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University of New South Wales Wildlife Ecology Research Scholarship

Restoring Biodiversity and Ecosystem Function from the Ground Up: Response of Soil Biota to Reintroduced Digging Mammals

Jana Stewart

Drylands cover seventy percent of Australia and are primarily impacted due to land management practices such as overgrazing and water extraction. Other various threatening processes contribute to the decline of biodiversity, including the loss of habitat, invasive species, and the direct impact of human activities. Biodiversity loss disrupts the biogeochemical processes that sustain these ecological systems. With naturally low and infrequent rainfall, arid and semi-arid (hereafter drylands) systems are particularly vulnerable to the impact of climate change over longer and more severe dry periods.

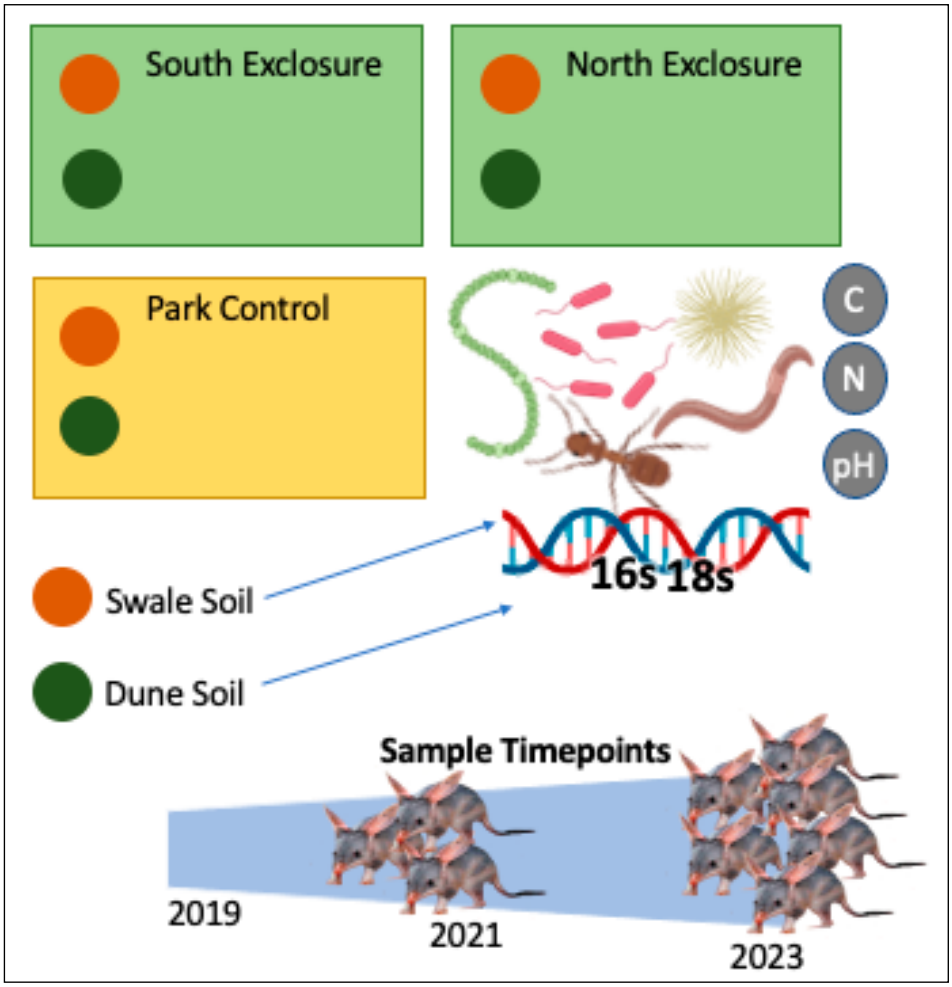
Australian soil is unique, lacking in recent geological history regeneration processes such as uplift, glaciation, or volcanic activities. Biological activity in the upper layers is the primary source of soil regeneration in Australia, with biodiversity therefore intrinsically linked to its function. Efforts to preserve and restore Australian dryland ecosystems have largely been unsuccessful and costly.

This project aims to understand the interactions and relations that drive soil functionality. Soil functionality is vital to maintain overall ecosystem health and sustainability through bottom-up interactions, with up to eighty percent of ecosystem processes associated with soil functions. Ecosystem engineers are particularly needed in the process as they provide services that restore the functionality and biodiversity of the soil. These include nutrient fixing microbes, decomposing invertebrates, and soil turning mammals, which improve soil stability, water and nutrient availability, seed recruitment, and germination. Microbes are also essential to maintain ecosystem functions. They are key drivers of processes such as pest suppression and nutrient cycling, with dominant species significantly influencing a systems' resistance, and resilience to change and disruption. The multifaceted cycles of interacting microbes, invertebrates, plants, and mammals are critical for ecosystem functioning. Knowledge of these interactions is increasing, but spatial and temporal effects remain poorly known. Understanding the

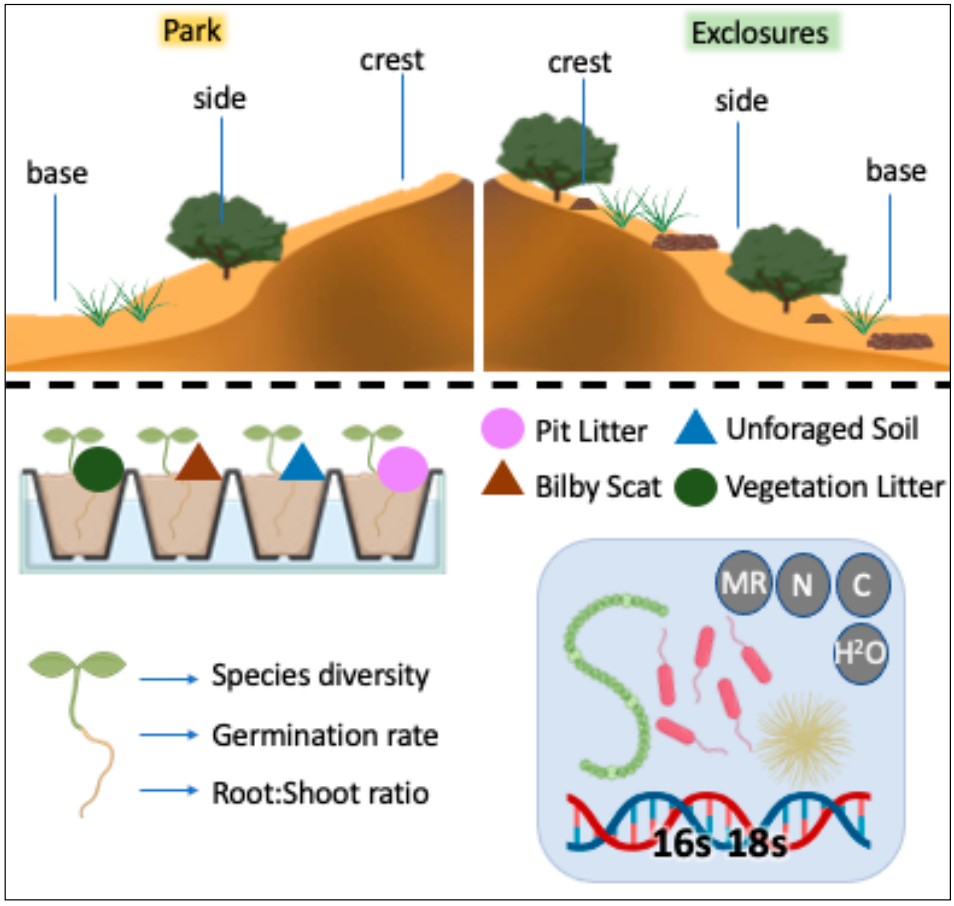
Top: Jana is a PhD Candidate at the University of New South Wales looking at soil microbes in dryland ecosystems.

Digging mammals can move large amounts of soil during their foraging activities which can help to disperse nutrients.

Soil biota in drylands improves stability, water availability, and nutrient access.



The first aim will investigate the response of soil biota to reintroduced digging mammals over time and density.



Using a glasshouse experiment, the project will compare how digging mammals facilitate nutrient dispersal and seed establishment.

dynamics of interactions that support soil functionality would allow the development of indicators to enable adaptive management for successful ecosystem restoration.

The project will analyse how soil biota diversity responds to mammal presence, and identify improved soil functionality. The project will focus on burrowing and digging mammals, which are powerful ecosystem engineers with their foraging behaviour and burrows providing many benefits such as dispersing soil nutrients, refugia for other species, and increasing landscape heterogeneity. Previous studies have compared habitat and microbial abundance with and without these engineers, showing variance. However, evidence of functional diversity differences is lacking. Understanding these differences may help understand how ecosystems benefit from these interactions and how these would be impacted if one of these pieces is altered.

The project will occur at the Wild Deserts project site in Sturt National Park, New South Wales, to investigate the response of soil biota to digging mammals. Wild Deserts is reintroducing locally extinct mammals to predator-free exclosures within the park. With many of Australia's native digging mammals threatened or locally extinct, Wild Deserts offers the unique opportunity to examine these interactions spatially and temporally. Reintroductions of bilbies (*Macrotis lagotis*), bettongs (*Bettongia leseuer*), bandicoots (*Perameles bougainville*), and *Isoodon auratus*) to Wild Deserts allows for comparison of areas without reintroductions and time points throughout the reintroductions (e.g., before, early-stage, and late-stage), and to enable comparisons of population density impacts. Glasshouse experiments will also allow the project to assess the role of these digging mammals in seed establishment.

Overall, the outcomes of the project can be used to improve the monitoring of drylands and potentially facilitate targeted restoration plans by restoring ecosystem functions driven by soil. Further information on Wild Deserts can be found at https://www.ecosystem.unsw.edu.au/research-projects/wild-deserts

Funds provided by the Australian Wildlife Society will be allocated towards genetic sequencing to identify soil biota that provides key ecosystem services and potential indicators for restoration success.