that trial plants should have remaining tree-guards removed and two final Sen-treeTM applications close together applied to attempt to allow the plants to hopefully reach a size where browsing can be sustained.
- 2) Improved processes for ensuring tight scheduling of re-treatments may be required by organisations using this product.
- 3) Consider reducing the re-treatment interval so that more vulnerable new growth can be protected under conditions of rapid growth
- 4) Further trials of this product appear warranted for *Acacia paradoxa*, *Bursaria spinosa* and *Melicytus dentatus*, to assess whether re-application at a higher frequency might improve performance to a significant degree.
- 5) For plantings including *Acacia paradoxa*, alternative protective methods are anticipated to be required for areas with Swamp Wallabies. Either fencing out plots of shrubs or using individual tall tree-guards (900mm). Alternatively, consider not planting this species in areas where wallabies are abundant.
- 6) Further observations from remnant sites are needed to determine whether the apparent absence of *Acacia paradoxa* from escarpments on the Merri Creek and its persistence on stony knolls is related to differences in the residence time (and browsing pressure) of Swamp Wallabies in these two apparently similar environments.

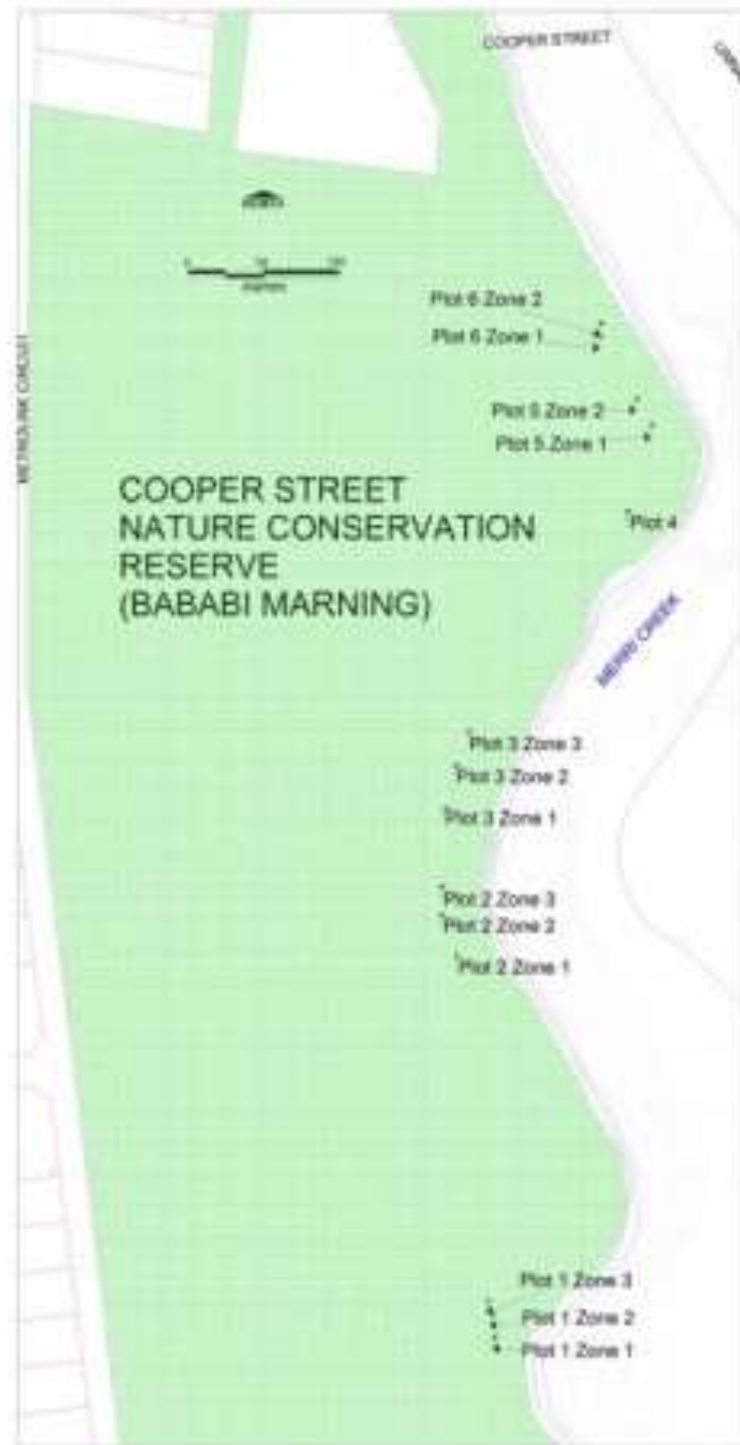
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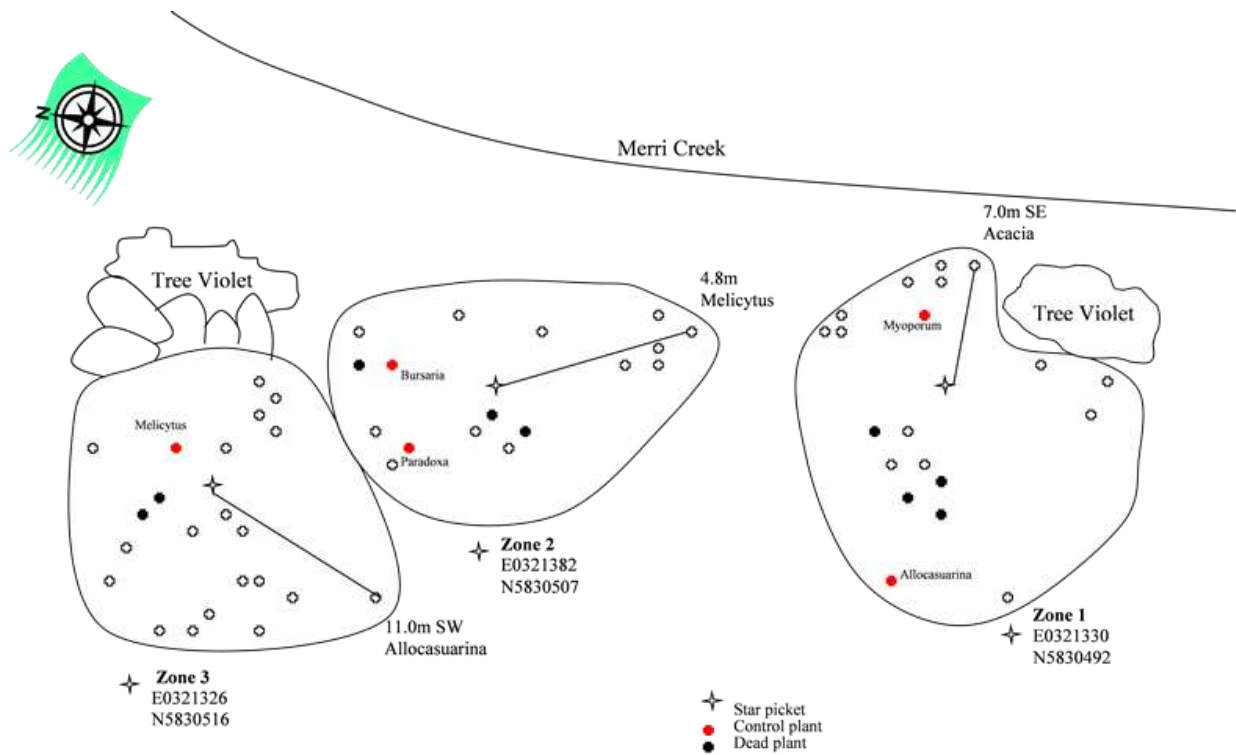
10 Appendix 1. Visual Estimation of Browsing Intensity

Species	None	Light Only young, soft growth browsed	Moderate Browsing extends into mature growth, hardened twigs	Catastrophic Browsing to stump or branches such that leaves are virtually absent. Possibly Torn from ground
<i>Bursaria spinosa</i>				
<i>Allocasuarina verticillata</i>				
<i>Acacia paradoxa</i>				
<i>Melicytus dentatus</i>				
<i>Myoporum petiolatum</i>				

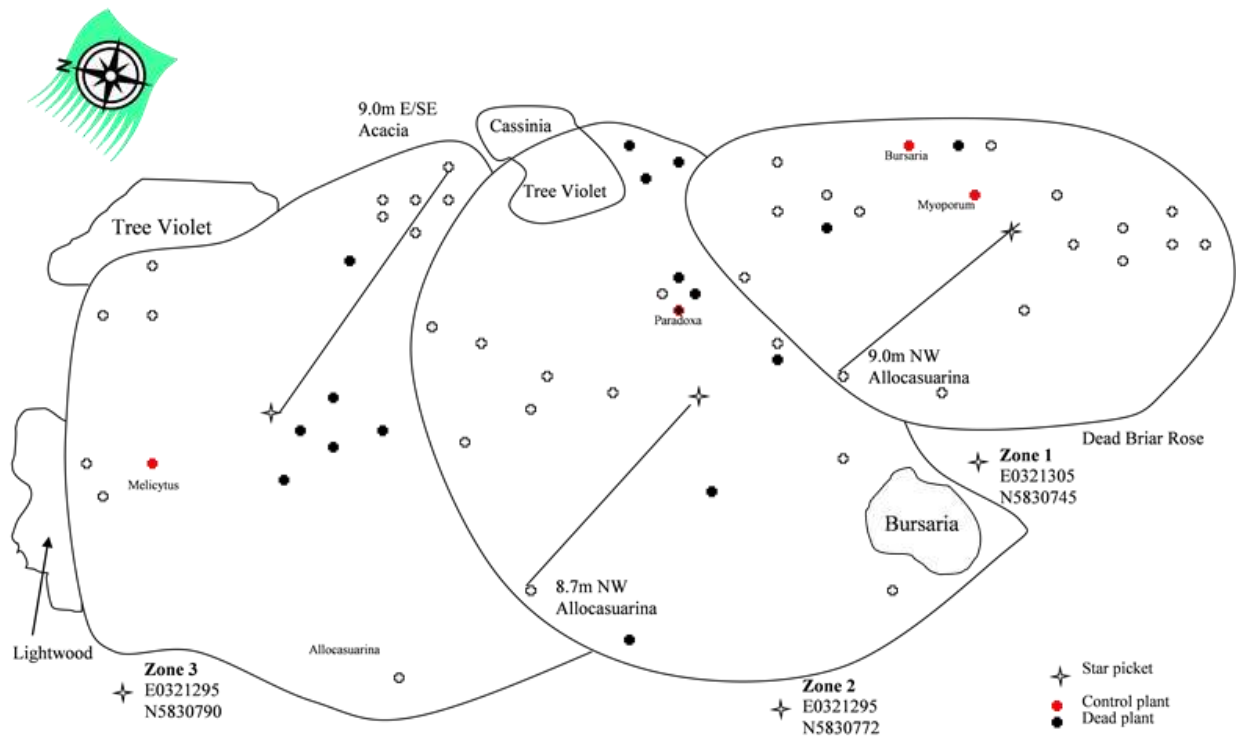
11 Appendix 2. Plot Locations within the Reserve



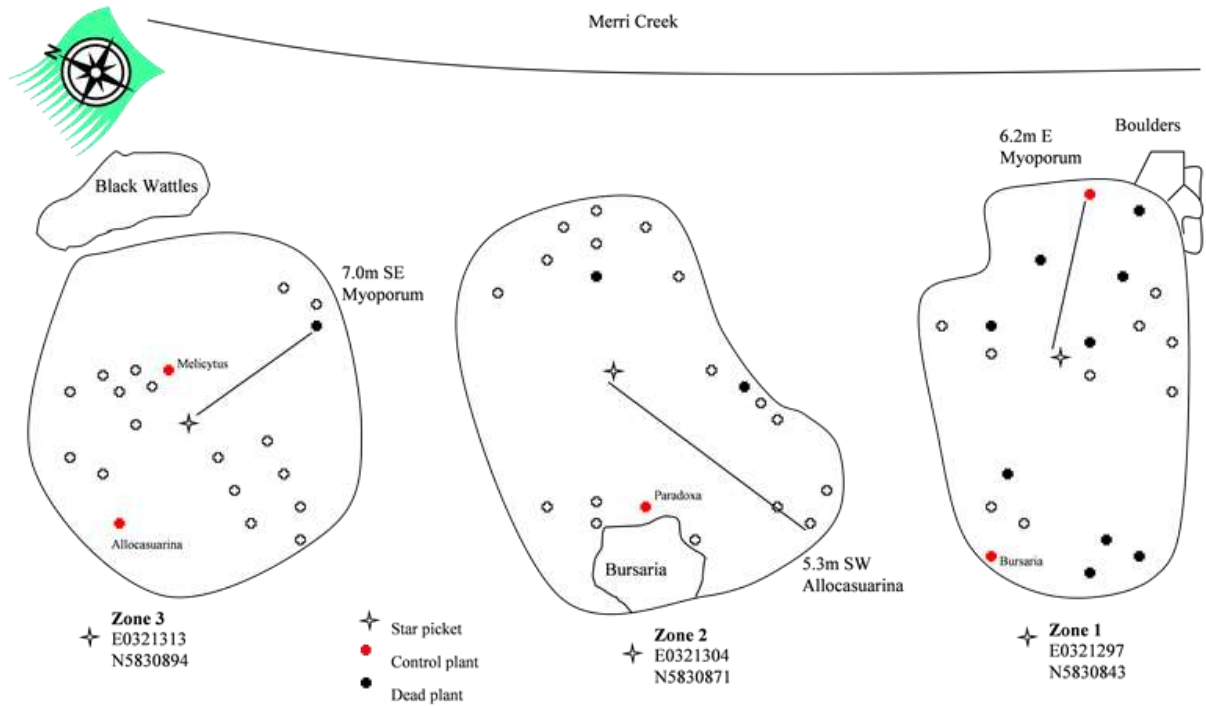
12 Appendix 3. Maps of planted plots



Plot 1

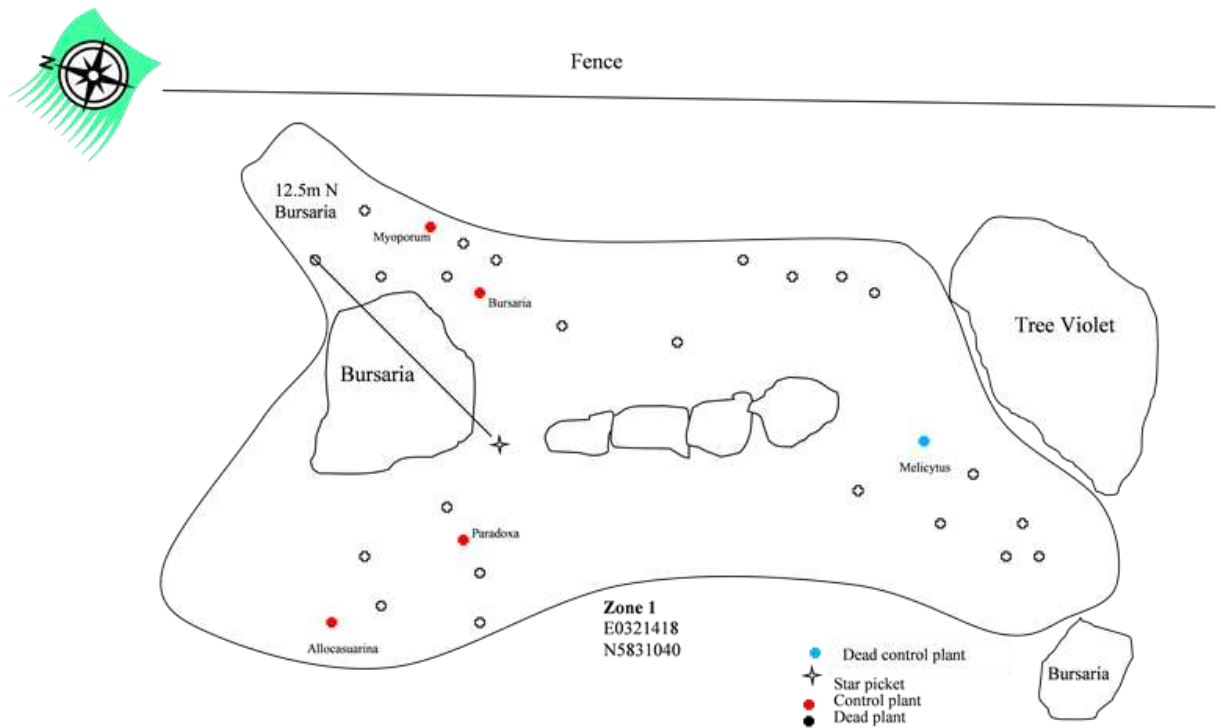


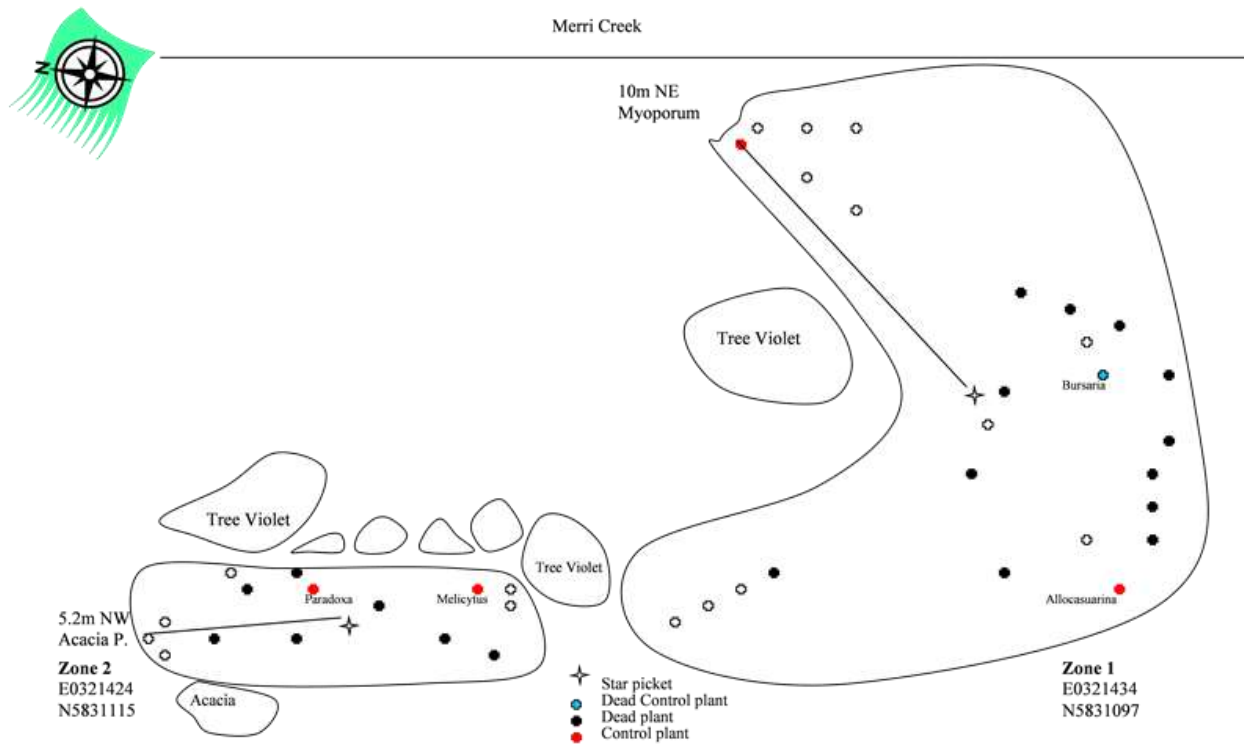
Plot 2



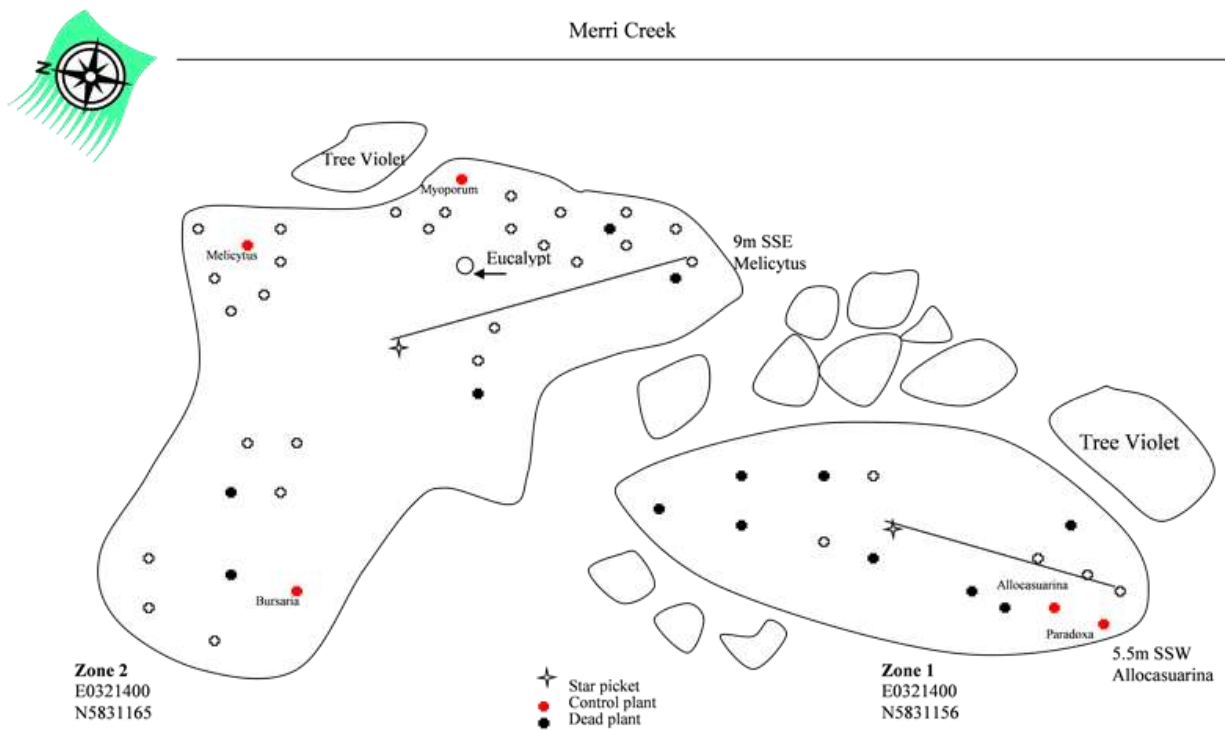
Plot 3

Plot 4.





Plot 5



Plot 6