Greening Australia

There's more to seed than local provenance

David Carr, Greening Australia

For many years conscientious seed collectors and revegetators have insisted on only using local provenance seed for conservation plantings. The evidence from this approach, along with recent research (Broadhurst et al., 2008), now shows that using local provenance as the first and only priority for sourcing seed does not always achieve the best results.

Local provenance – what is it?

For the uninitiated, local provenance refers to the collection of seed for revegetation projects from close to the site where they are to be planted. The rationale for this is that local seeds will be well-adapted to the site conditions; that this practice will conserve local genetic diversity; and that it will reduce the risk of "genetic pollution", where seeds from non-local sources could potentially interbreed with local plants to produce genetically different "hybrid" progeny. Biodiversity occurs at multiple scales: from ecosystem level to species level down to population level. The use of local provenance aims to conserve this diversity, particularly at the population genetic diversity level. There is an argument that as global warming changes the climate across the continent, using seed adapted to local conditions, may be consigning plants to a "genetic dead-end" (Harris et al., 2006), however in most cases locally adapted plants have been in situ for millennia and have probably gone through numerous episodes of climate change and most more than likely have the genetic resilience to see out plenty more.

One problem with sourcing seed locally, is that everyone interprets "local" differently. Some people think it should be collected within a few hundred metres of the revegetation site, while others will use the closest seed available at the time (up to hundreds of kilometres away). There is also a high risk that by rigidly using seed collected nearby, collectors will ignore the potential of these populations to provide a genetically diverse and vigorous source of seed. Regulators and seed buyers now apply arbitrary distance (5-20km) requirements on seed collection to ensure compliance with local provenance. This could potentially have adverse outcomes if seed is collected from only a few plants that are likely to have produced seed resulting from inbreeding. Another problem could arise if seed is collected from plants at a nearby site that has a completely different environmental match (such as higher altitude or soil type) to the site being restored.

To better understand provenance-related issues, Greening Australia coordinated a national workshop in 2004 (Carr, 2005). Conclusions from the workshop included that:

- the geographic proximity of a targeted seed source may not necessarily provide the best source of genetic diversity,
- maintenance of high levels of genetic diversity should be given greater emphasis rather than strictly adhering to the 'local is best' paradigm, and

Collecting Eucalyptus macrocarpa fruits and seed for revegetation, Western Australia. Photo: Penny Atkinson

- expert advice be made available to seed collectors and revegetators to decide on the most appropriate seed sources.

In progressing the workshop outcomes, Greening Australia has been working to develop and disseminate new guidelines for seed collection through the Florabank and Exchange programs. Based on the best available science, Florabank now recommends that when selecting seed for a revegetation project, collectors should consider: taxonomy, adaptation, physical and genetic quality, and proximity. These four points will help answer the questions, "where should I collect seed for my revegetation project, and how should I collect it?"

Taxonomy

The first step in selecting the right seed for a revegetation project is correct identification of the targeted taxon. In some instances, collectors will need to be aware that different but closely related taxa may occur nearby. There may also be instances where collectors may encounter an undescribed species that has yet to be recognised by taxonomists. Differences between provenances often indicate different sub-species. Adaptation to different environments is how species evolve into new species. Taxonomists are constantly looking at the diversity within plant species and reclassifying variants into new taxa. The Australian Plant Census, (**http://www.anbg.gov.au/chah/apc/ accessed August 2008**), coordinated by the Council of Heads of Australian Herbaria, presents a census of accepted plant names used on an Australia-wide basis. It also gives a comprehensive overview of all taxonomic treatments that have been published or are in preparation. If you are targeting a highly variable species for revegetation, you may need to seek expert advice from your State or Territory herbarium to ensure unpublished taxonomic work has not been conducted. This will help you choose the populations from which to collect seed from, and ascertain if two or more subspecies occur in any one region.

Adaptation

When plants occur on sites with different environmental characteristics, they are subject to different selection pressures that can lead to genetic differentiation among populations and even divergence into new species or subspecies. The choice to use only local provenance recognises the importance of conserving existing levels of genetic diversity across a landscape. Altitude, rainfall, temperature, soil texture and depth, and soil chemistry (pH, salinity) are major drivers of adaptation in plants. These factors can vary over very short distances and may be associated with adaptive variation in plant populations. There are many documented examples of plant adaptive variation across altitudinal gradients (e.g Brown et al., 1976). Plant populations that are many hundreds of kilometres apart, at the same altitude can be more similar than plants a few kilometres apart that are at different altitudes: *E. obliqua* for example (Carr, in press).

Florabank recommends that seed is collected from sites with similar environmental characteristics to the revegetation site. We suggest seed should be collected within the same bioregion (see **http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html**) as the revegetation site to ensure similarities in rainfall average and distribution. Within the bioregion, match your source seed as close as possible to the environmental conditions of your restoration site (e.g. soil types, topographic position, etc.). However, you should also collect from multiple populations within the bioregion to increase the potential of the plants to adapt to climate change (see box below).

Physical and genetic quality

An important factor to consider in seed collection is the physical and genetic quality of the seed. Seed collected from a large population following a heavy widespread flowering event will ensure the capture of genetically diverse and viable seed. High quality seed will optimise the chances of successful revegetation that can potentially develop into self-sustaining plant communities.

Climate change complication

The plants we establish from seed today will have the potential to develop into mature plant communities in 50, 100 and 200 years time. Over these periods, they are likely to have to cope with a climate that is substantially different from the present climate, along with associated changes in pests, diseases, soils and the like. For individual regions it is difficult to predict what the climate will be like in the future, although we can be confident that it will be hotter. The main action we can take at the revegetation patch scale level is to maximise the potential for reintroduced plants to be able to cope with climate change. To do this we need to ensure that they have been sourced from seed that captures high levels of genetic diversity (Rice & Emery, 2003). The more genetic variation plants contain the more likely it will be that populations can adapt to changing climatic conditions. Professor Andrew Young of CSIRO Plant Industry suggests we should "have faith in natural selection". To optimise the potential for high levels of genetic diversity it may be better to source seed from populations growing under a wide range of temperature and rainfall conditions, than just from a single site.

For species that are obligate out-crossers or have a mixed mating system (i.e. mainly outcrossing species with some propensity for inbreeding) it is essential that seed is collected from many plants from a large healthy, fecund population. Seed collected from a limited number of plants during a poor seeding year is likely to result in seeds not being viable, or if they do germinate they will grow poorly due to lack of vigour. Struggling plants are also unlikely to survive environmental stresses such as drought or increased temperatures associated with climate change. Recent Land & Water Australia funded research (Broadhurst, 2007) highlights the importance of genetic health in seed collection.

Seed must also be collected at the right stage of maturity, then stored under optimal conditions to ensure optimal germination rates are obtained. High temperature and humidity will rapidly reduce the viability of stored seed. For most sclerophyllous species storage at 5% humidity and 15°C is best. Fleshy-fruited species usually need to be used fresh. Storage problems can be avoided by sowing the seed as soon as possible after collection.

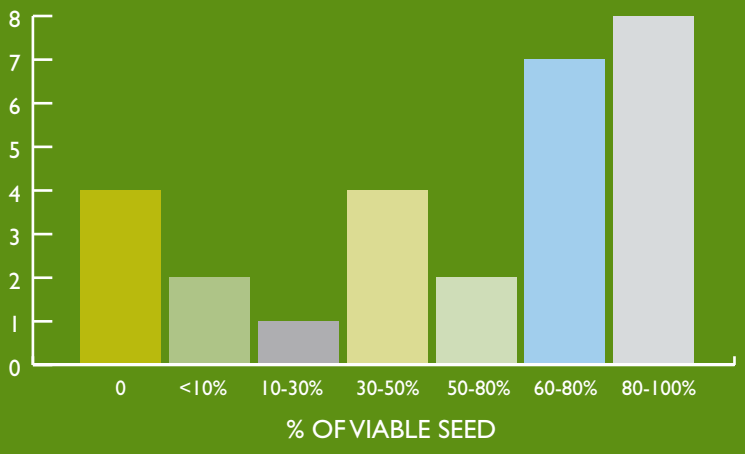
Proximity

Once you are sure you have correctly identified the species targeted for your revegetation site, you should source seed of the species from a site close to your revegetation site and with similar environmental characteristics. As outlined above it is essential that the population targeted for collection is a large, fecund, healthy population, that occurs on a site with similar environmental characteristics to your revegetation site. If collecting from a population in close proximity is not a viable option due to factors discussed above then the collector will need to keep looking further afield until a population that matches the quality seed criteria is located.

A cautionary tale

The Border Rivers Gwydir CMA and Greening Australia are currently conducting trials of large scale direct seeding using agricultural seeders in the Moree district of NSW. Seed for the trials was obtained by tender from 8 different seed suppliers including both professional and amateur collectors. As part of the trial process, all seed batches were tested for viability using a tetrazolium test. The results were alarming. Of the 30 seedlots obtained, 4 had zero viability and a further 8 had less than 50% viability. If these had been sown in the paddock, one third of the effort of seeding would have been wasted with little or no germination resulting. One seedlot of river red gum (*Eucalyptus camaldulensis*) had zero viability and made up most of the seed mix for one site. Sowing this mix would have resulted in a bare site that would need reseeding. The cause of the low viability is likely to be collecting immature seed, collecting poor quality seed from small isolated populations and/or from poor storage practice. Interestingly, both professional and amateur collectors provided seedlots that had serious viability problems.

Moree Seed Viability Trial



Collecting Weeping Pittosporum for seed in Victorian Mallee using a fruit collecting bag. Photo: D. Walters

For all sites however, the seed should be sourced to capture high levels of genetic diversity and have optimal physical health. The Florabank website contains several examples of how different organisations have tackled many of the issues discussed here.

For more information visit the Florabank website at **www.florabank.org.au**

References

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Florabank tools and resources

Florabank has launched a new suite of online tools designed to help seed collectors, revegetation planners and people working to revegetate sites around Australia. Developed by Greening Australia in partnership with CSIRO, with funding from the Australian Government through the Natural Heritage Trust, the new tools include:

- Species Navigator – an interactive key that assists users to select common revegetation species suitable for their revegetation site.
- Seed Collection Advisor – an interactive key to help seed collectors to maximise the genetic quality of collected seed.
- Site Descriptor Tool – provides basic guidelines, resources and a spreadsheet to effectively describe revegetation sites
- Vegetation Management Tool – a tool that helps users to design, prepare, revegetate and maintain their revegetation sites by providing information and access to resources.

Other resources and references available on the Florabank website include; Floradata Online, which provides information on how to collect, store, propagate and establish a range of Australian native species; and the Florabank Guidelines (how to collect, store and manage seed for revegetation).

Become a Registered User on the Florabank website to get access to discussion forums where you can ask and answer technical questions and discuss issues relating to native seed.

Florabank also provides Professional Development Training for seed collectors and can assist NRM regions to develop seed supply plans. Florabank is working with the native seed industry around Australia to develop and implement a certification and accreditation program and to educate seed buyers about the importance of using appropriately sourced, quality seed.

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Early stages of propagation of native seed stock for revegetation purposes. Photo: Penny Atkinson