Royal Zoological Society of New South Wales

2021

Paddy Pallin Science Grant – Progress Report

Neighbourhood watch – using 'virtual' neighbours to protect plants from herbivores during habitat restoration and post-fire recovery

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Project Description & Objectives

Summary

In Australia, mammalian herbivores can devastate plant growth in areas of habitat restoration and post-fire recovery. Current management solutions to this problem (e.g. shooting and fencing), hold social and economic limitations. We need alternative solutions. We know that a 'neighbourhood' of low-quality plants (high toxicity, low nutritional value) can make palatable plants unappealing for a hungry herbivore. Planting a 'neighbourhood' of plants can work, but it is problematic because they compete for water and resources with the plants we are trying to protect.

Many herbivores rely heavily on the smell emitted by plants when deciding where to go and what to eat. With this understanding, this project provides the first critical steps in the development of novel and non-lethal solution to unwanted herbivory. In harnessing the smell of unpalatable plants to develop 'virtual' neighbours we may be able to nudge herbivores away from vulnerable plants in areas we are trying to protect, avoiding the complications of using real plants.

Objectives

My project had three main objectives: **(1)** to demonstrate that real low-quality neighbouring plants (*Boronia pinnata*) could protect highly palatable focal plants from browsing damage in my study system, **(2)** using headspace volatile organic compound (VOC) sampling and GC-MS analysis, quantify complete odour profiles of *B. pinnata* to uncover the putative informative odour components for this species, and **(3)** using these informative odour cues, create artificial odour 'cocktails' (or 'virtual' neighbours) mimicking *B. pinnata* to see if these virtual neighbours alone could deter wallabies from browsing from vulnerable seedlings.

Project over duration of grant

Changes

We have made very slight changes to the experimental design of objective (1) based on nursery plant availability. Instead of having three treatments (i) A single *Eucalyptus punctata* surrounded by 10 *B. pinnata* shrubs, ii) a single *E. punctata* surrounded by 10 *E. punctata* seedlings, and iii) a single *E. punctata* alone (against background vegetation)), we instead used four treatments (i) A single *E. punctata* surrounded by five *B. pinnata*, ii) A single *E. punctata* next to one *B. pinnata*, iii) a single *E. punctata* alone (against background vegetation)), and iv) a single *E. punctata* surrounded by five pots with the same soil used in treatments i) and ii) (procedural control)). This shift in experiment design also

allowed us to compare the influence of a 'neighbourhood' of low-quality neighbours and a single low-quality neighbour on wallaby browsing.

Plans

The milestones I aimed to achieve in this research period were:

- to demonstrate that real low-quality neighbouring plants (*B. pinnata*) could protect highly palatable focal plants from wallaby browsing damage,
- to describe the VOC odour profile of *B. pinnata* using 'headspace' sampling and GC-MS analysis,
- from this odour profile, create artificial odour 'cocktails' (or 'virtual' neighbours) mimicking *B. pinnata,* and
- investigate whether these virtual neighbours were as effective at reducing levels of wallaby browsing compared to the real plants.

These milestones seek to address all of the objectives listed above

Achievements

My research project has mostly proceeded as planned, reaching most of my milestones (although with some delays):

- I have been able to demonstrate that a neighbourhood (five plants) of *B. pinnata* could protect highly palatable focal plants from wallaby browsing damage. Specifically, *E. punctata* seedlings alone (against background vegetation) were **7.2 x** more likely to be browsed than if surrounded by a neighbourhood of *B. pinnata* (Figure 1).
- Amazingly, I was also able to show that even a single neighbour can make a difference, with *E. punctata* seedlings alone being **3.5 x** more likely to be browsed, than if next to even a single *B. pinnata*.
- I have successfully described the VOC odour profile of *B. pinnata*. From this profile, I have determined the putative informative compounds (in specific ratios) unique for this plant species.
- Using these informative compounds, I have successfully created artificial odour 'cocktails' (or 'virtual' neighbours) in small glass vials to mimic *B. pinnata*. I have also balanced compound volumes to ensure that the VOC emission rate of a single vial is equal to the emission rate measured from a single real plant (Figure 2, 3).
- I am now in the exciting process of organising field work to test the burning question of whether these 'virtual' neighbours will be as effective at reducing levels of wallaby browsing compared to the real plants.

Difficulties

I experienced delays in obtaining the required number of plants needed for objective one of my research plan due to excessive rains and plant growth issues at numerous nurseries. Additionally, a major GC-MS malfunction earlier in the year and consequent repair time also resulting in delays in completing objectives two and three. Although this put my anticipated research trajectory for this project a little behind, I now have very promising results from my first objective, I have complete odour profiles of *B. pinnata,* and I have developed 'virtual' neighbours mimicking this species. Field trial using these 'virtual' neighbours are currently in progress.

Future Plans

I propose to:

- Complete 'virtual' neighbour trials by the end of February - March 2023. In the subsequent months I will then analyse the data and use results to write at least one paper on the success and suitability of the approach.
- By the end of the year, I also am aiming to have completed a short paper on my results showing the influence a single neighbour can make to focal seedling browsing vulnerability. To our knowledge, this would be the first paper to show that a single neighbour can make a difference to herbivore foraging behaviour.

Academic Outputs

Publications

An intended publication using data from this research titled 'A bad neighbour can make a good friend – single neighbouring plants influence generalist mammalian herbivore foraging behaviour' has undergone conceptualization and an early draft of this manuscript is in preparation. At the completion of objective 3 of this research in the next coming months, I also intend to publish work on the development and success of 'virtual' neighbours in influencing mammalian herbivore foraging.

Results and literature review for this project also aided the development of a recently published conceptual paper. This paper is:

Finnerty PB, McArthur C, Banks P, Price C, Shrader AM. 2022. The Olfactory Landscape Concept: A Key Source of Past, Present, and Future Information Driving Animal Movement and Decision-making. BioScience 72:745-752.

This conceptual paper has already been cited in others research.

Impact

I have been successful in engaging media interest in the research project, conducting a podcast with the Ecological Society of Australia that was recently aired: ‘Ecology Matters’ podcast, ‘Episode 7: Patt Finnerty’.

Additionally, I presented ideas from my recently published conceptual paper at the 2022 Animal Behaviour Society Conference in San Jose, Costa Rica in which I discussed the potential implementation of using ‘virtual’ neighbours as a novel wildlife management and conservation approach, which were well received.

I am also presenting results and ideas from my research thus far at the upcoming Ecological Society of Australia conference in Wollongong in November 2022, and at the Australasian Wildlife Management Society conference in Napier, New Zealand in December 2022.

Outcomes

As the most novel component of my research has not yet been completed, aside from generating discussion, it is too early for it to have influenced policy decisions. I have received additional funding from the NSW Government Department of Planning and Environment (DPE) to additionally support my research. Once I have results, I will report outcomes to the department and discuss potential end-user applicability at that point in time.

Attachments and other material

Figure 1: A ‘neighbourhood’ of *B. pinnata* surrounding a single *E. punctat*a in Ku-ring-gai Chase National Park, Sydney. Wallaby activity was recorded using remote camera traps 1.5 m away from focal seedlings.

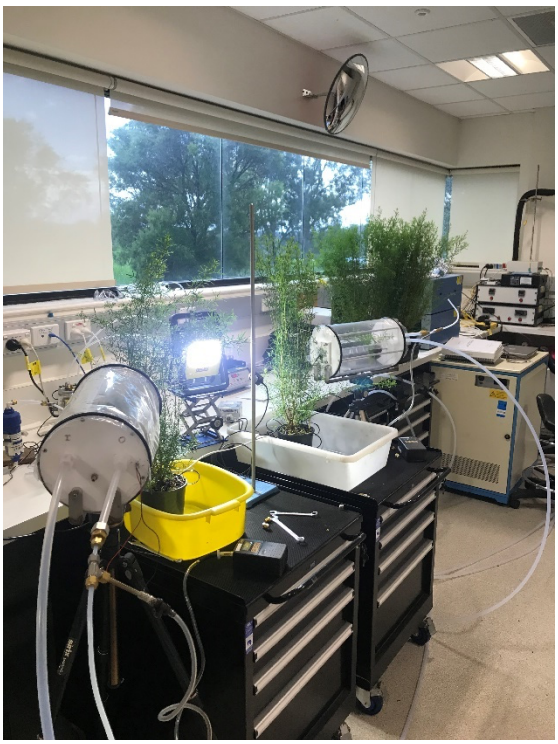

Figure 2: Total plant VOC emission rate of *B. pinnata* being measured using branch enclosures.

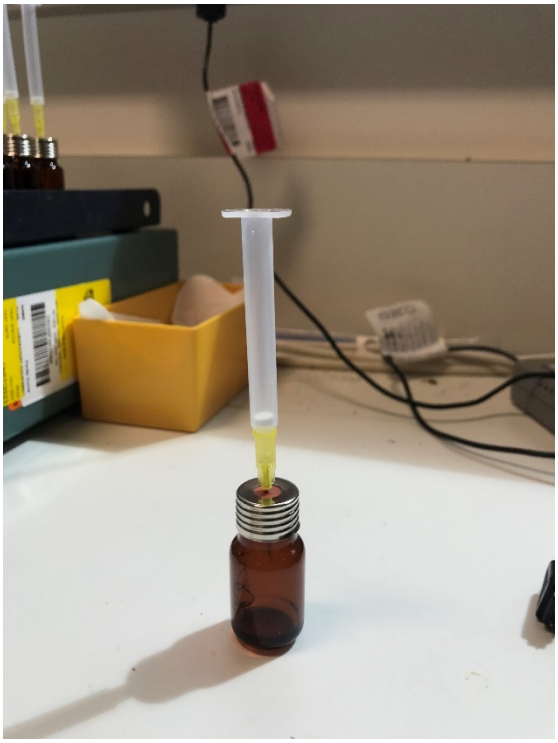

Figure 3: A 'virtual' neighbour. A 10 ml glass vial containing a 3 ml mix of informative compounds in correct ratios to mimic the odour emissions of real *B. pinnata*. Odour from an enclosed vial is slowly diffused through a 25mm hypodermic needle across a polyethylene frit and out a polypropylene tube. The VOC emission rate (micrograms per hour) of a vial with 3 ml of compound was measured to be equal to the emission rate of a single real B. pinnata.