Department of Biodiversity, Conservation and Attractions
GOVERNMENT OF WESTERN AUSTRALIA
Biodiversity and Conservation Science

Information sheet 95 / 2019

August 2019

Provenancing for landscape restoration in the Midwest

by Melissa A Millar[*1], David J Coates[1], Margaret Byrne[1], Dale Roberts[2], [1]Department of Biodiversity, Conservation and Attractions, [2]The University of Western Australia, [*]08 9219 9083, melissa.millar@dbca.wa.gov.au

Background

Practical recommendations for effective seed provenancing regimes for landscape restoration are limited. Restoration that is successful in the long-term is likely to be best achieved with provenancing regimes that acknowledge divergent evolutionary lineages, genetic diversity, historical and contemporary patterns of genetic structure and gene flow. The life history traits of plant species should also be considered, as well as current and potentially altered future ecogeographic conditions at seed source and restoration sites. The Midwest region of Western Australia has significant biodiversity conservation values where extensive mineral exploration and extraction activities will necessitate restoration of considerable areas of highly disturbed land. Successful establishment and long-term persistence of restoration populations is a key objective in this region.

We used an integrated approach to develop provenancing regimes for four foundation plant species required for restoration projects in highly altered post-mining landscapes of the Midwest. *Grevillea paradoxa*, *Melaleuca nematophylla*, *Grevillea globosa*, and *Mirbelia* sp. Bursarioides are perennial species that occur in thicket/shrubland or woodland/thicket communities of banded iron formation slopes and crests. These species are likely to be utilised for landscape restoration across large areas of the region. Genetic data (sequencing of chloroplast DNA regions and genotyping with nuclear microsatellite loci) was generated in order to assess the distribution of genetically divergent lineages and historical and contemporary patterns of genetic structure and gene flow for the study species. Genetic data was integrated with knowledge of species specific life history traits that affect demography and gene flow, and simulation modelling used to develop provenancing regimes that optimise the initial capture and maintenance of genetic diversity through subsequent generations.



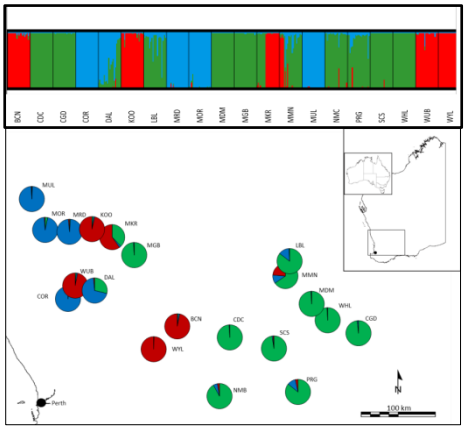
Left; *Grevillea paradoxa.* Middle; *Grevillea globosa*. Right: *Melaleuca nematophylla* (flowering, midground) and *Mirbelia* sp. Bursarioides (foreground). Photographs MA Millar.

Findings

The species showed different patterns of historical and contemporary genetic diversity and structure, that lead to different recommendations for seed sourcing for restoration.

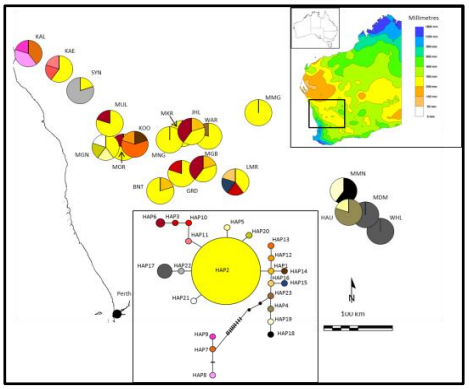
- *Grevillea globosa* showed high contemporary genetic diversity with geographical structure although divergence among populations was low, with only a weak signal of isolation by distance. This implies overall effective genetic connectivity across this species range.

- *Mirbelia* sp. Bursarioides exhibited moderate historical diversity and connectivity across its range. Contemporary diversity was high and geographically structured although divergence among populations was low, with only a weak signal of isolation by distance, implying overall effective genetic connectivity across the species range.
- *Grevillea paradoxa* exhibited moderate to high historical diversity, geographically structured across the range, but with low to moderate divergence. This suggests some limitations to seed dispersal that is likely limited by gravity dispersal and predation. Contemporary genetic diversity was low and geographically structured across the range, with high divergence among three genetic groups. The cause of this divergence is not clear and is further complicated by apparent geographic overlap of genetic groups in the region around Mt Karara, and secondary structure within populations at Mt Karara and Dalwallinu. Limited pollen dispersal by territorial bird pollinators may be affecting genetic divergence and driving limitations to contemporary genetic connectivity in this species.



Contemporary genetic diversity is geographically structured and clustered into three groups in *Grevillea paradoxa*.

- *Melaleuca nematophylla* exhibited moderate to high historical diversity, geographically structured across the species range, with moderate divergence. The population located within the Murchison River gorge may be considered a divergent evolutionary lineage and populations on banded iron formations in the south east have also been historically isolated. Contemporary genetic diversity was low and geographically structured across the species range, although populations did not form distinct genetic groups. A pattern of isolation by distance was evident implying some limitation to contemporary genetic connectivity with geographic distance in this wind pollinated species.



Historical genetic diversity implies geographical isolation of populations of *M. nematophylla* in the north-west and south-east.

Management implications

- Comprehensive provenancing scenarios that source and mix seed from all populations across the species range will provide the best long term genetic outcome for restoration populations of *G. globosa* and *Mirbelia* sp. Bursarioides.
- Provenancing scenarios that consider the genetic divergence among populations will provide the best long term genetic outcome for restoration populations of *G. paradoxa*. An appropriate provenancing strategy for this species would be to source seed for restoration only from populations of one of the three genetic groups, according to the location of the restoration site. Collections within a genetic group or region should be comprehensive.
- The population of *M. nematophylla* located within the Murchison River gorge is not a suitable seed source for restoration activities outside of the gorge. Populations in the south east at Mt Manning, the Helena Aurora Ranges, Mt Dimer and Watt Hill are also more suited to localised restoration activities. For populations within the more central part of the species range, provenancing scenarios that consider the geographic distance among populations will provide the best long term genetic outcome for restoration populations. A provenance zone of around 100 km radius from a restoration site would be appropriate.

Further information

Millar M, Byrne M, Coates D, Roberts J (2016) Contrasting diversity and demographic signals in sympatric narrow range endemic shrubs of the southwest Western Australian semi-arid zone. *Biological Journal of the Linnaean Society* 118, 315-329.

Millar M, Byrne M, Coates D, Roberts J (2017) Comparative analysis indicates historical persistence and contrasting contemporary structure in sympatric woody perennials of semi-arid southwest Western Australia. *Biological Journal of the Linnaean Society* 120, 771-787.

Millar MA, Coates DJ, Byrne M, Roberts JD (2019) An integrated genetic approach to provenancing and establishment of founding individuals for restoration in the semiarid Midwest region of Western Australia. *Australian Journal of Botany* 67, 218-233.