FloraBank

GUIDELINES 5

SEED COLLECTION FROM WOODY PLANTS FOR LOCAL REVEGETATION

Australian National Botanic Gardens

Natural Heritage Trust
Helping Communities Helping Australia
A Federal Government Initiative

Bushcare

Greening Australia

CSIRO
FORESTRY AND FOREST PRODUCTS
Australian Tree Seed Centre

What constitutes a good seed collection strategy depends greatly on the ultimate purpose for planting vegetation. In a short guideline such as this we cannot cover all the possible purposes. This guideline focuses on collecting good quality seed from woody native plants for use in revegetation. It is primarily intended for people who carry out revegetation, regeneration or the rehabilitation of degraded sites in their local area. The situation for non-woody plants such as native grasses and sedges can be more complex and less is known about how we should approach seed collection strategies; however, the principles outlined in Brown and Briggs (1991) are a useful starting point.

This guideline provides you with a working approach to issues about provenance (seed origin), collecting local seed, and using non-local seed. We provide collection strategies that aim to maximise the genetic quality of the seed you collect for the purpose you have identified.

Good quality implies that seed has been collected in a sustainable way from a known, well-documented location and contains the same levels of genetic diversity and viability as the plants from which it was collected.

Revegetation work is a long-term investment and it pays to get it right at the beginning. The seed used in the initial stages will greatly influence success. The initial genetic material cannot be changed unlike, say, management and tending activities, which may be refined over time to improve on poor establishment. The collection of good seed from an appropriate source is of fundamental importance and may ultimately determine the success or failure of a planting program. Seed is a relatively low-cost item compared to other establishment and management activities; that is, the cost of planting is the same whether you use high or low quality seed, but the consequences of using poor quality seed can have dramatically disappointing results.

FloraBank promotes ecologically sustainable collection practices so that seed is not over-collected from any population and damage to the natural environment is minimised.[1] FloraBank has developed a Model Code of Practice to provide guidance to community seed collection operations and seedbanks on these issues. The collection of native need is covered in detail in FloraBank Guideline 6, *Native seed collection methods*. Information on plantings involving rare and threatened species is given in *Guidelines for Translocation of Threatened Plants in Australia* and *Germplasm Conservation Guidelines for Australia* by the Australian Network for Plant Conservation.

[1] Seed collection is not benign and even the best collectors may cause some damage to plants.

Provenance

The term provenance is used to refer to seed collected from a natural population. Provenance collections are distinguished from cultivated seed sources such as plantations or ornamental plantings. The latter are usually referred to as 'seed sources' or in some cases the term 'land race' is used (see Eldridge *et al.* (1993) for more information). It provides a basic approach to describe genetic diversity below the species level. Provenance is also used to describe patterns of genetic variation exhibited by a species over its geographic range. These patterns are often closely associated with the ecological conditions in which the species has evolved. When a number of provenances of a species are planted out at the same site it is usual to find differences in survival and growth performance (and possibly other characteristics) between provenances. Because the patterns of genetic diversity can be difficult to quantify and delineate, provenance is difficult to define in a precise geographical way. Provenance is a very useful starting point for plant breeding but it is also an essential concept in seed collections for other purposes. Provenance provides information on genetic diversity which enables decisions to be made about how a seedlot should be used or its suitability for particular purposes.

Collecting locally is usually best

Collect seed *as locally as possible* from natural populations for use in revegetation and rehabilitation plantings wherever possible, having regard to a range of plant and planting site characteristics and how they may change as we move further away from the local area to collect seed. This is a precautionary approach, in the absence of detailed information on gene flow and genetic diversity.

Naturally occurring remnant vegetation is usually the best source of material for revegetation. Generally, in these natural communities, plants have evolved to suit local environmental conditions and have a desirably broad genetic base. Ecologically and genetically, local seed complements other plants and animals in the area, and poses the least potential threat of genetic contamination.

Local collection for revegetation projects has many benefits:

- Local plants will be naturally adapted to local conditions. This is important for establishing new plant populations and many seed users have practical experience of better performance from local plants in terms of survival and growth.
- Using local plants will promote genetic and ecological sustainability of local vegetation. In so doing, the genetic integrity and unique characters of vegetation remnants are maintained, thereby enhancing biodiversity.
- Use of local plants reduces the potential for hybridisation between the cultivated species and other species in surrounding areas.
- Using local plants and keeping long-term records about collection localities builds on the capacity to collect, use and better manage the vegetation that grows in the local area.
- The use of local plant material is vital to the rehabilitation of important conservation areas or where there is likely to be interaction with local wildlife.

However, there are areas where land use or degradation processes have greatly altered the original growing conditions with the result that locally adapted plants may not be the best suited to the current growing conditions. A good example is an area that has recently been affected by salinity.

As well, local plants may only occur in small and isolated or fragmented remnant patches, or as isolated individual plants in cleared land. Dieback, salinity or other environmental pressures may affect them. Seed crops may be negligible due to poor pollination, growth may be poor and the survival prospects bleak. It may be difficult to collect sufficient seed from local plants.

What is 'local'?

Start looking from where you are sitting now! If you have difficulty in collecting sufficient (or any) native seed from these local plants you should look for the next closest (geographically), viable population of the species and keep moving outward. As you move further away, observe the plant and planting site characteristics listed below and how they change. It is usually the case that at some point you no longer feel comfortable that the characteristics of plants you are collecting from, or the area in which they are located, *sufficiently match those of the planting location or its local vegetation.* At this point it is wise to set a 'local provenance' boundary for that species or group. Note that this boundary may be different for different species that occur together. Also note that it is easy to declare smaller provenance areas initially, and gradually extend or group them over time, than it is to make large provenance regions and attempt to split them as more is learnt.

In extreme circumstances it may be necessary to combine (or bulk) seed from a wide area to provide sufficient quantity or sufficient genetic material for long-term viability in the replanted population, but this should only be done with expert advice.

What characteristics should you look for?

By observing and gathering information on factors known to influence variation in plants you can make more informed decisions about whether to collect seed of a certain species from a certain site for use in local revegetation. Compare notes about these characteristics with other collectors, botanists and 'bushies'.

The *main factors* to observe are the environmental conditions present at the site when collections are made. We know that plants adapt naturally over long periods to these conditions and they may be very relevant to the distribution pattern of a species. Some species, such as River Red Gum, occur mainly in narrow, almost continuous bands along watercourses and may not vary over a section of a stream, a whole tributary or even a complete river system. Other species, such as Snow Gum, occur on mountain slopes at different elevations and may not vary over a range in elevation.

Try to closely match conditions present at the planting site to those of the collection location. To do this, you must keep accurate records about the collections and where and how the seed is used. You can't tell by looking at the seed (with rare exceptions) where it has come from, so your only link is through the records you keep. See FloraBank Guideline 4, *Keeping records on native seed*, for a full description of what records to keep and how to keep them. In addition, such information, when linked with the performance of subsequent plantings, can help determine the best seed sources.

It is fundamental to record the species, collection site, number of plants sampled, date and collector.

You should consider (or use a system that is based on and records) the following factors at both seed collection and planting sites:

- latitude
- altitude
- position in the landscape (ridge, mid-slope and so on)
- soil type
- vegetation type
- average rainfall and spread throughout the year
- average temperature and maximum degrees of frost.

The *Australian Soil and Land Survey Handbook: Field Handbook* (McDonald *et al.*, 1998) is a very detailed, standardised approach to field data capture, well suited to this purpose. Much of its content can be simplified to suit the end-user. Some mapping may already be available for your region to make the task easier. At the broadest level, bioregions and subregions have been defined for Australia and are useful. At a much finer level of resolution, land systems are a well accepted approach to classifying broad variation in the landscape as a composite of soil, vegetation, landform and climate – see the *Australian Soil and Land Survey Handbook: Guidelines for Conducting Surveys* (Gunn *et al.*, 1998). Land systems may already be identified for your region (typically at 1:50,000 scale) by State agriculture, environment or land management departments. The Forestry Tasmania Eucalypt Zoning System provides a system for consideration by Tasmanian collectors and is based on altitude, dryness and coldness factors.

There are three *lesser* factors to observe, but they are generally less obvious and therefore less useful than the above.

- Species breeding systems are a key to variation, though you need botanical skills to understand and identify these. Pollen dispersal mechanisms, seed shape, size and weight, fruit and seed dispersal mechanisms and the viable life of seeds may all have a significant

bearing on plant variation. For example, catchment boundaries may form 'divides' for species that disperse their fruit or seed in water whereas this may not be the case for those that are dispersed by fauna, birds or insects. The extent of outcrossing (mating among unrelated plants of the same species), self-fertilisation (pollination of an individual plant with its own pollen), or a mixture of both, affects gene flow between populations, which in turn determines how genetically different one population will be from the next. Gene flow is a major factor in determining differentiation between populations and thus affects the delineation of provenance boundaries.

- The pattern of distribution of the species is useful as a guide. If a species occurs continuously over an extensive area of fairly uniform environmental conditions there is likely to be minimal provenance variation and geographically large provenance boundaries. So, one may more confidently collect from further afield. By contrast, where a species has a similarly extensive range but is fragmented and environmental conditions vary greatly, there is likely to be considerable provenance variation and geographically narrow provenance boundaries. So, it is generally less likely that plants from further afield will be similar. Species confined to drainage lines or river systems may have less provenance variation within a catchment than between catchments.
- Variations in plant form, structure and function are sometimes obvious to the naked eye; for example, dramatic variations in flower, fruit or seed size, plant structure or growth habit. Botanical classifications (taxonomy) sometimes recognise such variations in plant form or function within species. Classifications of genus and species are always changing and even in common genera such as *Acacia*, new species are recognised. If the form, structure or function of a species shows marked variation from those of the local area, they cannot be considered as local plants.

Know your plants well before you collect

If you decide to collect seed yourself you will need background information on the target species. Can you accurately identify the target species and its flowering, seeding and seed ripening times? You usually need to travel about to obtain exact location details and to assess seeding times.

Gather and file information on the target species for collection including:

- botanical description
- identifying keys
- distribution
- occurrence in the local area
- flowering, fruiting and seeding times (including seed ripening period)
- fruit or seed located within hand's reach (two metres) or above
- approximate numbers of fruit per plant
- approximate number of seeds per fruit
- uneven fruit ripening on single plants
- safety precautions (allergenic or poisonous plants).

This information will be a valuable resource for future collections if it is kept up to date. Detailed information can be sought from regional and state herbarium records, field botanists, foresters, beekeepers or other seed collectors on identification and variability of species, flowering and seeding times and population locations.

Correct species identification is vital and you should also be aware of variation in appearance of the species. Several excellent field guides are available (see references). If you are in doubt, forward a botanical specimen (leaves, fruits and flowers or buds

pressed between sheets of newspaper or blotting paper) together with a description of the tree's location, size, general appearance and bark to your nearest herbarium for checking. Taking a voucher specimen for all collections is good practice as taxonomy of the species may change over time and labelling errors can also occur. However, the more seedlots you collect, the more work this creates and the more space is required for storage.

Obtain the best genetic quality possible

The seed collected from individual plants is usually combined or 'bulked' together to form a seedlot and mixed to an homogeneous blend. Similar quantities should be collected from each plant so that no individual is favoured or under-represented in the genetic make-up of the seedlot. The way we sample individual plants at the collection location strongly influences the genetic quality of seed collected. Here are five important things to watch for in the way you collect:

1. Ideally, look for local plants that are in healthy and viable natural populations and are large enough to provide sufficient seed by sustainable and responsible collection methods. Carefully assess populations prior to seed collection. Be aware that, in some instances, what appears to be 'natural' vegetation in State Forests, reserves and road verges has been planted in the past.
2. Ensure the target species is uniformly distributed, with a mature seed crop of preferably at least moderate quantity.
3. Make sure of plant identification. If there are any doubts about identity it is essential to keep seed separate until it can be accurately identified from a voucher specimen.
4. Collect seed from at least 10 to 20 widely spaced, healthy parent plants (not diseased) across the population.
5. Wherever possible, aim to collect from genetically unrelated plants, thus increasing the capture of genetic variability of the population; that is, from plants that are unlikely to be breeding with one another. This may be difficult for many reasons – and be aware that even in large, natural populations there may be high levels of inbreeding and genetic structuring. It has been demonstrated that seed with high levels of inbreeding can produce progeny with reduced survival, growth and capacity to contend with environmental stresses. So, it is important to keep two things in mind and follow some basic guidelines:

- *Closely spaced, neighbouring plants are likely to be closely related.*
  Collect seed only from plants separated from one another by a distance of at least twice the plant height. This means you should collect from trees spaced at least 100 metres apart and shrubs at least 50 metres apart. In addition, consider the impact of pollen dispersal distances and transport mechanisms (wind, water, insects and so on) between plants.
- *Isolated plants are less likely to breed with other unrelated plants*
  Avoid collecting from reproductively isolated individual plants, even if they carry heavy seed crops. If you don't have any option but to collect from isolated plants, then make sure you bulk this seed with that from other local plants (of that species) to achieve increased genetic diversity in the mix. Also consider taking cuttings for propagation purposes as these are a genetic copy of the parent plant.

Use responsible collection practices

You should ensure that ecologically sustainable collection practices are used and seed is not over-collected from any site or population. Seed collection should not jeopardise the natural functions of a population; for example, its regeneration after fire. Damage to the natural environment should be kept to the very minimum possible. Ensure that vegetation is not unnecessarily damaged or understorey plants trampled. Nesting sites, tree hollows and other recognised animal habitats should not be disturbed.

Collect no more than 20 per cent of the seed crop or fruit on any individual plant. Remove no more plant material (branches and so on) than required. Collectors should adjust these guidelines downwards in circumstances where this quantity might adversely affect a population; for example, where other collectors have taken seed prior to your arrival. If more seed is required, increase the number of individuals you sample. In some areas there are limits to the resource for collection and this must be recognised.

FloraBank has produced a *Model Code of Practice for community-based collectors and suppliers of native plant seed* in the interests of promoting responsible collection practices. We strongly encourage you to adopt this Code or a version of it tailored to your needs. It communicates important messages about the ethics, standards and practices of seed collectors.

Selecting non-local seed

Seed of non-local species may be required when local site conditions have been highly modified and the original or local vegetation will no longer grow. For example, reduced growth may be due to extreme salinity or acidity or changes in insect and animal predation. Revegetation (at least initially) may depend on using species that are unaffected by, or tolerate, such conditions. Certain rainforest species are notoriously difficult to re-introduce to cleared land without some initial protection – sometimes provided by non-local species. In other cases, amenity or commercial considerations may encourage the use of non-local species.

When using or collecting non-local seed (not local provenance) a rule of thumb is to obtain seed from other areas (other provenances) with environmental conditions that most closely match your planting site (see above).

The most important environmental characteristics to consider in matching origin and planting sites are:

- average rainfall and rainfall seasonality;
- mean maximum, mean minimum and absolute minimum temperatures; and
- some basic soil attributes such as texture and pH.

If you are not in a position to collect non-local seed for yourself, there are commercial seed collectors and suppliers who stock well documented, genetically representative seedlots. Many collect seed using good seed collection protocols and, if they do not have your target provenance in stock, they may be contracted to make collections to your specification. A list of Australia-wide government and private seed suppliers is available at the Australian Tree Seed Centre website (www.ffp.csiro.au/tigr/atscmain/index.htm) or through the Yellow Pages.

It is important to provide any contracted collector with a specification that includes the species and locations for collection, the minimum number of plants and the spacing between plants. Appropriate documentation for the seedlots should be provided by the collector.

Collections from planted sources

Seed production areas and seed orchards are an alternative source of good seed for planting programs. Seed production areas refer to plant populations established with the primary or secondary objective of seed production. While dedicated seed production areas (and seed orchards) are still uncommon, it is more likely that some stands of existing revegetation in your area are used for seed harvesting. You should avoid collecting seed from planted trees unless you know that they can be used for seed harvesting. This means that the seed origin is known and it originated from preferably 10 to 20 plants sampled according to the guidelines above. Of paramount importance is the standard of genetic integrity of seed produced from these stands.

Seed production areas are becoming more common and, if managed well, are a viable option for sourcing local as well as non-local seed for revegetation programs. Seed production is much like other long-term horticultural or forest crops, with the exception that we know relatively little about the cultivation and seed production capability of many native plants. Good production requires careful planning, management and harvesting (see FloraBank Guideline 7, *Seed Production Areas*).

Bibliography and references

FloraBank is seeking to assist in the training of collectors and revegetation practitioners and we are very interested in your feedback on the usefulness of this guideline and any further requirements you may have. Readers are encouraged to access the following references. Many provide a wider range of information on seed collection methodology and protocols than the brief outline given above, others provide information on topics such as seeding times and assessment of soil characteristics.

Anon. 1993, *Guide to requirements for collecting Australian plants and animals*, Australian Nature Conservation Agency, Canberra.

Boland DJ, Brooker MIH and Turnbull J 1980, *Eucalyptus seed*, CSIRO.

Bonney N 1994, *What seed is that? A field guide to the identification, collection and germination of native seed in South Australia*, Finsbury Press, Adelaide.

Charman PEV and Murphy BW (eds) 1991, *Soils – their properties and management: A soil conservation handbook for New South Wales*, Sydney University Press in association with Oxford University Press, Melbourne.

Coates DJ and van Leeuwen SJ 1997, 'Delineating seed provenance areas for revegetation from patterns of genetic variation', in Bellairs SM and Osborne JM (eds) *Proceedings of the Second Australian Workshop on Biology for Revegetation*, Newcastle, New South Wales,
11–12 October 1996, Australian Centre for Minesite Rehabilitation Research, Brisbane, Australia.

Doran JC and Turnbull JW 1997, *Australian Trees and Shrubs: species for land rehabilitation and farm planting in the tropics*, ACIAR Monograph No. 24, Canberra.

Doran JC, Turnbull JW Boland DJ and Gunn BV 1983, *Handbook on seeds of dry-zone acacias*, FAO, Rome.

Eldridge KG, Davidson J, Van Wyk G and Harwood CE 1993, *Eucalypt Domestication and Breeding*, Oxford University Press, Melbourne.

Guarino L, Ramanatha Rao V and Reid R (eds) 1995, *Collecting Plant Genetic Diversity: technical guidelines*, CAB International and International Plant Genetic Resources Institute, Rome.

Gunn RH, Beatie RE, Reid RE and van de Graaff RHM 1998, *Australian Soil and Land Survey Handbook: Guidelines for Conducting Surveys*, Inkata Press, Melbourne.

Isbell RF, McDonald WS and Ashton LJ 1997, *Concepts and Rationale of the Australian Soil Classification*, ACLEP, CSIRO Land and Water, Canberra.

Langkamp PJ 1987, *Germination of Australian Native Plant Seed*, Inkata Press, Melbourne.

Lorimer G 1995, 'Provenance – do we need to worry?', in *Linking provenance and biodiversity conservation*, Proceedings of a training seminar, 25 November 1995, Greening Australia Victoria, Heidelberg, Melbourne.

McDonald RC, Isbell RF, Speight JG, Walker J and Hopkins MS 1998, *Australian Soil and Land Survey Handbook: Field Handbook*, 2nd edn reprint, Goanna Print, Canberra.

Robin J 1995, 'Ecological considerations of provenance', in *Linking provenance and biodiversity conservation*, Proceedings of a training seminar, 25 November 1995, Greening Australia Victoria, Heidelberg, Melbourne.

Sydes M 1995, 'Genetic considerations of provenance', in *Linking provenance and biodiversity conservation*, Proceedings of a training seminar, 25 November 1995, Greening Australia Victoria, Heidelberg, Melbourne.

Turnbull JD and Griffin AR 1986, 'The concept of provenance and its relationship to infraspecific classification in forest trees', in Styles BT (ed.), *Infraspecific Classification of Wild and Cultivated Plants*, Clarendon Press, Oxford.

Your Comment

The FloraBank guidelines are a consolidation of existing information and draw on the practices observed at seedbanks across Australia as well as the expertise and technical understanding of the Australian Tree Seed Centre at CSIRO Forestry and Forest Products, Greening Australia's Seedbanks and the Australian National Botanic Gardens Seedbank. The guidelines present, as far as is known by the authors, best practices. However, they are drafts because we recognise that other people may have better approaches, and that best practices change with time. Also, our climate and vegetation is diverse and not all practices are equally applicable across Australia. If you would like to comment on any of the guidelines please contact the FloraBank Coordinator. If you have practices or knowledge you would like to share with others you can do this through the forum pages of the FloraBank website.

Written by Warren Mortlock and the Australian Tree Seed Centre

Published by FloraBank with the assistance of Bushcare – a program of the Commonwealth Government's Natural Heritage Trust. The FloraBank partners are Greening Australia, CSIRO Forestry and Forest Products through the Australian Tree Seed Centre, and the Australian National Botanic Gardens. FloraBank is funded by the Bushcare program of the Natural Heritage Trust and operates under the Agreement between the Commonwealth of Australia and Greening Australia Limited in relation to financial assistance for FloraBank.

Acknowledgments

The authors wish to acknowledge and thank the following people for their contributions to the development of this guideline:

Tim Vercoe and Maurice McDonald, Australian Tree Seed Centre

David Coates, Department of Conservation and Land Management

Peter Dixon, President, Australian Association of Bush Regenerators

Dale Tonkinson, Dave Watson and Marita Sydes, Greening Australia

All enquiries to:

FloraBank Coordinator
PO Box 74, Yarralumla ACT 2600
Phone 02 6281 8585
Email: greenaus@ozemail.com.au
Website: www.florabank.org.au