Beating the weed menace. The Grass Experiment

Restoring native grasses to the understorey of The Pinnacle. New knowledge that will aid recovery of degraded box-gum grassy woodlands.

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Background and justification

The widespread invasion of exotic grasses depletes native biodiversity. Exotic grasses contribute to reducing the number of bird species (Hannah, Woinarski *et al.* 2007; Maron and Lill 2005; Montague-Drake, Lindenmayer *et al.* 2009), reptile species (Jellinek, Driscoll *et al.* 2004) and invertebrates (Lindsay and Cunningham 2009). In the Australian Capital Territory, a number of woodland bird species are threatened with extinction. Additional threatened species most commonly associated with grasslands can also make use of grassy woodlands (ACT government 2004).

The most widespread groups of weeds at The Pinnacle are the exotic grasses, along with sorrel and exotic clover species. This cluster of species likely represents the most profound environmental change throughout the park, both because they cover the majority of the area, and because they exclude most other native plants. They also represent a substantial barrier to the restoration of native fauna. Restoration of The Pinnacle therefore requires that this most widespread and difficult problem is addressed.

Prober et al (2005) suggest exotic grasses may be reduced by mowing or burning in spring before they set seed. Reducing nutrient availability can also reduce the competitive advantage that some exotic grasses have over natives. In small scale experiments, nutrients have been reduced by addition of sugar or activated carbon (Kulmatiski and Beard 2006; Prober, Thiele *et al.* 2005), and this resulted in reduced cover of exotics and increased cover of natives. A new project currently underway (Lunt, Prober, Cole, Charles Sturt University) has also demonstrated dramatic improvement in native plant cover with the addition of sugar, suggesting that nutrient management is a key to understory restoration. However, adding sugar is very expensive and requires reapplication every few months. It is not really suited to restoring large areas of degraded grassy woodland (Rawlings, Carr *et al.* 2010). However, adding sugar can provide important insight into the potentially limiting role of nutrients, and therefore the benefits expected if nutrients can be reduced using some other, cheaper method.

Given this, FOTPIN proposes to examine methods for reducing nutrients, and the effects on weed control and native plant recovery. Our approach is to carefully monitor nutrient levels in trials that compare slash removal, burning and crop harvest as means to drive down the nutrient load.

Our approach also includes consideration of the impacts of herbivores. Grazing by rabbits and kangaroos is substantial at The Pinnacle Nature Reserve, evidenced both by the obvious prevalence of these animals, and by our observations that grasses have been grazed back to an extent that has limited flowering. If grazers remove plant material and replace the nutrients through urine and dung, then it may limit our capacity to remove nutrients. Furthermore, grazing by herbivores may also limit the capacity of native plants to re-establish in our experimental plots. Before we can implement widespread restoration activities, it is critical to understand how important herbivore management might be.

A third variable that we regard as potentially important is variation in the level of exotic plant cover. At Goorooyaroo Nature Reserve, McIntyre et al (2010) found plant communities dominated by exotic grasses had elevated soil nutrients, whereas soil nutrients were lower in communities dominated by native grasses. Conceivably, areas of The Pinnacle that have retained some cover of native grasses will have different nutrient loads and so may respond to our treatments in a different way.

Our management questions are:

- *Are native species enhanced or exotic species reduced by burning, slashing, harvesting a crop plant or applying sugar?*
- *Is there a substantial erosion risk associated with any of the treatments, particularly the fire treatment?*
- *Do high rates of herbivory by kangaroos and rabbits limit our capacity to remove the nutrients contained in vegetation?*
- *Do sites that retain the native grass species have increased soil nutrients and can such sites be restored using nutrient manipulation?*

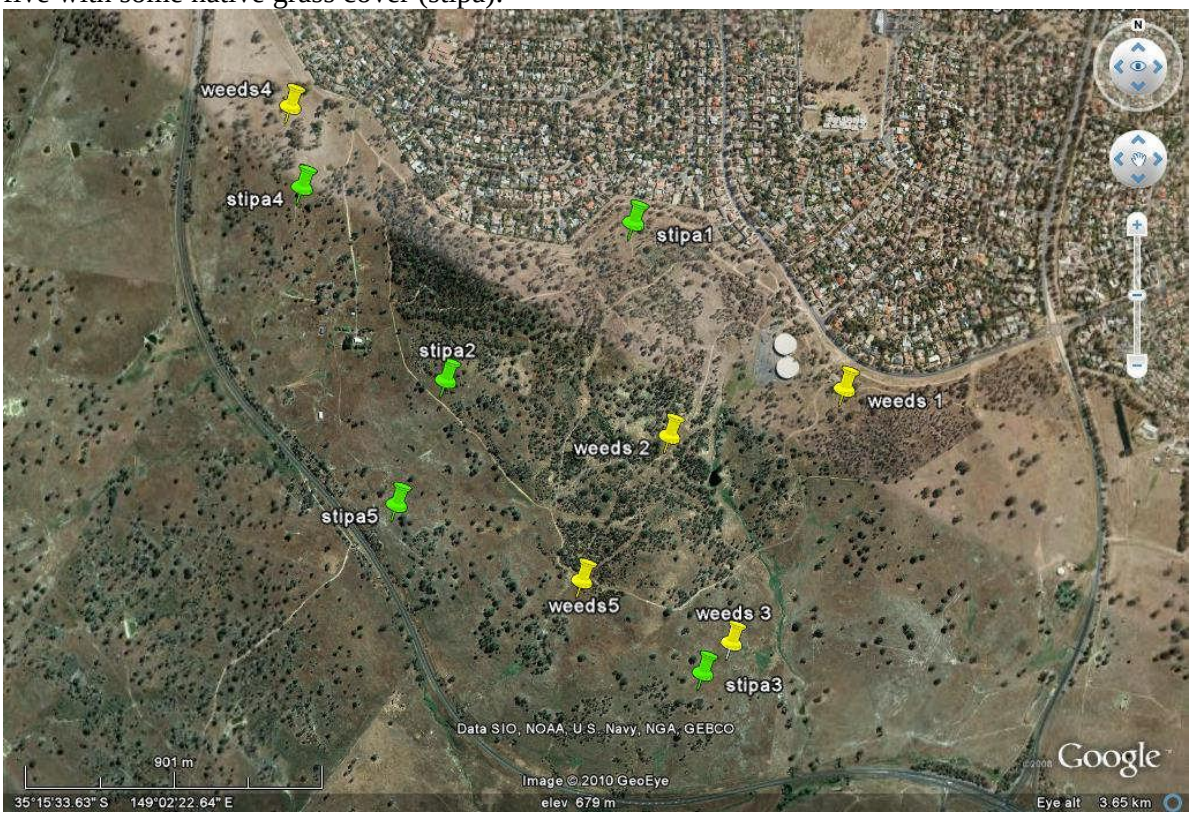
Methods

The project will run for three years as we assess changes in soil nutrients, and native and exotic plant cover. We have ten replicate experimental blocks (see Figure 1), with five in areas with high weed cover (weed sites), and five in areas with substantial cover of native grasses in addition to many weeds (stipa sites).

Each experimental block will include two plots (see Figure 2). One plot in each block will be fenced to exclude herbivores, the other will remain open. Each plot will have five 5 x 5m quadrats. One of five treatments will be applied to each quadrat:

1. Burn in autumn
2. Slash and remove cuttings before exotic grasses set seed
3. Direct drill a crop plant and harvest
4. Add sugar every four months
5. Do nothing

Figure 1. Ten study sites are proposed, including five that have high weed cover (weeds), and five with some native grass cover (stipa).



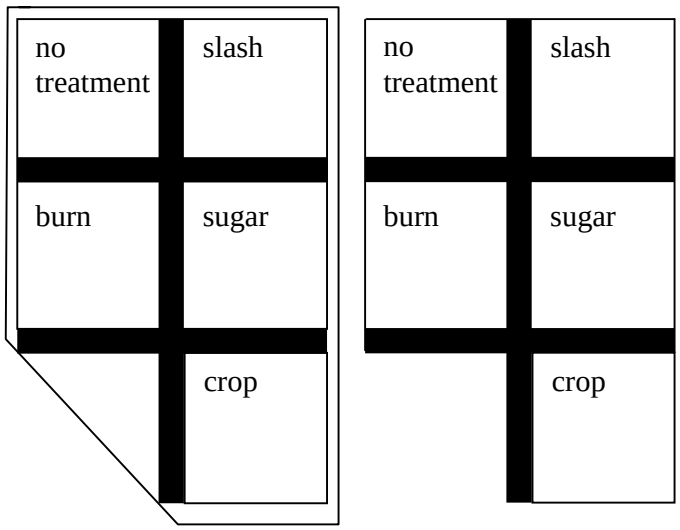


Figure 2. Diagram of one experimental block (of 10). It consists of two plots, each with five 5 m × 5 m quadrats and each quadrat has a different treatment. Treatments will be randomly allocated to quadrats. (see Appendix 2 for additional fence details)

The following measurements will be taken in each quadrat:

Soil nutrients.
Percent cover of native and exotic plants (to species level).
Estimates of herbivory
Erosion risk (using a landscape function analysis approach). Our experimental blocks will be placed on flat areas so that we can learn about erosion risk in a low-risk environment.

Implementing The Project

Treatments

Slash: Using brushcutters, FOTPIN will remove as much biomass as possible from the experimental sites before exotic plants have set seed, and after spring growth has finished (slash twice). Slash will be weighed, and samples collected for nutrient analysis.

Sugar: Apply 0.5kg of sugar per m^2 on sugar quadrats (Prober, Thiele *et al.* 2005; Rawlings, Carr *et al.* 2010) three times per year.

Burn. Burn all plants. The conditions and requirements of burning will be determined in collaboration with ACT Parks Conservation and Lands and the burns will be conducted by PCL.

Crop. Apply herbicide or slash weeds to allow crops to grow. Direct drill (to minimise soil disturbance) a crop plant (that is sterile and will not become established as a weed itself). Harvest the crop and weigh then sample for nutrient analysis.

Soil nutrient measurement. Phosphorus is in a chemical equilibrium between available and unavailable forms. As we remove available P, some of the unavailable P dissolves from soil to which it is bound, becoming available. This means we need to know how much total P there is in weedy sites compared with sites in good condition without weeds to determine how much P we might need to remove from the soil. We also need to measure available P, as this concentration influences the success of many native plants. Finally we need to measure P in the weeds and crop that we remove, so that we know how many times we will need to remove vegetation to have an impact on soil P. We also need to measure Nitrogen availability (total, nitrate and ammonium), because these influence the capacity of crops to grow (and remove P), but also influence native plant success. Nutrients will be measured in each quadrat at the start of the experiment, and then in autumn thereafter. The intial measures tell us about the need to remove P, the autumn measures are timed to detect maximum nitrogen levels (before annuals have started to regrow). Testing could be undertaken in the Fenner School of Environment and Society.

Communications

We will communicate progress on our project through frequent contact with ACT PCL staff and reporting. We will also have updated information on the FOTPIN web site, with additional information on the Ginninderra Catchment Group's website, the parkcare newsletter and our FOTPIN newsletter. For broader communication we will invite local media to report on our progress through provision of press release material and photographs. The results of the study

will also be written up into a research report that will be made available through an appropriate web site. It may also be written up for publication in a scientific journal.

Key Milestones and Timetable

Milestones	Activities	Key Dates
1	Peg corners of experimental plots, undertake initial soil analyses	Oct-10
2	Initial plant surveys complete. Herbivory and erosion-risk measurements taken. Implement slashing, and sugar treatments.	Nov-10
3	Fencing installed, burning treatment complete	Nov-10
4	Sugar treatments	Feb-11
5	Plant, herbivory, and erosion surveys	Apr-11
6	Soil samples collected	Apr-11
7	Crop treatment implemented (spray or slash, plant crop)	May-11
8	Sugar treatments	Jun-11
9	Review of progress and revise workplan if needed	Jul-11
10	harvest crop (collect harvest for P analysis)	Sep-11
11	Plant, herbivory, and erosion surveys, Burning, slashing and sugar treatments	Oct-11
12	Sugar treatments	Feb-12
13	Plant, herbivory, and erosion surveys.	Apr-12
14	Soil samples collected	Apr-12
15	Plant native grass seedlings in one quarter and native grass seed in another quarter of each quadrat	Apr-12
16	second crop planting if needed	May-12
17	Sugar treatments	Jun-12
18	Review of progress and revise workplan if needed	Jul-12
19	harvest crop (collect harvest for P analysis)	Sep-12
20	Plant, herbivory, and erosion surveys, Burning, slashing and sugar treatments	Oct-12
21	Sugar treatments	Feb-13
22	Plant, herbivory, and erosion surveys.	Apr-13
23	Soil samples collected	Apr-13
24	Sugar treatments	Jun-13
25	Final report and completed plan for Phase 2.	Dec-13

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