The influence of land-use change on soil microbial communities in riparian ecosystems

Research Note 21.4

Melbourne Waterway Research Practice Partnership

Riparian ecosystems are vulnerable to land clearing, where the native riparian forest is converted to agricultural production. Efforts to reverse the effects of land-use change and restore native riparian vegetation focus on revegetation with native plant species, and little is known about associated alterations to soil microbial communities.

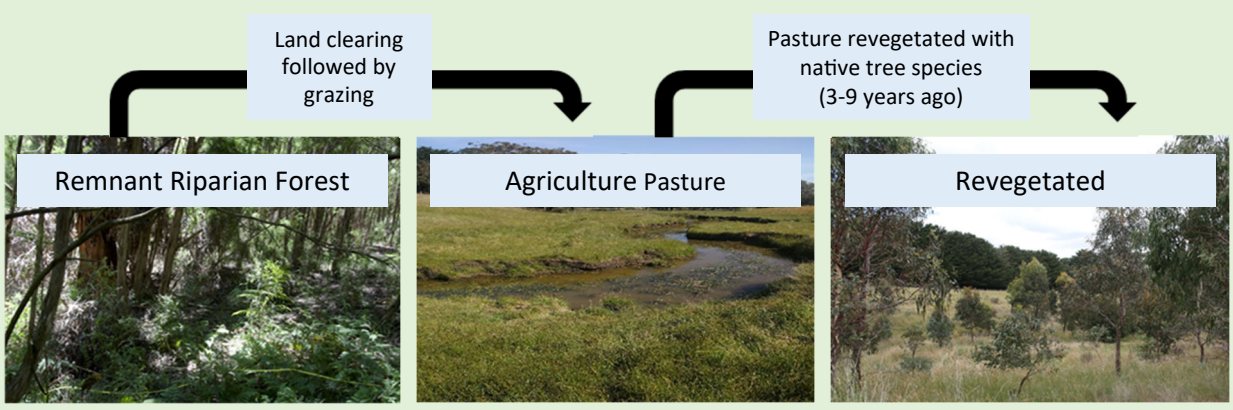
Soil microbial communities play a key role in organic matter decomposition and in carbon and nutrient cycling, thus affecting vegetation dynamics, including plant establishment, growth, and survival. Understanding changes in the diversity and functioning of soil microbial communities with revegetation could provide indicators of the progress of restoration projects and offer insight into potential pathways to improving revegetation outcomes.

At six sites, we characterised soil bacterial and fungal communities across three land uses: i) remnant riparian forests; ii) former riparian forests that had been cleared for pasture, and iii) pasture that had been revegetated with native plants within the last 3-9 years. Sites were located in the Yarra Valley, on the Mornington Peninsula and west of Bacchus Marsh.

We sampled soils at two depths and characterised three vegetation strata (canopy, sub-canopy and ground vegetation) at each site. Soil samples were analysed for physical, chemical and biological properties.

Key findings

- In our study sites, we found that the impact of land-use change on soil microbial communities was related to the extent that land-use change affects soil physical and chemical properties (Figure 1).
- Vegetation communities differed with land use type, whereas only 7 of 24 soil physical and chemical properties differed with land use type (Figure 1).
- Soil bacterial community composition was significantly altered by the conversion of riparian forests to pasture, and revegetation contributes to reversing such changes.
- Soil bacterial community composition



Relative to other land-use types:
Greater Richness of native ground cover
Greater total cover sub-canopy
Greater relative density of canopy
Top-soil higher C and N than sub-soil
Lower pH (~4), P and Ca
Lower Clay and silt

Relative to other land-use types:
Greater richness of exotic ground cover
No sub-canopy
No canopy cover
Top-soil > C and N than sub-soil
Higher pH (~5), P and Ca
Higher Clay and silt

Relative to other land-use types:
Intermediate richness of exotic ground cover
Developing sub-canopy and canopy
Top-soil > C and N than sub-soil
Intermediate pH (~4.5), P and Ca
Intermediate clay and silt

Figure 1: Summary of differences relative to other land-use types in vegetation and soil physical and chemical properties.

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Key findings continued

(taxonomic and functional) was related to changes in soil properties, but not to changes in vegetation.

- Soil fungal communities showed few differences between land-use types; larger variations were associated with changes in soil chemical properties.
- Taxonomic composition of soil bacterial and fungal communities was related to soil texture (clay content) and soil fertility (Nitrogen, Phosphorus, Potassium and Calcium - Figure 2).
- Functional composition of soil bacterial and fungal communities was related to soil texture (clay content) but not to soil fertility (Figure 2).

What does this mean for future revegetation projects?

Soil fertility (e.g. pH, Nitrogen, Phosphorus and Potassium) and soil texture emerged as good indicators of changes in soil microbial community composition and thus could be monitored to follow up restoration trajectories.

Restoration projects could include an initial assessment of soil properties to evaluate the magnitude of land-use change impacts.

Practices that aim to restore a range of vegetation types will enhance soil biome diversity (particularly soil fungi) and benefit soil functioning, which in turn can promote plant survival and growth and facilitate restoration.

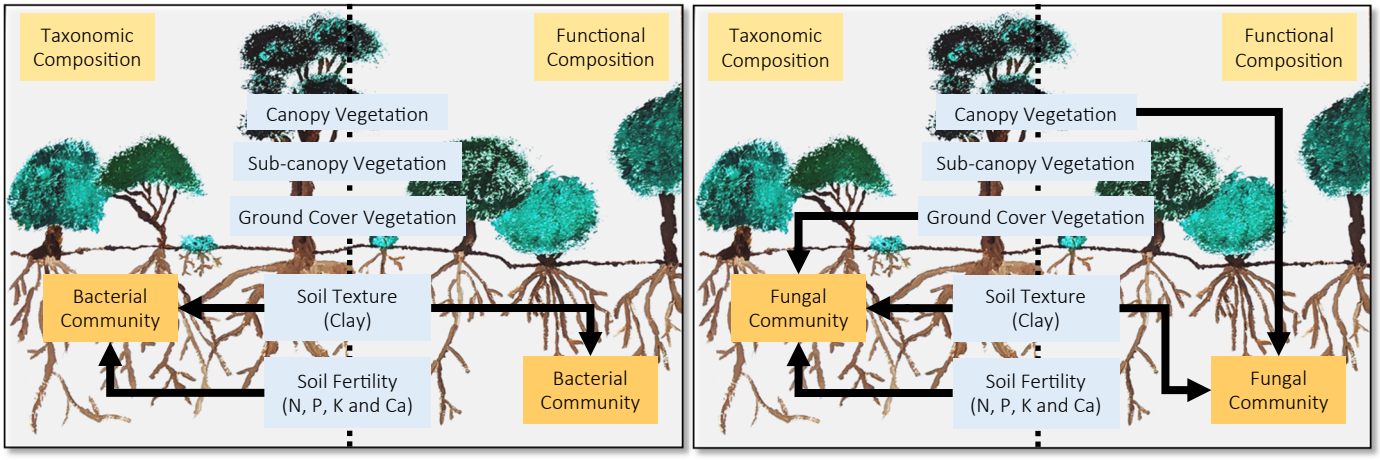

Figure 2: Summary of differences in soil bacterial (A) and fungal (B) relationships between taxonomic composition and functional composition. Arrows indicate where relationships were observed.

More details on the methods and findings of this research are available in the following research articles:

- Waymouth, V.; Miller, R.E; Kasel, S.; Ede, F.; Bissett, A.; Aponte, C. (2022) Riparian fungal communities respond to land-use mediated changes in soil properties and vegetation structure. *Plant Soil*.
- Waymouth, V.; Miller, R.E; Kasel, S.; Ede, F.; Bissett, A.; Aponte, C. (2021) Soil Bacterial Community Responds to Land-Use Change in Riparian Ecosystems. *Forests*, 12, 157.
- Waymouth, V.; Miller, R.E.; Ede, F.; Bissett, A.; Aponte, C.; (2020) Variation in soil microbial communities:elucidating relationships with vegetation and soil properties, and testing sampling effectiveness. *Plant Ecology*, 221, 837-851.