Florabank Guidelines

Module 4

Record Keeping

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Key points

- Quality record keeping is essential for all aspects of the seed supply chain and for all restoration projects.
- Easily accessible records provide the basis to learn and develop best practice.
- Data captured depends on the purpose and resources of the project.
- The more information that is gathered and documented, the better.
- The easier data is to capture, the more likely it will be recorded.
- The absence of sufficient data, or a lack of confidence in it, may render a potential natural resource valueless, or prevent analysis.
- A records system should be designed with both information capture and retrieval in mind.
- The foundations of a good record keeping system are templates, forms, and labels.
- Electronic record keeping tools are readily accessible and affordable and offer powerful advantages.
- A records custodian or manager of the system who oversees capture, validity, accuracy, and maintenance of the data is essential.
- Sharing of information leads to larger datasets, allowing for more effective decision making.

Introduction

This module details the importance of (and reasons for) good record keeping, the concepts behind and ways to design record keeping systems, ideas for the information that should be captured, considerations for collation and sharing, currently available technology, and publicly available resources. This module has been developed as a framework to complement all the other modules, and therefore does not provide any detail on what information to capture. Recommendations for data capture will instead be provided within each module.

In the information age, data is key and quality record keeping is essential. This is especially the case when working in often complex natural ecosystems, where the collective knowledge is continually growing. Whether a conservation volunteer, commercial practitioner, seed collector, nursery, land manager, regulator, ecologist, researcher, etc. there is a collective need for access to accurate and trustworthy records. The degree of detail captured during any restoration activity, be it seed collection, processing, germination or direct seeding, will likely vary between different groups and sectors. However, the more information that is gathered and documented, the better.

Records may be required for a number of reasons in conservation activities: to track progress, to trace movement of resources (e.g. seed), inform decision making, for statutory reporting, or for research and scientific analysis. Indeed, record keeping forms the legacy of any task being undertaken, which future users can draw upon. With all organisations experiencing staff/volunteer turnover, it is important that everything is recorded so that a full history of a project, seed lot, species, etc. is known and maintained. To effectively capture accurate data, contributors need to have a robust, user-friendly system for recording information. The easier the data is to capture, the more likely it will be recorded.

Purpose of Record Keeping

One of the driving forces for keeping up-to-date and accurate records is to learn from past experiences and inform best practices. Restoration work has a myriad of components, from the original seed (or plant material) collection (from wild collection or seed production areas) and storage, to propagation, planting/sowing, and monitoring the outcomes. Across these various tasks there will be standard data gathered and recorded, but also optional, more detailed data generated for specific reasons such as research. For example, at the basic level record keeping is required for all seed lots to meet minimum licence reporting conditions and demonstrate that seed has been lawfully harvested. However, at a higher level, detailed record keeping can help isolate attributes of seed lots (e.g. degree of fragmentation within a provenance [scattered paddock or road-side trees vs. continuous forest], tree-level fecundity, population size, conspecifics, etc.) contributing to scientific knowledge.

The absence of sufficient data, or a lack of confidence in it, may render a potential natural resource valueless, or prevent scientific analysis from occurring. It is important to keep in mind that information which may not be important to the person capturing it, may be critical to the ultimate end user. Therefore, consideration should be given to the information captured and its timeliness. To go back and retrospectively capture essential data may be very time consuming, costly, or impossible. This is especially the case if site conditions have changed since the last visit, or staff have moved on, then the knowledge is effectively lost.

Keeping detailed, up-to-date records in an easily accessible database provides the basis to learn and ask questions at each specific step of the restoration activity, such as:

- Which seed lots of a species are available and where were they collected?
- From how many maternal plants were seeds collected?
- What are the optimal collection times for the target species?
- What is the best method to harvest the seeds?
- What is the best way to clean the seed?
- For how long and under what conditions has the seed been stored?
- What are the optimal conditions for seed germination for a species?
- Does a species require dormancy breaking cues to germinate, and if so, what are they?
- Were local species/provenances planted or was there a mix of local and non-local species/provenances?
- What was the growth and survival of a specific seed lot when planted in local and non-local sites?

Reporting Information

Given that recording information is invaluable for learning, so too is analysing, reflecting on, and ultimately, *reporting* the information. Reporting enables knowledge to be shared and built on. It is equally important to share reports of 'failures' to ensure they are not repeated by others. If reporting is mandatory (such as part of a licence or funding agreement), there may be a standard form or online system (such as the Australian Government Department of the Environment and Energy's Monitoring Evaluation, Reporting and Improvement Tool (MERIT)). If contributing to an existing online database, there may be a template spreadsheet to use (e.g. Atlas of Living Australia). Other avenues for reporting information include:

- Internal reports, provided to funding bodies or made available online
- Talks given at workshops, conferences, or recorded and available online

Online databases, such as Seeds of South Australia, or the Seed Information Database (SID)

- Articles on websites and social media
- Press releases
- Radio interviews and podcasts
- Newsletter and magazine articles
- Articles in journals and bulletins such as *Ecological Management and Restoration*, and *Australasian Plant Conservation*

Record Keeping Concepts

To effectively capture and record trustworthy data, contributors need to have a robust, user-friendly system. A system is more likely to be used if it is designed with both information capture and retrieval in mind. Records that are incomplete, disorganised, illegible, or poorly structured are likely to frustrate end users. Similarly, systems that are onerous when it comes to data capture and input may discourage contributors from providing additional information. A little bit of forethought can simplify processes and ultimately increase outputs with less effort for all involved.

A good record keeping system is one that:

- is easily accessible and understood by its users;
- is trusted by its users to have accurate and useful information;
- provides for quick data entry both in the field and office;
- is easily interrogated by users to extract critical information;
- is robust and long lasting;
- has a clear set of standards for use and administration of the system that users are required to meet; and
- has the flexibility for users to make additional notes and comments.

A couple of additional considerations should be added to this where there is a greater reliance on electronic systems:

- ensure that records are not overwritten or updated and if changes are required these are documented separately (e.g. if withdrawals are made from a seed bank the initial record is not deleted, or quantity adjusted);
- ensure that data is regularly backed up;
- ensure consistent version control e.g. v1, v2 for each update;
- ensure date stamped to ensure currency; and
- include authors and collaborators, which contributes to trust and for fact-checking if required.

With nearly everyone having access to computers and smartphones these days, an electronic record-keeping system is recommended. Whilst it may not save any time for those capturing the data, it certainly will save time for those wanting to retrieve or analyse the information. However, it is not essential, and a hand-written record set can be just as useful as digital if it is structured similarly. These records can always be digitised at a later stage if desired. However, as with electronic records it is wise to keep a backup copy of hand-written records as they could be damaged or lost. This could be as simple as scanning the hand-written records and saving a pdf copy.

The foundations of a good record keeping system are templates, forms, and labels. Prompting data collectors for information is the most effective way of ensuring they capture the necessary information in a standard way (Figure 1). Forms should be tailored to the purpose and avoid where possible the scoring of subjective data which may vary among observers.

Consideration should also be made regarding resources available to the data recorder. For example, will all people have access to the required technology / software if an electronic system is developed? If data is recorded on paper and later digitised, this should also be factored into the form design to optimise the transfer. For an example of a template, see Module 6 – Seed Collection.

No matter what system is employed, there needs to be a custodian or manager of the system who oversees capture, validity, accuracy, and maintenance of the data. As well as protecting the integrity of the data they should also have responsibility for the structure of the database (including field metadata, relationships, reports, etc.) as well as version records and backups. The custodian should also be responsible for ensuring the database is accessible to others, up to date, and appropriately stored. If the custodian leaves that role, then there needs to be a transition process to ensure that information is not lost. A plan for long-term management of the data needs to be written into the project plan / business plan. Without such effort, confidence in the data can quickly be lost, diminishing its value and all the hard work put into capturing it. Without a transition process or suitable repository, valuable information can be lost when staff leave or project funding ceases.

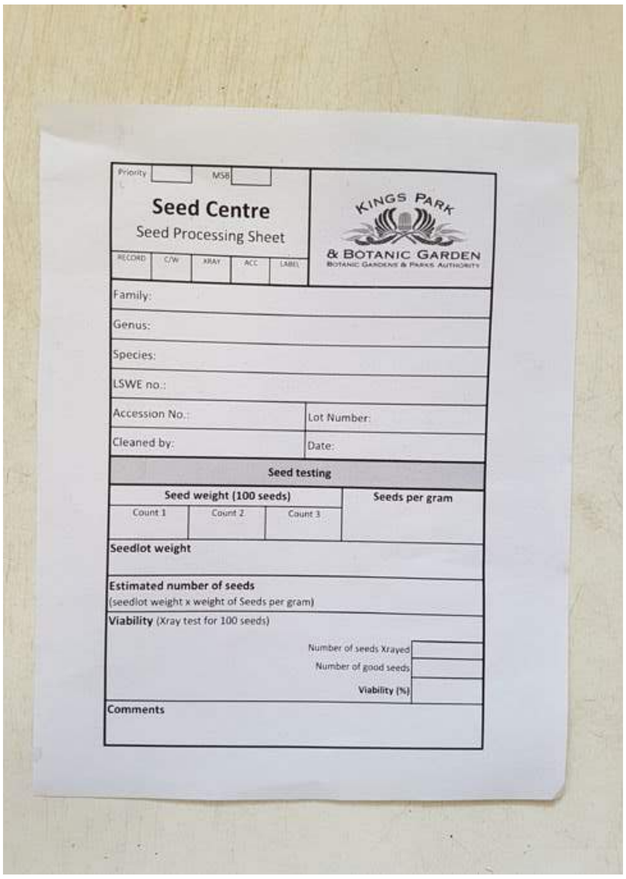

Figure 1. Templates to record seed collection (left) and seed processing (right) information. (Photos: L. Commander)

Electronic Record Keeping – Concepts and Design

The main advantage of electronic systems such as spreadsheets and databases (Figure 2) are that:

- data can be easily grouped, sorted, filtered and interrogated;
- formulas can be written to link data from other spreadsheets, databases and applications;
- data summaries and report templates can be created for automated reporting; and
- input restrictions can limit fields to a set list to avoid typographical errors and duplication, whilst speeding up data input.

Whilst the above can also be achieved with manual records, a computer can do all the hard work instantly, saving a lot of time.

In spreadsheet and database terminology the key definitions to remember are:

- field (i.e. column heading in a table); and
- record (i.e. a row in a table).

When designing a system, considering the following database theory will lead to a more user friendly and less error prone product:

- normalise the data;
- use multiple forms / tables to capture and group related data;
- use unique identifiers (often called primary keys) to relate records to other forms, tables, and records;
- use codes as shorthand; and
- create restricted value lists.

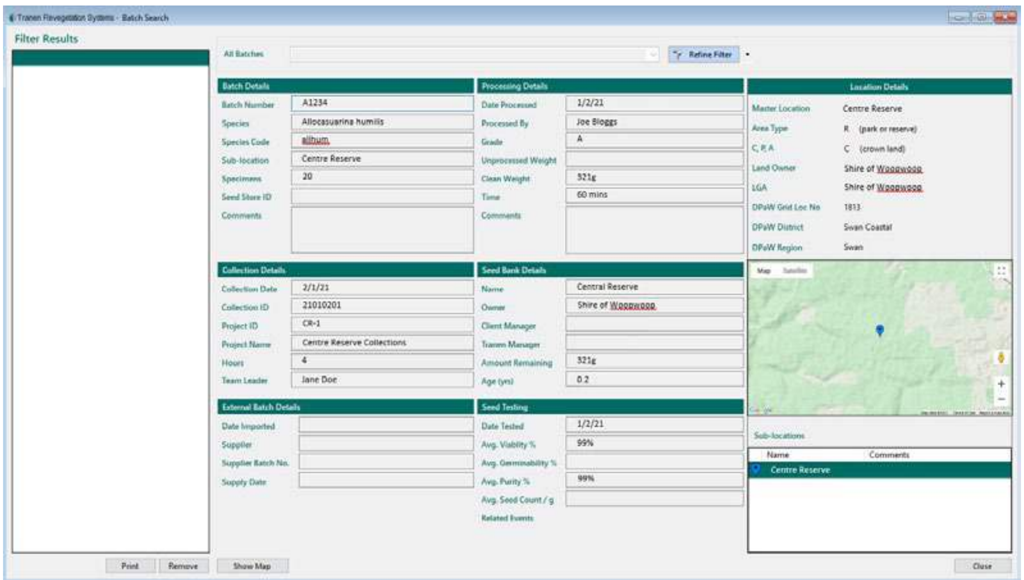

Figure 2. Example of a database to record seed collection, storage and testing details. (Photo: D. Grose)

Normalise the data

Data normalisation is the process of structuring records to reduce data redundancy and improve data integrity. The first step is to break data down as much as possible into single values. This assists with data grouping, searching, and using predictive text. For example, in Table 1 below there are two fields that could be broken down further: Genus species (into Genus and species) and Co-ordinates (into latitude, longitude, or northing and easting, and the datum). Genus species is more obvious, in that breaking it down to its individual component would allow the genus to be recognised separately from the species, whereas together it is just treated as a single value.

A point to make about co-ordinates is that mistakes are easy to make. Take extra care when recording the data and ensure that one coordinate system (decimal degrees, or Universal Transverse Mercator UTM) is used for consistency. It is also essential that the datum / Co-ordinate Reference System (CRS) is recorded with the co-ordinates, as there are many different systems in use, and without this information the data integrity is compromised. Datums include the Australian Geodetic Datum (ADG, AGD66, AGD84), the International Terrestrial Reference frame (ITRF), and the World Geodetic System 1984 (WGS84). See the Intergovernmental Committee on Surveying and Mapping website for more information on datums. Recording a 'plain language locality', in addition to the co-ordinates is important. Make the plain-language locality as detailed and site-specific as possible.

Table 1. Example batch information table – before normalisation

Seed lot #	Genus species	Common Name	Date Collected	Collected By	Location	Co-ordinates, datum/CRS	Site description	Plain language locality
111	*Anigozanthos manglesii*	Red and Green Kangaroo Paw	1/1/2020	Joe Bloggs	Kings Park	-31.9590518S, 115.8343078E, WGS84	Excellent condition Banksia woodland	Kings Park, 500 m along western fire trail from main gate, top of embankment

The second step is to consider having separate tables for different types of information, so that information doesn't need to be repeated, i.e. one table for all of the individual seed lots, another table for information about each species and another table for information about each collection location. For example, every species has a scientific name and any common name(s) are always going to be related to this scientific name. Therefore, asking people to type out the common name into the seed lot data table creates extra work. A second table, containing information for each species, which can be cross referenced using the species name (or a unique alphanumeric identifier), saves time and effort in terms of data entry. Similarly, the three location fields (location, co-ordinates, site description) could be separated into a different table. As long as a unique location identifier (name / number / code) is used to cross reference between the tables, and the coordinates and description of that site are recorded once, then that data does not need to be entered again. If the location identifier is recorded, the other information can be looked up again at any time. Extracting the species and location information into other tables has effectively cut the original eight fields down to five, reducing the workload by nearly 40%.

Use codes for shorthand

A coding system could be used to further simplify things for the data enterer. Scientific species names can be long and complex and are bound to be mis-spelled. Using a coding / shorthand system can reduce these errors. For example, a three-letter code for each of genus and species could reduce *Anigozanthos manglesii* from 21 keystrokes to six: animan. This is much less likely to attract spelling errors and is much less effort, whilst reducing the file size and increasing integration efficiencies. However, remember these need to be unique and there could be several species with the same code letters so there will need to be a way to separate them (e.g. include a number or additional letters).

Create restricted value lists

A final step to increase productivity and reduce error is to have a list of options that are restricted to a common set of values. Spreadsheet programs can be easily configured to only allow users to enter values from a dropdown list. This can eliminate typographical errors and spelling mistakes for those entering data. It also ensures the data integrity for later analysis and use.

Putting it all together

Taking the information in Table 1 and applying the principles above, results in Tables 2 and 3.

Table 2. Species Table

Species Code	Genus	Species	Common Name
animan	Anigozanthos	manglesii	Red and Green Kangaroo Paw

Table 3. Location Table

Location Code	Location Name	Co-ordinate Datum	X co-ordinate	Y co-ordinate	Site description	Plain language locality
KP	Kings Park	WGS84	115.8343078E	-31.9590518S	Excellent condition Banksia woodland	Kings Park, 500 m along western fire trail from main gate, top of embankment

So now instead of having to enter all the information in Table 1 for every single seed lot, it could instead by captured as shown in Table 4:

Table 4. New batch information table

Seed lot #	Species Code	Date Collected	Collected By	Location Code
111	animan	1/1/20	Joe Bloggs	KP

All the essential information is available for the seed lot by looking up the codes in the species and location tables. The difference being that once the information has been captured in the supporting tables only 26 characters are required to input the seed lot data in Table 4, instead of 135 in Table 1.

Deciding What to Record

What to record is really going to depend on the purpose, project goals, end user, amount of time available, and the relative value of that information. Each of the modules in this Florabank series explores the information relevant to that topic and suggests recommended attributes for which data should be recorded. Regardless, there are common themes / questions that should be considered no matter what the task or stage:

- Who – Who was involved? In what capacity? What is their experience / qualification? Who captured the data? Who was responsible for capturing and maintaining the records? Who is the licenced collector? What are the contact details of the collection site contact person?
- What – What was collected and how much? Was it identified by a botanist / experienced practitioner? What tasks were undertaken? What techniques were used (e.g. to harvest / process / test the seed)? Should more data be captured than immediately required for future use? What is the seed collection licence number?
- Where – Where was the seed sourced? What supporting geographical information should be gathered (i.e. landform, slope, aspect, nearby features, etc.)? Were the GPS co-ordinates captured? What is the accuracy of the GPS device (e.g., 5 m)? Were photos of the collected plant taken? Was the seed sent or used? What is the site tenure, who has the permits for site access?
- When – When did the work take place? Was it at the appropriate time of year? Was it a long time ago? Was the information captured at the time of collection or retrospectively?
- Why – Why gather the data, and does it influence what information will be recorded?
- How – How is the information going to be captured – manually or electronically? Will forms and templates be required? How is the information going to be stored?
- How much / many – How much data should be captured? How big is the source population / seed lot / sample size (for testing), etc.? What are the environmental / testing / storage conditions? How much confidence is there in the data?

The data captured should always consider the goals of the project as a minimum, to allow for monitoring of performance and outcomes. The data collected must be relevant and comparable to the established targets of the project, to determine whether they have been achieved. For instance, if one of the goals is to restore 30 species, then the number of species must be recorded. If a goal is to restore 40 trees per ha, then the tree density should be recorded. See Guideline 1 – Introduction for information about goal setting.

Figure 3 shows a flow chart of the life of a seed lot that will help inform the records that could be kept.

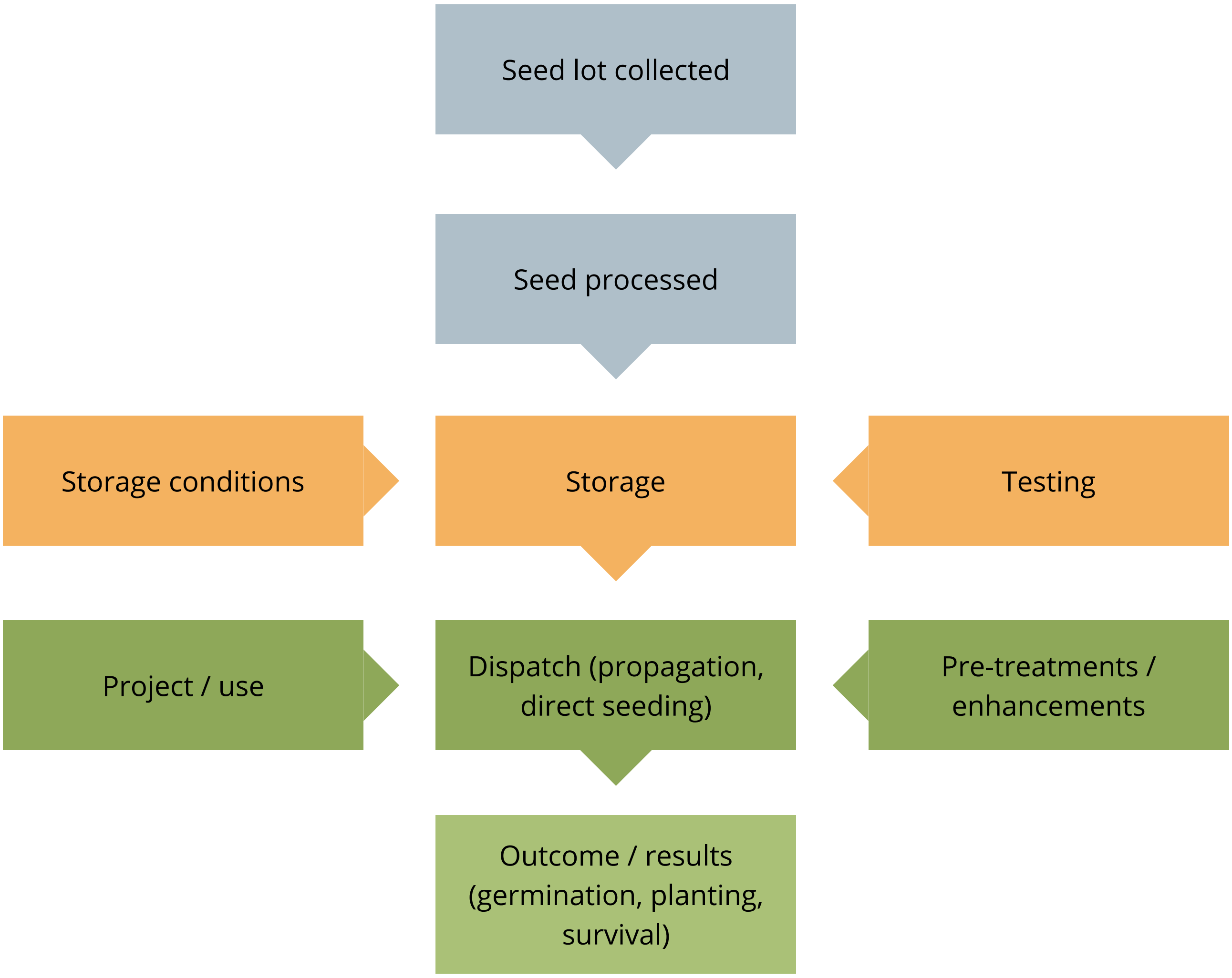

Figure 3. Flow chart of the life of a seed lot

Collation, Analysis, and Sharing

Sharing of information leads to larger datasets, allowing for more effective decision making. With advances in information and communication technology, it has become much simpler to analyse and share data across a wide range of platforms and organisations. Collation of data makes it much more powerful as larger datasets help to better inform decision makers, researchers, and practitioners.

The benefits of capturing data in electronic form become more apparent the larger the dataset. Inbuilt formulas and tools within spreadsheets can quickly and easily link, summarise, and analyse records. Pivot tables are a powerful tool that can summarise data quickly e.g. if you want to calculate the total weight of all seed lots of a species, count the number of seed lots of a species, or find the species and quantities available for a particular location. Vertical and horizontal lookups and cell reference formulas can be used to retrieve data from other tables and update a central table. An internet search for these terms will provide plenty of instructional websites and videos explaining how they work and what they are capable of.

In some instances, it is mandatory to keep records and provide them upon request, such as reporting to regulators under seed licence conditions. However, there are now several publicly available repositories for centralising biodiversity information, both mandatory and voluntary. One such example is the Atlas of Living Australia, which is a collaborative, digital, open access infrastructure that pulls together Australian biodiversity data from multiple sources, making it accessible and reusable. The ALA receives support from the Australian Government through the National Collaborative Research Infrastructure Strategy (NCRIS) and is hosted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Anyone can submit data to the platform, and it is regularly contributed to by Commonwealth, State and Local Government departments as well as corporate, not for profit, and private groups. To contribute to publicly available repositories, data must be collected and shared in a standard format.

Before sharing data, it is important to contemplate the ownership of the data to prevent loss of intellectual property and whether the data is sensitive or private. Data may be considered sensitive for reasons of conservation or biosecurity and could cause harm if made public (e.g. location information for endangered species which if known could put them under further threat). Information may be considered private (i.e. if it contains information regarding private property) or confidential if it is collected commercially, by a research institution, or on behalf of a third party. Intellectual property may belong to one or more stakeholders, including Traditional Owners (see Module 2 – Working with Indigenous Australians). In some cases, information can be released after an event, for example, a patent has been applied for, or publication in a peer-reviewed journal. Permission should be sought from all related parties before release so that no commercial arrangements or intellectual property agreements are jeopardised, or privacy laws inadvertently breached.

Technology

Over the last 20 years, technological advancements have put high-power computing within reach of all. Hardware costs have reduced, and most devices have inbuilt GPS making it easier than ever to capture data digitally. Cloud storage and mobile communications make information available to multiple stakeholders in real-time. Software advancements and availability make it easier to analyse and use data. A number of powerful software applications are either freeware or relatively inexpensive, opening up a range of options for even the most financially constrained organisations. This section explores some of the currently available options.

Hardware

At the time of writing, the majority of people in Australia have access to a smartphone. With the right choice of app, these resources can be converted into a readily accessible mobile work tool with no or minimal additional hardware cost and should be sufficient to satisfy the needs of many. Others may need to use more complex or customised solutions in which case laptops and tablets may be required (Figure 4). Most devices have inbuilt GPS capabilities, and for those that don't, external GPS units are becoming increasingly affordable.

Concerns about damage to equipment and power are easily addressed with accessories. Rugged protective cases are available for every type of device. Power banks now have the capacity to charge devices for several days, and for those working remotely for extended periods, personal solar or wind powered charging options are relatively cheap. Back-up systems can be put into place to ensure data is not lost.

Figure 4. Recoding data from seedlings on a tablet. (Photo: T. Bailey)

Barcodes (Figure 5) and QR codes (Figure 6) are an additional option for the capture and use of data External barcode scanners are available for most devices, although may not be necessary with the evolving use of inbuilt cameras to perform these functions.

Figure 5. Barcodes can be used on labels to link to records. (Photos: L. Commander)

Figure 6. QR codes can be used on labels to link to records. (Photo: D. Grose)

Software

Spreadsheets and databases make record keeping and the analysis and interpretation of large datasets simple. Systems can be set up so that even novice users can work with them with minimal training. Geographic Information Systems (GIS) can communicate with these data sources and present the data spatially if location coordinate information is captured. Tablet and smartphone applications bring this power to the individual, although sometimes this is limited to specific operating systems (i.e. iOS or Android).

Although many software programs are complex, there are generally free or low-cost versions available. Table 2 shows some of the commonly used currently available examples that may be useful. They are listed alphabetically and none of these are specifically endorsed, so users need to conduct their own research.

Table 2. Software programs

Type		Name	Platform	Free or Paid	Link and Commentary
Spreadsheets		Google Sheets	All	Free	https://www.google.com/sheets/about/ Web based and cloud stored
		Microsoft Excel	All	Paid	https://products.office.com/en-au/excel
		Numbers	iOS, macOS	Free on Apple devices	https://www.apple.com/au/numbers/
		OpenOffice Calc	Desktop only – Windows, MacOS, Linux	Free	http://www.openoffice.org/download/index.html Requires download of OpenOffice suite
Databases	*General*	LibreOffice Base	Desktop only – Windows, MacOS, Linux	Free	https://www.libreoffice.org/ Requires download of LibreOffice suite
		Microsoft Access	Windows only	Paid	https://products.office.com/en-au/access
	Purpose Specific	BG-BASE	Windows only	Paid	http://bg-base.com/ Database application designed to manage information on biological (primarily botanical) collections
		BRAHMS	Windows setup, browser-based access	Paid	https://herbaria.plants.ox.ac.uk/bol/ Database software for managing natural history collections, botanic gardens, seed banks, field surveys, taxonomic research and biogeographic study.
Geographic Information Systems		ArcGIS	All	Paid	https://www.esri.com/en-us/arcgis/about-arcgis/overview
		DivaGIS	Windows, Mac	Free	https://www.diva-gis.org/
		Fulcrum	iOS, Android		https://www.fulcrumapp.com/ Mobile customised form builder for spatial data collection, paid
		iGIS	iOS	Paid (limited free version)	https://www.geometryit.com/igis/ iPhone app for those with some GIS experience
		Quantum GIS	All except iOS	Free	https://www.qgis.org/en/site/ Free, open source
		R	Windows, MacOS, UNIX	Free	Software for statistical computing and graphics, can be used for analysis, mapping, and developing custom applications (e.g. Shiny apps) https://www.r-project.org/

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Online Resources

The following public datasets and papers may be useful resources for those wanting to add further value and information to their own datasets.

Atlas of Living Australia (ALA)
www.ala.org.au

Centre for Australian National Biodiversity Research (CANBR) and Australian National Botanic Garden (ANBG) databases
https://www.anbg.gov.au/cpbr/databases/

Intergovernmental Committee on Surveying and Mapping
https://www.icsm.gov.au/education/fundamentals-mapping/datums

Monitoring, Evaluation, Reporting and Improvement Tool (MERIT)
https://fieldcapture.ala.org.au/

Naturemap, mapping Western Australia's biodiversity
https://naturemap.dbca.wa.gov.au/

NSW BioNet database (NSW Department of Industry, Planning & Environment)
http://www.bionet.nsw.gov.au/

NSW Saving our Species database
https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/saving-our-species-program/saving-our-species-database

Pedrini S, Dixon KW (2020) International principles and standards for native seeds in ecological restoration. *Restoration Ecology* 28(S3), S286-S303
https://onlinelibrary.wiley.com/doi/10.1111/rec.13155

Royal Botanic Gardens, Kew – Seed Information Database (SID)
https://data.kew.org/sid/

Royal Tasmanian Botanic Gardens, germination database
https://gardens.rtbg.tas.gov.au/conservation/tsccgerminationdatabase/

Seeds of South Australia
https://spapps.environment.sa.gov.au/seedsofsa/