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Limits to revegetation of clay capped landfill sites by Australian native plants

Eleanor Jane Hannah
University of Wollongong

LIMITS TO REVEGETATION OF CLAY CAPPED LANDFILL SITES BY AUSTRALIAN NATIVE PLANT SPECIES

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Eleanor Jane Hannah

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Thesis Certification

I, Eleanor J. Hannah, declare that this thesis submitted in fulfilment of the requirements for the award of Master of Environmental Science (Research), in the School of Earth and Environmental Sciences, University of Wollongong, is wholly my own work except where otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Eleanor J. Hannah

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Abstract

The revegetation of closed landfill sites is an important issue due to the large and increasing amount of land involved, and because the demand for that land, and its value, is constantly increasing. If successful revegetation is possible, then these degraded sites provide an excellent opportunity for the establishment of native plant communities in the middle of urban sprawl. Common problems identified with the revegetation of landfill sites have included the use of poor quality soils with low organic matter, low levels of available nutrients, the use of species not suited to the conditions, and landfill gas. The problems with the soils are compounded by compaction, resulting in low permeability and porosity, leading to very low available soil moisture. Little research, however, has been conducted on the revegetation of clay-capped landfill sites in Australia using Australian native plant species. The overall aim of the thesis was to test the survival and growth of indigenous plants at clay capped landfill sites.

I used three landfill sites in western Sydney as case studies. Species that may be suited to the early revegetation of these sites were identified and information available on plant growth of these indigenous was found to be limited. So I initially surveyed the germination potential of a range of the target indigenous species with two pilot studies, one at Site 1 the other at Site 2. At both sites, very low germination rates (0% in 4 species, highest 4.1%) were observed, with the possible contributing factors being low rainfall and subsequent low soil moisture levels and herbivory of seeds and plants.

In order to overcome the fragile germination and early seedling establishment phase, I conducted a planting trial at Sites 1 and 2 using *Acacia linifolia*, *A. ulicifolia*, *Indigofera australis*, *Kennedia rubicunda* and *Lomandra longifolia*. Survival rates from these experiments were also very low, with the main contributing factors inferred to be herbivory, and low soil moisture availability. Importantly, the most successful species in the planting trial was *Lomandra longifolia*, which had zero germination in the seeding trials.

The role of soil moisture in limiting germination or seedling and plant survival was tested in two experiments: a glasshouse germination study; and field study, in which mulching and watering were manipulated. Germination in the glasshouse with daily watering was 10 times higher than that in the field (one-way ANOVA, $F_{x,y} = 243$; P

<0.0001) illustrating that low available soil moisture is a limiting factor in the germination of the tested species. In the field experiment, the addition of the equivalent of 10 mm of rain once a week in the field did not significantly increase germination or seedling survival over 1 year for any of the species tested. A thin layer of straw mulch, however, did result in higher germination and 1 year seedling survival for several species at one of the sites (ANOVA *Hardenbergia violacea* $F_{x,y} = 3.64$; $P = 0.03$ and *Kennedia rubicunda* $F_{x,y} = 22.49$; $P < 0.0001$).

The role of herbivory and seed predation were tested in two other studies. Seed removal in May 1996 was not very high overall at either site, with just over 80% of seed remaining after 1 week. In February 1997, seed removal rates were higher with just 7.1% (Site 2) and 3.3% (Site 3) of seed remaining in the caches after 1 week. The higher seed removal in February was likely to be due to the time of year, with ants being more active in the warmer months. Several problems were encountered with the herbivory study: vandalism, the presence of domestic stock that was not anticipated; and a period of low rainfall. These three factors combined to result in very poor survival rates (11% after 4 months).

I concluded that no one strategy or range of species could be identified for successfully revegetating landfill sites in the short term. However, herbivory, low soil moisture, seed predation, vandalism and ongoing site works, could all limit success in particular circumstances. As a consequence, adaptive management approaches will be needed in developing solutions to particular sites and to ensure new information can be incorporated into ongoing management of a restoration program and the development of a better general understanding about limiting factors.