Annual Report on the project

Identifying cost-effective reforestation approaches for biodiversity conservation and carbon sequestration in southern Australia. ARC Linkage Project Biodiversity Surveys 2013 - 2015

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Project Summary to December 2013

The project site is located in a single soil type of approximately 20 ha of previously cleared agricultural land at Monarto Zoological Park. It comprises 10 **blocks**, and each block comprises 8 **plots**: 6 reforestation plots plus two control plots totalling 80 plots across the site (FIGURE 1). Each plot consists of a single 25 × 25 m square surrounded by a 5 m buffer zone (10 m total between plots). Buffer zones are not planted but are managed throughout the experiment to keep grasses under control through herbicide application and/or slashing. Prior to any activity the site was slashed and treated with herbicide treated two weeks prior to planting to control weeds.

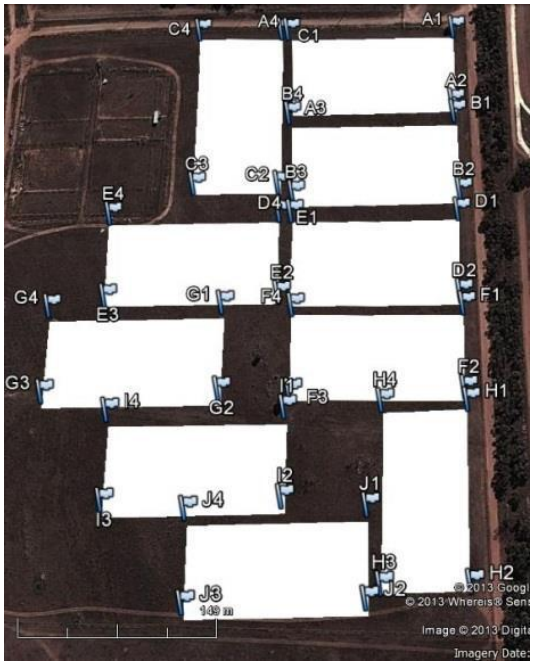

FIGURE 1 Layout of each of the 10 experimental blocks across the 20 ha site. Blocks are labelled A-J.

Biodiversity-Density Treatments

The two principal manipulations that comprise the experiment are: (1) a three-level biodiversity and (2) a two-level planting density treatment. Each plot was assigned randomly one of 6 replanting treatments or one of 2 controls so that each block has a single, randomly ordered representative of each treatment (FIGURE 2). Species were chosen on the basis of availability of propagating material (seed), germination

success and seedling survival in both the nursery and the field. A series of harvest plots (for carbon sequestration measurements) have also been established in areas adjacent to the experimental plots.

The three-level biodiversity treatment included: (1) **native tree monoculture**: *Eucalyptus porosa* Mallee box; (2) **low-diversity mixed culture** (3 species): *Eucalyptus porosa*, *Acacia rhigiophylla* dagger-leaf wattle, *Enchylaena tomentosa* ruby saltbush; (3) **high-diversity mixed culture** (10 species): *Eucalyptus porosa*, *Eucalyptus leucoxylon* SA blue gum, *Melaleuca acuminata* Mallee honey-myrtle, *Acacia rhigiophylla*, *Acacia brachybotrya* grey Mulga-bush, *Pomaderris paniculosa* pomaderris, *Enchylaena tomentosa*, *Rhagodia crassifolia* fleshy saltbush, *Prostanthera aspalathoides* scarlet mintbush, *Maireana brevifolia* short-leaf bluebush.

Each of the three biodiversity treatments are planted at two different densities: (1) high-density plantings: plants spaced at 1.5 m apart (49 plants), and (2) low-density plantings: trees spaced 3 m apart (16 plants). A temporary grid structure was created to provide a standard reliable measuring system for planting, with holes for each tubestock drilled at each intersecting joint. Each plant was assigned a code according to the location on the grid system to enable ease of monitoring, recording of plant death, and for growth measurement of low diversity structure plots. There has been a handful of plant death to date which has occurred during the months immediately after planting and has been limited to *Enchylaena tomentosa*; we are attributing this tentatively to a very wet season. Those plants were replaced and to date no further plant death has occurred. The site is monitored regularly and will be watered over summer should there be particularly hot periods.

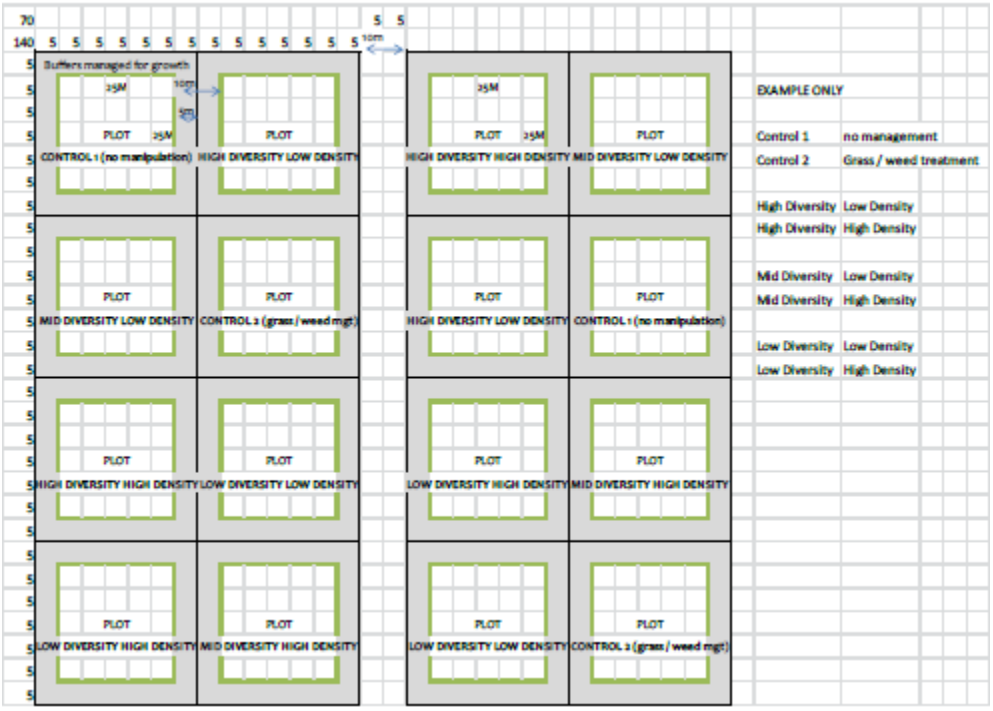

FIGURE 2 Example block layout showing the position of each plot, between-plot buffers and between-block buffers. Plot treatments were assigned randomly.

The two control plots included in each block comprise: (1) **grass management**: mow between planted trees / shrubs and spray broad spectrum herbicides to kill grasses and weeds four times a year post-planting which has been undertaken in July and December, and (2) **no manipulation**.

We have undertaken to manage adjacent fence lines for the Zoo maintenance team to ensure that no off-target damage occurs to the experimental site as a result of regular management activities.

Monitoring Methods

Vascular plants and non-vascular plants: Plant surveys before and after first planting follow a nested vegetation sampling method. Prior to planting, we mapped out the experimental plots and set up permanent plant surveying subplots using pin markers (also called mining tags) with each location recorded through GPS. In each experimental plot we established the following nested quadrats: one 15 × 15 m quadrat for sampling trees > 10 cm dbh, and two 10 × 5 m plots for sampling woody species < 10 cm dbh (Figure 3). We positioned the quadrats for sampling woody species in the centre of each 25 × 25 m experimental reforestation plot, allowing for a 10 m buffer from the plot edge and the sampled area.

We used the step-point method to sample herbs and non-vascular plants across the site. Four transect lines 300 m each running diagonally through the site have been sampled, with 200 sampling 'points' along each line and 1.5 m between each sampling 'point' (Figure 4). At each 'point' all plant species within a hand span were recorded. These lines are marked with permanent posts at each end, and the locations GPS recorded to enable ease of re-use. Given the former history of the site, the vegetation was predominantly pasture grasses and agricultural pest plants such as horehound; however, there were numerous native plant species recorded including *Austrostipa* and *Austrodanthonia* sp., *Enchylaena tomentosa* ruby saltbush, and *Dodonaea viscosa* sticky hop-bush.

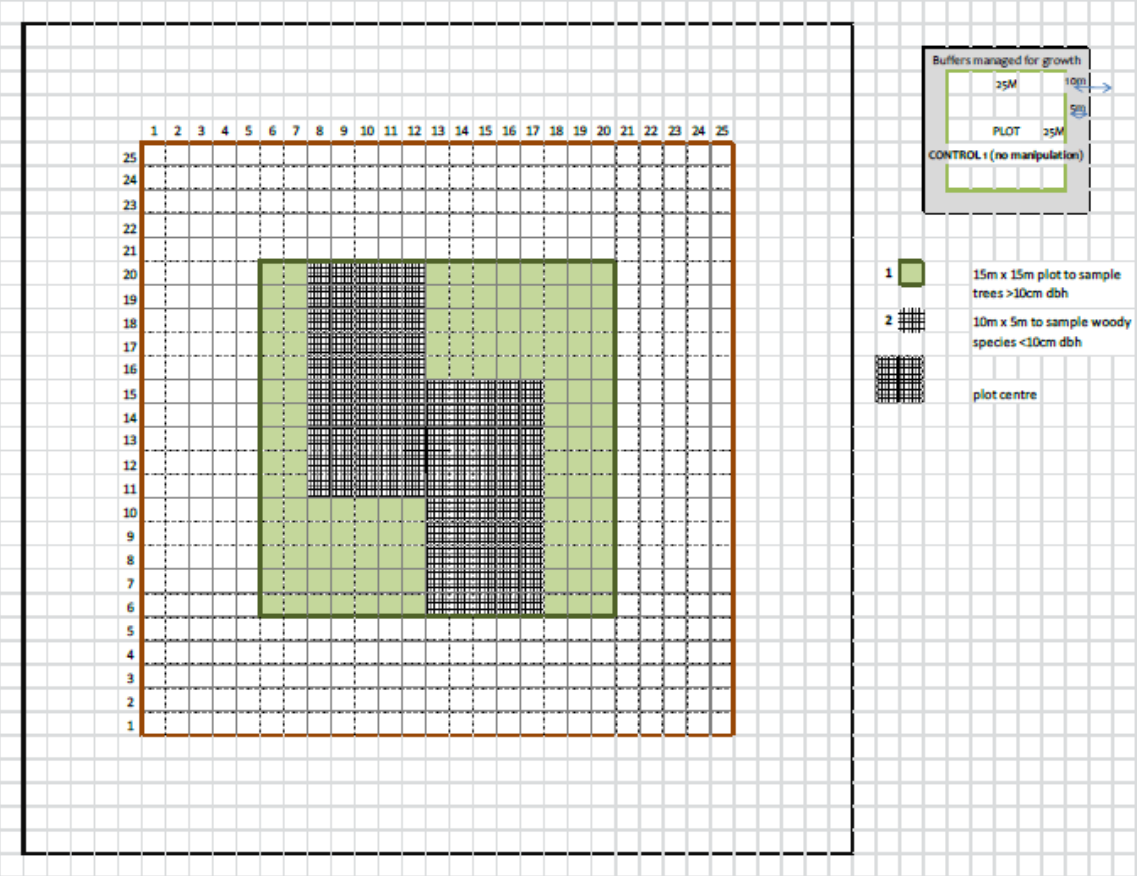

FIGURE 3 Vegetation quadrat monitoring per plot comprising one 15 × 15 m sampling plot and two 10 × 5 m sampling plots.

FIGURE 4 The four 300 m-long vegetation transect lines (marked in yellow) used for the step-point vegetation monitoring. Each line has 200 data 'points' or steps.

In each plot we recorded the identity and abundance of all plant species in Year 1. All woody species are labelled for ease of future sampling throughout the study. For pre-experiment surveys, 10 nested plots have been established in nearby forest fragments at least 100 m from the forest edge. These plots will provide the necessary data for comparison with developing experimental reforestation plots.

Bees: (Tobias Smith from University of Queensland has been implementing this aspect) We used standard pan trap and netting techniques to survey bees living in the cleared paddock before planting treatments and in plots after planting. While bees are highly mobile, many species have specific habitat and food requirements, so differences in bee communities can be detected in small plots. To ensure comparability between plots, we established permanent sampling sites within the centre of each of the treatment plots within all 8 replicate blocks (80 in total). Pan traps are made of blue, white and yellow plastic bowls filled with water and no-scent detergent. These traps attract bees that fly into the water and drown. Individual sampling sites consisted of nine bowls (three of each colour) placed in a triangle around the centre point, each spaced 2.5 m apart (Figure 5).

Traps were set for five 24-hour periods twice a year (April and October). Ten sampling sites of the same design will are located within the nearby forest patches. Five of these are located near the forest edge, and the remaining five are placed more than 100 m from the forest edge in the interior of the patch. We have also net-trapped bees by walking for 30-minute intervals throughout each experimental plot, netting any bees seen in the morning and late afternoon. Initial feedback from Tobias has been that bee activity in April appears to have been greater or similar to that in October which was unexpected (it was expected that the reverse would occur, given the presence of more spring-flowering species on-site).

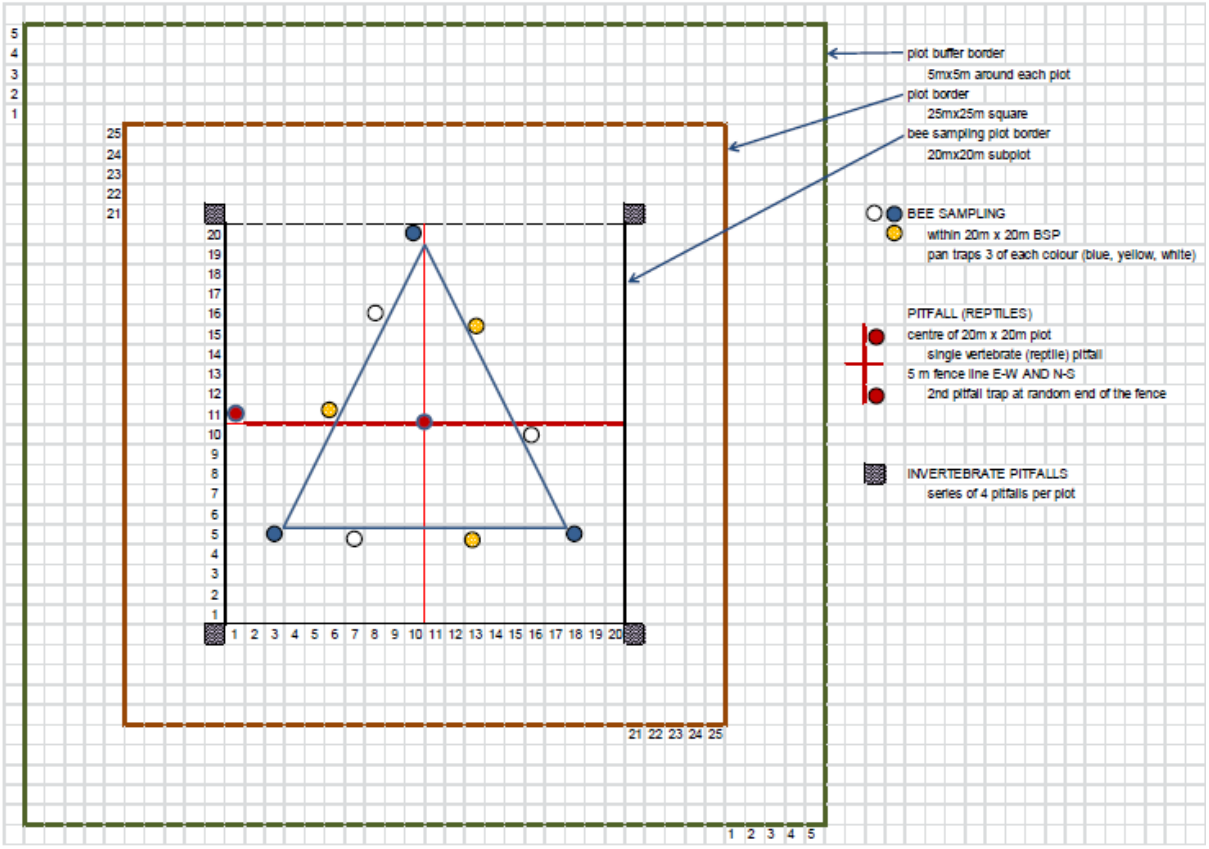

FIGURE 5 Fauna monitoring per plot showing pan traps (bees), pitfall (reptile) and micro-pitfall (invertebrate) sampling.

Other invertebrates: We sampled other invertebrates using pitfall and flight intercept traps. We used the same spatial arrangement of trap locations as for the bees to maximise efficiency of the field surveys (Figure 5). We placed a set of four pitfall traps 10 m apart at the centre of each treatment plot, thereby ensuring that there is at least 50 m between sets of replicates in different plots. We set traps one 5 day period once a year. We also ran ten sampling sites of the same design within adjacent forest patches, following the same spatial arrangement as for the bees.

Invertebrate processing and collation is being finalised, and identified to species (where possible).

Lizards: We used 10 standard pitfall traps set for small lizards (e.g., mainly scincids) per plot measured in October (this will increase to April and September in the final year). Captured lizards were marked and released, and we recorded species, and sex and snout-vent length as an index of size. Repeat captures made during the surveys were marked with a non-permanent mark across the tail to allow for identification. No permanent notching or marking is made. Additionally, we recorded any opportunistic sightings of reptiles recorded across the site to identify the relative abundance and species composition of sighted lizards. We repeated surveys and pitfall traps in adjacent remnants for comparison as described for other taxa.

Reptile processing and collation is being finalised, and identified to species.

Mammals: Although mammals are not the focus of this project, any captures during surveys (e.g., in the pitfalls) will be recorded. This will be limited to species identification, weight, length, sexing where possible and non-permanent marking to enable identification if repeat captures are made. No permanent notching or marking will be made.

To date no mammals have been recorded or captured in the pitfalls.

Anticipated actions December 2013-June 2014: The project site is in a period of maintenance, where we will monitor plant health, irrigate as necessary, and continue with the management regime of slashing and/or herbicide application. Additional tubestock are being propagated and will be planted in June-July 2014 pending break-of-season rains. One year following initial planting, we will begin to monitor the diversity of our five focal groups of organisms as well as soil and environmental conditions in plots and in adjacent remnant forested areas using the sampling methods discussed in this progress report.