Audit of Seed Production Areas in NSW Report

30 June 2020

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Executive Summary

The process of determining the number and condition of Seed Production Areas (SPA) in NSW required a combination of several different approaches and multiple lines of enquiry. Firstly, it involved following up and interviewing networks of past and current seed bank coordinators and their seed supply contactors for interview. Secondly, was to contact known current native seed license holders in NSW and their collector networks. And thirdly, was to identify Local Land Services staff involved in native vegetation restoration projects and identify where they source their seed. The associated interview process included both email survey and phone interviews in establishing the status of their enterprise across key parameters and the barriers and opportunities for SPAs in NSW.

The Healthy Seeds SPA Audit survey program was impacted by the drought, the widespread and extended fire season and the COVID-19 virus lockdowns. These impacts limited the level of response that was possible and restricted response from agency staff dealing with fire recovery and work lockdowns.

The Healthy Seeds SPA Audit survey program gathered data from 30 native non-government seed entities accounting for over 119 individual staff or contractors. This data was cross-referenced with the data from 12 Local Lands Services (LLS) and Landcare regions across NSW. There was also feedback obtained from several predominantly seed merchants and casual collectors. At least ten major seed merchants declined to provide seed collection data as they were concerned it may give competitors information about their business. 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.

This report details the findings of the Audit of Seed Production Areas conducted in 2019-2020 under the auspices of the Australian Network for Plant Conservation (ANPC).

Key Findings

- An investigation into known projects funded over the past 20 years managed to locate few actively managed SPAs in NSW.
- There is a current lack of sustained funding to support existing seed banks and the knowledge and funds to establish SPAs in regional NSW.
- There is a need for financing Regional SPA development, support and coordination.
- Demand for seed is inconsistent and unpredictable 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.
- 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 current workforce ages. (many current collectors are in their fifties and sixties)

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Introduction

The Australian Network for Plant Conservation (ANPC) Inc received funding from the NSW Environmental Trust for the 'Healthy Seeds for Resilient Restoration Project'. Part of this project is to undertake and oversee, in conjunction with a consortium of key stakeholders and experts, an audit of past and present Seed Production Areas (SPAs) in NSW and investigate the barriers and opportunities for achieving a reliable, genetically appropriate native seed supply to support resilient ecological restoration in NSW

Activities Undertaken:

- Prepare project and consultation plan
- Conduct an initial search for data and information about past and current SPA Projects, in collaboration with ANPC Project Manager, LLS contacts and Consortium partners.
- Conduct survey via phone/email to examine if SPAs are providing seed for restoration, if species are suitable, if they are actively managed, information on set up and history, pollination identification and distribution.
- Investigate and review barriers and opportunities in the seed and restoration sectors in NSW.

Methodology

Sampling

Local Land Services, Landcare, seed suppliers and other interested parties were invited to contribute to the Australian Network for Plant Conservation (ANPC) state-wide survey on the status of Seed Production Areas in NSW. The list of fifty (50) (which included non-government organisations, government agencies and private businesses collecting and selling seed) was compiled using LLS contact lists, consortium committee contacts and funded projects that were perceived as relevant to this report were followed up.

The audit was conducted between December 2019 and March 2020. This extended period was necessary due to the timing of the survey, which fell on the seed harvest period, and the catastrophic fires affecting NSW.

Survey design

Survey questions were developed by Martin Driver, Australian Network of Plant Conservation. A copy of survey questions can be found in Appendix 1

Respondents were emailed the survey and interviewed where possible, and the completed surveys were sent to the project officer.

Non-government organisations are identified as Landcare, Wholesalers Seed Sales, Wholesaler Nursery, Retail Seed Sales, Retail Nursery

Government agency is defined as Local Land Services, the agency within the Department of Primary Industry and Environment, which has a primary role in Natural Resource Management in NSW.

The information has been collated into two separate sets of data to compare the level of involvement of government and non-government organisations and the barriers and opportunities which are affecting/influencing their ability to establish, maintain and harvest SPAs for environmental restoration works.

Audit of Seed Production Areas in NSW.

What is a seed production area?

"Seed Production Areas (SPA) is a term used by the revegetation industry to refer to plant populations established under field or nursery conditions with the primary or secondary objective of seed production." ANPC's Germplasm Conservation Guidelines ed 2 (2009)

SPAs can range from small to large in size, complexity, and the number of people required to maintain them. They can use simple or sophisticated designs, technologies, and infrastructure. Seed grown from SPAs is primarily used for restoration but also for functional and amenity landscaping, bush food and fodder markets. SPAs are typically operated by private organisations, community groups,

government agencies, NGOs, and Landcare networks. Australian National Native Seed Survey Report (Hancock, N. et al., 2020).

For the purposes of this project the selection of SPAs was also restricted to those sites that have been designed specifically for seed production of individual species with seed sourced from across an extensive or entire geographic range of a known background population, designed and planted to improve the genetic diversity of seed with background records tracking SPA seed sourcing, history and distribution of seed.

SPA Audit

The audit aimed to identify and visit all currently active SPAs in NSW and visit SPAs identified as having been funded at any time since 2000 and investigate if they were still operating and if not, what was the reason/s they failed or ceased operating.

Data and project applications were obtained from funding programs of projects that identified seed production as an objective. Tracking and investigation determined that many of these projects did not establish or intend to establish a defined and managed SPA but to utilise restoration sites for seed increase and supply. In these cases, the revegetation activity did not fit the specific definition of a SPA of diverse and known genetic material even though there was some intent to increase seed supply capacity. There were funded projects identified which were reported as seed production areas which were Crown Land TSRs from which grazing had been removed or modified to allow for seed production. While these sites were not strictly SPAs they have allowed for effective regeneration and the harvest of seed for future SPA production that would not otherwise have been possible.

The small number of surviving sites that could be identified as SPAs under this selection and intent (2 of 4 originally established) weren't able to be directly independently audited due to the COVID 19 lockdown, which restricted travel, but were identified as non-functioning. There was also the difficulty of finding staff who had continuity with projects and who knew the history of funding/projects and why these sites did or did not succeed. Anecdotal evidence of project failure was lack of on-going funding and staff continuity as the primary causes.

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 large-scale seed businesses as a substitute for SPAs. 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.

For this audit, a SPA had to have been designed explicitly for seed production of individual species with seed sourced from known populations, designed and planted to improve the genetic diversity of seed and with records tracking SPA history and distribution of seed.

Key Findings

Apart from fourteen (14) active operational SPAs across the Murray LLS region, two (2) of five (5) original SPAs in the Central Tablelands and SPAs operated by Greening Australia in both the ACT and Greater Sydney, the audit of seed production found no evidence of significant established SPA capacity servicing NSW.

Are SPAs regularly providing seed for restoration work?

Some commercial suppliers considered and proposed past revegetation sites as SPAs, but they did not meet the definition description or were not able to meet the criteria for validating seed source or genetic diversity. This does not mean this seed cannot be used for restoration works, but its source needs to be clearly labelled and validated and its use confined to projects where it has the potential to be blended and documented. Poor or non-existent documentation and tracking of seed and its subsequent use is a significant issue of some consequence within government and non-government organisations. An emerging practice by seed banks is to blend SPA seed and seed collected from identified revegetation sites to help improve the genetic diversity of the seed mix used in direct seeding and seedlings grown for nurseries. This practice still requires effective record keeping and documentation to be maintained.

In one example it was established that seed of one species had been used for years in revegetation works from one individual parent plant. This has vast implications for the resilience of that species within restoration sites with only one genetic lineage represented in multiple sites. This narrow genetic profile may make the species in these sites more susceptible to changes in climate and other environmental impacts.

The Murray LLS Seed bank and SPA network is the only identified regionally and vertically integrated seed supply system that is capable of servicing seed and works across a significant area. The network was established primarily to supply seed for direct seeding restoration projects across the Murray catchment 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 (See Appendix 2 Case study: Seed Production Areas in the NSW Murray Catchment).

One identified Landcare Group in the central west of NSW established four SPAs, but over time, the drought, a lack of funding to maintain sites and limited hours to manage the sites resulted in them becoming unproductive. The group uses volunteer labour to collect seed from wild populations for nursery production for local projects. This highlights the need to invest in coordination, training and maintenance of SPAs.

Key findings

The survey results from government agencies, seed suppliers and nurseries found SPAs are not regularly providing seed for restoration works except for Canberra Greening Australia, Greater Sydney, a Landcare Group in the central west and Murray Local Land Services. However, it must be recognised that due to the lack of continuity of staff, projects and maintained records it was difficult to identify SPAs in NSW.

A key and critical finding of this study has been a lack of planning, coordination and tracking of restoration works in NSW at a state level over several decades, which was an obstacle in identifying where and if SPAs were being used in restoration projects or what was the origin and process of seed procurement.

Figure 1. LLS Murray SPA 'Ulunja' established in 2016 with funds from NSW Environment Trust. Photo S Logie

Are current SPA species suitable for systematic regional restoration?

Currently, apart from Murray LLS and Greening Australia, SPAs are not providing significant proportions of seed for regional restoration projects across NSW. The majority of NRM regions are not using species grown in SPAs for restoration and are dependent on sourcing seed from commercial seed suppliers, a network of local Landcare volunteers and or seed banks where they are available.

Murray LLS has established SPAs using strategically identified pioneering direct seeding species for each region of the catchment. This includes species which may be geographically widely distributed but often from diminished and fragmented populations that are vulnerable to collection pressure and

genetic bottlenecks. The inclusion of these species known to be in decline on roadsides/public lands, into SPAs reduces the need to collect from wild populations and ensures there is a reliable seed supply. In this situation, SPAs assist conservation and take the pressure off wild populations. The species selected for the SPAs have proved both suitable for direct seeding and extensive habitat restoration for over twenty years. SPAs are also used for conservation by producing seed for nursery propagation for species in decline locally that are not suitable for direct seeding but are in demand for restoration works (e.g. *Bursaria spinosa, Allocasuarina leuhmannii, Indigofera*).

Key Findings

If given the resources to establish and maintain SPAs, the employment of staff and on-going funding SPAs can provide suitable species for regional restoration.

Can SPAs be brought back to production at a lower cost than the cost of new establishment?

There were very few examples where SPAs had been rehabilitated/renovated and so it is difficult to establish if it is more cost-effective to establish a new SPA or rehabilitate an old one.

The only evidence where SPAs had been brought back into production was in 2016 where Murray LLS was funded by the NSW Environment Trust for a project titled 'Building the Resilience of Native Seed Production Areas'. The project audited forty- eight (48) SPAs and assessed their condition, developed a priority list for sites suitable for rehabilitation and developed new SPAs where there were gaps in seed supply for restoration activities (See Appendix 3 for SPA Audit). All SPAs were established with understory species to meet the demand for large quantities of genetically diverse seed for direct seeding restoration. Of the 48 sites audited, 10 sites were assessed as suitable for rehabilitation. The audit found the majority of the other sites (38) had been grazed out by stock and were not suitable for restoration. SPA rehabilitation activities included; removal of old plants, pruning existing plants, ripping for new planting, planting, guarding, laying weed mat, watering, fence repair, erection of new fencing and weed and pest control. An additional three new SPAs were established, two on public land and two on private property.

Travelling stock reserves (TSR) were used for the two public land sites which is a win/win, as it helps to increase biodiversity on low conservation value TSR to increase seed production and act as a SPA in its early stages of growth to produce seed for further restoration activities.

There were many factors which influenced if sites could be renovated. These included the size of the site, condition of plants, species numbers and diversity, the commitment of landowners and the site location relative to the processing facility. Generally, larger sites were assessed as worth bringing back into production, and smaller sites were not.

Rehabilitating SPAs was generally more labour intensive as they required a variety of activities and required more coordination and costs. Whereas new SPAs required fewer complex activities and less supervision and coordination. (See Appendix 4 and 5 for comparison of works and costs required for SPA Field establishment, seedling vs direct seeding and the renovation of existing SPA).

Figure 2: SPA Renovation: An excavator removes shrubs at a Berrigan SPA. Photo S Logie

Figure 3: A renovated SPA with newly planted seedlings to build genetic diversity of a species in an established site. Photo S. Logie

Key Findings

Rehabilitated SPAs can produce genetically appropriate seed for restoration if good records have been kept of the species and provenances that were initially planted on sites.

For it to be cost-effective the size of the site, the condition of plants and location of SPA should all be considered. Adding new provenance to the original plantings of a SPA can provide a quicker turn around for seed production as well as improving the genetics.

There is an opportunity to invest in TSRs to establish SPAs.

Can restoration projects be designed as SPAs and deliver better value for money?

There is anecdotal evidence there is an opportunity to design restoration projects as SPAs which could deliver better value deriving from increased capacity to service further rehabilitation/restoration. In the initial stages of establishment, there would need to be sufficient funding to cover the extra costs of planning, design, targeted seed collection, and coordination.

Restoration sites intended for dual use as SPAs would need to be designed to allow vehicle access for harvest and maintenance. There may also be conflicting objectives with restoration versus seed production as regeneration of species in SPAs creates issues with potential bottlenecking of genetics and difficulty to maintain sites.

If revegetation sites were to be direct-seeded as a SPA, this would require larger quantities of seed from wild populations or established SPAs. Direct seeding can take up to 5 years to establish, which is three years longer than planting seedlings, but sites would have to be assessed on a case by case basis. Direct seeding is generally a more cost-effective method of establishing species restoration and is better suited to larger sites.

Key findings

There is an opportunity for some restoration projects to be designed as SPAs and deliver better value for money and increase regional seed production, at least in the early stages of production prior to second generation volunteers and regrowth hindering effective management. Still, there is a need for additional funds to plan, design and establish sites and for on-going maintenance and recognition of the shorter duration life of such a system.

Tracking Systems

Of those seed collectors and merchants that responded to the survey, 26% operated a fully integrated database and tracking system for seed from collection through to distribution. Half of these were using a custom-built Access database funded and developed by the Murray Seedbank Network which it had shared to government and non-government seed banks across NSW.

22% operated limited spreadsheet systems which kept a record of collections and sales but didn't track or provide other seed quality data. 33% operated field collection datasheets, 8% maintained limited data, and 11% maintained no records.

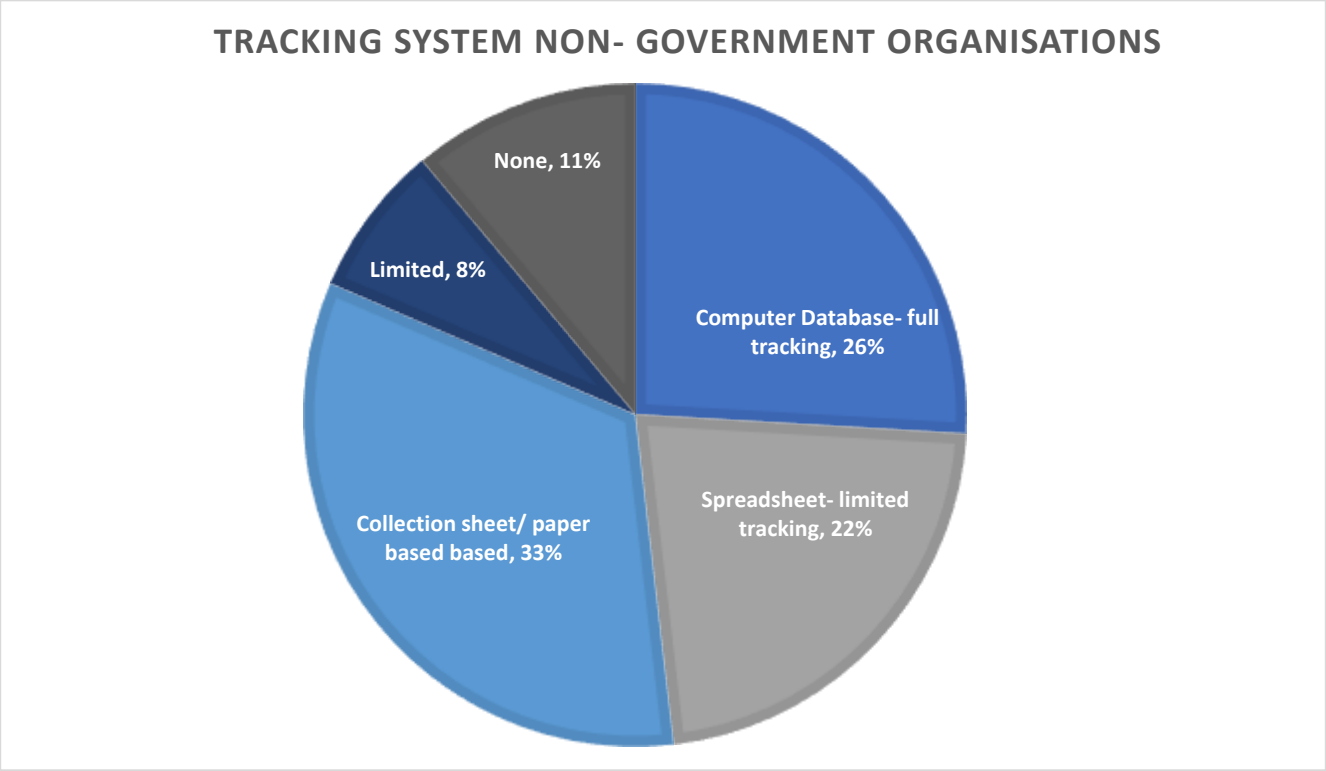

Figure 4. Use of integrated tracking systems for quality control of seed in non-government organisations.

Of the Government agencies who provide seed services, 33% have a full tracking database, 42 % use a spreadsheet system, and 25% used none.

It must be noted that the proportion of seed accounted for by government agencies and NRM projects was only a fraction of that reported from the combined total seed weigh throughput of non-government organisations and projects. This huge variance in quantities of seed handled and the differing objectives and resources available is an important consideration when comparing seed tracking capabilities. It is also clear that a significant proportion of seed supply contracts, purchases or supply do not require the supply of data tracking beyond species and weight.

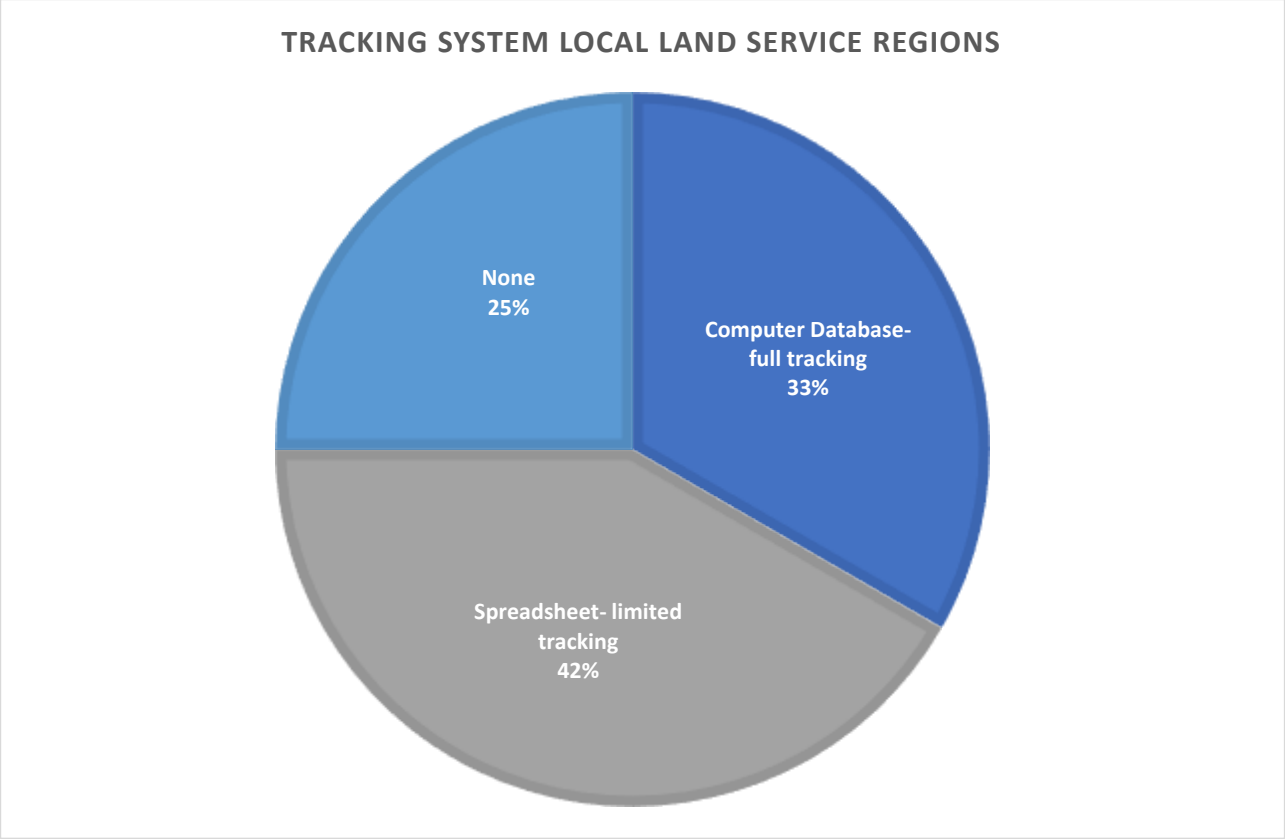

Figure 5. Use of integrated tracking systems for quality control of seed by LLS.

Key findings

- There is limited full computer database tracking systems operating in government and non-government organisations.
- Non-government organisations such as Landcare/Landcare nurseries have limited ability to invest time and funding into tracking systems.

A Short Case Study on purchasing seed

A Landcare group received funds to establish a native grass SPA to support their restoration projects. Finding it challenging to locate and harvest seed themselves due to the dry conditions, the group purchased grass seed from a commercial supplier. The seed was sown on the site, and some seed was sent to the local nursery for propagation. When the grass seed germinated, it was apparent the seed purchased from the commercial supplier was not the local grass species they had ordered. A specimen was sent to an herbarium for identification and subsequently identified as an introduced

variety from Asia. This was not just an isolated occurrence reported during this survey with many similar reports of misidentification, substitution or poor-quality seed being delivered to projects.

Licencing

The survey found that 61% of non-government organisations and 50% of government agencies did not have a current licence to collect native seed in NSW. It was also reported that seed collection was often undertaken without complying to the Endangered Ecological Communities terms of the licence. Commercial operators often devolve responsibility for seed licences to contractors and casual collectors, which impacts on the transparency of the seed supply chain.

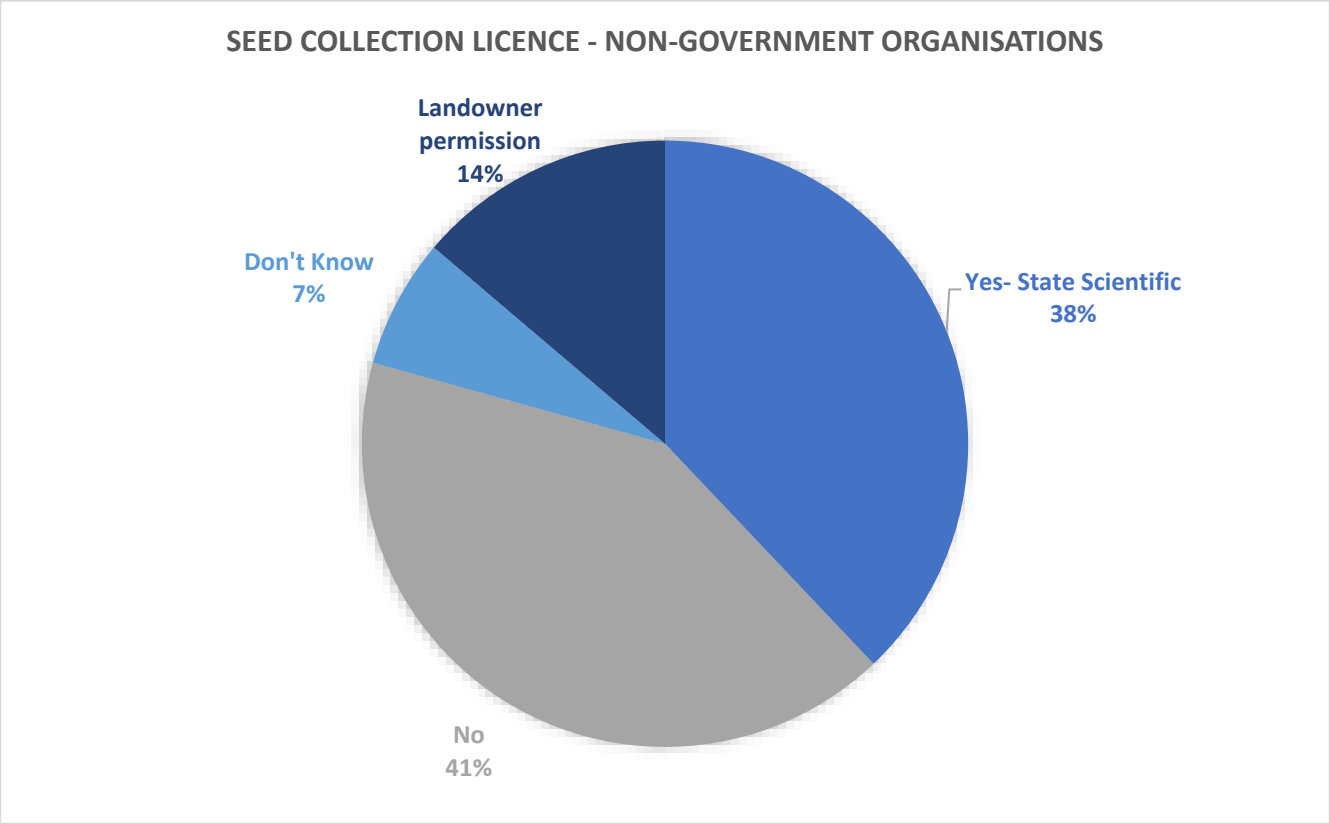

Figure 6. 62% of seed collection is undertaken outside of the licencing system

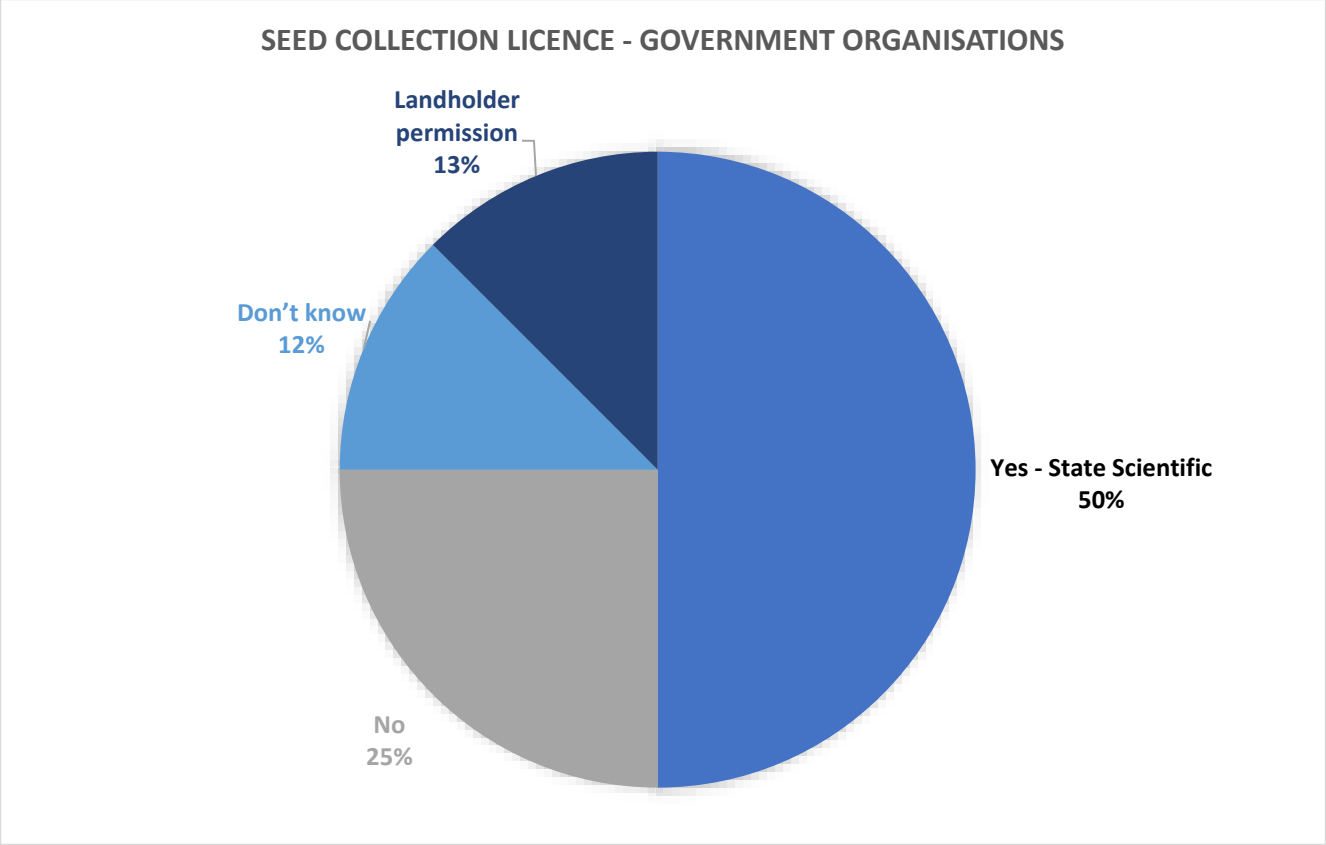

Figure 7. 50% of seed collection is undertaken without a licence.

Key Findings

- Licence process was perceived as unduly arduous for the small amount of seed, and Local Government permission was often sought instead.
- The time between applying for a licence and the licence being issued was often delayed, so collections proceeded on the basis that the licence would be forthcoming.
- The reporting and compliance systems are perceived as complex and not user friendly.
- A number of those surveyed questioned the purpose and use of the reported data.

Barriers

The following two bar graphs provide the critical issues reported from non-government and government organisations. Both sets of information have been combined in the key findings to highlight issues identified by respondents.

Twenty-seven (27) respondents identified the issues of climate change/seed decline and land access /seed decline as the biggest barriers. One respondent reported 'The last three years have been the worst seed collection seasons I have seen in 25 years.' Funding variability was identified by twenty-five (25) respondents and licencing by twenty-four (24) respondents. Although staff training and knowledge was identified by only fifteen (15) respondents there was a consistent message from all regions that there has been a loss of Natural Resource Management staff with the skill and expertise involved in community and front-line environmental services.

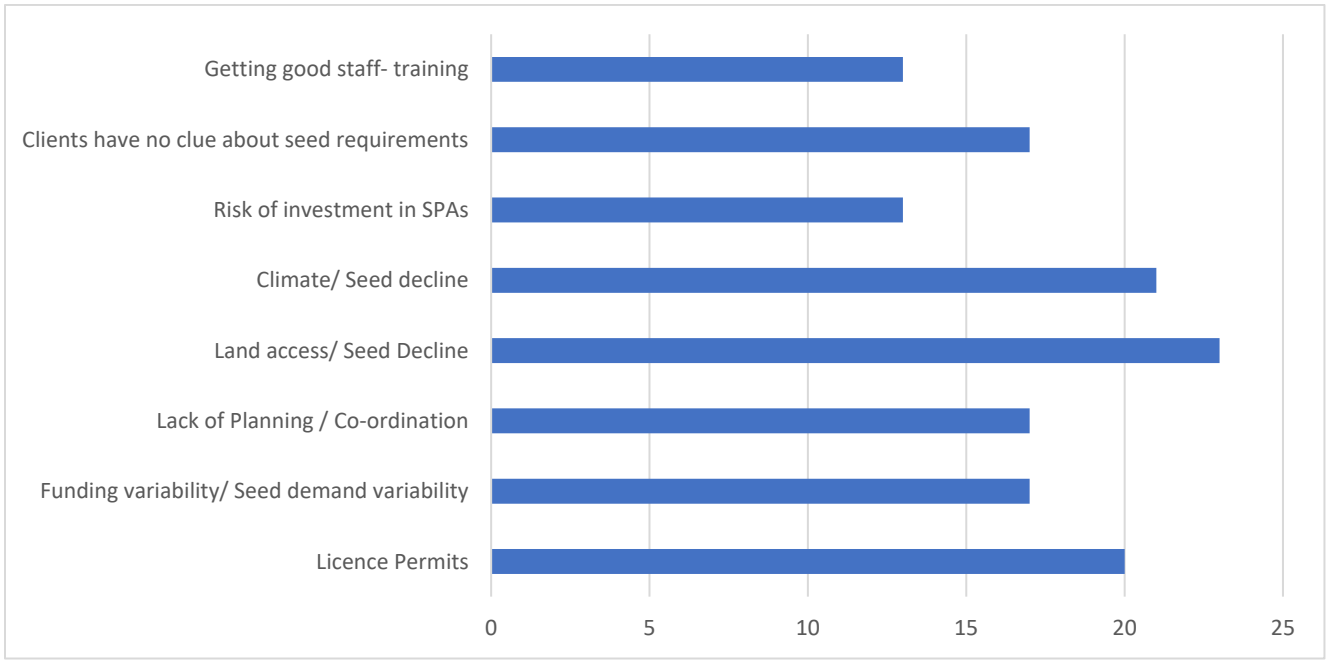

Figure 8. Barriers reported from non-government organisations

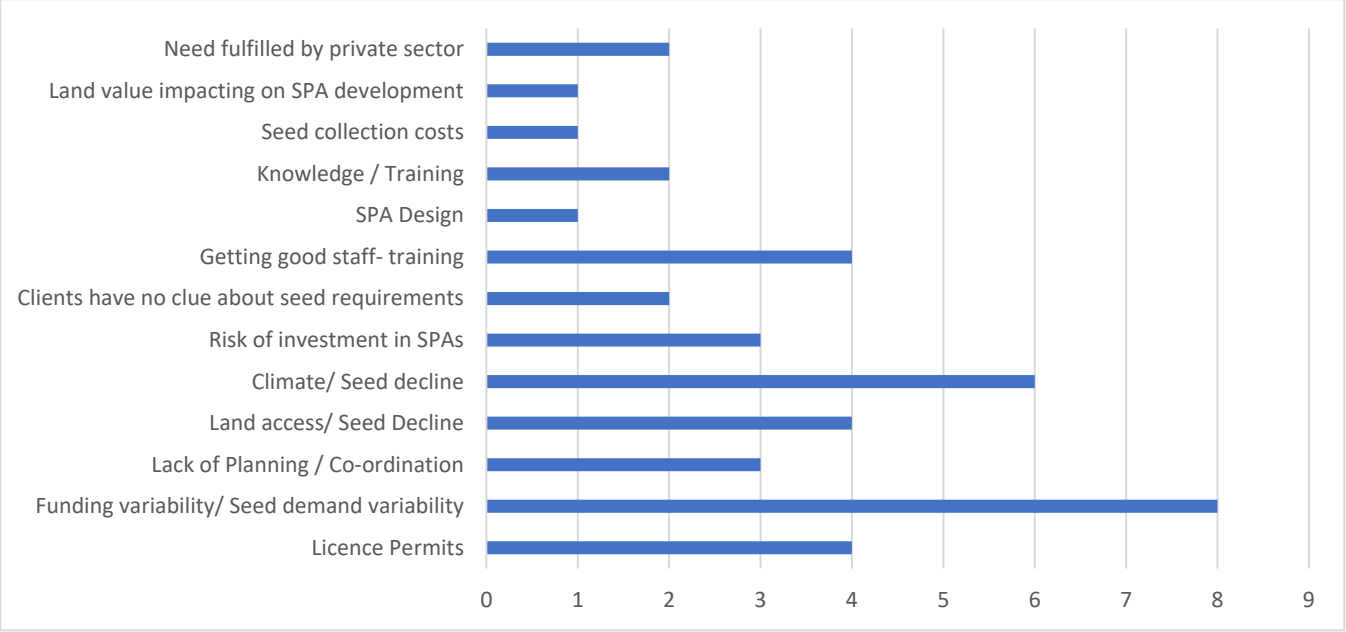

Figure 9. Barriers reported by government organisations

Key Findings

- Land access/seed decline
- Climate/seed decline
- Funding variability /seed variability
- Licence permits
- Knowledge and Training

Opportunities

The following two bar graphs provide the critical issues reported from non-government and government organisations. Both sets of information have been combined in the key findings to highlight issues identified by respondents.

Regional SPA development, support and coordination was the highest priority with twenty-nine (29) respondents indicating this as an opportunity. Non-government organisations such as Landcare were very interested in SPA establishment. A Landcare group commented 'Sea level rises in estuaries are turning floodplain forest to saltmarsh, and government agencies should prioritise setting up SPAs for public/private benefit.' Twenty- seven (27) respondents identified the following as opportunities:

- Regional technical support, training and research.
- Regional Coordination in project development, funding and delivery.

- Twenty -five (25) respondents identified licencing and the development of a tracking code of practice as opportunities for improvement.

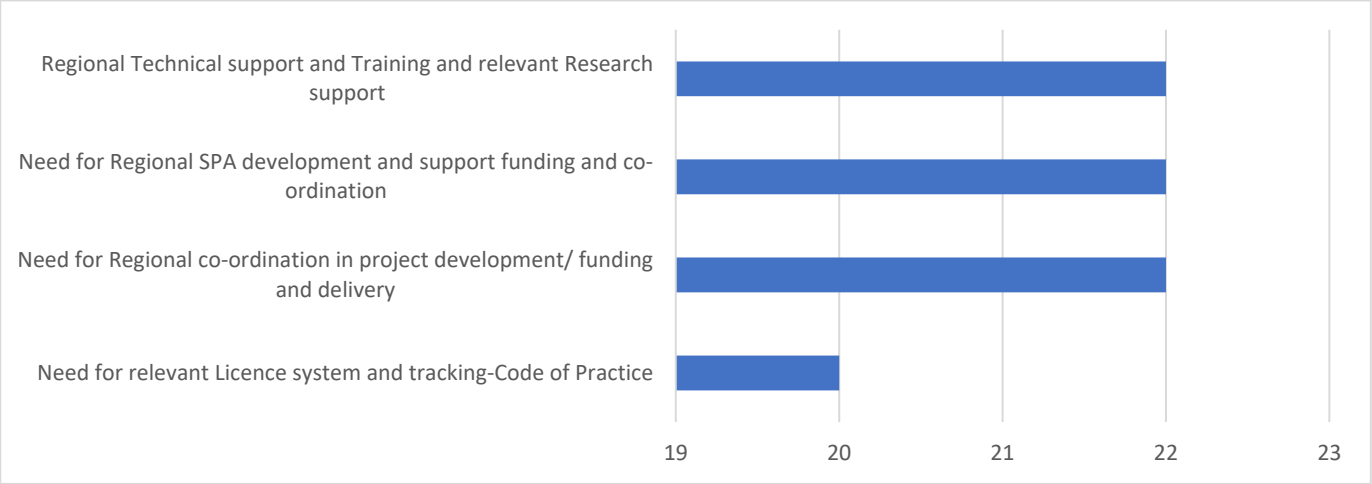

Figure 10. Opportunities reported from non-government organisations

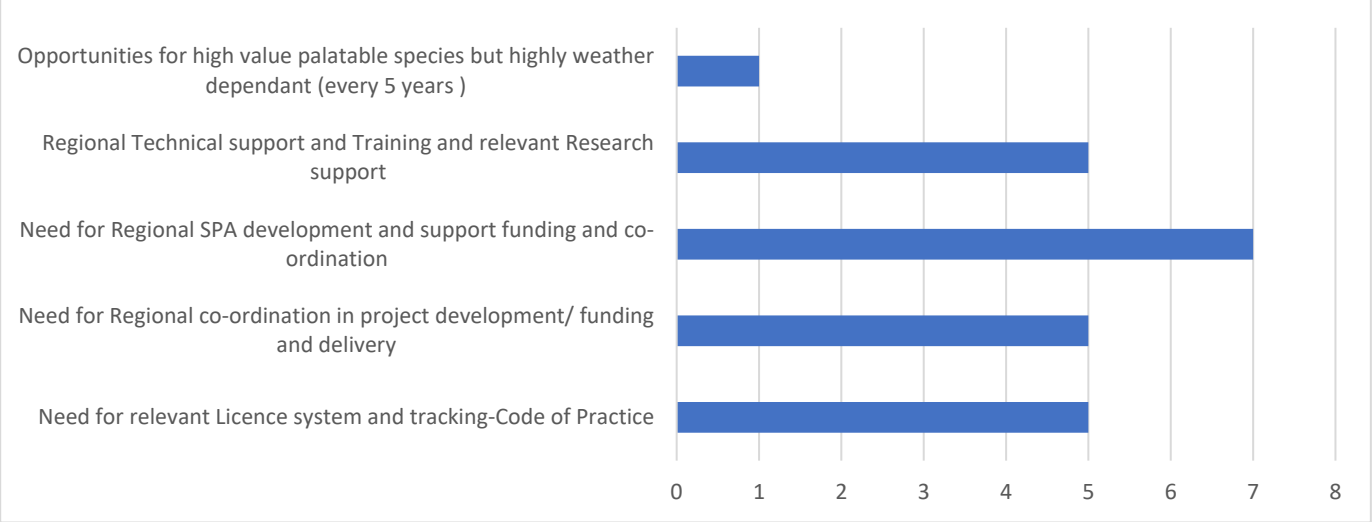

Figure 11. Opportunities reported from government organisations

Key Findings.

- Need for regional SPA development, support, funding and coordination.
- Need for Regional technical and training support and relevant research support.
- Need for regional coordination in project development, financing and delivery.
- Need for relevant Licence system and tracking -code of practice.

Acknowledgements.

I would like to acknowledge the support and assistance of ANPC Project Officer Martin Driver in the research and development of this report.

I would like to thank the Landcare groups, nurseries, seed collectors, agency staff and commercial operators for their time and contribution in the development of this report.

References

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ANPC’s Germplasm Conservation Guidelines ed 2 (2009)

Appendix 1: Survey

HEALTHY SEEDS SPA AUDIT SURVEY March 2020

LLS SEED/SEED PRODUCTION AREAS AUDIT SURVEY	Answer options in this column	Comments
Please use numbered options to answer the question. You can use more than one option if applicable and add comments if you have further information to contribute. If you have any questions, please contact Sue Logie 0427 352 117 Thank you!		
LLS Region		
Landcare Group		
Seed Supplier please provide contact details		
Contact		
Mobile		
Employed Staff working in Seed Services e.g. seed bank /coordinating seed for revegetation projects etc		
FT Staff		
Casual /PT		
Contract Collectors # contact details		
Other Collectors # (i.e. Landcare- number volunteers)		
What is the Geographical Range of your Seed Collection?		
1 = Local		
2 = Regional		
3 = Catchment		
4 = Multi-catchment		
5 = State		
6 = Interstate		
7 = International		
What is your seed collection strategy?		
1 = Collect to contracts/Projects		
2 = Collect to estimated demand		
3 = Speculative demand		
Who are your Primary Markets?		
1 = LLS/Landcare		
2 = Other agencies		
3 = Nurseries		
4 = Mining		
5 =Other (please comment)		
What is the Geographic Distribution Range for seed collected and used?		
1 = Local		

2 = Regional		
3 = Catchment		
4 = Multi- Catchment		
5 = State		
6 = Interstate		
7 = International		
How many species would you collect and or store?		
1 = Extensive > 30 species		
2 = Limited < 30 species		
3 = High > 300 species		
What is the total seed weight collected /stored (Kg)?		
Tree Wt (Kg)		
Shrub Wt (Kg)		
Forb Wt (Kg)		
Grass Wt (Kg)		
Where is your seed sourced/collected and what is the weight in kg?		
1 = Wild Public Land		
1A = Wild- Roadsides/ LG		
1B = Wild Private Land		
2 = Plantings /Direct Seeding		
3 = Seed Production Areas		
Do you have Seed Productions Areas in your region? Yes or No		
If yes how many?		
Do you have a Seed Licence to collect seed?		
1 = Yes- State Scientific		
2 = No		
3 = Don't Know		
4 = Landowner permission		
Do you have a database for tracking seed collected and used?		
1 = Yes- computer Database- full tracking		
2 = Yes- spreadsheet- limited tracking		
3 = Collection sheet/ paper based		
4 = limited		
5 = None		
Do you have a seed processing facility and equipment?		
1 = Full shedding and equipment		
2 = Adequate equipment		
3 = Limited facilities		

What is your Seed Testing Capability?		
1 = Viability/xray		
2 = Germination		
3 = Cut or Float test		
4 = None		
Do you have a Storage Facility?		
1 = Humidity/Temp controlled facility		
2 = Refrigeration only		
3 = Secure container		
4 = Storage bottles etc		
What are the Issues /barriers for seed production/collection?		
1 = Licence Permits		
2 = Funding variability/ Seed demand variability		
3 = Lack of Planning / Co-ordination		
4 = Land access/ Seed Decline		
5 = Climate/ Seed decline		
6 = Risk of investment in SPAs		
7 = Clients have no idea about seed requirements		
8 = Access to skilled staff- training		
Please add additional issues if required.		
What are the opportunities for seed production/collection in your region?		
1 = Provision for relevant Licence system and tracking-Code of Practice		
2 = Provision for Regional co-ordination in project development/ funding and delivery		
3 = Provision for Regional SPA development, funding and co-ordination.		
4 = Provision for Regional technical support, training and relevant research		
Has your region been impacted by the fires? Yes /No		
How would you use any extra funding to implement NRM recovery after the fires in your region?		

Appendix 2: Case Study -Pioneering species for direct seeding

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 (3) 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.

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.
- 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 11: 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 hrs 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 12. 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. 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 13 & 14. 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.
- 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 15. 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 3: SPA Audit Sheet

Murray Local Land Services SPA Audit Sheet:

Owner: **Email:**

Address:

Staff member: **Date:**

On site

- Accurately GPS site boundary using handheld GPS
- Draw mud map with layout of each species block planted within SPA area
- Take photos of the site showing the condition of the plants and any management issues that need attention.
- Identify species present. If unsure take samples and photos of the plants showing form, leaf and flower if possible. Bring back to the office for identification.

Overall quality of SPA:

Does the SPA have easy access? (circle) **YES** **NO**

Comments: ……

……..

Fencing: Is the site fenced? **YES** **NO**

What is the condition of the fence? (circle) Repair Replacement Good Condition

Comments: ……

……

Weeds: What is the weed burden like on the site (% of groundcover that is weeds this includes exotic grass species e.g. rye grass): (circle)

Few Weeds 0-10% Some Weeds 10-25% Weedy 15-50% Very Weedy >50%

Main Weeds Species: (if you are not sure take photos)

……

……

……..

Are the weeds impacting on the health of the SPA plants? **YES** **NO**

Are the weeds creating an issue for access and collection? **YES** **NO**

Pest Animals: Are there evidence of pest animals impacting on the site? **YES** **NO**

If **YES** what pests are present? (circle) Rabbits Hares Kangaroos Other……

How much impact are the animals having (circle) Minimal Moderate Significant

Any other comments on the health and condition of the site?

……..

……..

……..

What management actions would you recommend be undertaken to improve the health and productivity of the SPA?

- Weed Spraying
- Manual removal of weeds
- Slashing
- Repair fence
- Replace fencing
- Control rabbits or hares
- Replanting/ Replace plants
- Pruning existing plants
- Remove existing plants
- Other: ……
- Other:……..
- Other:……..

Is the landholder interested in continuing the SPA? (circle) **YES** **NO**

Is the landholder willing to sign a new Memorandum of Understanding for the SPA which outlines the roles and responsibilities in maintaining the SPA and providing seed to Murray LLS?

Is the SPA producing seed? **YES** **NO**

Does the SPA have the potential to produce seed in the future? **YES** **NO**

What level of investment do you feel would be needed to make the SPA productive?

Minimal **Moderate** **High**

SPA Audit:

Species:

- Please fill in a column for each plant species present on the site.
- If unknown list them as Species 1, Species 2 etc and label photos with numbers for plant ID.

Species:	**EG *Ac montana***								
Planted area									
• Approx area (mt x mt)	20x50								
• Number of rows	4								
• Spacing btw. rows (mt)	4								
• Plant spacing in row (mt)	3								
Species:									
• Number plants surviving	25								
• Are they healthy ?	No								
• Are there gaps in rows?	Yes								
• Any sign of disease e.g. galls,	yes								
Number needing pruning	All								
Other notes:									
Other notes:									

Species suitable for pruning:
Ac acinacea, Ac montana, Ac brachybotrya, Dodonea viscosa cuneata, Dodonea viscosa angustissima, Senna spp Bursaria spinosa

MAP: Please hand draw SPA and mark where you have taken your GPS points on the map. Mark the planting lines and where each species is located on the site and mark gate.

Appendix 4. Comparison of works required to establish new, renovated and direct seeded SPAs.

Establishing New SPA	Renovate existing SPA	Direct Seed a SPA
Secure Land Tenure Negotiate with landholder to secure tenure of the site, sign MoU/contract develop map. If on public land Cultural Heritage Assessment	**Secure Land Tenure** Negotiate with landholder to secure tenure of the site, sign MoU/contract develop map If on public land Cultural Heritage Assessment	**Secure Land Tenure** Negotiate with landholder to secure tenure of the site, sign MoU/contract develop map. If on public land Cultural Heritage Assessment
Preparation, Planning and Design • Site inspection to mark fencing, plan and design site, develop species lists and order and deliver seed to nursery propagation. • Mark rip lines for planting. • Order guards and stakes. • Employ contractors to fence, rip lines and control weeds and pests.	**Preparation, Planning and Design** • Audit site to establish works required; count extant plants, removal dead or unproductive plants, pruning, pest and weed control, fencing repair replacement. • Plan and design site, develop species lists, order and deliver seed for nursery propagation. • Mark rip line for planting. • Order stakes and guards. • Employ contactors to remove plants and rip lines for replacement or new areas for planting.	**Preparation, Planning and Design** • Site inspection to mark fencing, plan design, develop species list. • Target seed collect for direct seeding if required. Employ contractors to fence site, control weeds and pest. • Mark seeding lines and pre-spray direct seeding lines. Order seed and obtain quote for direct seeding.
Planting • Employ contractor to plant guard and water plants. • Coordinate planting	**Planting** • Employ contractor to plant guard and water plants. • Coordinate planting	**Direct Seeding** • Employ contractor direct seed site. Collect seed order/treat if required. • Coordinate direct seeding of site according to site plan.
Maintenance • Pest and weed control. • Fencing maintenance. • Water plants over first summer. • Audit site for replants after year 1. • Tip prune year 1 -3.	**Maintenance** • Pest and weed control. • Fencing maintenance. • Water plants over first summer. • Audit site for replants after year 1. • Tip prune year 1 -3.	**Maintenance** • Pest and weed control. • Fencing maintenance. • Thin seeding lines after three years.

Advantages • Reduced need for hiring contractors.eg no contractors for removal/pruning plants. • Able to use previous knowledge and experience gained over past 20 years to improve design and structure. • Seed production can take place in 3-5 years.	**Advantages** • Able to build on existing work. e.g. increase genetic diversity species. • Pollinators on site. • Established relationship with SPA owner. • Seed production can take place in 3-5 years.	**Advantages** • Cost effective limited use of contractors/reduced costs. • Minimal preparation compared to planting seedling.
Disadvantage • Due to continuing dry conditions, several watering's are required in the first year to ensure survival rate of seedlings.	**Disadvantage** • Due to continuing dry conditions several watering's are required in the first year to ensure survival rate of seedlings.	**Disadvantage** • Quantities of seed for direct seeding can be 100% higher than for seedling propagation. • Germination of seedlings is dependent on climatic conditions and if conditions remain dry, production may not occur for 6-8 years.

Appendix 5. Comparison of Cost to establish new, renovated and direct seeded SPA for pioneering species for direct seeding.

COST TO ESTABLISH A NEW SPA **Pioneering Species for Direct Seeding** **Area 1 ha 1000 stems**	**$**
Secure Land Tenure	
Negotiate with landholder to secure tenure of the site, sign MoU/contract develop map.	1500
If on public land Cultural Heritage Assessment	
Preparation, Planning and Design	
Site inspection to mark fencing and site layout	
Plan and design site, develop species lists, order and deliver seed for nursery propagation.	500
Mark rip line for planting.	250
Order stakes and guards.	1500
Employ contactors to rip lines.	1000
Planting	
Employ contractor to plant guard, mat and water plants.	5000
Coordinate planting	500
Maintenance	
Pest and weed control.	1500
Fencing maintenance.	300
Water plants over first summer.	4000
Audit site for replants after year 1.	400
Tip prune year 1 -3. Remove Guards	2400
TOTAL	**18850**
COST TO DIRECT SEED A NEW SPA 1ha **Pioneering Species for Direct Seeding**	
Secure Land Tenure	
Negotiate with landholder to secure tenure of the site, sign MoU/contract develop map.	1200
If on public land Cultural Heritage Assessment	
Preparation, Planning and Design	
Site inspection to mark fencing, plan design, develop species list. 1 Species x 5 provenance	800
Target seed collect for species if required. Cost seed	1000
Employ contractors to control weeds and pest.	1000
Mark seeding lines and pre-spray direct seeding lines. Obtain quote for direct seeding.	1000
Direct Seeding	

Employ contractor direct seed site. Collect seed order/treat if required.	1000
Coordinate direct seeding of site according to site plan.	500
Maintenance	
Pest and weed control.	1500
Fencing maintenance.	500
Thin seeding lines after three years.	2000
TOTAL	**10500**
COST TO RENOVATE AN EXISTING SPA **Pioneering Species for Direct Seeding**	
Secure Land Tenure	
Negotiate with landholder to secure tenure of the site, sign MoU/contract develop map	1200
If on public land Cultural Heritage Assessment	
Preparation, Planning and Design	
Audit site to establish works required; count extant plants, removal dead or unproductive plants, pruning, pest and weed control, fencing repair replacement.	2000
Plan and design site, develop species lists, order and deliver seed for nursery propagation.	250
Mark rip line for planting.	250
Order stakes and guards.	1500
Employ contactors to remove plants and rip lines for replacement or new areas for planting.	2000
Planting	
Employ contractor to plant guard, mat and water plants.	5000
Coordinate planting	500
Maintenance	
Pest and weed control.	1500
Fencing maintenance.	300
Water plants over first summer.	4000
Audit site for replants after year 1.	400
Tip prune year 1 -3.	2400
TOTAL	**21300**

Susan Logie July 2020