Restoration genetics in Murray Mallee and Neotropical Forests: implications for management and planning

2011 NCCARF PhD student Collaborative Travel Grant report

Martin Breed - The University of Adelaide

Supervisors: Prof Andrew Lowe, Dr Mike Gardner, Dr Kym Ottewell

Major Findings: During my visit to Europe, my analytical skills, future research projects and manuscripts were developed, based on the Uppsala University laboratory placement and meetings with academics in Sweden and Italy. Due to schedule changes of UK academics (Dr Cavers and Dr Boshier), unfortunately no meetings took place in the UK as proposed. Alternative meetings took place in Florence, Italy with Prof Giovanni Vendramin - director of the Plant Genetics Institute at the Italian National Research Council. *The outcomes of this travel have direct application to Australian revegetation practices where climate change is of great concern*.

Despite being crucial to understanding the impact of contemporary landscape change and developing genetic resource management strategies, too few studies have documented combined fitness and mating system changes as a result of habitat disturbance. We developed a novel analytical framework, documented in two studies, that would not have been possible without collaborating with academics in Sweden and Italy as well as my undertaking the previous trip to Costa Rica in 2010, also funded by *NCCARF*.

Firstly, we found that isolation disrupted mating patterns and reduced fitness in 16 big-leaf mahogany populations across Central America. However, for dry provenances, fitness was negatively related to correlated paternity (i.e. similarity of pollen donors), but for mesic provenances, fitness was positively related to outcrossing rate and negatively to correlated paternity. The poorer performance of mesic provenances is most likely due to reduced effective population size, as a result of poorer environmental suitability and greater disturbance history. Our results demonstrate changing trade-offs between inbreeding and reproductive assurance in mahogany, driven by exploitation history and contemporary landscape context.

Secondly, we found that a population of the bird-pollinated *Eucalyptus incrassata* from the South Australian mallee appeared to be resilient to the mating system and progeny fitness changes expected in fragmented landscapes, probably due to the maintenance of high gene flow among genetically diverse adult trees.

Additionally, we have prepared a review of seed-sourcing recommendations in light of evolutionary biology, the life history of considered species and environmental uncertainty. We found that accounting for evolutionary processes in revegetation projects will likely improve their long-term resilience, even in the face of great uncertainty. This review was conducted with helpful discussions with academics in Sweden and Italy as well as ideas discussed at the Genetic Translocations *NCCARF* workshop in Melbourne 2011.

Outcomes of collaboration: Outcomes of my visit to Sweden and Italy include improved statistical skills which were used in the first two manuscripts described above. Additionally, my laboratory and analytical skills were also developed which will be crucial for the final chapters of my PhD. Looking beyond my PhD, future collaborative options were explored during my travels with both Australian and EU-based project options being discussed.

In particular, a joint project was developed with the University of Adelaide (Prof Andrew Lowe, Dr Edward Biffin and myself), South Australian State Herbarium (Dr Hugh Cross), Uppsala University (Prof Martin Lascoux) and Italian National Research Council (Prof Giovanni Vendramin). Laboratory expertise partners (Michele Morgante - Institude of Applied Genomics, Italy), field locations (Mt Lofty and Flinders Rangers, SA) and potential study species (e.g. *Callitris gracilis*; *Eucalyptus leucoxylon*) were identified. A proposal is being drafted for an ARC Discovery Project submission in 2012.

All the analytical and manuscript developments achieved form part of my PhD. These skills and training were not possible in Australia, and NCCARF's financial support of my travel is greatly appreciated.

Significance to adapting and protecting Australia's terrestrial biodiversity: Genetic diversity and mating system are important considerations for revegetation for biodiversity. These factors govern the adaptive potential of future generations of plants and therefore the long-term success of revegetation projects. If climate change-resilient communities are to be created in place of cleared land, then how and when these genetic factors come into play, the strength of their impact and how they impact seed quality, need thorough investigation. Good data supporting these issues will help demonstrate how and where to collect appropriate seed to maximise biodiversity benefits. There are various general seed-sourcing strategies that are likely appropriate to create resilient communities, but we stress that evolutionary biology, the life history of the species and environmental uncertainty are key determinants that affect which strategy is most suitable. With financial support of *NCCARF* enabling me to hold discussions with the academics visited during my recent travel, as well as support from the Native Vegetation Council of South Australia and my PhD supervisors and co-authors, we are beginning to provide evidence that will help overcome some of these issues and provide guidelines for important key Australian species used in revegetation.