Florabank Guidelines

Module 6

Seed Collection

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Key points

Seed collection needs to be carefully planned.

Species must be correctly identified.

Seed should be collected when mature.

Seed can be collected manually or mechanically, depending on the species and volumes to be collected.

Collection data must be recorded, e.g. location, date.

Seed must be appropriately handled following collection to minimise viability loss.

Introduction

This guideline provides an overview of how to approach seed collection and the collection methods, both manual and mechanical, that can be used and the practices that are generally considered sustainable. It stresses the importance of preparation and planning, and focuses on collecting good quality seed from native plants in a sustainable way, for restoration and conservation. The quality of collected seed can affect the storage lifespan of seed, and ultimately determine the success or failure of restoration or other end uses.

Planning ahead

Thorough planning prior to seed collecting trips aids efficient use of time and resources. Planning ahead also means there is adequate time to obtain licences and permits for seed collection and to notify authorities and landowners/managers of collection plans (see also Module 14 – Approvals, principles and standards for seed collection). However, no amount of planning can change seasonal conditions or their impacts, such as naturally poor seed production, lack of rain or high levels of seed predation by insects - but planning can ensure you are aware of these conditions and that you can respond well to them. Two of the first steps in planning are to identify both the purpose of the collection and the target species to be collected (Modules 1 – Introduction and 5 – Seed Sourcing).

The purpose of the seed collection

A clear understanding of why a collection or series of collections is being made is essential i.e. collections from a specific provenance for ecological restoration, for long-term conservation, for nursery production of seedlings or direct seeding, or for production of living collections or specimens for botanic gardens. Further guidance on seed collection for the purposes of long-term conservation, nursery production of threatened species or living collections in botanic gardens can be found in Plant Germplasm Conservation in Australia (Martyn Yenson and et al. 2021; Offord and Meagher 2009), though the same general principles apply.

Target species

The target species might be a pre-determined list of species, possibly from a designated provenance or reference site (Module 1 – Introduction); or a range of species within a larger designated area; or species identified as being suitable for a given location based on current or future climate suitability (see also Module 5 – Seed Sourcing).

To determine which species occur within a certain area, a desktop survey may be needed. This can involve evaluation of previous flora and vegetation surveys undertaken in an area

(e.g. regional vegetation guides, local government plans, consultant's surveys, local land care or plant group surveys), as well as electronic sources of plant species occurrence information (e.g. The Australasian Virtual Herbarium, Regional Vegetation Guides, Local Government Roadside Vegetation Plans, Local Landcare or Plant Group Surveys, or the Atlas of Living Australia). This information can be used not only to establish which species occur in an area, but also where those species are likely to be growing within that area. They may also provide information on the size of a population and flowering or fruiting times which are useful when planning a collecting trip. For some areas, these sources of information may be lacking or dated. Reconnaissance and sampling of plants from target areas can be used to confirm desktop information or fill knowledge gaps.

Once a species list has been generated, it can be refined to a list of targets that will suit the goals of a specific collection program. Considerations when refining target lists include: the likelihood of collecting the species in the quantities required; suitability of the species for the intended use; and storage behaviour (orthodox or recalcitrant – see Module 9 – Seed Drying and Storage). Upfront information on these issues will inform handling of the collections and their longevity. Information about the target species should then be compiled.

A discussion of where to conduct seed collection is covered in Module 5 – Seed Sourcing.

Information about the target species

A botanical description and identification keys

A description of each target species, including details about fruits and seeds, will aid in field identification, helping to ensure that the correct species is collected. A species description will also provide valuable information about the phenology of the species, i.e. flowering and fruiting times. The description may also provide information about the distribution of the species and details of the type of habitat and soil where it can be expected to grow. A species description will indicate an expected range in plant height, which informs whether any special collecting equipment might be required if the seed is likely to be beyond arms reach, or whether a species possesses plant structures (e.g. spines or irritant hairs) or chemicals which may present collection challenges requiring special protective equipment.

Species descriptions and identification keys can be obtained from printed sources such as floras, field guides, regional vegetation guides or taxonomic journals. Many sources of electronic descriptions are now available such as e-floras (e.g. PlantNET, Flora of Australia, or the Atlas of Living Australia) or sites dedicated to a specific group of plants (e.g. World Wide Wattle for *Acacia* or EUCLID for Australian *Eucalyptus*). Potential sources of information can be found via the Australian Plant Name Index (APNI). Whatever the source of botanical information it is important to check that the names being used are current. This can be checked via the Australian Plant Census (APC), a website that provides a list of currently accepted Australian plant names and tracks any name changes through synonyms.

Care must be taken when using field guides to ensure that the name attributed to an image is correct and up to date. Collectors should be aware that considerable natural variation can occur within a species that may not necessarily be captured in a single information source such as a field guide. Some herbaria have scanned digital copies of specimens available. These scans allow for images to be viewed or printed life-sized and in colour. Living collections databases of local botanic gardens can also be checked for holdings of target species to enable familiarisation prior to field trips. If you are in doubt about identification, forward a botanical specimen (leaves, fruits and flowers or buds pressed between sheets of newspaper or blotting paper) together with a description of the plant's location, size, general appearance, and bark (if present) to your nearest herbarium for checking, however, a fee may be charged for this service.

Creating a customised collection manual that assists in identifying the target species or group of species in an area may be useful. This could be achieved by collecting herbarium specimens, identifying them, then capturing images of the specimens (e.g. Brixton Street Wetlands field herbarium). Alternatively, it could be produced by collating information from online herbaria, photographs, and botanical specimens. Having a customised, printed collection manual may be useful in the field if access to the internet is not possible. Alternatively, access to the electronic version of the collection manual on a portable device may be advantageous when outside of internet range. In this case, it is recommended to have an external back-up power source, such as a power bank.

Distribution of the species and their occurrence in an area

If a collecting program is aimed at collecting specific species, then an understanding of where those species grow will be an important consideration in the planning process. Information about a species' distribution can be found as part of its formal description or can be found in other sources such as field guides and vegetation surveys. Precise location information about where species have been recorded can be found in herbarium records which are available through online data sources such as the Australasian Virtual Herbarium. Seed sourcing considerations (Module 5 – Seed Sourcing) will need to be used when refining areas to target species for seed collection, as will land access permissions, license requirements and permit conditions (Module 3 – Approvals, Principles and Standards for Seed Collection).

Timing of flowering, fruiting and seed dispersal

An understanding of the timing of the reproductive stages of a plant will help schedule seed collection trips. A species description should provide general information about when a species might be expected to flower or fruit (phenology), but specific information can be found as part of herbarium records (mainly flowering information) or from records of previous seed collections such as can be found at The Australian Seed Bank website. Information about the synchrony of flowering and fruiting can also aid in the timing of seed collection. Species which have synchronous flowering (i.e. all the flowering happens at the same time), may have seeds that are be dispersed in a short period of time as compared to species which flower and fruit over a long period of time.

Plants are often at their most obvious when they are flowering. Therefore, reconnaissance trips are best taken during flowering time to locate good populations of plants that will likely make good targets for collection. For plants that are small or cryptic to find when not in flower and only in seed, the exact location of each plant may need to be marked with a GPS and/or physically marked (e.g. with flagging tape) to allow plants to be re-located upon return. Flowering can give an indication of how well a species is likely to fruit, but flowering may be variable across a species' distribution. If a species is not flowering well in one area, then it is worth visiting other areas, assuming other areas meet the seed sourcing considerations (Module 5 – Seed Sourcing) of the project.

The time taken between flowering and seed maturation varies greatly between species. It may be as short as a month, to over a year. The time between seed maturation and dispersal can also be highly variable, not only between species, but also within a species across its range. Seasonal conditions, such as temperature and rainfall can impact on the speed at which fruit ripens and seed is shed from a plant.

Whilst previous records and experience can help refine the timing of seed collection, seasonal conditions can alter from year to year which can cause variation in phenology patterns. Some species ripen and shed seed within a few days, whilst other species, known as serotinous species, can hold mature seed on the plant for several years. Observing the maturing of fruit ahead of the likely dispersal time can help avoid missing the window of opportunity for collection. Engaging locals to provide regular updates on fruit ripening can assist in the timing of collection trips to coincide with peak seed maturity.

Seed storage behaviour

An understanding of the seed storage behaviour (see Module 9 – Seed Drying and Storage) of target species will inform how a given species will likely need to be handled and stored throughout the process from collection to storage.

When to collect

When making a seed collection it is important to ensure that the seed being collected is mature. If seed is collected too early, it may not germinate. In addition, immature seed, even if it has the potential to germinate immediately after collection, may not have developed a tolerance to drying and will, therefore, die if dried prior to post-harvest ripening. Furthermore, the potential storage longevity of seed collected when immature may be adversely affected (Hay and Smith 2003).

Seed collections should, therefore, be timed to coincide with peak maturation of the target species, ideally at the point of natural dispersal. Indicators of seed maturity can include:

- changes in fruit/seed colour (Figure 1),
- pods or capsules becoming dry and brittle,
- the ease with which fruit are dislodged from the plant, i.e. if they come off with little pressure being applied, they are likely to be mature,
- signs of fruit beginning to split,
- some seed has already been dispersed.

For serotinous species (such as some banksia or eucalypts) natural dispersal will not be a good indicator of maturity. For these species, other indicators of maturity (e.g. fruit colour or fruit hardness) will need to be used or seed will need to be extracted and assessed. For some species (e.g. eucalypts) drying the fruit will be sufficient to release the seed. For other species (e.g. some banksias) more involved extraction methods will need to be used (see Module 8 – Seed Processing for more information).

Seed maturity can be assessed by conducting a simple cut test of a representative sample and observing the appearance of the seed using a hand lens. Mature seed will have firm, white/cream endosperm (where present). Immature seed will be soft and moist whilst very immature seed will have a watery appearance and consistency. As the seed matures the appearance will become milky, taking on a thicker consistency before becoming firm and white/cream at maturity. The consistency and appearance of the embryo, if it can be seen, should be like that of the endosperm i.e. firm and white. There are exceptions, however. For example, the embryos of several *Tetratheca* species are green when the seed are mature (Alford 1995). As well as providing a measure of the maturity of seed, the cut-test will also give an indication of how prevalent empty, predated, or damaged seed may be within a population. Some species have very tiny seed which will be difficult to assess in the field. For these species, the other indicators of seed maturity will need to be used. More information on cut testing and other methods can be found in Module 10 – Seed Quality Testing.

Whilst every effort should be taken to collect seed when it is mature, if immature seed is collected then rapid drying of the seed should be avoided. Seed should be maintained in cool, well ventilated conditions aimed at continuing the ripening process (Hay and Smith 2003). Where possible, immature fruit should be retained on the stem/branch to aid the post-harvest ripening process.

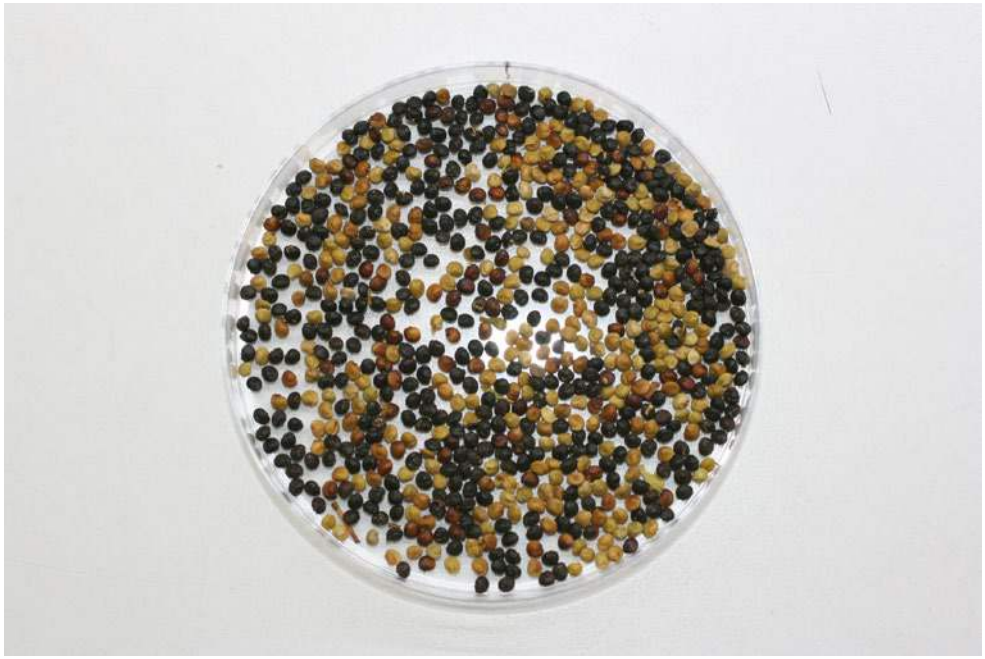

Figure 1. A mixture of mature and immature seeds. The black seeds are mature and the green and pale brown seeds are immature. (Photo: L. Commander)

How much seed to collect

Deciding how much seed to collect will largely be determined by the purpose of the seed collection but may be limited by natural factors such as plant number and seasonal availability of seed or other factors such as ensuring that collections do not adversely impact the species in situ or licencing considerations (Module 3 – Approvals, Principles and Standards for Seed Collection). If the season is good, collecting more than the current requirements (within the recommended guidelines below) and storing the remainder for future use may be a consideration (Module 9 – Seed Drying and Storage).

A genetically diverse seed collection can help improve the success of restoration and improve the future adaptive potential of plantings (Broadhurst et al. 2008). Seed should be collected from as many plants as possible (Cochrane et al. 2009; Hoban 2019) avoiding small, isolated populations where possible or to aggregate seed from across small population groupings. Minimum numbers of plants from which seed is collected depend on the context, for suggested minimum number of individuals, see Module 5 – Seed Sourcing). It is generally better to collect fewer seeds from more plants than many seeds from fewer plants. Plants should ideally be sampled without bias from across a population (e.g. random or stratified sampling), aiming for a similar representation of seed numbers from each plant. Seed is best collected from plants that are at a distance from each other as they are less likely to be related, thereby increasing the chances of a broader range of genetic diversity in your collection. This distance will be dependent upon the pollen and seed dispersal mechanisms of the target species. For tree species with gravity dispersed seed, the minimum recommended distance between sampled trees is twice the canopy height (Gunn 2001).

When collecting, care must be taken that the amount of seed harvested will not adversely affect the long-term survival of the source population. Unless specific information about safe collecting limits for a species are known, or the vegetation is due to be completely cleared (e.g. for development), a collection limit of a maximum of 20% of the available seed should be used (Cochrane et al. 2009; Way 2003). In some states or territories, the amount of seed that may be collected may be controlled as part of the licensing and permit process (Module 3 – Approvals, Principles and Standards for Seed Collection). These guidelines are based on a once-off collection from a population. If future collections are likely, more conservative limits to collection may be required. Seed held on plants of serotinous species may represent a number of years seed production, therefore care must be taken to ensure that collection limits are applied to the current seasons seed production and not to the total seed present on a plant. It is also possible that other collectors may target the same population. Good regional communication and coordination with groups or agencies managing seed collection is required to avoid over-collection from a population, and collectors should be alert to signs that collections may already have been undertaken.

Seed Production Areas (SPAs) alleviate the issues of limits to harvest and allow the total seed production to be harvested in any given year and enable stockpiling for lean harvest periods (see Module 7 – Seed Production).

Seed collecting methods

Seed collection methods vary according to the purpose and scale of collection. For small collections (such as conservation, research, or nursery propagation), or collections from small populations, collection by hand, using simple tools (such as secateurs) and/or seed traps may be appropriate. For large-scale collections (such as for restoration of ecological communities and/or commercial purposes), seed may be collected using mechanical means. Consideration should be given to whether these methods may be detrimental to the survival of the population, and to whether the technique is allowed under local licencing rules. See Table 1 for examples of collecting methods for some genera/fruit types.

Table 1. Harvest and cleaning/extraction methods for various genera/fruit types.

Fruit Type	Family	Genera	Harvest methods
	Asparagaceae	*Lomandra*	Strip with gloved hands
	Casuarinaceae	*Allocasuarina*, *Casuarina*	Cut branches or strip cones by hand
	Fabaceae	*Acacia*, *Jacksonia*	Strip pods by hand or shake bush
	Myrtaceae	*Eucalypts*, *Angophora*, *Callistemon*	Branch removal then cut fruit off
	Poaceae	*Triodia*, *Stipa*	Mechanical, cut seed heads or strip
	Proteaceae	*Banksia*, *Hakea*	Cut fruits from bush
Fleshy fruit			Strip or pick by hand

Manual collection

Collection by hand

The simplest method to collect seed is by hand and usually involves picking or shaking fruit or seed heads from branches/stems into a collection container such as a bin or a waist-mounted bucket or calico bag (Figure 2, Figure 3). When shaking fruit or seed from the plant, a drop-sheet can be placed under the plant to catch material as it falls. Collecting seed from the ground is not recommended. If seed is collected from the ground there is no guarantee that the seed will be of the target species or if individual plants are being collected and kept separate the seed may be from a mixture of parents. There is also the potential that material on the ground may be of poor quality (old, deteriorated, immature, empty, predated seed etc.). Seed traps (see below) can be used to catch mature seed/fruit when they are shed from the plant as long as care is taken to ensure that the potential for contamination from other species (or individuals if important) and deterioration of seeds in the traps can be avoided.

Figure 2. Picking seeds and placing in a calico bag. (Photo: L. Commander)

Figure 3. Shaking seeds into a bucket. (Photo: L. Commander)

Collection using tools

Sometimes, simple tools may be needed to remove seed or fruit from the plant. Secateurs are essential for collecting most species and can be used to cut fruit or seed heads from the plant or can be used to cut small branches containing the fruit. They can also be used to cut fruits to check seed fill prior to collection. When taking material in this manner it is important to try and minimise the amount of non-fruit material in the collection such as leaves or sticks as it may have a detrimental effect on the plant's survival, and this material can create potential cleaning problems when it comes to processing the collections after they have been dried (see Module 8 – Seed Processing). Ensure that tools are clean and sharp as clean cuts will aid plant recovery. Tools should be disinfected (e.g. bleach or alcohol) after each use to reduce potential for disease transfer between plants.

Sticks or poles can be used to help beat branches to dislodge seed or fruit, with a tarp under the plant, but care must be taken not to use too much force and remove immature fruit in the process.

For large scale collections bins and tools such as racquets (to tap) or broom heads (to brush) can be used for collecting fruit species such as saltbushes and bluebushes (Figure 4). Bins can then emptied into larger bulk bags such as poly woven bags or wool bales.

Figure 4. Collecting with a bin and racquet. (Photo: A. Quarmby)

Collecting from tall plants

Collecting seed from tall trees provides more of a challenge to the seed collector, and the taller the plant the more challenging the task becomes. Pole pruners can be used to extend reach up to around 5 m (Figure 5), however using poles of this length can be difficult and tiring, though modern battery-operated light-weight pole pruners help. Another option is to use an arborist's weighted throw line to pass a line over a branch containing fruit. The line can then be used to pull the branch down or to shake seeds from the branch (Youngentob et al. 2016). Alternatively, the throwline can be used to pull a stronger rope over the branch to pull the branch down or the line can be used to pull up a rope saw to cut the branch. When sampling from trees it is good to sample as high as possible in the canopy, and from all sides of the canopy, to maximise sampling of outcrossed seed (Patterson et al. 2004).

Techniques that can require more advanced training and/or permits include climbing into the canopy of a tree to collect seed; use of an aerial work platform e.g. a cherry picker; or shooting branches from trees.

Figure 5. Collecting from tall trees using a pole pruner. (Photo: L. Commander)

Seed traps

When the timing of seed shed is uncertain, when seed dispersal is spread over a long period of time, or when capturing seed at the point of dispersal is difficult e.g. wind dispersed seed, seed traps can be used to catch seed when it is dispersed naturally from the parent plant. Seed traps can take many shapes and sizes, from large traps that encompass the whole or most of a plant, to small bags that may enclose individual fruit.

Large traps to be placed under plants should be made of a porous material that will allow seed to be caught but water to pass through e.g. shade cloth or flyscreen. Traps should be checked regularly as the seed can be subject to predation. Consideration should also be given as to how much seed is likely to be collected from a plant using this method and how this would relate to licensing and permit considerations (Module 3 – Approvals, Principles and Standards for Seed Collection).

Seed bags can be placed over immature fruit to catch seed when it is shed (Figure 6). These bags should be made from a light weight, breathable, material that is moisture repellent or fast drying (so that seed does not rot after rain (e.g. organza bags)) and ideally is UV resistant if they are required to survive extended lengths of time during summer. Despite the bags giving better protection to shed seed than a seed trap, seed predation can still be a problem so regular checking is advised.

Figure 6. Bagging immature grasses for later collection using an organza bag. (Photo: L. Commander)

Mechanical harvesting

For restoration and/or commercial scales, seed collection can be aided by mechanical harvesting equipment where there are large areas of the same species (to minimise species cross contamination, depending on restoration objectives) and good access (i.e. open shrublands and grasslands) (Appendix 1). However, mechanical harvesting can be most beneficial in seed production areas that are specifically set up for single species production and harvest.

Just as the structure, morphology and type of seed influences the process of hand seed collection, it also dictates the feasibility and types of mechanical harvest and the machines used.

Seed vacuum techniques

Collecting using a vacuum is best suited to those species with either papery capsules (*Dodonaea*), seed pods (*Acacia*, peas), dry fruit (*Atriplex*, *Maireana*), a range of ground forbs (*Wahlenbergia*, *Convolvulus*) and some native grasses (*Rytidosperma*, *Stipa*).

Portable vacuums, such as a horse poo vacuum, can be used for native grasses and other light weight seed such as daisies (Figure 7). A horse poo vacuum is recommended over "blower-vacuums" as the latter often has an impeller that can damage seeds.

Figure 7. Vacuum collecting. (Photo: A. Quarmby)

Brush Harvesters

Many native grasses have complex 'seed head' structures and awns that make mechanical harvest and delivery problematic. Brush harvesters that use revolving or reciprocating mechanical nylon brushes to remove the seed and in some cases vacuums to collect and bag / drum the seed often prove the most effective means for large scale grass harvest (Figure 8). It should be noted that brush harvesters are useful for collecting almost pure seed, however, for species such as *Austrostipa*, seeds can become tightly bound, making it difficult to separate and broadcast. Alternatively, an adapted lawn mower with BMX wheels (Figure 9) and grass clipping catcher attached can be used. In this instance, the collection is far less pure, with seeds and stalks, however the material is far easier to separate for sowing.

Regardless of the type of mechanical harvester used, care needs to be taken to avoid non-target species. Note that in some instances where two or more species are on the target list, it may be acceptable if a collection contains a mix of these species. This can occur when the species grow together, and it may be difficult to avoid collecting the species simultaneously. Assess the site before collection for the presence of weeds and select an appropriate harvester or method to avoid the weed seeds.

Figure 8. Brush harvester.
(Photo: A. Quarmby)

Figure 9. An adapted lawn mower with BMX wheels.
(Photo: T. Zwiersen)

Seed handling

After collection, seed should be bagged and labelled ready for transport. Keep each provenance in separate bags. Sometimes, for specific projects, seed from individual plants may need to be kept separate (e.g. see The South East NSW Bioregion Working Group et al. (2019)). In some instances, material may need to be laid out on tarps to allow insects to escape and to facilitate seed drying to help excessive moisture and sweating during transport. This can also be achieved by opening calico bagged collections in the shade. Pre-cleaning may also be appropriate to reduce the bulk of material, remove excessive leaf material and to aid future cleaning of the collection. Reducing excess non-seed/fruit material will also help to remove insects from the collection but be aware that fruit and seed predation may still be very high and will need to be dealt with quickly.

For most seed collections, the bags used for transport should be breathable e.g. paper or calico (small collections) or woven polypropylene or wool bags (large collections) and securely tied or sealed. Breathable bags will help prevent excessive moisture retention and sweating which can lead to rapid seed deterioration. Fleshy fruit should be collected into plastic bags or tubs which should be checked regularly and given plenty of fresh air to avoid rotting or fermentation. All bags or tubs should be clearly labelled with basic details of the collection such as a unique collection number, species, collection location, collection date and the number of plants from which the seed has been collected. It is prudent to put a label inside the bags as well as on the outside in case the latter is lost in transport.

During transport, seed should be stored under cool, well ventilated conditions. Collections containing a large amount of moist material such as leaves or fruit, should be checked regularly for signs of decay and spread out to air dry where possible. If collection trips are lengthy it may be necessary to spread material out to dry or to hang bags in the shade (see also Module 8 – Seed Processing: Post-harvest Drying, Seed Extraction and Cleaning). Dried collections could be placed in airtight containers overnight, so they don't take on moisture as the temperature drops. Hygrometers could be used in the field to check relative humidity if required (see Module 7 – Seed Drying and Storage).

When handling plant and seed material appropriate personal protective equipment should be used to avoid contact with potentially hazardous substances such as saps or irritant hairs.

Plant identification and data

The identity of species collected must be confirmed, and a collection must be accompanied by good field data (see also Module 4 – Record Keeping). To confirm the identity of a species, collect a voucher specimen, representative of the population from which seeds are to be collected, as part of a reconnaissance trip when the plant might be flowering or at the time of collection. This specimen should be checked by a qualified botanist.

Information that should be documented with a seed collection includes (see Appendix 2 for a collection form template):

- A unique collecting number assigned to the collection by the collector.
  - This number then becomes a permanent identifier that links a seed collection to the information recorded during a collection, including the herbarium specimen.
- Species name.
  - This will be the species name assigned to a collection in the field. This may change once the identity of the voucher specimen taken with a collection is confirmed.
- The name of the company/institution that has undertaken the collection and the names of all individuals involved in the collection.
- The name of the person who confirmed the species identity.
- Latitude and Longitude.
  - The location coordinates from where the collection has been made, including the map datum used (e.g. WGS 84 or GDA 94).
- Location.
  - A written description of where the collection has been made which provides enough information to enable others to re-find the site.
- Date of collection.
- Number of plants collected from.
  - The number of plants sampled, an indication of the total number of mature plants in the population, and the proportion of those plants with seed.
- Area sampled.
- An indication of the size of the area from which the seed collection was made.
- Licence number – if a seed is collected under a licence or permit.

In addition to these essential data, the following information can also be of use either to aid in plant identification or for use of the seed collection:

- Plant description.
  - A description of the plant being collected, particularly features that will not be obvious from a dried specimen such as plant height and form, and flower, fruit, and leaf colours.
- Habitat.
  - A description of the environment from which the plant has been collected.

- Soil.
  - A description of the soil at the collection site including soil texture and colour.
- Vegetation.
  - A description of the vegetation structure from which the target species has been collected.
- Associated species.
  - A list of the most common plant species occurring at the collection site.
- Phenological information.
  - Details about the phenology of the population including the presence / absence of each phenological stage as well as an indication of abundance of that stage if present.
- Photographs - Close-up images of flowers and / or fruits, of the whole plant, and the general area assist with identification and re-finding the plant(s).

Information such as species name and collection location may be required for annual reporting to licencing organisations (see Module 3 – Approvals, Principles and Standards for Seed Collection) or if on-selling seed to someone else for restoration or other purposes. Traceability can also be important for biosecurity reasons.

Seed collecting equipment

Below is a list of useful equipment for seed collecting. Some equipment is easy to source and relatively inexpensive, such as secateurs and buckets. Others, such as mechanical harvesters, may be more expensive.

General equipment

- Licence and collecting permission/s (Module 3 – Approvals, Principles and Standards for Seed Collection).
- Plant identification books.
- Species lists (with photos).
- Collecting guides.
- Plant press, newspaper and boxes for specimens, tags.
- Compass**,** handheld Global Positioning System (GPS) instrument.
- Road and track maps, maps of species distribution.
- Field collection data sheets and pens/pencils (Module 4 – Record Keeping).
- Waterproof paper notebook for wet weather use.
- Hand lens, camera and binoculars.
- Secateurs, long-handled pruning shears.
- Flexible saw, bow saw, folding pruning saw.
- Telescopic pole pruner, pole and rope saws, aluminium extension pole (fruit knocker), throwing rope with weight, hard hat.

- Bow and arrows, or catapult with line, or rifle and ammunition (with appropriate licences and permits).
- Squash or tennis racquet.
- Large (40-60L) bins and buckets.
- Extension ladder, fruit-picker's ladder, climbing equipment and ropes.
- Drop-sheets/tarpaulins.
- Woolpacks, calico bags, woven polypropylene bags, paper bags, plastic tubs, material for seed traps (e.g. shade cloth or fly screen), bags for seed capture (e.g. organza bags).
- String and labels.
- Mechanical harvesters: brush harvester, lawn mower, horse poo vacuum (plus associated fuel and oil). (Petrol-driven garden blowers/vacuums are not recommended as the impeller can damage some seeds.)
- Trailer with high wire-mesh cage, or sturdy roof-rack with ladder.
- Charging device e.g. solar panel, phone battery packs, spare batteries.

Vehicle

- A mechanically sound vehicle suitable to access collecting sites.
- Vehicle safety equipment – tool kit, fire extinguisher, fire blankets, first aid kit, recovery equipment, jump starter packs etc.

Safety

- Leave details of collecting location(s), itinerary and contact details with employer, family, or friends before departure. Set regular check in times.
- Undertake a risk assessment prior to departure.
- Radio or satellite phone for communication.
- First aid kit.
- Location information for nearest medical facilities and contact details for emergency services such as the Royal Flying Doctor Service.
- Ensure all equipment is in top condition and properly serviced.
- It is advisable to work as a team, if not a Personal Locator Beacon (PLB) should be carried when working alone.
- Appropriate clothing, footwear and personal protective equipment (PPE) as required (e.g. gloves, sun protection, safety goggles, dust masks, hearing protection, gaiters, hard hat).
- Biosecurity kit (e.g. bucket, disinfectant etc).
- Be aware of specific PPE requirements for the work environment (e.g. working on road verges or mine sites).
- Ensure the activity of collecting from each technique, species or area is assessed for hazards and ensure controls are in place to ensure the activity can be undertaken safely e.g. using Take 5 (Stop, Look, Assess, Manage, Safely start).
- Adequate food and water for the trip duration.

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Online resources

Atlas of Living Australia
http://www.ala.org.au

Australasian Virtual Herbarium
https://avh.chah.org.au

Australian Plant Census
https://biodiversity.org.au/nsl/services/APC

Australian Plant Name Index
https://biodiversity.org.au/nsl/services/APNI

The Australian Seed Bank
https://asbp.ala.org.au

Brixton Street Wetlands Field Herbarium
https://florabase.dpaw.wa.gov.au/projects/brixton

Census of the Queensland Flora 2020
https://www.data.qld.gov.au/dataset/census-of-the-queensland-flora-2020

eFloraSA
http://www.flora.sa.gov.au

EUCLID – Eucalypts of Australia
https://apps.lucidcentral.org/euclid

FloraBase
https://florabase.dpaw.wa.gov.au

FloraNT
http://eflora.nt.gov.au

Flora of Australia online
https://www.environment.gov.au/science/abrs/online-resources/flora-of-australia-online

Flora of Tasmania online
https://flora.tmag.tas.gov.au

Global Plants
https://plants.jstor.org

How to Collect Herbarium Specimens - Western Australian Herbarium
https://www.dpaw.wa.gov.au/images/documents/plants-animals/herbarium/how_to_collect_herbarium_specimens.pdf

NatureMap
https://naturemap.dbca.wa.gov.au

PlantNET
http://plantnet.rbgsyd.nsw.gov.au

VICFLORA
https://vicflora.rbg.vic.gov.au

World Wide Wattle
http://worldwidewattle.com/infogallery/publications/wattle.php

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Appendix 1. Seed Machinery for seed harvesting

Forbs	Notes	Pro's	Con's
Handheld battery vacuum cleaner	Works well on fluffy seed such as: Asteraceae and Wallaby Grasses	Collects more seed in short time than by hand Light and easy to use Cheap to purchase	Short battery charge (10–15 min) Limited life capacity Possibility of cross contamination of seed, needs cleaning before different species.
Blower/vacuum. Petrol or battery handheld machines	Larger volumes of seed collected in short times e.g. Horse poo vacuum (Figure 7)	Larger volumes of forb or fluffy grass seed can be collected Greater time to harvest with lithium battery or petrol Less possibility of weed contamination as it is done by walking through stand	Requires multiple collection bags to reduce cross contamination of seed or lots of cleaning of bags. Two stroke noisy and toxic fumes. Expensive outright purchase Fatigue to user
Combined vacuum brush / steel beater machines	Rosevale Reaper grass harvester uses vacuum and brush / beater	Large volumes of seed can be harvested	May harvest unripe seed Possibility of collecting weed seed
Industrial vacuum harvesters	Large trailer mount seed vacuum to allow collection of forbs with large hose	Allows large volumes of forbs to be harvested No batteries so longer harvest time	Expensive to purchase Limited use other than fluffy or light seed Possibility of collecting weed seed

Forbs	Notes	Pro's	Con's
Handheld seed harvesters (Brush cutter harvesters' style)		Good for inaccessible areas (steep country, wet ground) Faster than hand collecting	Small amounts of grass harvested Fatigue to user
Brush Harvesters	Many types available from small push machines to tow or front mount models for cars, ATV, and tractors Bandicoot, Kimseed, Grasshopper Grass Grabber, reel over brush harvesters.	Fast and efficient to harvest large volumes of grass seed with rotary brush Ability to harvest for long periods when operator is in a vehicle. Use smaller machines to harvest smaller patches or between weeds	Can easily be contaminated by other grasses and weeds The brush may harvest unripe seed so, higher amount of non-viable seed The rotary brush will also harvest stem of grass so seed will not be pure Prone to damage from wire, rubbish and sticks
Trough harvesters	Mounted on tractor	Only harvests ripe seed Little stem and trash in seed mix Ability to harvest for long periods as operator is in tractor	Less seed harvested per hour Can easily be contaminated by other grasses and weeds

Appendix 2. Seed collection information sheet templates

Collector number:	Collector name:
Additional collectors:	
Company/Institution:	
Voucher reference:	
Species name:	Family:
Species confirmed by:	
Collection Latitude:	Longitude:
Map datum: WGS 84 / GDA 94	
Location (State, region, LGA, property/park name, nearest road):	
Collection date:	
Population size:	Number of plants collected from:
Collection area:	
Plant description (height, flower colour, leaf morphology, leaf colour, bark, form, habit):	
Phenological information:	
Habitat (forest, woodland, shrubland, heath, grassland, wetland, coastal):	
Soil colour and texture:	
Underlying geology:	
Topography:	
Vegetation community:	
Associated species:	

Seed Collection Field Data Sheet

COLLECTION SITE LOCATION		SEEDLOT DETAILS	
Vegetation Type: Remnant Planted SPA		**Species name:**	
Land Ownership: Public Private		**Vegetative form:** Tree Shrub Grass/Sedge Vine Saltbush Other	
Site Name: (e.g. locality, property or paddock name)		**Date/s collected:**	**Collection Number:**
Closest Road:		**Allocated project:**	**Voucher specimen?:** **Number:**
Closest town:		**COLLECTION SITE COORDINATES** (Please record GPS coordinates in GDA 94 mode)	
Shire:	**Land owner:**	**Coordinates from:** Map GPS	
Subcatchment: (see guide)	**Bioregion:** (see guide)	**Map number:** **Scale:** **Map date:**	
COLLECTION SITE VEGETATION		**MGA zone:** 54 55 56	**Easting:** **Northing:** **Elevation (m):**
Dominant species (at or adjacent to site)		**Position in landscape:** Watercourse Floodplain Plain/Flat Lower slope Mid slope Upper slope	
Species abundance at site: Dominant Abundant Common Uncommon Rare Solitary		**Surface soil colour:**	**Surface soil texture:** Sand Clay Loam
Population size at site (if <10 enter actual number): 10-25 26-50 51-100 101-500 501+		**Aspect:** N NE E SE S SW W NW n/a	
Nº of plants collected from (if <10 enter actual number): 10-25 26-50 51-100 101+		**COLLECTOR DETAILS:**	
		Main collector:	**Supervisor:**
Collection Timing: Early Peak Late		**Total Nº of collectors:**	**Additional collectors:**
Seed crop quantity: Light Medium Heavy		**Main Collectors signature** I declare that this seed has been collected in an ethical and sustainable manner in accordance with the seed collection guidelines.	
Additional details:			

SEED PROCESSING DETAILS				OFFICE USE ONLY	
Seed quality:	Poor	Average	Good	**Date delivered**	
Seed rating:	Low value sites	Medium value	High value only	**Nº of bags delivered**	
Processing:	**Date or n/a**	**Processing:**	**Date or n/a**	**Deposit weight (g)**	
Hand cleaned		Floated		**Additional deposits to seedlot (g)**	
Threshed		Gassed			
Sieved		Dryacide		**Database entry complete**	
Seed graded		Other			