Progress Report SP 2001-001

Mating system variation, genetic diversity and viability of small fragmented populations of threatened flora, and other key plants of conservation importance

BCS Plant Science and Herbarium

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Project status as of July 17, 2023, 11:38 a.m.

X X Update requested

Document endorsements and approvals as of July 17, 2023, 11:38 a.m.

X X
Project Team granted
Program Leader required
Directorate required

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Context

Understanding the interaction between mating systems, levels of inbreeding and patterns of genetic variation within populations of species is a key element in assessing the viability of plant populations, particularly rare and threatened taxa, and the development of management strategies that reduce the likelihood of local extinction and increase the probability of successful establishment of restored populations.

Aims

- Assess the relationship between effective population size and levels of genetic diversity and the minimum effective population size for maintaining genetic diversity in natural and restored populations.
- Assess the effects of population size and habitat degradation on mating system parameters that indicate inbreeding or the potential for inbreeding.
- Assess whether reduction in population size, increased inbreeding and reduced genetic variation are associated with any reduction in fitness.
- Assess whether there are differences in the levels of genetic diversity and mating system parameters between rare and common congeners, which will provide a more general understanding of rarity in this flora and how it can be managed.
- Assess patterns of genetic diversity and population differentiation in rare species to assess previous management actions and inform future actions.

Progress

- A study to assess mating system variation and genetic diversity for two translocated *Banksia brownii* populations and benchmark these measures against seven natural populations has been completed. In addition, a pollination study on a subset of four of the natural and one of the translocated populations of *Banksia brownii* to assess the adequacy of pollination in the translocated population, has also been completed. Key findings were the use of multiple source populations for translocation resulted higher reproductive output and equivalent levels of genetic diversity compared to reference wild populations. However, the translocated population had the highest rates of selfing, which could potentially lead to the long-term erosion of genetic diversity through unfavourable patterns of mating.The results of these studies have been published in the *Australian Journal of Botany*.
- Assessment of fitness traits is ongoing in a common garden experiment involving 1100 seedlings of *Banksia brownii* from montane and lowland natural populations and a translocated population, to examine trait differences between montane and lowland populations, and implications for population mixing, and to benchmark the performance of the translocated population. Initial findings have shown that outcrossed seedlings have higher fitness than self pollination seedlings and management of the translocated populations should focus on ways to improve pollinator services to improve long-term translocation success. Two manuscripts have been prepared from this work. One is in draft and the second is in review for publication in *Restoration Ecology*.
- Data analysis has been completed on genetic diversity data for natural and translocated populations of *Acacia cochlocarpa* subsp. *cochlocarpa* and *A. cochlocarpa* subsp. *velutinosa*. This study will benchmark genetic diversity in translocated and natural populations of *A. cochlocarpa* subsp. *cochlocarpa* and assess genetic structure across the range of both subspecies. A manuscript describing this study is in preparation.
- Analysis of genotyping and mating system data has been completed for *Banksia anatona,* to assess mating system performance and genetic diversity in a translocated population compared to natural populations. A manuscript describing this study is near completion.

- A common garden experiment to assess the fitness of *Lambertia orbifolia* subsp. *orbifolia* and *L. orbifolia* subsp. *vespera* has been planted.
- Genetic and taxonomic revision of subspecies within *Lambertia orbifolia* has been completed. This work used earlier genetic analysis of *Lambertia orbifolia* and combined this with a genetic study of a recently discovered population and measures of herbarium specimens to formally describe three subspecies. This taxonomic revision was published in *Nuytsia*.
- Genomic analysis of two species, *Banksia cuneata* and *Chorizema humile*, is currently underway to assess genetic diversity and population differentiation across extant populations, both natural and translocated, as well as assess the genetic diversity of seed collections currently stored in the Western Australian Seed Centre.
- Genomic analysis of *Tetratheca butcheriana* is currently underway to assess fine scale patterns of genetic diversity and population differentiation across its very narrow range in the Pilbara.

Management implications

- Assessment of genetic variation and mating system parameters will inform prescriptions for the prevention of inbreeding and maintenance of genetic variation in small fragmented populations of rare and threatened plants, and will facilitate strategies for managing inbreeding and loss of genetic diversity during translocation programs involving species such as *B. brownii, L. orbifolia, A. cochlocarpa* and *S. filifolia*. For species in resource-rich areas, such as *T. butcheriana* in the Pilbara, information on genetic diversity and gene flow patterns will also inform impact assessments for future mining activities.

Future directions

- Finalise mating system and genetic diversity studies on translocated and natural populations of *B. brownii*, *A. cochlocarpa*, *B. anatona, B. cuneata* and *C. humile*.
- Develop and implement a monitoring plan for the *L. orbifolia* common garden experiment.
- Finalise and report on the genetic study of *T. butcheriana*.