



Report developed by the ANPC Healthy Seeds Project, funded by  
the NSW Environmental Trust



# Healthy Seeds Roadmap

A strategic plan to improve native seed supply  
for ecological restoration in NSW

(Final - endorsed)

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*"...that game (PLANTS), to be successfully conserved, must be positively produced, rather than being negatively protected. ...we have learned that game (PLANTS) is a crop, which nature will grow and grow abundantly, provided only we furnish the seed and a suitable environment."*

**Aldo Leopold**

Aldo Leopold (1887 – 1948) was a leading American ecologist, conservationist and author. A founder of the science of wildlife management, he was also a pioneer in restoration ecology, restoring 80 acres of his own land in central Wisconsin. He was instrumental in establishing the US Forestry and Federal lands management, restoration, and current seeding and reintroduction regimes across the continent.

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Please be advised that the recommendations presented in this document do not necessarily represent the views of the agencies / organisations in which the consortium members are employed.

# Preface

This report aims to improve the NSW native seed sector by providing a series of recommendations.

The structure of the report is as follows:

- Executive summary
- Introduction to the project
- New South Wales Seed Sector Survey
- A summary table of the barriers identified in the survey, their implications and opportunities to address them (Table 2)
- The Roadmap – proposed sector interventions using evidence from the New South Wales Seed Sector Survey, the Seed Production Area Audit, and the Australian Native Seed Survey Report.

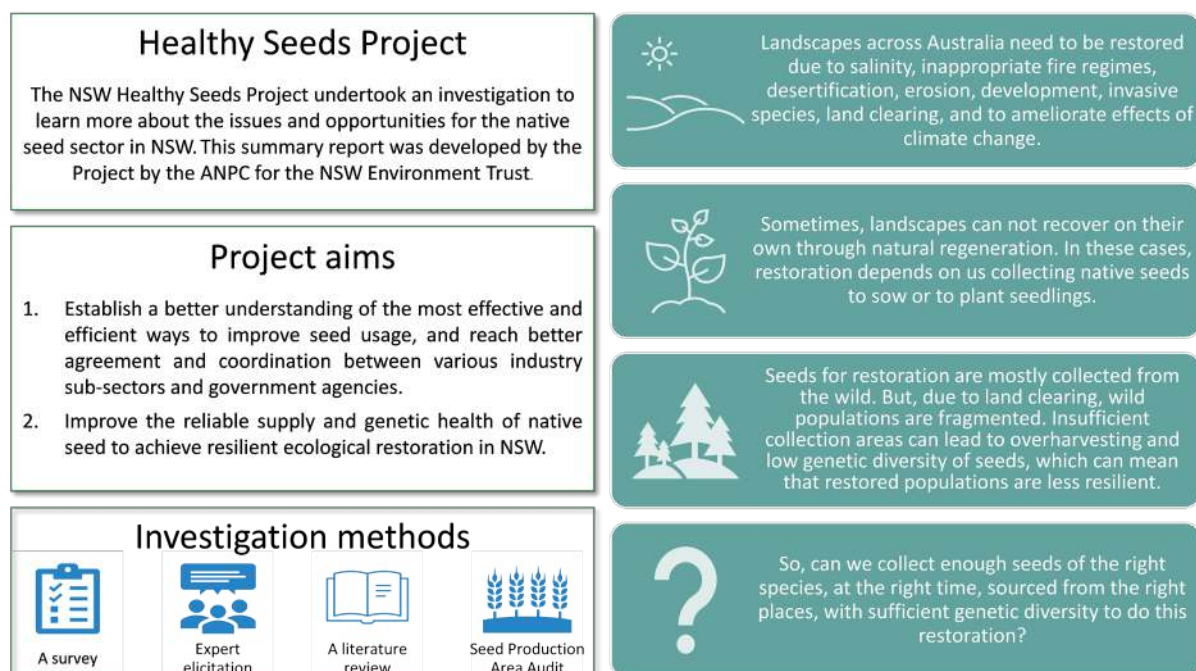
Ultimately, by improving the native seed sector, the report authors aspire to more efficient and better-quality ecological restoration, which will provide benefits to flora and fauna, ecosystem services, economic returns, carbon capture and storage, resilience to extreme climatic events, employment opportunities, and contribute to Australia's international commitments.



# Executive Summary

## HEALTHY SEEDS PROJECT: ROADMAP SUMMARY

A STRATEGIC PLAN TO IMPROVE NATIVE SEED SUPPLY FOR ECOLOGICAL RESTORATION IN NSW



## THE INVESTIGATION FOUND

### Supply and demand characteristics



### Main supply barriers



## RECOMMENDATIONS TO OVERCOME BARRIERS



### 1. Co-ordination

Co-ordinate seed supply and demand, plan restoration, identify infrastructure and seed production needs, provide training, and communicate research needs and outcomes at state and regional levels.



### 2. Licencing & Record Keeping

Ensure that licencing systems are more efficient, effective, useful and fit for purpose; licence applications have clear instructions, and achieve the aim of preventing over-harvesting and having a net positive environmental impact. Adopt and implement minimum standards for seed collection (including data collection) and use these to underpin regulatory approvals. Use appropriate record keeping systems and provide data to the buyer to improve transparency in seed quality.



### 3. Project management

Restoration projects and funding models must take into consideration the logistics of the seed supply chain, the time required for seed sourcing, propagation (if needed), implementation and monitoring, as well as the variability of climate from year to year. In some cases, this may mean project budgets and grant timelines should be extended from one year to five or more years.



### 4. Restoration planning

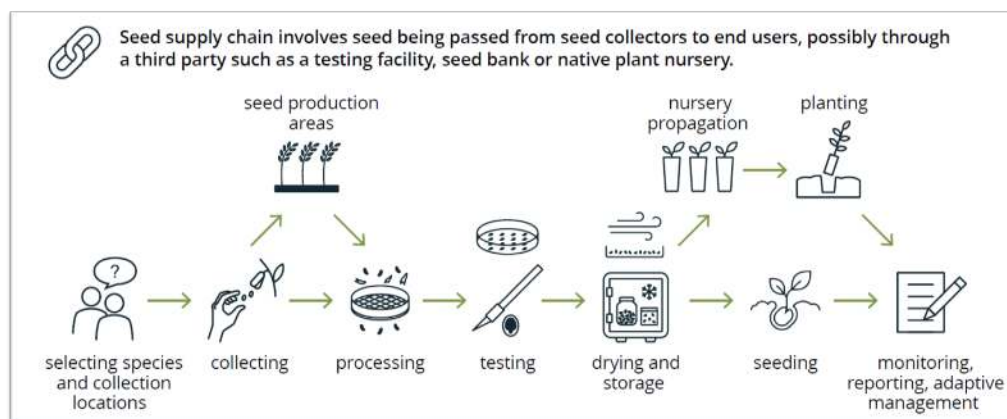
Co-ordinate and plan areas to be restored and seed requirements at a regional level to strategically plan resource allocation and forecast seed requirements. Assist restoration planning and inform seed collection requirements by developing vegetation guides for each region. Identify existing regional infrastructure (e.g. seed stores, seed production areas), and determine infrastructure requirements.



### 5. Training

Initiate and implement a sector-wide training program in seed literacy to improve restoration community capacity.

## HOW THESE RECOMMENDATIONS WILL HELP SEED SUPPLY



Selecting species and locations	Collecting	Seed production areas	Testing	Processing & Storage	Entire supply chain
Funding timelines to allow for collection of sufficient seeds from the required species and the ideal locations. (R3)	Regional coordination and allocation of field collections. (R1)  Standardised record keeping. Provision of data to buyer. (R2)  Efficient and effective seed collection licencing systems. (R2)	Regional coordination of species needs for seed production. (R1)  Investment in regional seed production areas. (R4)	Standardised record keeping. Provision of data to buyer. (R2)	Identify current seed processing and storage infrastructure capacity, and future needs and gaps. (R4)	Seed literacy training to assist seed purchasers, project funders, regulators, users and sector participants. (R5)

Specific suggestions along seed supply chain linked to recommendation number (previous page)



# Background

This document summarises the findings from the Healthy Seed Project which includes the NSW seed sector survey and the Seed Production Area audit. The survey identified a wide range of interacting concerns and potential solutions to support the native seed sector in NSW (and beyond).

To address the issues raised in the survey, this document outlines a proposed Roadmap with intervention options. It draws on the feedback of active participants in the native seed and restoration sectors, government agency staff and those with research or academic interests.

The report also provides a background history of the more recent development and evolution of the native seed sector in NSW. There has been significant collaboration and alignment with the similarly focused objectives of Greening Australia's National Project Phoenix.

## Main findings

The NSW seed sector survey found that most of the seed for restoration is sourced from wild populations, which is currently insufficient to meet the demand for seed for a range of species, in sufficient quantities, from appropriate geographic locations, with sufficient genetic diversity, and in a sustainable manner. These shortcomings may result in inadequate or poor quality ecological restoration, as well as organisations not being able to fulfil their environmental obligations.

The seed sector in both NSW and Australia is made up of a fragmented and ad hoc group of individuals and businesses and lacks an industry body or any form of co-ordination. Seven main barriers to the sustainability of the native seed sector were identified.

## Summary of recommendations

Interventions to overcome these barriers have been proposed, and these interventions form the basis of the Roadmap. The barriers are inter-related, so, by developing wholistic interventions, several barriers can be addressed with a single intervention. Hence, this Roadmap is an action plan for these interventions, each of which address multiple barriers. The interventions are grouped into five main categories: co-ordination, model system and licencing, funding, restoration planning, and training.

# Introduction

Extensive research has been undertaken and a great deal written about the decline of our natural environment, and an ever-increasing litany of environmental disasters, in Australia and across the world. Native vegetation loss is at the core of many of declines. To reverse and address these issues, restoring native vegetation is key. While natural regeneration can harness the existing soil seed bank or seed dispersal, this technique is limited in its application when levels of degradation are high. In this case, reintroduction or reinforcement through planting, is needed. This restoration approach requires propagules, usually seeds or cuttings. Hence, native seed is often needed for restoration of plant communities in bushland, agricultural land, riparian zones, coastal areas, mine sites, offsets, urban areas and roadsides. Seed can be planted directly in the ground or grown into seedlings in a nursery. As the demand for restoration increases to address environmental issues, so does the demand for native seed. However, while the demand for native seed is increasing, the seed supply is diminishing, due to the decreasing areas of native vegetation.

## Project background

The need for the Healthy Seeds Project (HSP) grew from an increasing anecdotal awareness by those in the native seed sector that all was not well, and that change is required (Appendix 1). There have been stories of formerly successful seed businesses or seedbanks struggling to survive, and projects failing or falling short of expectations due to limited seed availability. Additionally, experienced seed collectors are worried about what seems to be an ever-diminishing supply of seed from some species in the wild and the impact of droughts and unseasonal weather.

To explore and discuss such concerns, the Australian Network for Plant Conservation (ANPC) held a workshop focused on the native seed sector as part of its 2016 national biannual conference in Melbourne in 2016. This workshop categorized and prioritised the barriers identified by attendees. It also established a commitment by ANPC to initiate a National Native Seed Survey (reported in Hancock *et al.* 2020). Sector concerns were then discussed in 'The NSW State Seed Roundtable' which led to the NSW Healthy Seeds Project.

The targeted objectives of the Healthy Seeds Project are to:

- Publish the results of the Australian National Native Seed Survey
- Commission an update of the national Florabank Guidelines
- Conduct an audit of native seed supplies in NSW and existing Seed Production Area (SPA) systems
- Identify and investigate barriers and opportunities to native seed supply in NSW and produce an 'Investigations Report'
- Produce a 'Sector Roadmap' to assist and guide interventions that might improve native seed supply in NSW.

## Aims of the investigations report and sector roadmap

Key report aims are to:

- i. Establish a better understanding of the most effective and efficient interventions,
- ii. Reach better agreement and co-ordination between various industry sub-sectors and government agencies, to improve the reliable supply and genetic health of native seed to achieve resilient ecological restoration in NSW (Figure 1).

The information for the report was gathered from a survey and expert elicitation - the NSW Seed Sector Audit. This survey of key stakeholders investigated the seed sector make up, seed supply and demand. The survey identified several barriers which are grouped into seven themes. The responses from the survey, along with information from a literature review and an audit of Seed Production Areas in NSW (Appendix 7. Seed Production Area Audit) were then used to develop a series of recommendations to make improvements to the seed sector.

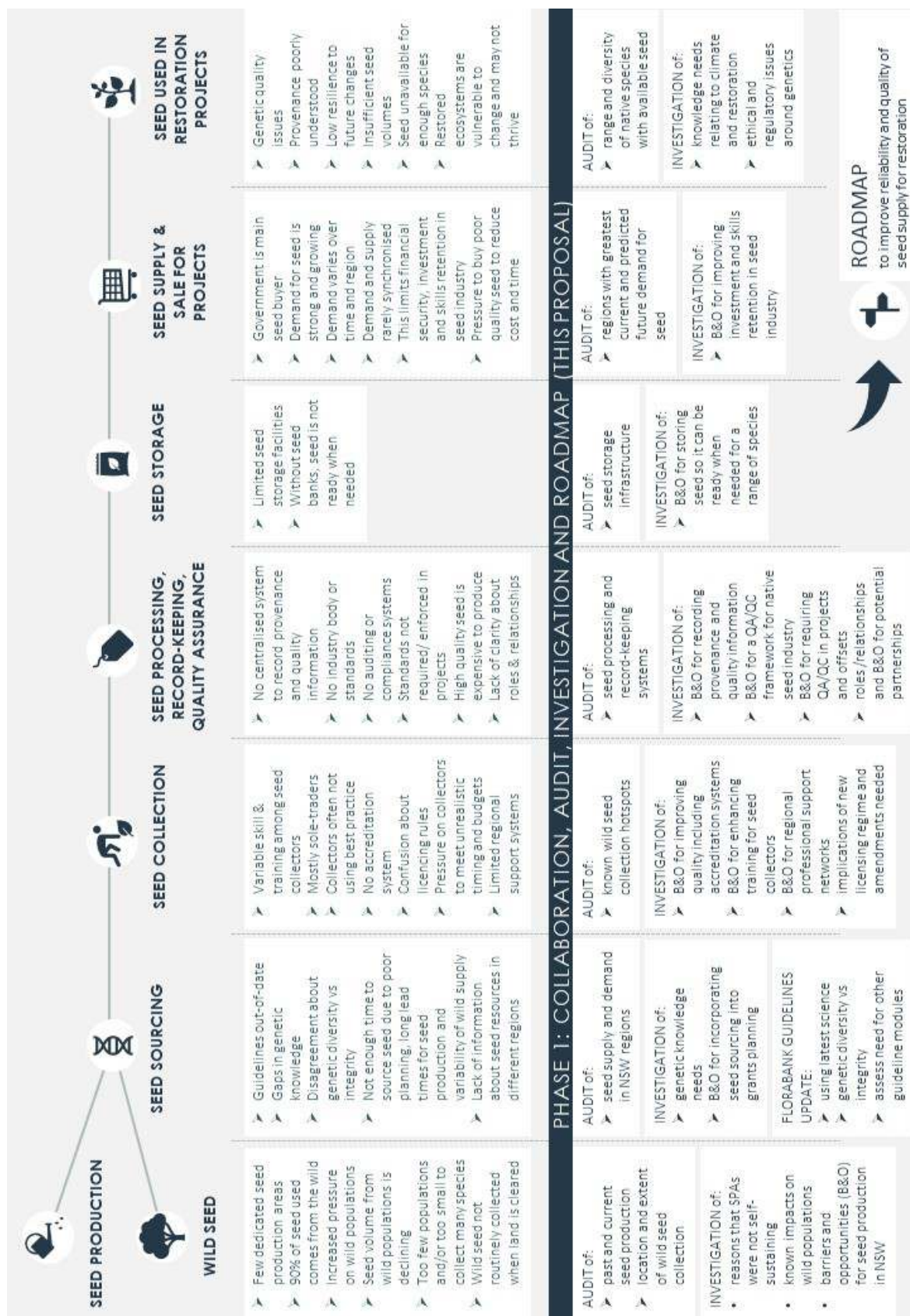


Figure 1. Seed sector issues and the aims of Healthy Seeds Phase 1 (Source: Healthy Seeds Business Plan).

# New South Wales Seed Sector Survey

## Methods

The process of determining the current status of the NSW native seed sector involved a survey and expert elicitation. This combined several different approaches and multiple lines of enquiry. Firstly, it involved interviewing those known networks of past and current seed coordinators and operators and tracking down their own additional seed supply contacts for interview. Second, the Healthy Seeds consortium called for expressions of interest call to current native seed license holders in NSW and their collector networks. And thirdly, there was an internal Local Land Services (LLS) call to track down staff involved in native vegetation restoration project implementation, funding programs and seed supply. This also involved the identification of past and current Seed Production Areas (SPAs) and their current production status. The interview process involved an email survey (see Appendix 2. Seed Survey Questions) and phone interviews to establish the status of their enterprise and the perceived barriers and opportunities of the native seed industry in their area in NSW (Table 3). Note that not all interviewees were required to answer all the questions, as not all were seed suppliers and hence did not have data on seed collections. Cross-referencing of contacts was also undertaken to eliminate duplication of reporting.

## Results

The results are reported in four sections: a description of the survey participants (sector make up), data on seed supply, data on seed demand, and qualitative information on sector issues (barriers and opportunities) which have been aggregated by theme.

### Seed sector make up

#### *Seed Industry participation*

- Primary contact and survey of 25 seed collectors, seed suppliers, merchants and seedbanks and 12 separate regional Local Land Services (LLS) staff surveys were completed.
- These entities account for c. 244 individual staff.

The NSW native seed sector is comprised of a fragmented and ad hoc group of individuals and businesses representing growers, suppliers, casual collectors, nursery collectors, landcare, community and Natural Resource Management (NRM) groups and primary users spanning a wide range of private land managers, government agencies, mining companies and other users of native seed.

A key finding established in this study was that there is no formal or informal single point of reference or data on native seed supply or demand, nor any one point of co-ordination in NSW.



## Seed supply

### *Quantities of seed collected*

Data was compiled from collectors of native plant seed collected across NSW either as their average annual collection or over the most recent twelve months period. This was over a year which was generally described as being a very low seed production and harvest year after a successive seasons of reduced yield. While there was universal agreement that seed supplies had diminished over a considerable period of time, 84% of respondents indicated that supply was down by 40-90%, and that this decline could be attributed to previous low collection demand/reduced funding, gradual reduction of the total amount of quality and health of native vegetation, disturbance, clearing, declining rainfall, drought, climate changes, or ill-timing of significant climatic events (frost, heatwaves, wind/ storms, rain, fire).

Over a 12 month period c. 94,547 kg of native seed collection was reported.

Some major seed merchants declined to provide seed collection data, possibly for commercial reasons.

There may be more than 100 additional other collectors that operate below the level of operation targeted in this study and hence no data is included at this level.

### Quantities collected under licence

- From information supplied, a maximum of c. 1,900 kg of seed was collected under a current NSW seed licence.
- Most collectors surveyed, that held a seed licence, noted very small annual collections (c. 5 kg) or reported that a significant proportion of collection may not be covered by the licence.
- At least five reported that their licences have lapsed, and they have been waiting for renewals for longer than eight months. Many reported that they were unsure of their licencing status, or that they depended on the licences of contractors or operated under the licences of others.

### *Where is seed collected and how much is produced?*

#### Wild collection

- Most seed reported by respondents was collected from wild populations on public land (60,114 kg or 63%) and roadside areas (19,963 kg or 21%).
- A much lower quantity (1,670 kg; c 1%) was reported to be collected from wild populations on private land and 8,747 kg (c 9%) from plantings (not SPAs) on private land.

The breakdown of reported distance range of collections was fairly evenly spread with:

- 12% reporting local collections
- 24% regional collections
- 24% catchment collections

- 20% multi-catchment collections
- 12% state-wide collections
- 12% interstate collections

#### Seed Production Areas (SPAs)

- Only 219.1 kg (0.2%) was derived from SPAs in the 2019-2020 seed season.
- While only a small proportion of seed was secured from SPAs, according to this survey, it can often form a significant proportion of the supply in some regions. In the Murray region, seed sourced from SPAs can range from 9% to c. 60% of total seed supplied per annum.
- In the reporting year, Murrumbidgee LLS collected just 260kg of seed due to low demand but in some years SPAs are capable of producing up to 1 tonne of seed.
- In total only c. 33 productive SPAs were identified in production across NSW.
- The audit of seed production found little evidence of ongoing SPA capacity servicing the NSW restoration sector. The survey showed 14 perennial shrub SPAs are operational across Murrumbidgee LLS (down from a total of 59 previously established); two of five SPAs surviving in the Central Tablelands; in addition to SPAs operated by Greening Australia in the ACT and Greater Sydney (see Appendix 7 Seed Production Area audit).

#### *Who is purchasing seed in NSW and how much is being purchased?*

- The majority (c. 80%) of seed suppliers nominated Local Land Services / Landcare / nurseries as their primary clients. The remaining c.20% of suppliers nominated the mining sector as their main customers which accounted for c. 59% of the total seed being collected and sold.
- Of the c. 94,547 kg native seed reviewed by this project only 3,609 kg (c. 4%) was specifically nominated for NRM/ restoration projects.
- Most seed demand is for mining and commercial offset and potentially, export markets. Between 56,136 kg (c. 59%) and 88,136 kg (c. 93%) of native seed was nominated as allocated to mining offsets or primarily to mining contract and commercial trade (export) projects.
- Companies supplying seeds to mining companies tended to operate under contracted arrangements rather than supplying opportunistically collected seeds. They tended to supply grasses and forbs to mining clients.

In terms of the quantities of seed being purchased by each market:

- The majority of the seed by quantity is reported to be going to the mining sector (53,538 kg or 56%).
- The horticultural/ export was identified as a likely target market for c. 32,000 kg of seed.
- Only 8,402 kg is accounted for as being directed to LLS/landcare/community/nurseries combined.

#### *What is being collected across NSW*

- Most of the seeds collected (by weight) were grasses (25,047 kg), shrubs (13,723 kg) and trees (13,684 kg), with a smaller amount of forbs (5,595 kg).
- In terms of species diversity, most collectors (c70%) targeted fewer than 30 key species, whereas 16% of collectors (all mining focused) targeted more than 30 species but less than 100. Only 12% of collectors (primarily seed traders and exporters) targeting greater than 100 species.
- All respondents indicated that current seed collection supplies (2019-20) are down by 40-80% due to a run of drought years, reduced demand, reduced funding and reduced areas of native vegetation (as a result of clearing and disturbance).
- Virtually the entire grass harvest was allocated to mining offset projects.

### *Seed storage conditions*

In terms of seed storage:

- 19% of respondents have full humidity controlled refrigerated seed storage capacity.
- 14% have refrigerated seed storage (without humidity control).
- 43% have secure unrefrigerated storage or shipping containers.
- 24% store seeds in bottles or sealed containers in sheds or housing.

### *Seed testing*

The majority (72%) of respondents indicated that they had no capability to execute any in-house seed quality testing and that there would need to be some sort of regional or local service available to make it practically feasible. They indicated they may consider outsourcing such tests for large orders or if testing was paid for. Most saw the costs of seed testing as prohibitive at current scales and prices.

Twenty-four percent indicated that they had the capability to do germination testing and four percent indicated a viability testing capability. Testing was not regularly requested or provided.

### *Seed sourcing*

- It was noted that many seed supply arrangements do not require the provision or supply of seed source data beyond species and weight.
- Respondents noted that some seed being used in NSW was sourced from Queensland, Victoria and other states, and that some seed collected in NSW was being used in other states.

### *Record keeping*

- Of the 25 respondents interviewed, seven indicated that they used a computer-based seed database tracking and interrogation system for record keeping (Table 1). Three of these operated modified versions of the same integrated seed management tracking system developed for the Murray Seedbank. A further six indicated they keep simple spreadsheet seed tracking systems. Seven maintained paper-based field collection sheet records and five maintained limited or no seed record systems.
- Of the 12 regional LLS and government agencies using and tracking seed use, c.33% use a database, c. 42% use a spreadsheet and c. 25% maintain no records.

**Table 1.** Number of respondents using each type of record keeping system

Record keeping system	Number of respondents	Percentage of total
Computerised database (full seed management and tracking)	7	28%
Computerised spreadsheet (minimal seed data and no tracking ability)	6	24%
Field Collection data sheet records (paper)	7	28%
Limited or no seed record systems	5	20%

There is no centralised amalgamated data on species collected, source location, amount collected or final allocated use and location held in NSW. None of those surveyed provided any data on storage conditions, storage life and any applied seed treatments either pre- or post- storage as a matter of course. In fact, none stated that they have any regular requests for the information as part of any seed supply contracts or sales. All suppliers indicated that if additional seed quality information was required by purchasers that some limited and variable capability was available. Every contact also agreed that if additional seed quality data was required it would have to be supplied with a commensurate service charge and would require considerably more lead time to sample and document this information.

## Seed demand

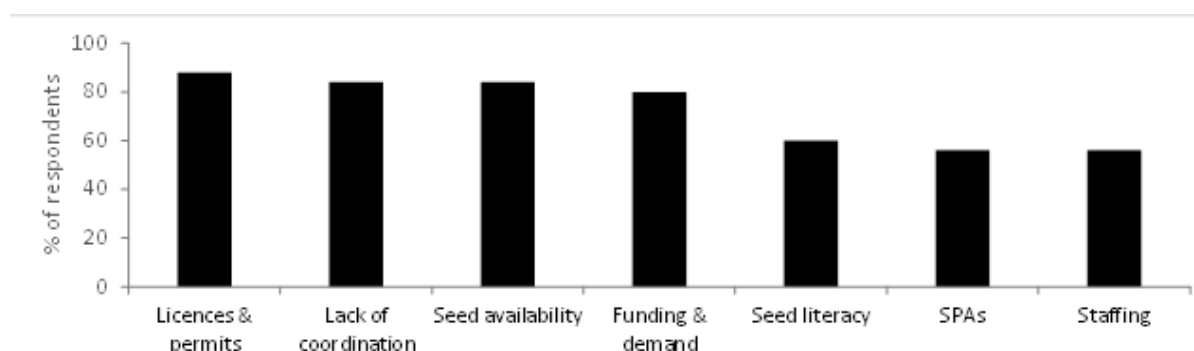
The following qualitative data has been assembled from interviews with personal contacts, participation in project planning and project meetings and state and regional level committee participation. It can only be considered indicative of the quantum of areas flagged and funded for native vegetation restoration and native seed required to meet this objective in NSW. In no way is it considered exhaustive or easily verifiable.

Preliminary investigation and personal contacts within at least seven NSW and Commonwealth agencies have identified that at the time of this survey (2019), there is in excess of 132,000 ha of rehabilitation or offset projects that will require native seed input within one to ten years across NSW. This is in addition to any community NRM restoration projects that may emerge over this period. There are no current data projections of this seed demand.

## Barriers and opportunities

Survey participants were invited to give their perceptions of what they identified as the key barriers and opportunities to the sustainability of seed and seed supply systems in their part of the native seed sector, in their geographic area of operation. While the survey was not exhaustive or able to cover the entire spectrum of the seed sector, the information provided through expert elicitation may assist in understanding the state of the sector.

The responses have been grouped here into seven key themes, and there is a high degree of overlap across themes (Figure 2). For instance, although co-ordination and funding are both key themes, they are also cited within other themes.



**Figure 2.** Most frequent seed sector barriers cited by survey respondents; licences and permits, lack of co-ordination, seed availability, seed literacy, SPAs and staffing.

### 1. Seed licences and permits

(cited by c. 88% of participants)

Those surveyed would like:

- Clearly defined processes and timely licence renewals.
- Better clarity of licence conditions, including which species and communities are included (regional support systems).
- Less complex and more useful reporting.
- Clear and realistic species lists to supply for offsets.
- Clarity between 'commercial' and 'scientific' licences.



Less than one percent (1%) of seed collectors surveyed had collected seed under a valid NSW seed collection licence. The reasons given were varied but in increasing order of reporting were:

- Licence process was perceived as unduly arduous for the small amount of seed (or a council permit was sought instead).
- Licences had been applied for but had not been issued (in some cases the delays were reported as across two collection seasons) so collections proceeded on the basis that the licence would be forthcoming.
- Applicants expressed they couldn't get clear responses on a process for particular species or vegetation communities.
- Both the application and reporting processes were perceived as difficult and time consuming and had no clear benefits in providing data.
- Applicants did not see the purpose in providing reporting data because it was perceived that the data was not collated and used nor was it available to enable future regional seed planning and supply.

## *2. Lack of co-ordination*

(cited by c. 84% of participants)

Survey participants would like to see:

- State and regional co-ordination of restoration projects.
- Forward planning of seed requirements and funding allocations for restoration project collections.
- Consistent and realistic species lists for each vegetation community (regional vegetation guides).

## *3. Decline in seed availability*

(cited by c. 84% of participants)

- Respondents reported 40% decline in seed availability in the season surveyed.
- Erratic and declining rainfall and increase in extreme/ unseasonal events.
- Reduced and declining areas of native vegetation (clearing, fires, incremental loss).
- Vegetation health decline- lower seed yields.
- Decreased areas of land access.

## *4. Funding variability*

(cited by c. 80% of participants)

Respondents noted:

- Decrease in NRM funding resulting in a reduction in restoration projects.
- Reduced seed demand for projects through drought and reduced project funding.

- Project delivery is unpredictable and currently precludes ability to carry large seed storage stock.
- Lack of regional project co-ordination and development.
- Inability to retain skilled and experienced staff and effect succession planning.
- Enterprise vulnerability in not being able to risk funding on opportunistic collections.

#### *5. Seed purchasers lack of knowledge in seed sourcing requirements*

(cited by c. 60% of participants)

Respondents would like:

- Training in which species are suitable for revegetation and appropriate methods and quantities.
- Increase in regional vegetation guides and restoration species lists specific to landforms profiles and areas.
- Regional vegetation reference lists and guides to also provide guidance for seed collection.
- Information on seeding rates, and therefore number/weight of seeds required for different species and different seeding techniques, and seedling production.
- Understanding of seed location sourcing implications, seed quality, tracking and data management and monitoring.

#### *6. Failure to invest in opportunistic seed collection and SPAs*

(cited by c. 56% of participants)

Respondents noted:

- Opportunistic seed collection is financially risky because collectors do not know if the seeds will be purchased. Also, they will not receive funds up front as they do not receive payment until seeds are purchased.
- Developing seed production areas is financially risky, because of the long time-frame for set up and several years of growth before seed set. Species need to be selected in advance so there needs to be clients identified who will purchase those species.
- There is a need for investment in infrastructure, technology and practice.
- Lack of investment is mainly due to variable funding and short-term projects.

#### *7. Inability to attract, train and retain staff*

(cited by c. 56% of participants)

Inconsistent funding and temporary contracts lead to difficulties with business planning. Also, government agencies, companies and individuals cannot provide long-term employment, leading to short-term positions, lack of support, training and career pathways, and ultimately poor skills retention and succession planning.

## Discussion

This project surveyed 37 organisations or business entities that represent over 200 individuals from across NSW who collect, buy, sell or use native seed. They have provided feedback on the issues that affect the seed sector and suggested a range of interventions to improve seed supply and operations for restoration in NSW. The main themes arising from the survey were licencing, co-ordination, availability, funding, knowledge, investment risk and staffing. Information has been gathered to help inform a Roadmap for further consultation with stakeholders.

As already identified in the national native seed survey report (Hancock *et al.* 2020) the native seed sector is a critical component of ecological restoration in Australia and both face challenges due to the continued loss and fragmentation of native vegetation, low levels of restoration funding and the impacts of climate change. The four highest priority concerns identified from that survey were reiterated in this survey and often overlap with what are seen as the principal barriers that require intervention to advance the native seed sector in NSW.

These issues remain as:

- Future demand for seed will be difficult to meet from wild harvest.
- The market is unwilling to pay for the true cost of seed collection/seed production.
- There is a lack of seed available from a broad range of species.
- Demand for seed is inconsistent and/or unpredictable.

It is now time to document a way forward to overcome these barriers and embrace the opportunities for improvement.

### Seed sector participants

The NSW seed sector is a fragmented group of individuals, businesses and organisations, without co-ordination or an industry body. Campbell *et al.* (2017) has well-documented the rise, innovation and impressive outcomes of the wider restoration sector over four decades from the 1980s. They have also noted the more recent fragmentation and gradual decline of the sector and outlined that it is regionally confined and at risk of not learning from past programs.

To improve cohesion, structure and co-ordination in the sector, changes are needed (Appendix 3). An industry body and state and regional co-ordinations could help bring the sector together. Training programs to educate all those interacting with the sector (including funding and policy) with a comprehensive understanding of the entire native seed supply chain would improve sector capacity and provide visibility for all operators in the supply chain.

### Seed supply

The main implications of the seed supply findings are:

- Annual seed collection quantity was higher than found in Hancock *et al.* (2020).
- Seed supply quantity seems to be disproportionately requested for offset rather than conservation projects. Future offset demands appear to be significant (c. 132,000 ha). Future demand for or planning for restoration and conservation projects is unknown and currently unable to be quantified.

- Wild populations on public land and roadsides are the major source of seed, and anecdotal reports suggest that continual seed removal may limit recruitment to wild populations, particularly during drought or with significant environmental impacts of fires etc.
- The initial source of the seeds used for revegetation may or may not be known and recorded. Unless comprehensive and well maintained data on seed source exists, there is a risk that non-local species and non-local genotypes are and will continue to be used. In those cases, it may not be appropriate to collect from revegetated areas.
- There is a poor understanding of seed supply constraints, sector requirements and timelines. "Seed literacy" is generally poor, especially on the demand side. Lack of clear and available information and technical support on species, species applicability/availability and practice often results in high levels of seed wastage, inefficient use of time and resources. This can often lead to frustration and financial burdens for suppliers and potential misunderstandings and contract failures as well as poor project performance and outcomes.
- The recent extended drought and fires have only served to further highlight the risks in lack of native seed available for large scale restoration works.
- Within the Murray LLS Seedbank, opportunistic seed harvest from SPAs for longer-term seed storage is also precluded and artificially constrained by net cost of service accounting procedures that limit the amount (and value) of seed that can be kept in stock (Appendix 4). Anecdotal evidence suggests that the NSW NRM sector tends to purchase seed that has already been collected, rather than planning their seed requirements in advance and pre-ordering or commissioning a collection. This type of purchasing is often due to short-term funding cycles, meaning that seed needs to be purchased immediately for projects instead of having the ability to plan several years in advance. The consequence of short-term funding cycles which do not align with seed collection seasons, and purchasing seed already collected, is that buyers may not be able to purchase the species and quantities that they require. An inability to purchase species/quantities can then sometimes lead to inappropriate provenance or species sourcing or in a much-reduced range and diversity of species. In contrast, the mining sector, (especially larger companies and those doing progressive restoration but perhaps not those doing offsets), tends to commission seed collection of particular species in specific locations. The increased planning for collection is in part due to Government mining licence permits which require demonstration of longer-term restoration planning and multi-year budgets.

*Where is seed collected and how much is produced?*

## **Wild collection**

Climatic and seasonal issues, and cited loss of vegetation or vegetation decline have resulted in declining seed harvest opportunities it is clearly apparent that in the NRM sector the key driver reducing harvests have been reduction in core project funding and project delivery. The demand for seed for mining reclamation has not declined and there is some evidence that it may be increasing for grass species.

The role of regional co-ordination in collating, distributing and allocating seed collection targets, collection locations and access would be valuable in initially balancing seed requirements with availability based on available planned funding. It would also assist in identifying seed shortages and target species for SPA establishment and networking between regions and collectors to balance regional seed constraints.

## SPAs

While regional SPA networks are acknowledged as a way to sustainably meet seed demand, the survey found that SPAs were in decline. SPA development was also seen as a prohibitively risky strategy, financially, to most individuals, groups and entities involved in seed supply and projects because of the large upfront investment of resources and absence of long-term supply contracts. It was felt that the only way this could proceed was if SPAs were funded, the price of seed was considerably increased and secure contracts were available to cover the long-term investment, or a regionally coordinated SPA supply system was established with attributed responsibility and agreements. This also assumes that investment in restoration and revegetation will be both consistent and sustained so that there is a return on investment in the SPAs, i.e., the seeds produced will be purchased.

Within the mining / offsets sector, there is an equally high acknowledgement by the contractors that the establishment of SPAs would alleviate a lot of concerns about seed security, diversity, sustainability and medium-term cost issues, particularly for shrubs, forbs and grasses. Hence, there is an opportunity for establishing SPAs to deliver seeds for mining and offsets. Synergistically, if SPAs were set up for clients seeking long-term seed supply, they would also benefit the regional landcare and NRM sector, as seed supply and quality is increased. To achieve investment in SPAs from the mining / offset sector, it is likely that stakeholder consultation and raising awareness of the benefits of SPAs would be required.

## How much

In terms of the quantities of seed collected for different types of projects, the local collections were very small and dedicated to specific species or projects and increased in quantities as the collection area increased. Catchment-wide targets were predominantly LLS based or targeted projects while wider coverage collections were predominantly mining focused or aggregated trading.

### *Who is purchasing seed*

The allocation of seed quantities and seed flow to nurseries is very difficult to determine and highlights a number of issues. But some insight gained from regional experience contacts during the



survey is helpful. Most of the seed collected or contracted by local or small regional nurseries goes straight to tubestock production often for local projects or horticultural use. In these instances, keeping track of both species and collection provenance is relatively easy as well as a priority for the collector. If collected under licence, the supply chain can be followed, but otherwise accounting of seed collected for this purpose is difficult. The real issue with these collections is the risk of narrow genetic and geographic range in the seed and resulting offspring. It is often the case that plants are grown from one seed collection or annual collections from the same convenient parent material year after year. This can result in multiple projects over many years with a very narrow genetic range of parent material, and in some documented cases, coming from one individual tree specimen for over 25 years.

Issues of tracking and quality assurance become more complicated when the scale of tubestock production is much larger and the nursery more remote, or planning and production is fragmented across multiple collectors, producers, and retailers. For instance, if project funding suddenly becomes available to purchase a range of species for planting within two to three months, when conditions for planting are optimal, the local native nursery may not have those particular species in stock. So, if the funds need to be spent immediately, then the project may need to seek the plants from elsewhere, such as a wholesale nursery further away. The risk of this approach is that the seed source used to produce the plants may not be known, and could have been sourced from anywhere if wild collected, or could be clones if vegetatively propagated, or could have been multiplied by cultivation. Hence, projects with short timelines may have compromised outcomes because short timelines often result in challenges in sourcing seeds and plants from appropriate species and appropriate locations.

### *Seed storage conditions*

The majority (42.8%) of respondents store their seed in unrefrigerated shipping containers or similar. This type of storage is only suitable for short term storage (<5 years), if the shipping containers remain at approximately room temperature (c. 23°C), which is usually very unlikely. If the temperature is much higher than room temperature for extended periods, seed viability is likely to be compromised. Lack of appropriate storage conditions could hamper the sector's regional capacity to stockpile seed to respond to increasing demand, such as restoration following extreme climatic events or if large-scale restoration projects are commenced. Also, it could mean that seeds are stored for longer than the recommended time, leading to viability loss i.e., seed death. If seeds die in storage, this represents a waste of both genetic and financial resources. Unless seed testing occurs, seed death may not even be obvious to the end user, until the project fails. Few in the industry have the infrastructure to store seed for the medium or long term. So, if supply is increased, there may not be the infrastructure to cope with this increased supply.

## *Seed testing*

The survey established that there is little requirement to account for seed quality in most seed supply arrangements except for some large-scale mining contracts. So there is little incentive to do seed testing or provide test results beyond cursory visual inspection. Seed testing is an essential element for quality assurance in native seed supply. Without testing, seeds that are insect-infested (predated), empty or non-viable (i.e. dead) could be sold or used, leading to incorrect calculations of seeding rates or restoration failure, as well as a waste of financial resources. If seed quality is high, but unknown, restoration failures may be wrongly attributed to seed inputs. There is limited seed testing capacity in NSW, with 72% of respondents not performing seed testing. This was primarily a financial decision the fact that most buyers do not expect or require the information.

Many buyers are also unaware of seed quality issues through lack of 'seed literacy' and therefore do not know what information to request of the supplier.

As seed viability and quality is one of the key quality attributes that need to be addressed in the native seed sector, a process must be established to achieve this. To address the lack of testing, several options are available: 1) educate end-users on the importance of knowing the quality of what they are buying, so that they demand testing when they purchase seeds, 2) educate seed sellers on inexpensive ways to test quality, 3) implement a code of practice to mandate minimum standards for quality testing and reporting, 4) outsource testing to regional seed banks with trained staff and facilities for high volume testing (e.g. using X-ray analysis). All of these approaches have both direct and indirect costs, as well as requirements for data systems to be costed and implemented. This occurs at a time when there is pressure to supply cheaper seed and the true costs are not being met.

In the USA, the Seeds of Success program (the national seed collection program led by the Bureau of Land Management) has centralised testing, whereby seed collectors across the country send their seed to the Bend Seed Extractory<sup>1</sup> for processing, and seed is tested nearby at Oregon State University<sup>2</sup>. This model could be undertaken in NSW, for example, with regional processing and centralised testing.

## *Record keeping*

Seed collection data identifying seed species information, the collection location, and whether wild or cultivated material (with known origin) and date of collection is the most critical information to provide genetic and financial value to native seed supplies, as well as improving understanding and utilisation. However, limited, inconsistent, and non-uniform data is collected or required across the entities surveyed and agencies consulted. There is currently no state-based data management system or organisation accounting for seed required, used, licensed or stored.

Of those entities using a database for record keeping, several operate iterations of the same database that was developed by the Murray Seedbank network. This system enables seed collection and use to be tracked back over twenty-five years. With training, this model system would ideally be adopted for regional co-ordination and amalgamation of data across the state.

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<sup>1</sup> <https://www.fs.fed.us/forestmanagement/vegetation-management/nurseries/index.shtml>

<sup>2</sup> <https://seedlab.oregonstate.edu>

Additional valuable data to determine seed quality is the record of storage conditions, storage duration and pre-treatments. Each of these factors can have an impact on seed viability and germination and thus, project success. However, this information was generally not requested nor provided at sale.

## Seed demand

Key points:

- Demand for native seed can be unpredictable in some sectors, but more consistent in others (i.e. mining sector).
- This unpredictability could be due to short-term funding cycles and a lack of long-term restoration planning, meaning that seed purchasers look to buy seeds at short notice and may not order in advance.
- The consequence of unpredictable demand is that insufficient seeds are collected opportunistically and stored, because the collector does not know whether or not there will be a buyer for that seed lot. Purchasers then cannot buy seed off the shelf, because it hasn't been collected in advance. This can lead to species substitutions or insufficient seed for projects.
- Data on seed collection and purchasing is not collated on a regional or state basis, which makes it difficult for suppliers to forecast demand based on previous years.
- To overcome these barriers, longer term restoration planning would mean that seed purchasers could order seed they require in advance, and collectors could collect the seeds in the appropriate locations and at the optimum time of year. Collectors could also provide more consistent employment for staff if they know they will have ongoing work.

### *Lack of long-term planning to determine seed demand*

Eighty percent of those directly involved in conservation seed supply identified lack of planning and co-ordination at any level in restoration programs as key barriers to seed collection and delivery. This included lack of long-term funding programs (76%), ad hoc small and independent projects, fragmented demand and delivery with no central co-ordination and lack of data or knowledge. Most of the collectors we surveyed report that they collected speculatively according to what seed was available, and on historic demand, with only minor firm knowledge of what species and quantities would be required. Many highlighted the increasing cost and capital risk tied up in collecting seed for unconfirmed markets.

Poor planning jeopardises restoration outcomes as it reduces control over key variables that underpin restoration success, such as species selection, provenance, and seed quality and purity. In the absence of forward planning, seed collectors are often required to make trade-offs between providing the required species from the required locations and meeting the budget and timing constraints of projects (Appendix 5).

Stochastic NRM funding boosts may not benefit seed demand, without first ensuring that the appropriate planning and supply prerequisites are established. In fact, apart from Murray, Central West, and Northern Tablelands LLS regions (some rainforest species of Illawarra/ North Coast do not currently lend themselves to longer term storage), there is almost no capacity to collect and store seed in large quantities across a range of species should project funding become available. This is in part due to the shift in emphasis from NRM within LLS structures and in part due to the reduction and co-ordination of secure, long-term, devolved grant funding for regions.

The sector needs to know:

- where are the areas of future restoration;
- which species are required for restoration;
- where seed of these species can be sourced;
- the volumes of seeds required for this restoration;
- the timelines required to collect this volume of seed of these species;
- where the seeds can be stored, and for how long.

#### *Lack of coordinated data collection on seed demand*

One of the primary principles of an efficient market is that there are clear market signals on the commodity demand, and ability of the supply chain to anticipate and deliver commodities to meet this demand. The lack of coordinated data from the primary market on future demand makes it difficult to anticipate and deliver on unknown quantities and species, which poses a major threat to all projects requiring native seed. Those data are critical for estimating supply and demand, which will help set realistic expectations for future restoration projects.

Improved data collection and planning is likely to have the following benefits:

- reduced potential for conflicting commercial demand;
- reduced pressure to over-harvest seed from wild populations;
- sufficient time to allow for targeted seed collection, rather than relying on previously collected seed which may not fit the project specifications;
- ensuring that there is sufficient infrastructure to process and store seeds without risk of seed death;
- identify opportunities to strategic investment in SPA development.

Meeting the demand for seed is further complicated by the fact that seed is predominantly collected from the wild, and subject to natural variability. Seeds of some species are only able to be collected during a few weeks each year, and available quantities may be affected by seasonal rainfall, fire and other events. Hence, it may take several years to accumulate sufficient seeds to meet demand, but of course, advance planning is required to do so (Appendix 6).

If demand is known, but cannot be met by wild harvest, seed production areas may help meet the shortfall. While seed production can control some variables (i.e., irrigating to supplement rainfall),

and reduce some costs (e.g., travel), it also requires investment in infrastructure and crops may take some years before they can be harvested.

### *Demand for species diversity*

Respondents involved with the vegetation offset sector raised concerns about their lack of ability to supply all of the species required by the offset project. While aiming for biodiverse restoration is admirable, in some cases, it may be challenging to collect all the species required. Whether this is due to requirements for species that do not regularly set seed, and are more appropriately propagated vegetatively, or the species are not common and difficult to locate, or whether collectors do not have access to the areas in which they grow is not known. Discussion with seed collectors early in the planning process may inform species lists for restoration, as collectors are likely to have knowledge about from which species it may be challenging to source seeds, and alternative propagation methods and the timeline for producing these may be required.

### *Mining*

While those total number of respondents involved in the commercial mining and offsets market were less than those in the conservation market, they accounted for most of the seed harvested. They also reported a much higher confidence in determining seed demand and an overall higher degree of forward planning and pre-harvest orders. The bigger operators reported that they would only operate on long-term contracts and that most clients were happy with this as they had long-term programs to meet. This scale of mining demand has apparently created a degree of competition and potential threat between operators and competition over limited wild seed supplies.

Respondents reported a lack of central communication or co-ordination for similar seed requirements between multiple mines for rehabilitation within the same mining group even when in the same area of operation.

Respondents also reported a general lack of understanding by the buyers on the realities of the seed supply chain, its constraints, timelines, costs and a basic understanding of seed procurement guidelines and contracts. Another concern identified was the need for training of all parties in the process in the difficulty of sourcing seeds of all the species on their list.

Species in demand for mining restoration are predominantly grasses and ground layer species, at the expense of greater structural and species diversity, which is converse to the aims of NRM and landcare groups. Therefore, there could be an opportunity to develop seed production areas to supply grasses and ground layer species for mining and supply other species for the landcare sector.

### *Market failure*

In economic market terminology there has been a widespread market failure, meaning that the allocation / distribution of goods and services by a free market (i.e. where prices are self-regulated) is inefficient.



## Barriers, opportunities and interventions: Implications of results from the Healthy Seeds and SPA audit surveys

This investigation has confirmed that the issues identified from the Australian Native Seed Survey Report (Hancock *et al.* 2020) are still relevant and encompass all the main barriers identified by the respondents as needing to be addressed. The proposed opportunities for interventions to address all these barriers in the NSW seed sector needs further discussion, consultation and co-development. It is also important to note that most opportunities are potentially interactive across multiple issues and may require prerequisite actions and a systems approach to implementation. These are discussed here in descending order of highest number of respondents that raised them, not necessarily in priority order of required intervention, and summarised in Table 2.

These interventions form the basis of the Roadmap.

**Table 2.** Common themes of barriers identified in the survey of the Native Seed Sector in NSW, including survey data, implications of the barriers and opportunities for improvement. This information has been used to develop the recommendations in the Roadmap.

Themes	Barriers	Data	Implications	Opportunities
Seed Licences / Permits.  88% of respondents.	Administrative delays/ failure to respond to applications. Lack of clarity on licence conditions and species for funded projects. Excluded species and communities in licence conditions. Complexity in reporting with no feedback/ outcome Lack of data and continuous reporting Inability to address conflicting seed site demands for offset projects.	c.1% of seed accounted for with seed licence or permit. 85% of all seed sourced from public lands. 11% of seed sourced from private lands c.4.5% seed sourced from SPAs-licencing obligations ambiguous.	Many projects delayed or operating outside of licence conditions. Many species unable to be legally targeted or pre-conditions met. Precludes the implementation of many projects. Inability to assess, co-ordinate and track seed use Inability to protect vulnerable sites or species. Inability to source and use data for projecting seed sourcing or future regional demand, or gaps in data available Lack of clarity on SPA conditions and seed sourcing.	Develop and implement concurrent regional seed co-ordination/ model system of practice and database tracking system. More support and coordination within licence administration, to provide clear and timely advice.

Themes	Barriers	Data	Implications	Opportunities
Lack of Co-ordination 84%	No state/ regional co-ordination in project development, needs and data. Failure to co-ordinate information during project development. Lack of regional project development and funding in NRM Lack of data on forward project planning or seed/ species demand. No consistent regional vegetation community, target species requirements determined or documented.	LLS/ Landcare/ regional nurseries account for 80% of seed sector resource allocation but account for only c.9% of seed demand. Mining accounts for 24% of entities but 56% of seed demand Horticulture/ export accounts for c.8% of entities but c.32% of seed quantity demand.	No regional species/ vegetation guides universally available to establish standard species lists or requirements for projects. No/ little co-ordination of regional project development, funding, implementation or monitoring No/little links to networks for updating technology, infrastructure or research implementation. Without independent co-ordination and technical support there is the potential for conflicted interests in project development, costing, procurement and quality.	Implement a state seed co-ordinator role to liaise and co-ordinate project development, technical and infrastructure support, seed demand and agency interaction. Implement a network of regional seed, project, data and technical co-ordinators Formalise networking between regions.
Seed Availability Decline - Climate impacts - Reduced vegetation area & decline - Land access  84%	Respondents reported a 40% decline in seed availability.	84% of respondents indicated that the 2019-20 seed harvest had been the poorest in terms of seed harvest and most difficult on record.	Concerns about ability to meet longer term seed supply from wild harvest. Concerns about pressure on wild, vulnerable populations.	Regional co-ordination of species and location targets Strategic SPA development with identification of regional species needs and gaps. Formalise networking between regions
NRM Funding Variability/ Seed Demand variability  80%	Decrease in NRM funding resulting in a reduction in restoration projects. Reduced seed demand. Project delivery is unpredictable. Lack of regional project co-ordination and development. Inability to retain skilled and experienced staff and effect successional planning.	80% of respondents cited NRM funding variability and subsequent lower seed demand as a significant impact on their survival. 80% identified organisational planning and dysfunctional seed market as equally problematic to sustainability.	Inability to sustain regional seed supplies Inability to sustain business entities and skills. Inability to ramp up if funding is available Loss/fragmentation on seed sector networks, knowledge and capability.	Strategic allocation of resources to improve infrastructure and implement projects. Co-ordinators involved in network and project development and support.

Themes	Barriers	Data	Implications	Opportunities
Seed buyers lack of knowledge in seed sourcing requirements  60%	Need for training in what species are suitable for revegetation and methods Need for Regional vegetation reference lists and guides Need for understanding species and seed ratio requirements for different techniques. Need for understanding of seed quality tracking and data monitoring.	60% of respondents saw the lack of specific seed literacy and technical understanding as a major impediment with both commercial and some NRM clients.	Wrong or inappropriate species sought Inappropriate quantities of seed acquired Wrong technologies or methods of restoration applied. Misunderstandings on seed quality specifications and need for quality testing.	Regional vegetation guides available for species lists and order templates. Regional seed co-ordinators network in technical support, training needs analysis and delivery, and research and technology networking and linkages. Production of fact sheets about supply chain and timeline.
Risk (Failure) of Investment (collection/ SPAs)  56%	Inability/ risk to develop seed banking opportunities Inability/ risk to develop SPAs. Inability/ risk to invest in infrastructure, technology and practice.	56% of respondents recognised the benefits of SPA investment but indicated that without secure long-term projects they would not take the risk of larger seedbanking, stockpiling, infrastructure or in development of SPAs.	Inability to advance direct seeding technologies as the regions are unable to develop systems to provide the quantities of seed and scale to efficiently deliver it. Inability to bank/ store and carry forward seed in sufficient quantities for future project development. Inability to respond to future demand in poor seasons.	Develop regional SPA strategies to identify species needs and gaps for restoration works. Implement networking between regions on coordinating seed and SPA requirements. Development in regional planning of infrastructure and investment in processing, testing and storage.
Inability to attract and retain staff and maintain training support  56%	Volatility in funding and business/job security. Contracts and tenures are mostly temporary and provide no long-term career security or development. Positions often lack stability, support, training and career pathways. Little or no ability to address skills retention or succession planning	56% of respondents indicated that without secure long-term projects they could not guarantee staff positions or support investment in retaining positions, training upgrades or succession planning. Many indicated despondency in their own continuing prospects in the seed sector and a frustration in past failure of the sector to flourish.	Lack of business security and investment. Lack of job security is resulting in skilled and experienced people leaving the sector and young people not considering it as a viable career path.	Regional project co-ordination and project development to provide stability and continuity for skilled staff to provide seed and technical support to project delivery. Development and support of regional seed co-ordinator networks to provide technical support, training needs, data and reporting, research and technology networking opportunities.

## 1. Seed licencing and permits

The lack of co-ordination among agencies, programs, projects and delivery is no more clearly demonstrated than in the issue of native seed collection licences and permits. By far the majority of those surveyed indicated having some form of issue, administrative delay or complexity, conflict or problem with the seed licencing system as it currently exists in NSW. In cases where applicants had licence queries or long wait times for licences to be issued, seed collections were generally carried out on the assumption that licences were forthcoming.

The Australian Native Seed Survey Report (Hancock *et al.* 2020) and Healthy Seeds project have both identified and confirmed that there are several concerns and constraints within the seed collection licencing system. Within NSW, these arise from respondent feedback about administration of the seed licencing system. While one of the assumed purposes of the current licence system is to manage and protect plant species and populations, the feedback and lack of available data mean that it is unknown whether this objective is being met. It is clear that review is required to identify what the purpose of the licence system, what are the key objectives and outcomes that are trying to be addressed and what is the best way for this to be achieved.

Survey respondents need clarity about licence requirements for seed procured from different land tenures and seed production areas. They would also like an easier reporting mechanism for collection data. Having comprehensive collection data in a record keeping system that allows easy retrieval would enable agencies to analyse collection data and help forecast future collection. Centralised data collection could also support the review mentioned above, and ensure licences help effectively manage and protect plant species over time.

This survey has identified that, for those that responded, the majority of native seed collected and delivered to projects in NSW is done so outside the current seed licencing system. Even when licences exist, the collections are beyond the restrictive terms of the licences. It is also apparent from these data that the majority of valid seed collection licences are held for the smallest seed collections. The larger the collections, the less likely they are to hold valid licences or to defer seed licence responsibility to contractors or others in the supply chain. Purchasers deferring responsibility for seed licences to other collectors and assuming that licences have been obtained exacerbates the lack of transparency in the supply chain. This seems to even be occurring in funded projects for rare or endangered species and/or Endangered Ecological Communities (EECs) where plants or seed is supplied to projects where no requirement exists to document the validity of licencing in the supply contracts.

In addition to the lack of documentation of seed licencing, seed collection data appears not to be required for most or many seed supply contracts in NSW. Nor is seed harvest coordinated or any data collected, compiled or used in the seed licencing system at a state level. This lack of collated data is a missed opportunity of the licencing system and may limit the ability to manage and protect native plant species in NSW.

It would appear from the data, personal communications and experience that the NSW seed collection licence system is “not fit for purpose” in protecting plant species, plant populations and communities. Nor is it effective in providing an administrative system that is capable of documenting and tracking seed supply and use. Due to a lack of centralised documentation and tracking, potential assessments of the effectiveness of the licence system to protect wild populations are limited. For instance it is not able to assess or supply

site seed yield potential or past collection data, or appropriateness or allocate and coordinate seed collection across collectors at a regional level. Nor is it able to provide data of quantity or species of seed collected, distributed or use or provide any effective tracking of seed source location, end use or quality for any year or over time. It is therefore unable to determine through any project monitoring whether the target collection site was appropriate, has been negatively impacted or that seed used in any project investment is resulting in sustainable ecological outcome. It is therefore unable to make any judgement on the ethics, applicability, use, value or future assessment of any seed collection nor ensure that the wild populations are protected.

The lack of collated data on seed collection also limits the ability of projects to determine whether the seed source was a contributing factor to success or failure of the project, and limits the ability to undertake adaptive management. For instance, unless accurate records are collected on seed source, it will not be possible in the future to determine the effect of seed source on restoration success under a changing climate.

A licencing system that is easy to navigate and transparent is key, as stipulating higher levels of mandatory licencing and reporting with more complexity is also unlikely to prove fruitful as experience here already demonstrates. It is more likely to result in increasing numbers of people opting out of the system and no gain in data acquisition, and would hence be counterproductive as it would not increase information on supply and demand, or improve the potential to monitor seed progeny outcomes and performance.

### **Opportunity and intervention**

The NSW seed collection licencing system should exist to protect self-sustaining populations of native plants, as well as allowing access to restore plant populations. Collectors would like a licensing system that is easier to navigate, as well as transparent and supportive of achieving restoration outcomes.

A key opportunity for the seed sector would be the ability to collate seed collection data to track seed supply, seed use, and outcomes from seed-based restoration. With this information, the sector could better estimate seed requirements and improve management of this resource. In order to collate and compare data, the recording of data needs to be standardised. Data collected in a standard format can then be provided to a) regulatory authorities as part of licencing conditions and b) end-users to enable them to inform management and interpret restoration outcomes. The collection of standardised seed data could then be collated at a state or regional level.

Various documents can be used to inform the development of standardised recording, including the Florabank Guidelines (Commander 2021), International principles and standards for native seeds in ecological restoration (Pedrini and Dixon 2020) and the Revegetation Industry Association Seed Standards<sup>3</sup>. The Healthy Seeds Project has recently updated the FloraBank Model Code of Practice<sup>4</sup>, using the aforementioned resources.

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<sup>3</sup> <https://www.riawa.com.au/assets/documents/01-RIAWA-Seed-Standards-191021.pdf>

<sup>4</sup> [https://www.greeningaustralia.org.au/wp-content/uploads/2017/11/FLORABANK-GUIDELINES\\_Model-code-of-practice.pdf](https://www.greeningaustralia.org.au/wp-content/uploads/2017/11/FLORABANK-GUIDELINES_Model-code-of-practice.pdf)

The provision of seed data could be written into seed supply contracts to ensure that for instance, source and quality is known at sale. Without this minimum data, scalability of seed could be limited, encouraging collectors to comply. With quality information of all seed batches reported, batches with higher quality could attract a higher price.

While most commercial mining and offset programs currently operated outside the licencing and restoration regime, a regional network co-ordination model provides the opportunity to look for opportunities to develop synergies and develop commercial SPAs in some regions with increased opportunities of seed supply for restoration programs.

Collating seed data at a state or regional level into a database could enable better projection of future demand for wild harvest seeds, and allocation and co-ordination of collection sites. A co-ordinator would be required to undertake this activity. Databases of this nature are currently being used by some of the survey respondents.

This co-ordination of planning and tracking proposed regional projects combined with access to devolved regional funding and project development provides the opportunity to ensure effective project development, this includes seed collection from the right species in the right places, seed supply allocation, seed delivery and projects with appropriate lead times and limited follow up monitoring.

**The sector needs more efficient and effective seed collection licencing systems, improved sector co-ordination and regional-scale restoration planning.**

## *2. Lack of co-ordination*

Overall, respondents noted a lack of co-ordination in the sector, in terms of regional project development, funding, implementation or monitoring. Lack of co-ordination can lead to potential conflicts in project development and seed procurement. Improved co-ordination at a regional level is required to develop regional vegetation guides to direct species selection for seed collection. Also, networks would improve access to technology, infrastructure and research outcomes.

### **Opportunity and intervention**

While it is recognised that there is much fragmentation in the native seed sector, a significant informal network exists at the local level, across regional and state boundaries and between groups of operators. This network operates at a range of levels between individuals and groups at a project level and in seed and knowledge exchanges for SPA development across regional and state boundaries in the south of the state. It also exists at the commercial level where it appears that there is significant inter-regional and interstate networking and exchange, in particular for native grass seed. The network needs to be fostered to grow.

However, the overall status of the native seed sector in NSW is still highly fragmented, as there is effectively no co-ordination at a state, sector or program level and effective co-ordination within only a few regional NRM entities. There is certainly no current unity in co-ordinating a representative national or state seed organisation, despite the acknowledged benefits. The general feeling is that if there was stability in market co-ordination and demand the need for organisational representation would eventually come to the fore over time. However, that time is still a long way off.

While there was a high degree of support for effective co-ordination of the native seed supply from the respondents that participated, it is unlikely that there would be universal support for such a move. Indications from those entities that were less inclined to provide explicit seed data gave the impression that there was little advantage to their operations in having a co-ordinated market. It can be inferred from this and other feedback that those larger operators with an established commercial or mining market were quite content with less interference even when they had expressed other concerns about seed decline, competition and staffing.

### **State and Regional co-ordinators**

If a system of both operational and market co-ordination is to be supported it has to be supported at the NRM regional delivery level. It would also be best delivered, from the market demand and sector compliance end of the market, and that is currently predominantly held with Government. This would require the funding of regional co-ordinating staff embedded within NRM regions, overseen by a State Co-ordinator. A State Co-ordinator role would be beneficial to work between the envisaged Regional Coordinators, operators and projects and state level operations, embedded within the existing state and regional NRM organisational structure, but also communicate among the key conservation and restoration agencies, researchers, the state planning, infrastructure and compliance agencies, and private and corporate projects.



The Regional and State Co-ordinators would need to be from the seed sector, and hence more than likely be recruited from within the existing regional seed networks and be engaged to assist in improving the network reach and capacity. Their primary and initial roles would include:

- Improving communication within existing networks, state agencies and corporations.
- Establishing a central point of contact for state and regional seed and restoration issues.
- Scoping of current projects and upcoming opportunities.
- Establishing technical and physical support systems e.g. disseminating the Florabank Guidelines, developing Regional Vegetation Guides and species lists, identifying gaps in state and regional seed infrastructure and storage, developing a state and regional seed database and projects database, and establishing Regional Seed Collection Zones.
- Reviewing state and regional seed availability and demand.
- Identifying and quantifying seed and species shortages.
- Identifying priority species for inclusion in SPAs.
- Identifying capacity and opportunity for nursery, planting and direct seeding and project delivery.
- Identifying and co-ordinating project delivery and resourcing.
- Co-ordinating seed collection, validation and data systems and collating data for state level amalgamation. Amalgamating state level seed collection, validation and data systems and Code of Practice compliance.
- Liaising between industry and regulators, i.e. to assist seed supply industry to obtain correct licences, approvals and permissions.
- Assisting with capacity building for small operators, e.g. volunteer groups, community groups, landcare and coastcare groups, NGOs, not for profits, nurseries, TAFE, and training providers.
- Collating of state level projects, data and upcoming opportunities and links.
- Networking and matching agency technical skills, training needs, research needs and physical infrastructure across the state.
- Supporting resource allocation and delivery.

**The sector needs improved co-ordination**

### 3. Decline in seed availability

While the Healthy Seeds Project has been able to elicit a lot of indicative data, feedback and views from individual seed collectors, agencies, merchants and users, it is evident that no individual agency or program holds any single source of data on native seed used in the past, either annually or cumulatively. In addition there is no single data source on quantity, location or species of seed sourced under seed licencing in NSW. This lack of data precludes accurate estimates of the total annual amount of seed used, its source location and end use.

#### Opportunity and intervention

- Develop a single data source for quantity, location and species collected under regionally coordinated seed licencing or surrogate systems.
- Develop and utilise regional Vegetation Guides and target 'workhorse' species.
- Coordinate regional seed allocation sites.
- Coordinate regional seed collection site allocations and targets.
- Identify seed supply gaps and SPA establishment opportunities.

**The sector needs improved regional-scale restoration planning to meet current and expected declines in seed availability.**

### 4. Funding variability

Key barriers related to funding are: the lack of sustained funding to support existing seed banks and the knowledge and funds to establish SPAs in regional NSW; inability to quickly respond to increased demand if funding becomes available; inability to sustain businesses; and lack of resources for co-ordination.

One central theme of concern raised was the inconsistency, delays in allocation and complexity of current state and Federal funding programs within NSW. In addition, the decline in dedicated project funding is a concern, and has been exacerbated by the loss of regional support staff and dedicated project staff in recent years. A valid and proven alternative would be to revert to a devolved regional funding delivery model with consistent allocated funding over a minimum of five years. Longer project timelines would enable much better and closer development, supervision, control and reporting than a remoted centralised model. It would also directly link the seed supply chain throughout the state and enable the co-ordination and recording of all seed supplied to projects to be maintained in a centralised database.

### **Opportunity and intervention**

One of the greatest opportunities to deal with many of the interrelated issues highlighted in this report is to examine the employment of regional seed management staff. There are a variety of options for where these individuals could be placed, however, there is a strong argument for a consistent network of positions located within the Local Land Services (LLS) and Landcare networks. Positions within LLS and Landcare would maintain interaction with extension networks and help optimise delivery of state and federal projects utilising seed state and federal project.

A major opportunity for co-ordination of a large-scale restoration project in NSW is the management of seed supply for direct seeding of the NSW Travelling Stock Reserves (TSRs) in relevant LLS regions. Such a funded project allocation immediately establishes a market demand “floor” for seed and enables the identification of species and locations of seed required and potential SPA requirements. The same opportunities exist with co-ordination of Local Government Roadside Management and vegetation restoration plans. Both these projects could effectively also operate as surrogate regional seed production sites until dedicated and more strategic seed production areas are initiated or come into production. A co-ordinator could prioritise production of resources to deliver these projects, initially ensuring that the region has an up-to-date Regional Vegetation Guide that provides key reference sites and targets for restoration. Opportunities exist for collaboration with state-funded Saving our Species projects and the Royal Botanic Gardens and Domain Trust and other conservation programs on threatened species recovery.

One of the greatest criticisms for existing funding models has been competition between projects and the failure to unify, coordinate and create synergy across a range of projects. By bringing together individuals and groups, a co-ordinator could improve project planning at a regional level. In addition, loss of regionally controlled budgets, and the lengthy application processes to access funding from either state or Federal Governments has been a challenge. The time and capacity to deal with these fragmented funding sources often resided in the full-time NRM staff, and that capacity has been mostly eroded. Most groups indicated that it was just not worth the time and trouble to try and access these funding sources in their current form for short-term projects. Funding applications and reporting can be onerous and would be far better achieved by a coordinator position to achieve restoration outcomes at the desired scale, implemented within each region.

In addition, funding schemes need to consider the time required for seed collection, processing and propagation. In some cases, seed sourcing could take a year or more depending on the season of seed maturity and quantities required, with additional time for processing and propagation. The cost of seed should be correctly estimated and incorporated into funding applications. Infrastructure such as seed banks and seed production areas should be eligible for funding as they support the seed supply chain.

The various elements of intervention to address funding issues are:

- Funded full-time coordinator role.
- Devolved project funding (to develop and maintain project demand).
- Regional vegetation guides (updated and linked to identification guides and on-line).
- Adoption of Florabank Guidelines and regional Code of Practice and Seed Database for seed supply contracts.
- Regionally managed (NRM funded) and integrated seed database and tracking systems.
- Agreed seed quality standards.
- Identification of existing infrastructure and how it could be better utilised across the sector, as well as infrastructure gaps. Infrastructure includes mechanised harvest systems, seed processing facilities, drying facilities, temperature and humidity-controlled seed storage facilities, nursery facilities, direct seeding equipment.
- Identification of species seed supply needs and shortfalls.
- Coordinated establishment of SPA seed supply systems for target shortfall species (regional and cross-regional), could be private or public.
- Staff training and retention for continual employment and prevent loss of knowledge.
- Funding programs need to consider the time required for seed sourcing and propagation, and not assume that seeds and plants are available for immediate purchase. Deployment of additional technologies eg tissue culture or seed enhancement require additional facilities, expertise and time, to achieve species diversity and project success.

**The sector needs improved project management, restoration planning and co-ordination.**

#### *5. Seed purchasers lack of knowledge in seed sourcing requirements*

Sixty percent of respondents saw the lack of specific seed literacy and technical understanding of seed clients as an impediment to effective seed market demand and a significant time waster to their business. This occurs through:

- Wrong or inappropriate species sought (many consultants species' lists may be very extensive but with little consideration of the realistic practicalities and disproportionate costs of collection, propagation and use). Some of these issues could be resolved with research input but all lists should involve effective and realistic discussion and collaboration to achieve the best and most appropriate outcomes with the resources available.
- Inappropriate quantities of seed requested or acquired.
- Wrong technologies or methods of restoration applied.

- Unrealistic expectations, belief that a large range of species of seed for a broad geographic range of large quantities is freely available “off the shelf” at negligible cost.
- Misunderstandings or lack of clarity on seed quality specifications and timelines and planning required to acquire seed.
- Lack/ variable and inappropriate levels of “seed literacy” and exchange between all levels of the native seed sector leading to misunderstandings, suspicion, fragmentation, dysfunction and inefficiency.

There was a general dissatisfaction with the lack of practical knowledge of seed systems displayed by agencies and unrealistic expectations that seed from a wide range of species would be just available off the shelf at the time required. Similarly, there was little understanding that the lead time for delivery of tubestock is at least two years, assuming seed is available to collect. Or that while timelines are much shorter for direct seeding that the seed availability, machinery and staff availability and seasonal timing all must be pre-booked and aligned. We describe this as a lack of ‘seed literacy’ and the need for training of buyers, users and agency staff involved in project development, funding and assessment was almost universal across all regions and sectors.

#### Regional Vegetation Guides

An essential pre-requisite for a restoration program is to define the species selection. Regional Vegetation Guides can assist with this species list, as they document the vegetation types across each landscape, provide reference sites which can be used for restoration targets and set standard requirements for project delivery. By guiding species lists, they can enable better planning and allocation of seed collections. The Guides should also provide some understanding of the relative ease and availability of procurement, species identification, seed collection methods and timing, as well as propagation techniques and methods of establishment. Support from researchers and horticulturalists will be essential in developing these guides.

Some regions (Upper Murray, Upper Murrumbidgee, South West Slopes, Western Riverina, Lachlan, Border Rivers/ Gwydir) already have hard copies of these Vegetation Guides<sup>5</sup>, but are now out of print and much sought after. Ten regional vegetation guides exist for travelling stock reserves (TSRs). These publications are the collective knowledge of many people over many years and make the assimilation and communication of this collective knowledge so much easier and more effective. As some of the Guides are currently out of print, they need to be updated for every NRM region in NSW and made available online. Once online, they could be linked to online maps and species identification guides. The template of these documents should be the benchmark for all restoration programs. Online access has the capacity to break down some of the fragmentation of knowledge that has occurred.

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<sup>5</sup> <https://www.ils.nsw.gov.au/help-and-advice/growing-grazing-and-land/travelling-stock-reserves/conservation-of-tsrs/#~:text=Regional%20TSR%20Vegetation%20Guides%20NSW%20Environmental%20Trust%20Linear.potential%20status%20of%20native%20vegetation%20in%20the%20field.>

### Opportunity and intervention

All these issues can be reduced or eliminated with regional co-ordination providing:

- Regional Vegetation Guides to develop species lists for seed collection.
- Liaison between collectors and end-users
- Assistance with seed contract quality specifications and pricing.
- Training for seed purchasers.
- Linking practitioners with researchers.
- Regionally co-ordinated seed quality testing.

**The sector needs improved regional-scale restoration planning and training opportunities for seed purchasers.**

### *6. Failure to invest in opportunistic seed collection and SPAs*

Key points:

- There is a need to finance regionally focused SPA development, support and co-ordination.
- Demand for seed is inconsistent and unpredictable due to funding variability.
- Inability to advance direct seeding technologies as the regions are unable to develop systems to provide the quantities of seed and scale to efficiently deliver it.
- Inability to bank/ store and carry forward seed in sufficient quantities for future project development due to lack of planning and infrastructure e.g., storage facilities.
- Inability to respond to future demand during poor seasons.

While 56% of respondents recognised the benefits of SPA investment, none could justify the risk without secure, co-ordinated long-term (i.e., ten years or greater) supply contracts. They also conceded that without co-ordinated regional knowledge and networking of identified species and predicted quantity requirements, the risks were magnified.

Similar views were expressed on the investment risks posed by opportunistic wild harvest and storage infrastructure as a speculative proposition without some element of market insight or forward contracts.

Without the ability to increase seed supply and storage capability, there is limited ability to advance direct seeding and other restoration technologies that have the potential to facilitate restoration at scale. In addition, sufficient seed is not available in storage to carry over from extended low production years or negative environmental events.

### Opportunity and intervention

The risks of lack of investment in opportunistic collection and SPAs could be reduced or managed with regionally co-ordinated project development, planning and funding. An example of this has been demonstrated with the Murray CMA/ LLS Seedbank where the projects were collaboratively conceived, developed, seed sought and stored and sites prepared, fenced and direct seeded as part of a one-stop project, with multiple partners (see Appendix 3.)

The key objectives of regional co-ordination would be to:

- Document current and upcoming restoration projects at a regional level.
- Identify requirements for seeds and ability to supply.
- Identify current seed storage infrastructure capacity and future requirements to store opportunistically collected seeds.
- Identify opportunities to develop SPAs based on species requirements for restoration and ability to supply.
- Develop databases for seed stores.
- Develop networks within and between regions to manage seed requirements.

**The sector needs regional-scale restoration planning.**

### *7. Inability to attract, train and retain staff*

Key points:

- There is concern about succession planning, career security and training for seed collectors over the next 5-10 years as the current workforce ages (many current collectors are in their fifties and sixties).
- Lack of business security and investment.
- Lack of job security is resulting in skilled and experienced people leaving the sector and young people not considering it as a viable career path.

### **Loss of skills and knowledge in regional areas**

There was a consistent message from all regions that there has been a gradual loss of staff and skills from regional NRM agencies. This has been in part due to agency restructuring, staff reductions and shifting priority within agencies. This was particularly evident with the transition from CMA to LLS. Even where positions have been maintained, there was failure to support succession planning and a failure to offer job security. There are many young people that have grown up on the land, have an affinity with both the natural environment and the regional community that could transition into employment in the regional environmental economy, if there were long-term programs in place. However, even when the skills, aptitude and enthusiasm and young people available, annual tenure positions (or worse) make it impossible to get bank loans, housing or establish longer term career paths and training. During the Healthy Seeds project, it was identified that at least seven highly



skilled and dedicated regional staff had ended their tenure and roles due to funding insecurity, stress and fatigue, age or declining health. Most of these positions will be difficult to fill with appropriate skills and experience in the short term and impossible to maintain in the longer term without a change in emphasis, priorities and resourcing in regional NRM delivery.

Lack of retention is also an issue within business and in community groups. There has been a gradual aging workforce and failure to implement business succession planning. Job security for young people is not apparent or they have seen the hardship, insecurity and lack of support and already left the region. The decline and aging within the community groups is also a function of this general decline. If there aren't young people (or effective middle-aged people) being held in employment in regional communities, it is not just the local sports clubs and art societies that decline, it is the local birdwatchers, field naturalists, environmental groups and landcare that suffer. And it is usually the program or agency staff that are the organisers of these groups. Without these people the opportunities, enthusiasm and skilled professionals to support programs will disappear.

Dynamic regional communities are required to implement state and federal environmental priorities and projects. In addition, regional communities are going to have to be the solution to many of our collective problems on vegetation management, climate change, food and energy security and require the investment to address them. Without the investment to respond to these issues "...metropolitan Australia's perpetual neglect of our regions is eroding the security..." and capacity of Australia to respond effectively (Klomp 2020). Hence, investment in people is sorely needed.

### **Opportunity and intervention**

An important component of this continual decline in individuals, jobs and regional programs is the failure to document the collective knowledge of these people and the learnings from the past. Ensuring that local knowledge is captured and retained in Regional Vegetation Guides is critical.

To attract, train and retain skilled staff in the seed sector in regional areas, reliable funding is required.

Regional project co-ordination presents the opportunity to provide:

- regional project co-ordination and development and funding to enable business/ agency and project security to provide employment continuity, skills support and training and career development,
- support of regional seed co-ordinator networks to provide technical support, training needs, data reporting, research and technology and extension employment roles.

**The sector needs improved training opportunities and ongoing investment in skilled staff.**

## Box 1. NSW Seed Production Area (SPA) audit summary

By Sue Logie

The Healthy Seeds SPA Audit survey program (Appendix 7) gathered data from 30 native non-government seed entities. This data was cross-referenced with the data from 12 Local Lands Services (LLS) and Landcare regions across NSW. Feedback was also obtained from seed merchants, casual collectors and seed projects. Every effort was made to contact independent seed collectors for this survey, but not all of them were able to be interviewed for this report.

For the purposes of this audit, a SPA had to have been specifically designed for seed production of individual species with seed sourced from known populations and a wide and defined representative area with a layout and planted distribution to encourage cross-pollination and as wide a genetic diversity of seed produced as possible. It is also required that there are adequate records and tracking of both the initial seed source material for the SPAs and the subsequent use and distribution of the seed. In this way it is possible to produce greater quantities of a known species of a validated genetic range and diversity and match to a wider geographic distribution range for projects. In some vegetation communities and species (i.e. widely scattered rainforest or rare species) it may be advisable to actually validate assumptions with genetic testing of background target populations and material going into SPAs to ensure that genetic variation is being captured). It is important at the outset to differentiate SPAs from previous restoration or revegetation areas from which seed has been harvested. Such systems were nominated by some largescale seed businesses as a substitute for SPAs. There were also past state-wide funded projects to alter management regimes on some targeted TSRs to allow for the potential of seed collection which have been listed as SPAs but also don't meet the specific definition used here. While this definition may be valid for some native grass and forb production it would not meet the criteria for tree or shrub SPA production.

### Key Findings

- An investigation into known projects funded over the past 20 years managed to locate few (14) actively managed SPAs in NSW.
- There is a current lack of sustained funding to support existing seed banks and seed production and a lack of well-distributed knowledge, skills and understanding or funds to establish new SPAs in regional NSW.
- There is a need for financing regional seed supply co-ordination, SPA development, technical support and co-ordination.
- Demand for seed is inconsistent and unpredictable in the NRM sector due to funding variability.
- Seed demand is linked to funding, and the reduced investment in NRM has made it difficult for existing seed banks to maintain services and bank seed for future projects.
- There is poor understanding of licencing permits and conditions and licencing constraints impacts on SPA development and seed banking opportunities.
- The recent fires have highlighted the lack of seed available for large scale restoration works.

- There is concern about succession planning and training for seed collectors over the next 5-10 years as the current workforce ages (many current collectors are in their fifties and sixties).

Apart from twenty-six active SPAs across the Murray LLS region, two (of the original five) in the Central Tablelands and SPAs operated by Greening Australia in both the ACT and greater Sydney, the audit could find no actual evidence of major established SPA capacity servicing NSW. The SPAs in both the Murray and Central Tablelands were established by Greening Australia partnerships to increase shrub seed production for designated restoration projects. Hence, the project has identified the Murray LLS Seed bank and SPA network as the only regionally and vertically integrated seed supply system out of all the LLS regions, that is capable of servicing seed and works across a significant proportion of the Murray LLS area. The network was established primarily to supply seed for direct seeding restoration projects across the Murray LLS area as well as to provide seed to a range of community and commercial nurseries. The network currently consists of 14 SPA sites, producing seed from 25 species and a centralised processing, seed bank and storage facility. The network is backed by an integrated database and seed tracking system.

The link to the full SPA Audit is available in Appendix 7.

## Box 2. Comments on the US Native Seed and Restoration Sector

By Paul Gibson Roy

The native seed and restoration sectors in the USA are magnitudes larger and more developed than those in Australia. The early use of native seed in the USA stemmed from land conservation and social programs developed from the 'dust bowl' era that financially supported the use of perennial grasses (exotic and native) to stabilise eroded farmscapes. Over time the use of native grasses grew as farm-based programs began to also focus on biodiversity conservation (in addition to delivering ecosystem services). A prime example of a farm-based program supporting the use of native species is the Conservation Reserve Program, which pays rental and setup costs to farmers for re-establishing natives on farms. This program (and others like it) have seen the creation of a large and stable seed supply sector and restoration services and has resulted in ~9 million ha of restoration on US farms since 1986. Much of the seed for these programs comes from native seed farms, where high quality control, and testing and labelling standards are established. The other biggest users of native seed are government agencies such as the Bureau of Land Management (BLM), U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), tribal nations, National Park Service (NPS), and U.S. Department of Defence, who collectively manage more than 360 million hectares of land. The bulk of native seed used by these agencies is to remediate the impacts of extreme events such as bushfires, floods, and hurricane. These agencies use many thousands of tonnes of native seed annually.

While native seed use in the USA is extensive, the suppliers and users of seed and restoration services have also shown the foresight and maturity to develop a National Seed Strategy for Rehabilitation and Restoration (the first phase running from 2015-2020). This cross-sector collaboration creates a coordinated approach for restoration goals and provides a framework for the seed industry to properly address current and future challenges. Australian governments (as the prime funders of restoration) and the broader seed sector should take all steps necessary to learn from the progress made in the USA. That they in the USA are aware enough to recognize the need to better understand their sector (e.g. such as seen in the 2020 NASEM - Assessment of the Need for Native Seeds and the Capacity for Their Supply: Interim Report) or to continue to coordinate and facilitate industry development and structure (e.g. National Seed Strategy) suggests they will continue to develop their capacity to meet national restoration objectives. That Australia is so far behind the USA in all these areas (as evidenced through the Australian Native Seed Sector Report) is cause for great concern, and one that should prompt both reflection and concerted action.

### Box 3. Sector interventions from an economics viewpoint

Summarised from information provided by Tarecq Shehadeh

A recent review has identified economic factors that affect how the seed sector functions, and proposes a plan of action to lift capacity and future investment.

The current market is under-developed and informal. There is concern about the sustainability of wild harvesting. Regulation could better meet the needs of conserving a diminishing resource with the need to provide resources for restoration. In the current market, the purchaser regards the price of the seed lot as sufficient information, and not taking into account information on seed quality or source location.

There is a need for regulation to address market failure. A regulatory framework could assist with the management of seed quality and supply. It could also provide incentives for purchasers to trade with collectors who are licensed, and purchase seed that is sustainably sourced.

The plan of action has four key points:

1. Engage regulatory bodies to monitor and understand the industry for native seed collection, production and sale to ensure its working in a manner that befits its critical role in sustaining ecosystem health.
2. Provide primary industry support for the native seed sector in the form of technical and commercial knowledge and support testing and certification
3. Develop a strategic seed reserve policy and program.
  - Governments should purchase large-scale seed supplies, such as is done by the Bureau of Land Management in the USA.
4. Pilot a market mechanism to address transaction complexities, provide a transformative level of transparency on demand and supply for seeds, and ultimately greater efficiency in the way the resource is managed.
  - Document seed supply shortfalls
  - Include seed quality data
  - Use forward demand to inform seed production areas

## Box 4. A strategy for the Australian Seed Sector

Since the commencement of the Healthy Seeds Project, Project Phoenix was initiated as a response to the 2019/20 bushfires. As part of Project Phoenix, several reports were drafted to inform a strategy for the Australian Seed Sector. The draft strategy underwent public consultation.

The draft strategy contains six strategic objectives, each with a goal:

- **Quality standards**  
To agree on, promote and actively adopt one 'living' set of national best practice standards (or Code of Practice) for (voluntary) use across the sector
- **Information sharing**  
To support the native seed sector through access to new and existing knowledge, that is freely available, accessible and applied to support practices
- **Smarter regulation**  
To better protect threatened species, biodiversity and land tenure while improving access (supply) through smarter regulation
- **Market co-ordination**  
To enable the native seed sector to make coordinated market decisions by better sharing market-based information and connecting accessible networks.
- **New industries**  
To foster the growth of new and emerging industries to increase economic activity.
- **Sector leadership**  
To develop a single voice for coordinated action in the native seed sector to ensure strategic leadership and oversee the future growth and development of the sector.

Healthy Seeds Project staff were involved in Project Phoenix, through the External Steering Committee and as report authors. Hence, there has been a high degree of cross talk between the two projects.

The objectives and goals of Project Phoenix align well with the recommended interventions within this roadmap. Given that the draft strategy developed by Project Phoenix is written at a national level, we note that this roadmap goes into greater detail to highlight the requirements of NSW, while still contributing to national objectives.

Roadmap Interventions (HS)	Draft National Strategy Objectives (PP)
Co-ordination	Market co-ordination Information sharing New industries Sector leadership
Licencing & record keeping	Quality standards Smarter regulation
Project management	Market Co-ordination
Restoration Planning	Market Co-ordination

## Survey limitations

The Healthy Seeds survey program was impacted to some degree by timing and initial impact of the seed collection season, the drought, the widespread and extended 2019-2020 fire season and COVID-19 lockdowns. This probably limited the level of response that was possible and severely restricted response from agency staff during lockdowns and fires. Contact had been made with 25 native seed entities and 12 Local Lands Services (LLS) and Landcare regions across NSW including multiple staff.

The survey was also constrained by lack of responses for other reasons. At least ten major seed merchants declined to provide seed collection, source or target destination data, indicating it wasn't in their best interests to do so. The survey may have failed to locate many collectors operating on a small scale.

Due to the small number of responses, there was a lack of statistical analysis, which is another limitation.

## Moving forward

### **Why do these barriers exist and how can change be facilitated?**

Across NSW, the seed sector is functional in parts, however, to improve functionality, it needs to be assembled so it can operate in a systematic, co-ordinated and efficient way, so that it improves economic and environmental outcomes.

The sector requires:

- an overall acceptance and understanding of the importance of native seed and the seed sector to the objectives of conservation or restoration programs.
- a vision within those areas of influence of what can be achieved with a plan and co-ordination across the conservation and restoration sectors.
- a concerted interest in implementing the required co-ordination to introduce the systems, tools, processes and data tracking to support improvement in supply, thus improving restoration outcomes.
- a sustained long-term investment in people and skills to make sure these activities happen at a regional level where this is needed.

Reasons for the barriers include insufficient restoration planning, loss of funding, ineffective restoration monitoring and lack of sector representation.

The seed supply chain is rarely directly integrated into restoration or project planning. This results in suppliers receiving orders for seed from purchasers who assume the species they need will have already been collected. The consequence of poor planning is that key species are either deleted or substituted, often with alternative and inappropriate seed sources or species that are available, or the project is delayed or subsequently fails. The native plant nursery industry which grows plants for restoration has similar issues, but some issues are compounded, given that seedlings, unlike most seed, cannot be stored for subsequent years. Seed orders should be placed at least one season in advance.



There has been a loss of funding for programs from a uniform, staged and planned process to an 'ad hoc' approach of small and short-term grants for community and volunteer groups rather than professional programs. This has diminished the delivery of planned, long-term regional restoration programs that by their very nature must account for variable seasons, climate, seed availability and establishment responses. These small grants fail to foster sustainable professional regional project delivery models and related business and employment opportunities.

Insufficient monitoring of restoration projects is also leading to barriers in the seed supply sector. Without effective monitoring systems in place, project managers cannot determine the return on investment in seed. Also, without records of seed quality, if seedlings don't emerge, or emerge in numbers lower than anticipated, it cannot be determined whether this recruitment failure is due to seed quality or environmental factors such as rainfall or soil conditions. Hence, improved record keeping of seed quality and restoration monitoring would help improve restoration outcomes, and feed information back into the seed supply chain.

The lack of representation of the native seed sector is another reason that the barriers exist. The sector is geographically disparate and deals with the diversity of species and environmental conditions across the continent. Hence, the sector needs an organisation to provide a voice to help raise standards and advocate for change.

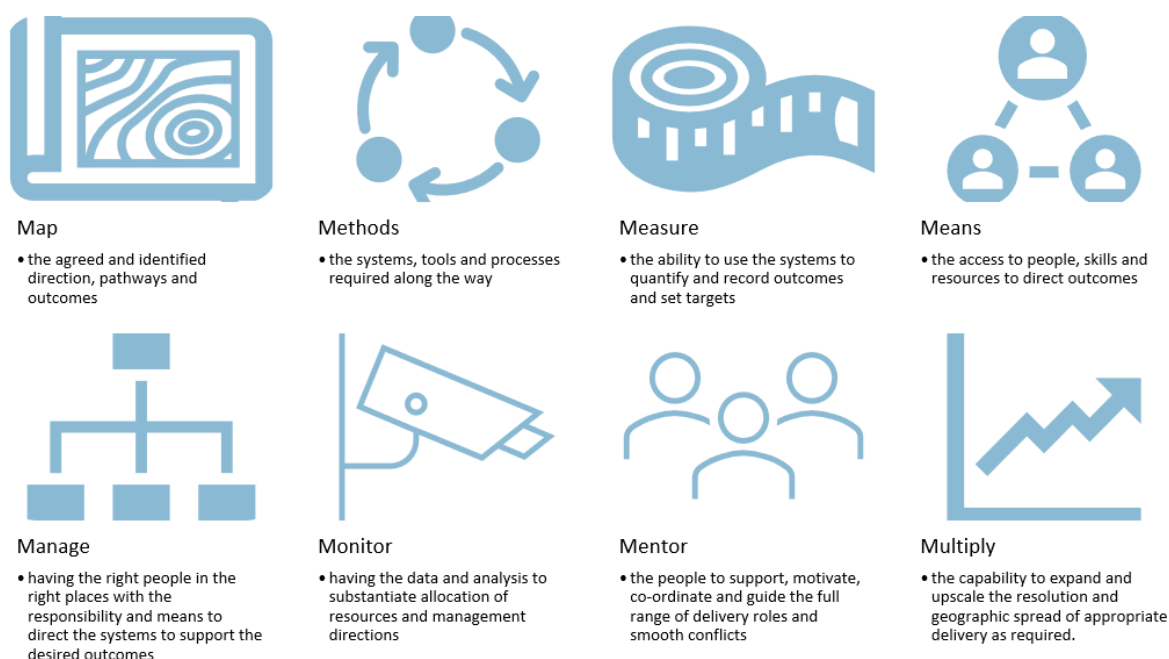
## Goal setting

In NSW there is an urgent need for a collective or agreed vision for the future state of native vegetation restoration and, by default, the seed sector in NSW. This project has established that there is little current data available on projected or past vegetation restoration targets by any agency or group in NSW. There is no aggregated data nor any current program to coordinate how this is going to happen. However, it is true that many are now struggling to pull these targets and data together.

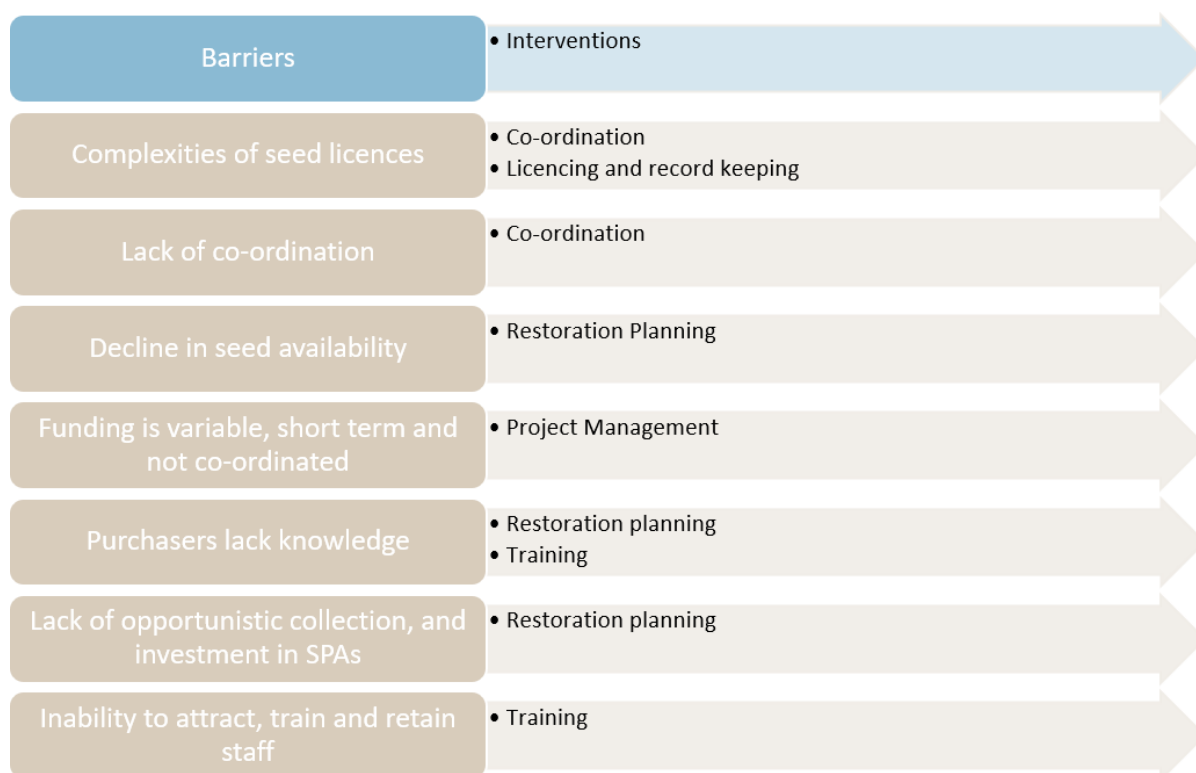
We need:

- Leadership and a vision of what the sector needs to achieve in terms of restoration goals, to create an agreed plan of action, and to articulate to others where we are going (Figure 3).
- A plan that is adaptable to the range of regions and needs in NSW.
- Data to back up the vision to quantify the scale and resources required.
- Adequate, coordinated and regionally relevant resources to deliver on the various stages of delivery.
- Sustained and meaningful acknowledgement for demonstrated targeted outcomes to support and motivate skilled people.

To overcome the barriers to seed supply, the sector needs interventions in five key areas: co-ordination, licencing and record keeping, project management, restoration planning, and training (Figure 4).



**Figure 3.** How we should go about designing sector interventions



**Figure 4.** Barriers and interventions to overcome these barriers.

# The Roadmap: recommended interventions to improve the native seed sector

These recommendations are based on the findings and feedback from the National Native Seed Survey (Hancock *et al.* 2020), and the New South Wales Seed Sector Survey and the Seed Production Area Audit (Appendix 7. Seed Production Area Audit). Specifically, the survey and audits identified issues and barriers, and proposed interventions needed to address these issues. The recommendations align with the draft Strategy for the Australian Seed Sector<sup>6</sup>, which was developed after the commencement of the Healthy Seeds Project (Box 4).

## 1. Improve co-ordination

Lack of co-ordination was raised as an issue, but by improving co-ordination, all other issues, from licencing to staffing will benefit. A state seed co-ordinator is required, with a network of regional seed co-ordinators. The co-ordinators could oversee seed demand and supply and determine seed requirements to assist with forecasting. They could identify gaps in seed supply that could be filled by SPAs. An audit of seed infrastructure at a state and regional level could identify what infrastructure is needed and where. Co-ordinators could provide liaison between on-ground practitioners and research agencies to facilitate two-way flow of information. They could also facilitate collaboration between those doing large scale restoration (e.g., mining companies) and those doing small scale restoration (e.g., landholders), to gain synergies in seed collection and use. Training needs could be identified and met by the co-ordinators. Hence, these co-ordinators could liaise with all sectors of the industry, including regional, state and federal agencies, research, botanic gardens, seed suppliers, seed purchasers and licencing agencies. Finally, the co-ordinators could amalgamate data on seed collection, storage, and use at a state level.

Addresses the following barriers: Licencing / Permits, Lack of co-ordination, Seed availability decline, Funding variability, Lack of seed knowledge, Failure to invest in opportunistic collection and SPAs, Inability to attract and retain staff.

1.1 Fund and appoint NSW State Seed Co-ordinator and Regional Seed Co-ordinators within each LLS NRM region. Staff to be appointed within agency structure to ensure ongoing and long-term funding for positions.

1.1.1 Duties of a State Seed Co-ordinator would be to liaise and co-ordinate:

- project development,
- technical and infrastructure support,
- research needs,
- training needs,
- seed supply and seed demand,
- liaise with agency licencing staff to overhaul seed licencing system,
- agency interaction, and
- amalgamate seed use, uptake, storage and data at a state level.

6 <https://www.greeningaustralia.org.au/wp-content/uploads/2021/08/3.01.pdf>

#### 1.1.2 Duties of State and Regional Seed Co-ordinators would be to:

- Facilitate collaboration and co-ordination between mining and NRM projects in appropriate areas to gain synergies in seed production and demand and extend NRM capability.
- Maintain research linkages with state and national research bodies to assist with addressing regional research needs and translate knowledge to end users (e.g., seed storage/ longevity, seed treatment/ germination for direct seeding, background genetic benchmarks and genetic representation in SPAs, project monitoring; genetic work in rainforest species in northern NSW and in SPAs in Central Tablelands; germination response and triggers in key direct seeding species on Northern Tablelands).
- Co-ordinate the identification and resourcing of regional native seed infrastructure (seed processing, equipment, storage capacity, direct seeding machinery, skills and mechanisation).

#### 1.1.3 Initiate a Regional Seed Co-ordinators network to facilitate networking between regional seed, project, data and technical co-ordinators to:

- provide technical support,
- analyse training needs,
- deliver training,
- determine research and technology needs,
- coordinate projects,
- liaise between industry and regulators with regards to licencing, approvals and permissions,
- facilitate communication between groups within the sector and help capacity building for small operators, e.g. volunteer groups, community groups, landcare & coastcare groups, NGOs, not for profits, nurseries, TAFE, and training providers,
- determine seed requirements,
- determine SPA requirements, and
- provide stability and continuity for skilled staff to provide seed and technical support to project delivery.

## 2. Licencing and record keeping

Ensure that licencing systems are more efficient, effective, useful and fit for purpose; licence applications have clear instructions, and achieve the aim of preventing over-harvesting and having a net positive environmental impact. Adopt and implement minimum standards for seed collection (including data collection) and use these to underpin regulatory approvals. Use appropriate record keeping systems and provide data to the buyer to improve transparency in seed quality.

Addresses the following barriers: Licencing / Permits, Seed availability decline, Funding variability, Lack of seed knowledge.

- 2.1 Develop an industry Code of Practice for seed supply
  - 2.1.1 Align the Code of Practice with the operation and objectives of the state licencing system.
  - 2.1.2 Adopt compliance with Code of Practice as a standard requirement in all restoration contracts.
  - 2.1.3 Adopt the Florabank Guidelines and the Code of Practice as the primary reference for setting clear seed quality and market standard and price signals.
- 2.2 Ensure that applications for seed collection licences and seed-based restoration funding show how the project complies with the Florabank Guidelines.
- 2.3 Ensure that the native seed required for any restoration projects or required offset projects are to comply with the Florabank Guidelines at the outset of the programs, and that costs and realistic budgets are established at the planning stage.
- 2.4 Implement native seed supply standardised labelling based on the Code of Practice
- 2.5 Implement a seed database tracking system to enable buyer confidence in seed source and compliance with licencing requirements, and a collate data at a regional and state level.
- 2.6 Implement standardised Seed Collection Zones based on NRM regions with standardised regional seed zone numbers.

### 3. Project management

Restoration projects and funding models must take into consideration the logistics of the seed supply chain, the time required for seed sourcing, propagation (if needed), implementation and monitoring, as well as the variability of climate from year to year. In some cases, this may mean project budgets and grant timelines should be extended from one year to five or more years.

Addresses the following barriers: Funding variability, Failure to invest in opportunistic collection and SPAs, Inability to attract and retain staff.

- 3.1 Review of fragmented program funding models to ultimately enable stable staged delivery within a coordinated regional model.
- 3.2 Strategic and coordinated allocation of resources for project development and implementation.
- 3.3 Allocation of project funding for a minimum of five years to resource identified regional seed supply issues, gaps and core project implementation. Grant funding schemes need to consider the time required for seed collection, processing and propagation.
- 3.4 The cost of seed needs to be incorporated in project budgets.

## 4. Restoration planning

Restoration planning at a regional and state level will help improve seed supply, if restoration projects requiring seed have a strategic and staged delivery. All NRM regions require regional vegetation guides to enable planning and inform species selection. Plans for seed sourcing need to be integrated into every government and non-government restoration program. Investment into the SPA network is sorely needed to reinvigorate SPAs and provide seed that cannot be sourced sustainably from wild collection.

Addresses the following barriers: Lack of co-ordination, Seed availability decline, Lack of seed knowledge, Failure to invest in opportunistic collection and SPAs.

- 4.1 Undertake regional planning of infrastructure and investment, and project forward planning.
- 4.2 Ensure that all NRM regions have up to date (and on-line) Regional Vegetation Guides<sup>7</sup> of reference vegetation communities and landforms with species lists to underpin all seed collection, restoration projects targets and implementation.
- 4.3 Identify restoration opportunities within the Local Land Services Traveling Stock Route Plans of Management project within each region.
- 4.4 Native seed requirements and supply systems should be considered, accounted for and resourced in the development of any Government restoration project or programs.
- 4.5 Planning and resourcing seed collection should also incorporate resourcing infrastructure for seed storage.
- 4.6 Identify species needs on a regional level, identify which of those cannot be sourced sustainably through wild collection and could be supplied by SPAs.
  - 4.6.1 Resource and establish co-ordinated regional SPA networks, and processing, storage and delivery facilities to supply the identified species. This is particularly important in delivery of LLS TSR potential projects and larger scale regional opportunities where seed is not freely available.

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<sup>7</sup> [https://www.lls.nsw.gov.au/data/assets/pdf\\_file/0008/1200878/20-SE-TSR-Veg-Guide-web.pdf](https://www.lls.nsw.gov.au/data/assets/pdf_file/0008/1200878/20-SE-TSR-Veg-Guide-web.pdf)



## 5. Training

A training program in Seed Literacy is needed for both suppliers and purchasers. It would lift the success of seed-based restoration, assist purchasers make better decisions, provide job training and improve career path development. The training program could be based on the content of the Florabank Guidelines.

Addresses the following barriers: Lack of seed knowledge; Inability to attract and retain staff.

- 5.1 Initiate and implement a training program in Seed Literacy. This program should build on the Florabank Guidelines and the International Seed Standards. This would initially target internal program staff and devolve to include project implementation and contract agencies and seed purchasers/users. It can be used in lifting seed operational systems standards, successional and on the job training and support standards for improving career path development.

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## Appendix 1. A personal plotted history and perspective of native seed use in NSW

The history of using Australia's native vegetation and seed predates European settlement history and we acknowledge that the collection of native plant seeds and other plant products was integral to both the ecology and economy of Australia's First Nation peoples. What really differentiates this utilisation is that for many thousands of generations of management prior to European settlement, human utilisation was balanced by predominantly self-sustaining ecological systems. European settlement rapidly overturned this with very early over-exploitation of the vegetation resources. The Cedar (*Toona* spp.) industry was already well underway in the colony of NSW by 1800 and these species were already being seriously depleted by 1850, but limited extraction persisted into the 1930s. This trajectory of exploitation and depletion of species, ecosystems and landscapes has been repeated many times across various parts of NSW and is predicated on the notion that supply is unlimited or at the very least is self-replacing. Little regard was ever paid to the notion of sustaining supplies through seed collection and establishing plantations, or the appreciation that the ever-decreasing supply of seed-bearing trees was not capable of producing sufficient viable progeny to keep up with the rate of harvesting. The long-established order of recruitment, harvest and time had been irretrievably disturbed.

Vegetation and ecological loss have been occurring across large parts of NSW since European settlement, either by direct exploitation of valuable resources or incidental losses in clearing or degradation in pursuit of other valued resources (grazing, cropping, mining, infrastructure and urban development). The knowledge of the range of impacts of these losses and the increasing realisation of the costs of vegetation and species loss and the need for native seed supplies have been well outlined in the Australian Native Seed Survey Report. It is also obvious that the restoration sector can never, nor even adequately keep up with uncontrolled land clearance. We already have a backlog of land needing to be restored, even without continuing clearing.

The recognition that the loss of species, landscapes and ecosystems was significant and could be reversed also occurred very early and has been well documented. There have been numerous attempts to address and reverse some of the adverse impacts of vegetation loss but each of these required a substantial and well-structured local or regional seed supply system or effective natural regeneration. With regard to the decline and loss of the saltbush pastures of the Riverine Plains the NSW Government Veterinary Surgeon noted in 1886 that "...We have no doubt that plenty of roots and seeds are available in the back portions of the colony where the effects of excessive feeding off are not so apparent as they are here, and that were small nurseries created here, it is likely that in a few years we would again have such valuable plants thriving vigorously on the local pastures. Is the experiment worth a trial?" (Pastoral Times, May 15, 1886). Similar observations were made regarding the loss of White Cypress Pine in the 1880s, 1900s, 1930s, 1940s, 1950s, 1980s, 1990s and 2000s. But other than promotion of the problem and small incentive programs, no extensive program of native seed supply and broadscale re-seeding has ever been initiated. Consequently, White Cypress has effectively been lost as a commercial opportunity in the south of NSW and its diverse ecosystem is virtually unknown except for a few relict sites.

Where there were valuable commercial forestry assets, there have been long and well-established seed collections, seed selection and seed orchards and in more recent times irrigated seed production systems of high value, high rainfall Eucalypt species. The various iterations of NSW Forestry and CSIRO Tree Seed Centre have a proud history of tree improvement and development in this area. Unfortunately, much of the benefit of this effort has been realized in China, South America, South Africa and South East Asia.

This notion of investment in extensive and diverse native seed supplies has never much advanced into the conservation area except for the now defunct network of NSW Forestry and Soil Conservation Nurseries. These systems began with the provision of free amenity trees to new subdivision farm settlers under closer settlement schemes and later evolved into a much greater range of native species and a very skilled and valued extension service. Ironically these closer settlement schemes also required the complete removal of significant areas of the native vegetation to maintain occupancy.

Many of these new closer settlement blocks across inland NSW can still be identified today by the cluster of either exotic Peppercorns, palms or Sugar Gums provided by these nurseries in an otherwise over-cleared landscape. The limited range of species was purely a function of what seed was freely available and easily produced and what species were known to be hardy and grow. It was and still is a widely held contention that you need to look elsewhere to find species that will grow in your area. This is partly because of the radical depletion or complete loss of locally native species (and limited appreciation and local knowledge) in many areas and partly that tree and shrub seed was already much more freely available from either overseas where there were seed supply systems or Western Australia where a diversity, appreciation and industry was already emerging.

Prior to the 1980s Western Australian tree and shrub species featured prominently on many tree species lists, in nursery supplies and forestry and farm tree trials in NSW. The focus in extension, production and supply was on trees, primarily as windbreaks. There was little emphasis on the ecological values of native vegetation or in planting local tree species and next to no structural or species diversity in the way of locally native shrub or ground-layer species. This was at least in part a function of lack of supply of local native seed and in part due to the lack of awareness, promotion and appreciation of the local species and also that there was other seed already easily and cheaply available from elsewhere.

The regional NSW Forestry nurseries and associated Forestry extension staff were effectively increasing the diversity and range of native species available through the staffs' own personal small scale (and presumably limited genetic range) seed collection efforts. Emphasis was still very much focused on tree planting with no direct seeding being promoted or trialed, though some mechanized planting was developing. The quantities of seed required were therefore minimal and insufficient to support full-time collectors or broadscale restoration. The demand for locally native seed in regional agricultural landscapes was comparatively low (but growing) compared to the volumes required for uses such as broad-scale restoration, mining rehabilitation and native forestry further to the east and in Western Australia.

Probably some of the greatest efforts, expertise and extent in broad-scale land rehabilitation and seed supplies and native vegetation establishment in NSW was that initiated by the NSW Soil Conservation service in the Western Division of NSW. The expertise and extension in plant identification, seed collection, seed sourcing, direct seeding and land reclamation was a model well worth imitating, but unfortunately now regionally either much reduced or mostly lost.

Awareness of environmental issues in general and native vegetation decline in particular, had been gaining awareness and prominence throughout the 1970s and 1980s and culminated in the formation of organizations like Greening Australia (1984), and the Landcare movement through the efforts of the Australian Conservation Foundation (ACF) and the National Farmers Federation (NFF) (1986). These organizations created awareness and demand for tree planting and funding for tree planting programs, landcare and landholder support. This came with the coinciding elements of the National funding for the Greening Australia One Billion Trees Program and Landcare, and in NSW the Greening Australia Trees by the Million Program, the formation of Total Catchment Management (TCM) and the Catchment Management Committees (CMC) in 1989. Campbell *et al.* (Campbell *et al.* 2017) provide a much more comprehensive and critical national overview of this period of four decades of land restoration in Australia to the present.

The formation of regional CMCs in NSW provided for the first time a coordinating entity across all Government agencies and community interest groups to focus on and target natural resource management issues at the regional scale and allocate financial resources accordingly. Greening Australia initially employed five regional coordinators across regional NSW who worked with and between the CMC, community and network partners to create awareness of relevant regional issues, run training in seed collection, plant propagation, revegetation techniques and assist in developing and coordinating projects. In retrospect this was a very effective model to employ local people with appropriate skills and passion in their own regions to inspire, motivate and facilitate resourcing for regional projects.

It was also a way to establish at close quarters what the impediments and barriers were at the technical, community, landholder, agency and systems levels. While every regional coordinator and Greening Australia region operation responded to varying regional needs in different order of priority and scale, there was networking between regions and co-ordination and overlapping and exchange between regions and a level of consistency in approach.

Not surprisingly, some staff that were already involved in the native seed or restoration sector or trained during the 1990s are still involved in some form in different agencies with changed or reduced vegetation related responsibilities. Others have moved into their own businesses or are involved in native seed supply to the mining sector which has been the biggest winner in resourcing over this period. The NSW native seed sector displays a fairly clear dichotomy between the mining sector and a much reduced NRM/ restoration sector- with NRM and conservation/restoration being the big loser in terms of resourcing and agency support.

## Appendix 2. Seed Survey Questions

**Table 3** Survey Interview Questions.

Interview Questions	Response categories
Which LLS region(s) are you in?	Western Murray/Riverina
How many full time staff do you employ?	#
How many part time staff do you employ?	#
How many subcontractors do you employ?	#
What is your entity?	Local Land Service Local Government Wholesale Retail/Nursery Project based
Across what geographic range do you collect?	Local Regional Catchment Multi-catchment State Interstate
Indicate the proportion of your collection strategy	Collected to contract order Collected to estimated demand Speculative collection
Across what geographic range do you distribute	Local Regional Catchment Multi-catchment State Interstate International
How many species do you collect?	<30 >30
Indicate the total weight (kg)of seed collected	
Indicate the total weight (kg)of seed of the following: <ul style="list-style-type: none"> <li>• Trees</li> <li>• Shrubs</li> <li>• Forbs</li> <li>• Grass</li> </ul>	
Indicate the source of seeds	Wild – public land Wild – roadsides Wild – private land Plantings / Direct seedings Seed Production Areas
Do you have a seed licence?	Yes – State Scientific No Don't know Landowner permission

Interview Questions	Response categories
Do you have a database?	Yes – computer database, full tracking Yes – spreadsheet, limited tracking
What processing facilities and equipment do you have?	Full shedding and equipment Adequate equipment Limited facilities
What is your seed testing capability?	Viability / xray Germination Cut or Float test None
What storage facilities do you have?	Humidity controlled Refrigeration only Secure container
Were you impacted by the 2019/2020 fires?	Yes No Indirect
Please list the issues in the seed industry	
Please list the opportunities in the seed industry	



## Appendix 3. Case Study: Seed Supply Collaboration

Central West Landcare have the knowledge and skills but no capacity from wild seed supplies to deliver the on-ground projects that they would like to initiate. There is also no current seed capacity to develop and deliver the efficiencies of direct seeding in the region or expand the scope of projects. The local mining industry is in a similar position with a requirement to deliver some of the same species in their offset programs that the Landcare network would like to use at a greater scale. They would like to develop SPA systems but are lacking the skills, knowhow and networks and trust to go down the commercial or community path. Co-ordination, skills sharing, devolved funding and resource sharing could ensure effective and equitable seed supplies for a range of entities and create jobs where a market already exists but supply is limited.

Such a level of regional co-ordination obviously also enables the establishment of regional SPA systems where species gaps and opportunities are much more easily identified. Devolved funding can also be more effectively planned and delivered in a coordinated way and matched with devolved developing markets to secure the future of the SPAs. This then enables more closely matched supply, demand and tracking of seed.

The regional seed coordinator model is an essential and increasingly important role in the identification and delivery of those essential elements and shortcomings in regional seed infrastructure in each of the NRM/ LLS regions of the state.

## Appendix 4. Case Study: Pioneering species for direct seeding

By Sue Logie

### Seed Production Areas in the NSW Murray Catchment

In 1996 a seed bank network was established with Natural Heritage Trust funding secured by Greening Australia Riverina. Seed banks were established in Albury, Deniliquin and Swan Hill with three full-time coordinators. The role of the seed banks was to provide seed for restoration projects across the catchment. At this time, direct seeding was becoming the preferred method of revegetation, and it became clear that the wild populations could not meet the demand for seed. The first SPA was established in 2000 using the newly produced Florabank guidelines.

By 2003 the regional support model for Greening Australia ceased due to funding cuts. The seed bank operations were taken over regionally by the Nature Conservation Working Group (NCWG) with Catchment Management Board support and limited Federal funding and contract project revenue. In 2005 the seed banks were merged into one and relocated to Berrigan and absorbed into the newly formed Murray Catchment Management Authority and then Murray Local Land Services in 2015/16. In 2009 the seed bank moved from Berrigan to Deniliquin to a purpose-built facility at a location 10kms from the Deniliquin town centre.

Over 20 years the management of the seed bank has changed several times, however staff were still able to build a network of over 48 SPAs across the Murray catchment. The majority of sites are on private land and the areas vary from 0.25 ha to 7 ha.

In the first 10 - 15 years, the SPAs produced large volumes of seed and were used to direct seed Natural Resource Management projects funded by State and Federal Governments. These projects would not have been possible to undertake without the increased SPA seed production capacity, storing of large quantities and the effective ability to record and track seed through the seed bank database.

Despite this SPA capacity, decreasing project and core funding and lack of administrative support led to both staff reductions and loss of capability and revenue. Over time, this has reduced the ability to manage and harvest SPAs, store SPA seed and inability to develop and deliver on NRM projects. A primary consequence of this cycle of the decline of SPA site management and investment was a decline in productivity of many of the SPAs.

This happened for a number of reasons:

- During the SPA establishment phase, there was not enough emphasis on maintenance and without pruning, weed control and good fencing many became unproductive or were grazed out by stock (Figure 5).
- Many of the SPAs were designed using revegetation principles and seedlings and rows were too close together and sites became overgrown and inaccessible. This was also exacerbated by a lack of maintenance.
- There was a loss of knowledge and experience when seed bank staff departed. This impacted on the ability of the seed bank to maintain SPAs and provide good guidelines to landholders and keep them motivated.



**Figure 5:** Overgrown *Acacia brachybotrya* blocking access and in need of hard pruning as many plants have become unproductive. Photograph by S Logie.

In 2016 LLS was successful in obtaining funding from the NSW Environmental Trust to audit and rehabilitate SPAs in the Murray catchment. There were over 50 sites registered, and it was essential to ensure the funds would be used to increase productivity and improve the genetics of SPAs.

Sites were prioritised for rehabilitations using the following criteria:

#### **Location of the site and accessibility**

It is important that sites are within 1 - 1.5 hours travel from the seed bank and are easily accessible. e.g. if there are five gates to open and shut and it takes 2 hours drive to get to the site.

#### **Size of the site**

The optimal area for a site is 2 - 7ha. There were a number of small sites which were considered too small to be cost-effective to harvest or rehabilitate.

#### **Number of species and condition of plants**

The diversity of species, the quantity and the health of the plants were important factors in determining which SPAs should be prioritised for rehabilitation. Larger sites usually had more species and were a better option for redesign.

#### **SPA Owner commitment**

The commitment of the owner was an important factor in determining if funding was invested in the SPA. Owners who showed interested and had maintained their SPAs were a high priority.



## Species suitability for pruning

Some species can be hard pruned, which was a cost-saving exercise. Selected sites were pruned, and additional new provenances were introduced to increase the genetic diversity of species (Figure 6).



**Figure 6.** An excavator removes *Acacia pycnantha* plants which were unproductive. Photo by S Logie.

Four new sites were established as well as the rehabilitation of several sites (Figures 7 & 8). New sites were designed to ensure there was space for plants to grow, and there was vehicle access between the rows for harvesting and maintenance. Targeted collection was conducted to provide a diversity of provenance for species, and additional species were introduced to increase the seed bank catalogue.



**Figures 7 & 8.** Yorta Yorta property 'Ulunja' newly established SPA and Woka Walla crew planting seedlings. Photo S Logie

## Lessons Learnt

- Many of the pioneering direct seeding species have a limited lifespan and require regular maintenance and replanting to meet the ongoing demand.
- It is essential to have a well-designed and well-maintained database to ensure the seed source is accurately tracked.
- Collect and store pioneering species seed during the most productive years (years 5-10)
- It is important to establish a SPA Bank, which is a bank of wild seed populations collected and used only to establish SPAs. This ensures a range of provenances from a variety of species to increase the genetic diversity of SPA populations.
- Ensure plants have room to grow, and there is vehicle access between the rows for harvest and maintenance (Figure 9).
- The bigger the site the better. Large sites increase the number of provenances and plants for each species and reduce travel and harvest costs.
- Running a seed bank requires organisations to be adaptable to institutional changes, government investment priorities and funding fluctuations.

## SPA Requirements

- Secure land tenure. If on private land, an MoU or agreement needs to be developed which clearly outlines the responsibilities of the owner and the agency and seed payment rates.
- Fencing, weed and pest control, particularly woody weeds and pest herbivores such as rabbits, hares and deer.
- Sites should be located near or as close to remnant vegetation as possible to maximise number of pollinators.
- Rigorous attention to genetic sourcing.
- Regular maintenance, e.g. pruning, replacement of dead or unproductive plants.
- The development of a ten-year plan to ensure SPAs continue to produce seed, taking into consideration species longevity and number of provenances available at the time of establishment (you may want to increase the number of provenances later).
- Accurate recording of species, number and provenances for sites.
- Site map with GPS and species locations.



**Figure 9.** Renovated SPA at Berrigan where *Acacia pycnantha* plants were removed and replanted. The distance between rows was increased to 8 m and spacing between plants increased to 6 m. Photo S Logie

## Appendix 5: Case Study: The Regional Approach to Native Seed Supply in the Riverina

To convey an outline of the evolution of this regional approach it is worthwhile giving a case study of the broad development across several Greening Australia regions in southern NSW. It was soon apparent to Greening Australia regional coordinators that the role of advocacy, encouragement and training were insufficient to satisfy the pent-up demand to actually deliver on-ground change in revegetation and restoration at a scale that was relevant to the ecological problems and vegetation loss. There were many sites on community land with community groups wanting to take on projects and many private landholders that wanted to set aside areas for restoration but did not have the financial resources to achieve it. While it was possible to deliver some of these projects through a competitive regional CMA process this was long, slow and relatively cumbersome process and wasteful of precious time and resources.

It was also apparent that while regional species lists were important it was no use advocating local species plantings if the nurseries weren't supplying local species. It was soon identified that nurseries were unable to deliver local species because the seed was not available. The seed was unavailable in part because the species were not advocated and requested but also because there was no organized demand, local capacity or skills to collect the seed and the species were in some cases so diminished that collection was unfeasible and too expensive. Seed collection training workshops were conducted. Landcare, field naturalists, landholders and community groups were formed and coordinated. Small community nurseries and limited seed collections were initiated on minimal CMA funding and commercial nurseries were initiated and expanded on an increasing demand for seedlings and funded planting projects. At its peak there were at least twenty-one native tree and shrub nurseries operating in the greater Riverina region including an across border collaboration with Victoria.

The issues of across border seed supplies and project support were partly addressed in 1994 with the establishment of the Greening Australia Commonwealth-funded Corridors of Green Project. This enabled the employment of a network of additional regional coordinators operating with devolved funds to support projects and small-scale seed networks mirrored across the border.

This development of increasing awareness, knowledge, demand and funding for locally native plant restoration also coincided with the experimentation and development in direct seeding technology. If vegetation restoration and enhancement was going to occur at any scale the development of this technology and equipment to suit local conditions was going to be imperative. The one thing that was the major impediment was the amount of seed and efficiency of seed collection from widely dispersed and fragmented remnants. As the demand for plants and projects increased so too did the need for seed until the Natural Heritage Trust (NHT) enabled the founding of a network of seedbanking facilities. This also funded full-time native vegetation extension staff.

In the Riverina, as well as other areas of NSW, it was established that most of the key restoration species occurred on roadsides and Travelling Stock Routes and Reserves (TSRs). This led to mapping of the distribution, extent and site quality of all species along roads in the Murray and Riverina catchments. Ultimately this led to the development of management plans to protect and manage some of these remnants and the evolution of the NSW Roadside Environment Committee (REC). This enabled the uptake of this



approach across NSW and eventually led, through a long and tortuous route, to the adoption of the Local Lands Service (LLS) Travelling Stock Routes (TSR) Plans of Management and Local Government Roadside Management Plans.

The state based Vegetation Incentives Program (Deposit for the Future) (Driver *et al.* 2000; Spooner *et al.* 2002) was highly successful at devolving regional delivery of restoration through Greening Australia and the regional Murray Nature Conservation Working Group (MNCWG). It provided employment for full-time vegetation extension staff and seedbank managers and coordinators. The strategy of the Vegetation Incentives Program was to link the co-ordination of direct seeding development and site restoration and enhancement incentives on private and public land to the native seed supply system. This program also fostered the expansion of the local and regional nursery sector with up to twenty-one regional nurseries being supplied with local native seed and coordinated project species lists. This ensured that co-ordination and matching of species to sites was integrated and the increasing for demand seed could be met by both increased areas of restoration and by the creation of seed production areas (SPAs). The mapping of roadside remnants also enabled the dissemination and co-ordination of regional seed collections and ultimately the collection of seed across the known range of key species and depleted restoration species that could be incorporated into the regional Seed Production Area network.

It was during this expansion phase of vegetation enhancement and restoration activity across NSW and beyond that the seed supply networks within and beyond Greening Australia were initiated and were included in the first national Native Seed in Australia Survey (Mortlock 1998). This Greening Australia regional extension and seedbank model and others like it were seen as the future direction and solution to addressing our vegetation decline issues across NSW and beyond. Without seed any major efforts in revegetation were obviously left wanting.

When the effectiveness and support for the regional incentives and seedbank co-ordination model was demonstrated, funding and support were in decline. This decline in direct funding continued and extension staff and skills were lost and the seedbank was only operational on delivery of limited CMA projects and other contracts. By 2003 the regional support model for Greening Australia had stopped after both federal and state funding was withdrawn. The seedbank operations were taken over regionally by the Murray Nature Conservation Working Group (MNCWG) with CMA support and limited Federal and contract project revenue. A significant contract revenue base was able to be sustained through delivery of direct seeding services to the Murray Irrigation Limited (MIL) Land and Water Management Plan for the Government funded on-farm site restoration projects.

Even as funding for on-ground projects was diminishing at this stage, negotiations with both State and Commonwealth Departments and Ministers centred on the expressed notion that “....we are not interested in seed, we just want trees in the ground.”. This fundamental lack of understanding of the need and complexity of the native seed supply system still seems to pervade the bureaucracy, programs and politics to this day. It is even still evident in an almost complete lack of understanding in seed supply requirements in large commercial contracts, seed ordering and native plant species recovery programs. This lack of knowledge and understanding of the seed sector at so many levels, including the end user and primary market of Government is hereafter referred to as a lack of Seed Literacy.

Despite the continued decline in funded vegetation projects across the state during this period (early 2000s), and the declining revenue and viability of the seedbank, it continued

to operate vegetation extension and seed supplies to regional nurseries and contract direct seeding to the CMA, NSW Roads and Traffic Authority (RTA), Murray Irrigation Land and Water Management Plans and private landholders. The CMA and associated projects were the primary indirect and direct revenue stream of the seedbank through until being absorbed, with staff, into the CMA in 2006. This model operated effectively despite decreasing funding and administrative and accounting constraints until the formation of the Local Land Services (LLS) in 2013.

With the formation of Local Land Services there was a statewide shift in emphasis from a balance in natural resources management and agriculture to a more production focus and a resultant de-emphasis in native vegetation extension, funding and project development in many regions of the state. However, in the Murray the integrated central co-ordination and extension skills in developing and supporting projects, seed production and seed harvest and direct seeding capability provided an integral opportunity to further develop direct seeding enhancement of LLS TSRs.

If it were not for the historical investment in increased capacity to produce locally native seed in SPAs (Appendix 1- Riverina Case Study & SPA Development) and the capacity for medium to long-term storage of a range of species, many small and some large-scale restoration projects would not have been able to be delivered during this period. The Murray and Riverina TSR direct seeding project (2012-2017) utilized 1180kg of over 35 mainly tree and shrub species over at least 2000 hectares of enhancement seeding through funding provided by the Australian Government (Davidson and Tzaros 2017). The 20 Million Trees, Riverina Sandhills and numerous National Parks projects were also able to proceed when funding was available due in part to the capacity of SPA production, the temperature and humidity-controlled seed storage and processing capability and the retained staff skills and experience by the CMA and LLS.

However, without certainty on future project investment, reducing revenue and reducing collections there is a decreasing capacity to respond to an upswing in demand even if funding was immediately restored. Despite continued need and small-scale demand for nursery seed supplies and for vegetation restoration there has been a resultant decline in staff, capacity and funding to deliver. A consultant's review of seedbank activities in 2019 (Henderson 2019) has demonstrated the projects vulnerability, viability and sustainability concerns without the availability of direct investment and future regional project delivery. Without this base funding the enterprise is unable to exist and therefore develop and expand into other market opportunities.

While this case study overview is a brief potted history of just one region of the state, the story and trends are representative of the sector as a whole, even if the specific levels, projects and operations vary from region to region. In some regions direct seeding was never able to be developed because seed quantity availability was never able to be increased with seed production. In other regions seed quality and genetic diversity were never addressed for the same reason. If there was no effective longer-term, scaleable seed storage in an area it was not possible to respond to short-term funding or delivery. In some regions the level of extension support awareness, species guides, references and incentive support for projects was not available to the level to initiate appropriate projects. But while the scale and delivery varied, in simple terms, there had been an increasing investment in restoration and vegetation management extension from the 1980s, rising through the 1990s to a peak, followed by a long decline and then a complete hiatus. This has led to a varying degree of collapse or dispersal in staffing, skills, infrastructure and capacity in seed supply in the public NRM sector across most regions in NSW. This has also meant a decline or increasing exposure to risk in delivery systems and options in the private sector in all those regions where seed supplies to mining restoration were not an option.



## Appendix 6. Regional priorities

New South Wales is divided into 11 Local Land Services regions<sup>8</sup>.

There are a number of key NRM regions, projects and seed supply systems already in place and operating in NSW at present. Some are at risk of closing due to lack of core funding for staff and/or reduced project spending which would ordinarily fund project staff (or both). Other regions or projects have been identified as a priority need for implementing early stage seed supply identification issues, co-ordination or as having a gap in systems, infrastructure, research support or co-ordination.

There are also some issues that are a state-wide priority that need to be centrally initiated, coordinated and resourced. These would include the co-ordination and development of regional vegetation guides, collation of state seed data and permits, interagency collaboration etc.

It is also assumed that as regional programs evolved and developed they would require the deployment of supplementary staff to seedbank activities in extension, implementation and direct seeding.

### South East/ Illawarra

The South East LLS is a very diverse and physically fragmented region covering many landscape and vegetation communities. It is highly likely that multiple geographic, landscape and vegetation seed coordinator roles will be required. It is recommended that investigation is undertaken to identify the placement of additional seed co-ordination roles in the upper and lower tablelands and south east coastal areas. It is also apparent that the Australian Capital Territory (ACT) is intrinsically and functionally part of the South East native seed supply and distribution chain. It also is imperative in both infrastructure and skills dissemination across a significant portion of the region through Greening Australia and other agencies.

The long-running South East LLS Illawarra Landcare restoration project co-ordinator funding is expiring, currently only part-time and has been intermittent and unreliable and dependent on volunteer input. To retain the position and project operations a full-time funded position through South East LLS is recommended as a priority.

It may be worth investigating the opportunity for genetic diversity analysis of rainforest source material for nursery material in this project and research into direct seeding options for some species.

### North Coast

There are several effective long-standing restoration programs and widespread community engagement in the north coast of NSW. With the major emphasis being on rainforest species there is little current scope for long-term storage and seedbanking though there is scope for research collaboration and implementation.

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<sup>8</sup> <https://www.lls.nsw.gov.au/regions>

A priority issue is support for co-ordination of seed supplies from genetically diverse populations and individual species. To ensure this is developed it is a priority to establish a genetic audit of background populations of key restoration species within different plant guilds. This will enable decisions to be made to select genetic material and establish seed production areas (SPAs) from diverse genetic material for at least some of the key restoration species. This would ultimately reduce the costs of travel and sourcing difficult and remote populations while protecting from the risks of in-breeding from using limited genetic stocks. It is probably prohibitively expensive and logistically onerous to audit all restoration species and then to establish SPAs for all species, at least initially. It would therefore be wise to identify key plant guilds and key restoration species within guilds to develop first.

Given the expansion of currently operating projects and development of extensive newly proposed biodiversity projects in the region, there is a strong case for investment into permanent seed collection, processing and storage infrastructure. This needs to also include the development of vegetation profile templates and seed training for the regional networks in collaboration with systems and networking with adjoining LLS regions.

## **Murray/ Riverina**

Murray LLS Seedbank network is probably one of the longest running, best equipped and most integrated seed supply and restoration operation of any of the NSW NRM regions. The primary issue has become the viability of its operations under reduced on-ground project funding and the maintenance of a full-time seed co-ordinator if the position is not funded as part of its core operations. Consultants reports (Henderson 2019) have identified a number of key opportunities, but all are dependent on either increased access to devolved regional projects, internally delivered incentives for works or large co-ordinated restoration projects.

Murray has a history of effectively delivering devolved incentives projects on private and public lands as well the extensive restoration projects on TSRs and National Parks and reserves over a number of years. Because the skills, systems and infrastructure already exist with the Murray LLS it would be negligent to let the system collapse for want of minimal on-going devolved project investment that can then enable the leverage and development of other projects.

It would also be wise to review the accounting policy anomalies within NSW in the asset treatment of the storage of seed and its impacts on net cost of service. This policy decision places inappropriate restrictions on the ability to stockpile seeds in high yield seasons above the immediate replacement levels. This is exactly the reverse of the intended purpose of the operation of a working seedbank.

## **Northern Tablelands**

There has been a long history and concern about tree and vegetation decline on the Northern Tablelands. There have also been well established tree planting projects and groups. While the LLS/ Landcare networks have maintained collaboration with a diversity of groups and commercial suppliers this has not yet been fully integrated or optimised. There has been recent interest in expanding a conservation seed supply program network and seedbank including the establishment of SPAs to increase seed supplies. Although direct seeding has been used in mining rehabilitation in the wider region in commercial operations it has not been adopted within agricultural, production or NRM restoration

on the Tablelands. This has been in part to do with the lack of adequate quantities of appropriate seed supplies of restoration species and also the lack of appropriate market incentives.

While the LLS currently have a position that in part covers this role, it is not full time or necessarily secure. The employment of an LLS/ Landcare full-time regional seed coordinator and collaboration and resource sharing with commercial suppliers and mining interests to scope, develop and implement a regional SPA project. It may also require the collaboration of plant geneticists to sample the genetic diversity of the parent seed material collected and advise on inclusions within the constraints of availability.

Such a program would also require devolved funding to resource the development of enhancement incentives and would provide the opportunity for LLS TSR direct seeding restoration, landcare planting and seeding projects and reciprocal exchange with the commercial industry operators.

## Central Tablelands

There is a general need and much interest in restoration and rehabilitation in the Central Tablelands. There is also a significant obligation by mining companies for restoration and rehabilitation works. The major limitation is in supply of seed for local species, particularly shrubs. As well as limitations in actual quantities of seed there is likely to be lack of genetic diversity in the extremely depleted populations. If any future restoration of landscapes,

habitats and appropriate ecology is to occur in the future it is imperative that SPAs are established now in this region. It is also likely that synergies can be gained between the needs of LLS/ Landcare and mining groups to source initial parent seed, establish SPAs and use and extend seed populations in the landscape on roadsides and TSRs and mine rehabilitation sites.

This would require the employment of an LLS/ Landcare full-time regional seed coordinator and collaboration and resource sharing with mining interests to scope, develop and implement a regional SPA project. It would also require the collaboration of plant geneticists to sample the genetic diversity of the parent seed material collected and advise on inclusions within the constraints of availability. It may be imperative to seek seed material from further afield.

## Hunter

While the Hunter region is arguably the best supplied region of the state for quantities of native seed, most of this seed is going to the mining reclamation and offset markets. It is also likely that at least some of this seed is not necessarily sourced from within the Hunter region, or from within the state. This has meant that there has been little incentive to develop the local conservation and natural resource management markets and that those markets themselves have been quite small, and reducing in recent years and usually focused on plantings which have required little seed in any case.

There has been a recent developing interest in establishing a conservation seed supply program and seedbank within Hunter LLS and Landcare and recent training programs have been initiated. Although direct seeding has been widely used in mining rehabilitation it has not been adopted within agricultural, production or NRM restoration in the Hunter region. This is obviously in part to do with the lack of appropriate supplies of restoration species and also the lack of appropriate market incentives.

The employment of a Hunter LLS/ Landcare seed coordinator (with appropriate devolved budget) would enable the initial establishment of networks with existing mining sector seed suppliers to identify the availability, extent and cross-over of local native species seed availability for restoration works within the Hunter region. This would establish the species gaps not currently readily available for restoration and identify collection and production opportunities. Dependent on projected use and demand some of these species may be suitable for SPA production and would provide the opportunity for LLS TSR direct seeding restoration, landcare planting and seeding projects and reciprocal exchange with the mining industry suppliers.

## North West

While there are significant opportunities for TSR direct seeding enhancement, offset and other projects in the North West region the view from those interviewed (though perhaps not the official view) was that there would be little appetite or interest at this stage in any restoration programs. It was also expressed that cleared agricultural land values were now so high that it precluded any interest or opportunity to revegetate unless incentives were significantly increased. In short, it is much easier and there is much more incentive to clear the land than restore it.

## Western

There have existed very effective soil conservation and rangeland regeneration programs in the past. There are some current mining industry rehabilitation projects underway. There are also a number of very specific and widely dispersed restoration ambitions at various locations across the Western Division. It is considered that it would be an injustice to the needs of the landscape and the individuals of the west to think that one centrally located staff member could address the vegetation extension and resourcing needs of the Western Division and the conflicting issues of total grazing pressure and feral animals, shrub invasion and fire exclusion and seasonal variability.

The highest population centre of Broken Hill has a long history of restoration experience (Broken Hill Regeneration Area) and Landcare activity. It would be essential to support the LLS/ Broken Hill Landcare Hub Seedbank and Nursery operations and projects in and beyond this vicinity.

It is also warranted to look at servicing the needs of the Mallee and south west vegetation projects and in the Wentworth/ Dareton locality and mining offset obligations

It is our suggestion that a separate forum is established to try and establish a clear idea of separate sub-regional needs of the north and northwest and direction pathways to address at least some of the identified issues of rangelands restoration and management.

## Greater Sydney

Because of the diversity and relatively small scale of projects occurring within the Greater Sydney Basin and the predominance of small landcare groups and commercial interests the suggestion that an LLS/ Local Government coordinator role is going to be quite different to west of the ranges. One of the clearly identified needs was that of access and co-ordination of access to seed on Local Government and other public land for small projects by individuals, groups and commercial interests and working between projects groups and different local government areas on similar or adjoining projects.

The idea was also raised about a Greater Sydney forum to communicate, network and collaborate on what projects are being developed, funded and implemented to share seed, plants and resources and not duplicate effort or overexploit seed sources.

## Appendix 7. Seed Production Area Audit

See separate document at:

[https://www.anpc.asn.au/wp-content/uploads/2020/12/Final-Edited-Audit-SPA-NSW-Report\\_-\\_Consortium-Adopted.pdf](https://www.anpc.asn.au/wp-content/uploads/2020/12/Final-Edited-Audit-SPA-NSW-Report_-_Consortium-Adopted.pdf)