The Australian Native Seed Survey Report

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Cover image: *Acacia terminalis* subsp. *terminalis* (image credit Gavin Phillip, Royal Botanic Gardens Sydney).

Foreword

I write this foreword as Australia struggles with fires burning across the continent threatening not only humans but wreaking an incalculable cost on our natural landscapes and biodiversity. What will be the final cost to Australia's endemic plants and animals will take many years or decades to assess. For many species though, they have probably exceeded their tipping point and face the inexorable decline towards extinction. And extinctions will start to happen but we can make a change but this will require our best endeavours backed by solid science. We created this crisis and now is the time for action to stem what will be an avalanche of species losses.

Thus it is heartening and timely that this survey of native seed has been completed which is a blueprint for what we need to do now, in Australia, to ensure that plant species and their ecosystems have the fundamental building blocks preserved and made available for the ecosystem restoration challenge that lies ahead.

Extensive in its outreach from suppliers to end-users of native seed, this survey highlights both the demands for native seed and our national capacity to deliver the diversity and quantities required. The survey found, not surprisingly, that the native seed industry relies on wild stands for much of the seed supply chain. Clearly with impacts such as the fires compounded by the many landscapes now depleted of healthy ecosystems through decades of habitat decline, we need to move on a national front to ensure that Australia's restoration future is truly sustainable through ethical sourcing of native seed. And such an opportunity for creating seed production areas and native seed farms creates a cornerstone of the emerging restoration economy for Australia. Rural and remote regions and indigenous Australians can, and should be, part of developing vibrant economic opportunities through native seed farming enterprises. Development of these enterprises will ensure a steady, reliable, high quantity and quality, biodiverse and cost-effective native seed capacity for the nation.

The survey has many facets and outcomes that are the basis for creating a new future for restoring Australia. The survey is in concert with major international initiatives such as the UN Decade on Ecosystem Restoration, 2021-30 and the first International Principles and Practices for Native Seed in Ecological Restoration with the survey's key recommendations set to create a paradigm shift in how we source and deploy native seed.

The time is now for seizing this once-in-a-lifetime opportunity to build a solid framework for commencing the daunting task of rebuilding Australia's nature. To not act and develop the policy and planning instruments to give effect to the key recommendations in this report is to deny future Australians a land that is truly rich and rare.

Kingsley Dixon FLS
John Curtin Distinguished Professor

Executive Summary

The Australian native seed sector comprises an ad hoc group of individuals and businesses representing suppliers and primary users spanning a wide range of land managers and other users of native seed. The native seed sector is a critical component of the ecological restoration industry 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 (to name but a few). To help prepare for such challenges, a national survey of participants engaged in the native seed sector was conducted. This survey aimed to better understand the current structures and practices of the sector, to gauge its capacity to meet current and future demand for native seed, and to gather feedback on issues that are perceived by the sector to be affecting their activities.

This report details the findings of the Australian Native Seed Survey conducted in 2016-2017 under the auspices of the Australian Network for Plant Conservation (ANPC). Many issues facing the sector were presented to survey respondents who ranked them in order of importance. Findings revealed that the order of importance varied depending on the primary role of the respondent in the sector (defined within the survey as – Seed Collector, Seed Production Area (SPA) Grower, Seed Purchaser or Other User). When combined across these four groups, the most important issues were:

- 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; and
- Demand for seed is inconsistent and/or unpredictable.

A collection of native Australian seeds (image credit Lucy Commander).

Other key findings from the survey include:

- The formation of a peak industry group to represent the native seed sector was ranked as being highly desirable;
- More seed is collected from private property than from other land tenures with collection being lowest in national parks;
- There is a lack of seed available for a broad range of species being used for restoration;
- A large proportion of the seed harvested by Seed Suppliers comes from geographic ranges that greatly exceed those considered to be 'local provenance';
- Seed Purchasers commonly accept seed from locations much farther away from the planting site than is commonly thought;
- Current provenance range stipulations are considered too restrictive;
- Native seed is not commonly tested to determine its quality attributes;
- The majority of seed collections or seed purchases made annually are small in volume (i.e. usually <5 kg) suggesting that overall native seed volumes (supplied or purchased) are modest in quantity and may not be sufficient to support large-scale restoration; and
- Seed production areas are an increasingly important supplier of seed for restoration and other end uses.

Issues of high importance to respondents are discussed in detail in this report, as are the key survey themes that include seed supply and demand practices, seed provenance, seed handling and testing, and seed production areas (SPAs). It is hoped that the survey findings and the subsequent recommendations will assist governments to develop policy and planning that is more finely attuned to the needs of the sector. This will help the sector to transition from a state of impeded growth and capability to one of viable growth and increased capability, in order to provide better outcomes for native seed users, especially those involved in biodiversity conservation via ecological restoration.

Contents

Acronyms and Abbreviations used in this report

AABR	Australian Association of Bush Regenerators
ANPC	Australian Network for Plant Conservation Inc.
APCC11	11th Australasian Plant Conservation Conference (2016)
ASBP	Australian Seed Bank Partnership
ASF	Australian Seed Federation
CMA	Catchment Management Authority
COAG	Council of Australian Governments
B	Billion
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ISTA	International Seed Testing Association
LLS	Local Land Services (NSW)
NGO	Non-government Organisation
NSW	New South Wales
NHT	National Heritage Trust
NLP	National Landcare Program
NRM	Natural Resource Management
RBC	Royal Botanic Garden
RIAWA	Revegetation Industry Association of Western Australia
SA	South Australia
SERA	Society for Ecological Restoration of Australasia
SPA	Seed production area
TAFE	Technical and Further Education (Institute or College)
wa	Weighted average
WA	Western Australia

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1 Introduction

1.1 The Australian native seed sector

The Australian native seed sector is an *ad hoc* group of individuals, businesses and government agencies that includes seed suppliers (collectors, growers and sellers), seed purchasers (buyers, distributors and end-users) and an assortment of other participants. In recent decades, there has been increased government and public focus on the need to restore degraded native plant communities, both in Australia and globally (Mortlock 1999, Society for Ecological Restoration International Science & Policy Working Group 2004), which has important implications for the supply of native seed. Planting of native vegetation to ameliorate land degradation can take many forms and the Society for Ecological Restoration Australasia recognise three types of activity (See Box 1); here we use restoration inclusively to describe all of these activities that require native seed. Government policies and programs direct and underwrite much of the activity within the sector through various environmental and agricultural departments, park agencies, catchment management authorities, local land services and local governments. In addition, non-government organisations (e.g. Trust for Nature, Bush Heritage and Greening Australia), universities, community groups, and commercial enterprises also contribute to a rich network of sector participants. The sector is often collectively referred to as the 'native seed industry', which services a range of end-users including (but not confined to) groups involved in ecological restoration, native forestry, mine rehabilitation, bush foods and products, pasture production, landscaping, and horticulture (Broadhurst, Driver et al. 2015).

Several umbrella groups in Australia act as technical and support networks for native seed users including (but not limited to) the Society for Ecological Restoration Australasia (SERA, http://www.seraustralasia.com), Australian Network for Plant Conservation (ANPC, http://www.anpc.asn.au), Australian Association of Bush Regenerators (AABR, http://www.aabr.org.au), and Australian Seed Bank Partnership (ASBP, http://www.seedpartnership.org.au).

Bushcare volunteers revegetating wildlife corridors with Boorowa Community Landcare, NSW (image credit North Sydney Council).

A past key resource for the native seed sector was the Florabank program. Florabank was funded through the Federal Government's National Heritage Trust Bushcare Program and was initiated in 1998 as a collaboration between Greening Australia, CSIRO (through the Australian Tree Seed Centre – Forestry and Forest Products), Australian National Botanic Gardens, Australian Centre for Mining Environmental Research, and Nursery Industry Association of Australia (Victorian Department of Sustainability and Environment 2004). In its heyday, Florabank provided a wide range of web-based resources including best-practice guidelines (https://www.greeningaustralia.org.au/publications/), access to information from research, and various databases. Florabank also ran a nationally accredited seed collector training program that was well regarded and supported by the sector. Most of these activities ceased after the funding ended and today Florabank exists as an historic web-based resource (managed by Greening Australia).

Box 1. Restoration, revegetation or rehabilitation?

The *SERA* "National standards for the practice of ecological restoration in Australia" (Standards Reference Group SERA 2017) use the following definitions to describe different types of restoration:

Ecological restoration – *"the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed".*

Rehabilitation – *"the process of reinstating a level of ecosystem functionality on degraded sites where ecological restoration is not the aspiration as a means of enabling ongoing provision of ecosystems goods and services".*

Revegetation – *"establishment, by any means, of plants on sites (including terrestrial, freshwater and marine areas) that may or may not involve local or indigenous species)".*

In this report we use the term "restoration" to collectively include all these activities that involve the use of native seed.

In terms of representative industry bodies, the Australian Seed Federation (http://www.asf.asn.au) represents the broad seed industry, but is primarily focussed on the agriculture and horticulture sectors rather than on native seed for conservation and restoration activities. Australia lacks a national native seed-focused body that represents the interests of members and the sector. Such organisations do exist in other countries and include The American Seed Trade Association (https://www.betterseed.org/), and the soon to be formed European Native Seed Producers Association (http://ser-insr.org/news/2018/5/26/formation-of-the-european-native-seed-producassociation). The Revegetation Industry Association of Western Australia (http://riawa.com.au/wordpress/) (RIAWA) undertakes this role in that state.

The collection and use of native seed are key activities for restorationists, farmers, public land managers and others seeking to restore degraded land across Australia or promote the use of native species in other areas. Consequently, native seed is collected and used by a broad range of people who have a variety of skills and experience to support wide-ranging outcomes. These outcomes include restoration on farms, mine sites and public lands; creating amenity plantings in urban landscapes; native plantation forestry; growing farm fodder; and, producing bush foods and medicines. This wide scope of activities highlights the need to develop a coherent and functional native seed sector that is capable of meeting individual, local, regional, national, and international biodiversity goals and obligations as well as various other end-user aspirations. Climate change has also increased the need for species-rich restoration to improve landscape resilience (Williams, Falconi et al. 2017). In response, the sector will need to increase the diversity of species and ensure that high quality seed is delivered to the native seed market (Broadhurst, Driver et al. 2015, Delpratt and Gibson-Roy 2015).

Restoration in Australia's agricultural landscapes has traditionally focussed on the reinstatement of trees and shrubs (Coor 2003) and these plant types have logically been the prime focus of the native seed sector.

More recently, there has been a growing acceptance of the importance and feasibility of restoring species diversity and community function and, in some cases, 'whole community' restoration (Gibson-Roy and Delpratt 2015). This understanding has led to a slow but steady increase in the demand for native seed from a much broader range of species and plant types from across all vegetation strata, especially from the ground-layer (P. Gibson-Roy, 2019, personal communication). Concurrently, there is also a growing interest in commercialising native plants for food (e.g. http://www.abc.net.au/news/2018-06-15/native-bushfood-helping-remote-nsw-community-thri/9870698) and medicines (e.g. http://www.abc.net./news/rural/2014-03-12/growing-bush-medicine/5313118). However, the demand for native seed for these latter products is comparatively low compared to the volumes required for uses such as broad-scale restoration, mining rehabilitation and native forestry.

Research advances in areas such as genomics, cytogenetics and plant systematics suggest that the demand for more refined information on the characteristics of native seed will grow in the coming decades (Garris, Baldwin et al. 2016, Hodgins and Moore 2016). Technological advances have also occurred in seed harvest, processing, and delivery with a view to improving efficiencies and cost-effectiveness. For example, there are now purpose-built mechanical seeders specifically developed for seeding native species. These machines are capable of sowing any number of species in a single pass, unlike agricultural seeders that do not cope well with many of the physical structures (awns, hairs etc.) associated with native seeds (Gibson-Roy and Delpratt 2015). Elsewhere, drones are being used to deliver native seed in highly inaccessible terrain [e.g. (Elliott 2016) and (https://asia.nikkei.com/Life-Arts/Life/Thai-team-fights-climate-change-with-aerial-reseeding)]. It is likely that as restoration technologies and practices become more effective and cost-efficient, the demand for native seed will increase.

Harvesting native grass seed on Kangaroo Island SA (image credit Peter Cuneo).

1.2 Major drivers of native seed-use in Australia

For several decades, considerable government investment has been directed to restoring degraded landscapes in Australia (Hajkowicz 2009, Broadhurst, Waters et al. 2017). Salt (2016) estimates that $6.51B had been spent by governments on natural resource management (NRM) programs between 1990 and 2013. Several of these programs supported the establishment and operation of the native seed sector including the *National Landcare Program* (NLP) established in 1989. Other important programs include the *Natural Heritage Trust* (NHT, 1997 to 2008), *National Action Plan for Salinity and Water Quality* (2000 to 2008), *Caring for Our Country* (2008 to 2013), and *Biodiversity Fund* (2011 to 2017). Significant quantities of native seed for restoration were required to support these programs, e.g. NHT1 is estimated to have resulted in at least 163,000 ha of restoration and planting of at least 63M seedlings (Broadhurst, Waters et al. 2017).

In 2014, the Federal Government merged the *Caring for Our Country* and various programs under the National Landcare banner (http://www.nrm.gov.au/news-and-resources/resources/previous-programmes). At the time of this report, the NLP represented the main source of federal funding for biodiversity conservation and hence the native seed sector. The *20 Million Trees* program, which sits within the NLP, was budgeted to spend $70M over six years to 2020 for restoration (http://www.nrm.gov.au/system/files/resources/5e7f44d5-787c-4444-a7c7-f6b8cc12eead/files/2-million-trees-grant-guidelines-round-three.pdf). As at 30 April 2017, this was Australia's largest restoration program with some $43M approved to plant >13.4M trees (http://www.nrm.gov.au/national/20-million-trees). As with preceding programs, the *20 Million Trees* program is almost entirely reliant on wild-collected native seed and as such is a substantial underwriter of native seed collection and plant propagation activities.

Yellow Box (*Eucalyptus melliodora*) restoration in NSW (image credit Linda Broadhurst).

Several high-profile public-private restoration projects comprised of multiple partner organisations/agencies with large landscape-scale and even cross-jurisdictional restoration goals have emerged in recent decades. Examples of these include Gondwana Link (http://www.gondwanalink.org/), Great Eastern Ranges (https://www.ger.org.au/home), Habitat 141 (https://www.habitat141.org.au/), Living Flinders (https://www.greeningaustralia.org.au/proj/living-flinders/), Wild Eyre (http://wildeyre.com.au/), and Save Our Species (https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/saving-our-species-program). These projects represent potentially large users of native seed.

In recent decades, the demand for native seed and restoration services has grown as markets that plant native trees for carbon sequestration, carbon emission avoidance and emissions reductions continue to mature (Jackson, Argent et al. 2016). Increasing interest by some state jurisdictions to allow 'active restoration' (i.e. not natural regeneration) to be included or recognised in offset mechanisms to increase biodiversity gains at stewardship and offset sites, may also increase the demand for native seed.

Rehabilitation of a closed mining site to a woodland community (image credit Paul Gibson-Roy).

For example, NSW is developing operational manuals providing guidance for applicants and accredited assessors in applying its Biodiversity Assessment Method (established under of the NSW *Biodiversity Conservation Act 2016*). The manual will focus on how active restoration can be used to increase biodiversity outcomes (see: https://www.environment.nsw.gov.au/biodiversity/assessmentmethod.htm).

The mining industry is another large user of native seed. While the amount of seed used for Australian mine restoration has always been difficult to determine, information from a Florabank seed sector survey in the late 1990s found that the mining industry was the single largest user of native seed at that time (Mortlock 1999). There seems little doubt it remains a significant user of native seed today. With strict mine closure processes being adopted in many Australian States, increased demand for native seed is anticipated to meet obligations related to restoration. As an example, some 20,000 ha of ex-mining land requires remediation in the Pilbara region of Western Australia of which ~2,500 ha has so far been successfully undertaken (Mattiske 2016). An estimated 100 to 140 tonnes of seed is required to meet this final target (Merritt and Dixon 2011).

For decades there has been discussion about the desirability of utilizing native species in agriculture. Organisations such as the STIPA native grass association and the Meat and Livestock Association (MLA) advocate using native pastures on farms, as is now common in many parts of the USA (Gibson-Roy 2018). However, in many farming areas across Australia, there is limited use of native grasses in pastures. This is possibly due to a lack of native seed at prices that are comparable to exotic pasture species, or the availability of government schemes that provide incentives for the use of native pasture seed. As a result, this area does not yet represent a major driver for the native seed sector. Other areas where the use of native species has been widely promoted are on road and rail corridors, in urban landscapes, and for the food industry. Again, for reasons that include seed supply and quality limitations, the cost of native seed, and a lack of government incentives to grow such markets, these activities do not yet represent major drivers for the native seed sector (Gibson-Roy 2018).

1.3 Challenges for the Australian native seed sector

1.3.1 Deteriorating state of the environment

The most recent State of the Environment Report concluded that the overall condition of Australia's natural environment was poor and deteriorating (Jackson, Argent et al. 2016). Yet the scale and magnitude of pressures on the environment, which include habitat clearing, fragmentation, overgrazing, invasive species, and climate change (and the interactions among these pressures), continue to out-weigh investment in biodiversity conservation (Cresswell and Murphy 2017, Metcalfe and Bui 2017). Eastern Australia has also been identified as one of the top-ten global deforestation fronts (W.W.F. Global 2015). While land clearing rates have stabilised across much of Australia since 2011, rates in Queensland have not (Cresswell and Murphy 2017), with some 395,000 ha of woody vegetation cleared between 2015 and 2016 (Queensland Department of Science 2017). In August 2017, the NSW Government introduced reforms to its *Biodiversity Conservation Act 2016* and *Local Land Services Amendment Act 2016*, which have significantly reduced government regulation of clearing in much of the State in favour of clearing by land managers under self-assessable codes (https://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation and associated pages). The long-term trends resulting from these changes in NSW are not yet clear, but a recent report by the NSW Auditor General found that "The [self-assessment] Code around land clearing may not be responding adequately to environmental risks", and that "The amount of land clearing has increased but the latest data is yet to be publicly released" (Audit Office of New South Wales 2019).

Erosion in South Australia (image credit John Coppi).

In Australia, there remains much contention about what constitutes tree clearing and what constitutes tree thinning and vegetation management. Many advocates of this latter process argue that thinning of the dominant woody stratum allows other strata (e.g. grasses, forbs and shrubs) to regenerate and occupy that space to then provide valuable habitat or fodder for stock (https://northerntablelands.lls.nsw.gov.au/sustainable-land-management/on-the-ground-real-exa/sustainable-land-management-at-glenreagh2/glenreagh-case-study). Under either concept, there will often be cases of impoverished soil seed banks and a need to *assist* regeneration of native-dominated lower strata to the desired optimal state. The most efficient means of this will often be via the use of high-quality native seed.

The 2012 *Australia's Native Vegetation Framework* (http://environment.gov.au/land/publications/australias-native-vegetation-framework) was an initiative of the Council of Australian Governments (COAG) Standing Council on Environment and Water. The Committee stated that the loss and degradation of native vegetation constituted an ongoing threat to biodiversity and to the productivity of Australian industry. It also reinforced the notion that agriculture, forestry, fisheries and tourism all rely on productive and healthy native vegetation ecosystems and that further action was required from land users and managers (public and private) to ensure that healthy and resilient native vegetation was retained over the Australian landscape. Importantly, of the five goals the Council developed to meet this vision, the first aimed to "*increase the national extent and connectivity of native vegetation*". This goal, if implemented, would have important direct and indirect implications for the native seed sector. Such aspirations would dramatically increase the scale and complexity of restoration undertaken across the country for many decades and drive a need for high volumes and quantities of native seed and the associated biological knowledge to deploy it efficiently.

1.3.2 Vegetation fragmentation

Tulloch, Barnes et al. (2016) estimated that for at least 22% of Australia's major vegetation communities, approximately half of the remaining remnant patches are <1000 ha. Surveys from Victoria in the early 2000s revealed that ~1,600 ha of woody native vegetation and ~3,000 ha of grassy native vegetation were being lost annually, mostly from private land (VEAC 2010). When this vegetation was categorised into 10 patch-size classes across the state, 88% of these patches were found to be less than a hectare (VEAC 2010). Fragmentation of native vegetation into smaller and more isolated patches has many consequences for native seed supply. Firstly, fragmentation reduces the amount of vegetation from which seed can be collected (Figure 1.1 A → B). Subsequent ecosystem disruption by factors such as soil erosion, soil salinity or reduced pollinator habitat (Figure 1.1 B) can also reduce the amount of seed produced by remnant vegetation. Reduced genetic diversity and increased inbreeding as a consequence of populations becoming smaller and more isolated are also well-known (Aguilar, Ashworth et al. 2006) and can reduce seed production as well as impacting on seed viability and subsequent seedling vigour (Young, Boyle et al. 1996, Broadhurst, Lowe et al. 2008). The use of seed of poor genetic quality for restoration (Figure 1.1 C) may result in more small, inbreeding populations (Figure 1.1 D) that have limited long-term viability (Figure 1.1 E) (Broadhurst, Hopley et al. 2017).

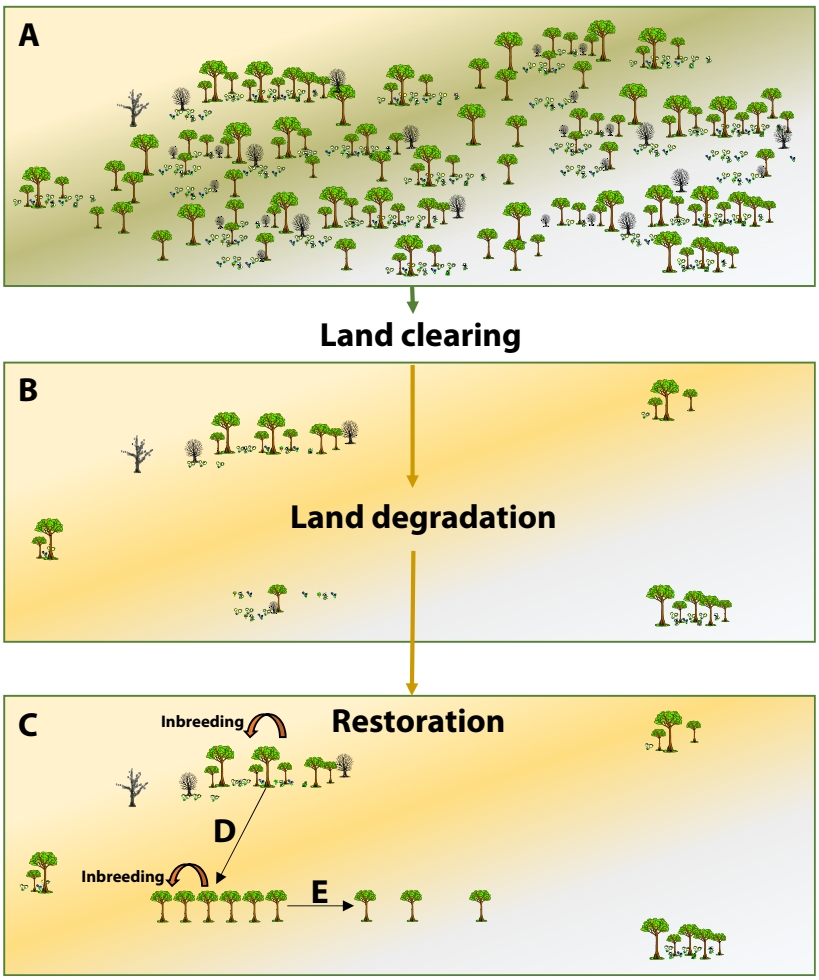

Figure 1.1. Schematic representation of the relationship between land clearing, land degradation, restoration and demand for native seed.

1.3.3 Climate change

Climate change projections are, broadly speaking, deeply concerning for effective landscape-scale restoration in Australia. Average air temperatures in Australia have already increased by ~1.1°C since 1910 (Bureau of Meteorology 2018) as has the frequency, and in some cases intensity, of extreme weather events (Steffen, Rice et al. 2018). At current rates of greenhouse gas emission, 2090 predictions for Australia include further increases in temperatures of 2.8-5.1° C as well as more frequent and extreme hot days with associated risks of more uncontrollable fire and a lengthening of fire seasons (CSIRO and Bureau of Meteorology 2015). Rainfall changes are less certain, but across the continent, an increase in the intensity of extreme events and changes to seasonal patterns are predicted (CSIRO and Bureau of Meteorology 2015). The level of greenhouse gases already emitted globally commits our planet to at least another degree of warming over coming decades, irrespective of current emission reduction strategies (Friedlingstein, Solomon et al. 2011).

Climate change has the potential to affect the availability and viability of native seed (Broadhurst, Jones et al. 2016) through:

- Rising temperatures altering flowering times and/or flowering duration, changing pollination activities, impacting on the depth of seed dormancy depth, germination cues and seed longevity, and, increasing seed abortion rates.
- Reduced water availability lowering seed-set (in addition to the effects listed above), and, reducing seedling germination and establishment success.
- Increased frequency of extreme or severe weather events causing damage to (or loss of) plants and negatively impacting seed-set.

Extreme weather events include drought, bushfires, floods and cyclones at landscape scale that obliterates unharvested seed in the wild and / or at a frequency that does not allow plants to attain maturity. This scale of devastation would substantially hinder restoration activities through a lack of native seed supply.

Observations consistent with the predictions, including reduced seed yields from normally reliable wild populations, are now being informally reported by seed collectors at workshops and forums in South Australia and New South Wales (L. Broadhurst, 2017 personal communication). Such feedback suggests that climate change impacts will test the capacity of remnant vegetation to supply seed for Australian restoration (Broadhurst, Jones et al. 2016). The 1996 to 2010 Millennium Drought (http://www.bom.gov.au/climate/updates/articles/a010-southern-rainfall-decline.shtml) provided some insights into how an extreme and prolonged climate event could negatively affect restoration programs and hence, the native seed sector. During this period there were reports from many restoration practitioners of failed or delayed projects due to poor planting conditions (M. Driver, 2017, personal communication). Some projects successfully initiated during this period include the Grassy Groundcover Restoration Project which relied totally on direct-seeding to initiate restoration (Gibson-Roy, Moore et al. 2010).

At the landscape level, climate change is predicted to result in new ecological environments, substantially altered vegetation communities, and an increased risk of local extinctions (Williams, Prober et al. 2014). These impacts could affect seed collection practices, seed availability, and revegetation practices. For example, current guidelines regarding the amount of seed that can be ethically collected from plants or populations at any time are likely to be challenged as population sizes and ranges decrease and/or shift while seed demand potentially increases. This could mean seed collectors and growers will need to source seed from a broader geographical range or from cultivated seed crops (Jalonen, Valette et al. 2018).

1.3.4 Defining seed collection or usage ranges

Using seed and cuttings collected from populations within a defined geographical (provenance) range to a planting site has been commonly recommended within the restoration industry for many decades (Falk, Millar et al. 1996, Ennos, Worrell et al. 1998) and has been debated ever since (Broadhurst, Lowe et al. 2008, Breed, Stead et al. 2013, Delpratt and Gibson-Roy 2015). Initially, highly precautionary native seed use strategies were devised to preclude possible negative effects that might arise given the limited genetic, ecological, and taxonomic knowledge available for most restoration species. Rationales for using strict local provenance approaches include the ethical need to preserve the genetic character of local populations, to avoid poor restoration outcomes due to the use of maladapted seed, capturing benefits associated with local adaptive qualities, limiting matings between genetic distinct populations that could create less fit or sterile hybrids (outbreeding depression), and to avoid the introduction of 'weedy' genotypes (see Broadhurst, Lowe et al. 2008 and references therein, Delpratt and Gibson-Roy 2015) . These strategies favoured a strong adherence to the use of seed from the immediate region for restoration (i.e. local provenance) and were widely promoted in early best practice guidelines (e.g. Florabank Guidelines Nos. 5 and 10 (Mortlock and Australian Tree Seed Centre 1999, Mortlock and Hawkesbury-Nepean Catchment Management Authority 2000)). Some collection guidelines suggested that seed should be collected within 5 km of a revegetation site or 'as local as possible' (Mortlock and Australian Tree Seed Centre 1999). However, some suppliers and utilisers of native seed are using more flexible approaches in defining provenance ranges including being guided by the identity and characteristics of the individual species (Hancock and Hughes 2012, Cooper, Catterall et al. 2018). More recently, revised provenance and collection strategies, which seek to incorporate broader genetic diversity and adaptability to climate change, have been developed and are becoming more widely promoted (see Prober, Byrne et al. (2015) for a summary of recent provenance strategies). At an operational level, these newer strategies seek to incorporate seed from both local and more distant locations, beyond the immediate vicinity of the restoration site.

The practice of buyers setting clear directions for sourcing local seed is also practiced in other countries. In a recent survey of global forest and landscape restoration practitioners, (Jalonen, Valette et al. 2018) reported that 51% of respondents said that their main criterion for selecting seed source populations was that these were located close to the target restoration site (a 10 km median but within a 1 – 300 km range). However, the practicality of adhering to narrow collection ranges (i.e. 1 to 10 km) can create logistical difficulties and even ethical conundrums for both suppliers and users if seed from within those restricted ranges/provenances is unavailable or limited or of poor quality or low genetic diversity (Broadhurst, Lowe et al. 2008, Hancock and Hughes 2012, Nevill, Tomlinson et al. 2016, Jalonen, Valette et al. 2018). Furthermore, Jalonen, Valette et al. (2018) suggested that, across the globe, seed collection records often lack enough detail to properly clarify seed origin. This omission has led to increased interest in establishing seed certification programs (e.g. the US-based Iowa Crop Improvement Association's *Native Species Seed* program) that give seed buyers/users more certainty about the origin and characteristics of native seed (Gibson-Roy 2018). The only Australian accreditation scheme we are aware of is the RIAWA Native Seed Accreditation System (http://riawa.com.au/wordpress/?page_id=105901-RIAWA Seed Standards 191021.pdf).

1.4 Aims of this survey

It has been some time since the Florabank native seed survey of the late 1990s provided an important snapshot of community restoration and the Landcare sectors (Mortlock 1999). Despite the many recommendations that followed this survey, the slow pace of sector change continues to frustrate many participants. This *Australian Network for Plant Conservation 2016/17 National Seed Survey* is the first to target the Australian native seed sector since 1999 (although we recognised that regional surveys such as in the Corangamite region of Victoria (Dodds, Dennis et al. 2002) have been undertaken). We aimed to provide an updated snapshot of the sector's characteristics and capacities by addressing a range of subjects including seed collection practices, seed-use, business structures, and operating models. Implicit in the survey was the knowledge that this information would be important to those wanting to understand how the sector operates and its capacity to meet current and projected seed requirements for landscape-scale restoration and numerous other end-uses. The survey also explored common perceptions and relationships between different users of native seed, gauged opinions, and gathered feedback on major issues experienced by those in the sector, with a goal to establish updated baseline knowledge.

We anticipate that the results of this survey will provide information and insights to help pave the way for positive change in the native seed sector, moving it to a forward-focused, structurally sound and cohesive industry across Australia. A transition of this nature is required to create a sector capable of contributing to the many and complex challenges facing the Australian environment including the restoration of Australia's biodiversity.

Mixing bulk native grass seed (image credit Peter Cuneo).

2 Methods

2.1 Sampling

Australian seed collectors/growers/sellers/suppliers, purchasers/users/distributors, and other interested parties were invited to contribute to the *Australian Network for Plant Conservation (ANPC) 2016/17 National Seed Survey* on the status of the Australian native seed sector. An initial list of 387 potential participants was compiled from the existing ANPC database, delegates to the 11th Australasian Plant Conservation Conference (APCC11 – Melbourne, November 2016), seed industry professionals and the broader plant conservation and restoration communities (which included non-government organizations, government agencies, universities, botanic gardens, and the mining, Bushcare, landscape, and native food sectors). The ANPC issued an invitation to participate on 4 October 2016 and the survey closed at 5pm on 24 October 2016. Preliminary results from the 112 respondents were presented at the APCC11 conference in Melbourne. Following that presentation, the ANPC received many requests for the survey to be re-opened and a further 34 responses were received between 2 February 2017 and 28 April 2017. The re-opened survey was promoted in the *Australasian Plant Conservation* bulletin and on the ANPC webpage, directing those who wished to participate to contact an ANPC officer who would then send the survey link. This process was followed to avoid any duplication of responses.

2.2 Survey design

Survey questions were developed by Paul Gibson-Roy and Martin Driver, representing the Australian Network for Plant Conservation with feedback provided by several sector practitioners. A pilot of the survey using six practitioners known to the authors was conducted to eliminate ambiguity and faults with survey questions. A copy of the final questions posed to each group can be found in Appendix 1.

Respondents used the online survey tool SurveyMonkey® (https://www.surveymonkey.com/) to record their answers. After answering an initial question – "*From the list below, what is your primary role within the native seed industry? You may feel that you fall into more than one of the following categories, but please choose the one which best describes your role and answer all questions accordingly*" - respondents were categorised into one of four Groups (Table 2.1). The abbreviated Group names in Table 2.1 are used throughout this report.

The next four questions, answered by all Groups, were worded slightly differently depending on the Group that a respondent had identified with. For example, Seed Collectors were asked "*How is the bulk of your seed prepared for sale or for your own use?*" while Seed Purchasers were asked "*How is the bulk of your seed purchased?*". This wording allowed the questions to be compared within and among the different survey Groups. Respondents answered 18-25 questions depending on the Group to which they had identified but were not obliged to answer all questions. To avoid respondent fatigue, all questions (apart from "*What is your postcode?*") were multiple choice. Many questions also allowed for written responses by free-form comments or by elaborating in the 'Other' response category. These responses and general comments were reviewed and where possible, incorporated into the themes outlined in Section 3 Survey Findings.

Table 2.1. Survey question 1 to allocate respondents to the Groups they identified as their primary role within the native seed sector.

Pooled Group	Group	Description
Seed Supply	**Seed Collectors**	Collect seed or hold seed collected by others on consignment (i.e. community seedbank), for sale, or for use in your own projects (i.e. nursery production or direct seeding)
	SPA Growers	Grow seed in Seed Production Areas (i.e. plants grown in cultivation to produce seed) for sale or for use in your own projects (see Box 5)
Seed Demand	**Seed Purchasers**	Purchase seed for your own projects or for distribution to other projects
	Other Users	Use seed for other purposes

2.3 Analyses

To determine if there was a significant difference between responses from the first and second (re-opened) phases of the survey, results from randomly selected questions from each phase were compared and no major differences were observed. Accordingly, all data were combined for analysis. The answers were compiled within SurveyMonkey® as percentage responses, a weighted average or both. For responses to questions that were ranked according to their importance (i.e. ranked from 1 being the least important to 5 being the most important), and where there were multiple categories within a question, SurveyMonkey® calculated the weighted average of the responses across each category within the question for each Group. Weighted averages are like an ordinary arithmetic mean except that instead of each data point contributing equally to the final average, some data points contribute more than others - see Box 2 for the formula used to calculate weighted averages and a worked example. Weighted averages are commonly used to compare group data sets from different sized groups such as in this survey. For example, to gauge the importance of several perceived or actual concerns within the native seed sector, 13 statements of potential issues were provided and respondents were asked to rank on a scale of 1 (being the least important) to 5 (being the most important). As a guide to the gravity of these responses, a weighted average of 3 was considered to indicate a moderate concern while 4 indicated a very important concern. To determine the order of importance of the potential issues of the combined groups, a mean of the four weighted averages was calculated.

Where the data were combined to represent the Seed Supply Group (Seed Collectors and SPA Growers) and/or the Seed Demand Group (Seed Purchasers and SPA Growers), the count responses of the sub groups were added to together to calculate a weighted average for each Group.

Box 2. Calculating weighted averages

The weighted average of survey responses is calculated as:

$$\text{weighted average} = \frac{((\text{n x w1}) + (\text{n x w2}) + (\text{n x w3}) + (\text{n x w4}) + (\text{n x w5}))}{\text{total number of respondents}}$$

where n = the response count and w = the weight of the response; w1 is given a weighting of 1, w2 = 2, w3 = 3 etc.

Example

For this survey, the four groups were asked about the origin (e.g. public reserves or roadsides, state or national parks, or private property) of their seed collections/purchases. Using state parks as an example, 28 Seed Collectors indicated that they did not collect from state parks, 18 nominated the 1-20% category; 5 the 21-40%; 2 the 41-60%; 2 the 61-80% and 1 > 80%. The weighted average of Seed Collectors for state parks is therefore:

$$\text{weighted average} = \frac{((28\text{x}1) + (18\text{x}2) + (5\text{x}3) + (2\text{x}4) + (2\text{x}5) + (1\text{x}6))}{56}$$

$$= 1.84$$

Using the same process for state parks for the other groups (i.e. SPA Growers, Seed Purchasers and Other Users), the weighted average is 1.68 for SPA Growers, 1.58 for Seed Purchasers and 1.60 for Other Users. These results represent a value that can be compared between the four groups, regardless of the different number of responses obtained for each group.

3 Survey Findings

3.1 Preamble

One-hundred and forty-six surveys were completed representing a 40% participation rate from 387 direct invitations (noting that the number of potential respondents contacted may be larger since it was likely that ANPC emails were forwarded among much larger communication networks). A 40% response rate is comparatively high for similar-style surveys. For example, the Florabank revegetation sector survey had a percentage response rate in the low twenties (Mortlock 1999), while a global survey of biodiversity experts focusing on conservation options under uncertainty achieved a response rate of 26.5% (Hagerman and Satterfield 2014). A New Zealand Department of Conservation survey on conservation genetics had a 36% response rate (Taylor, Dussex et al. 2017). More recently, a survey focussing on seed sourcing strategies for global forest and landscape restoration projects received 137 completions (Jalonen, Valette et al. 2018), while a 2017 survey of the European native seed industry received 216 response from 20 countries (De Vitis, Abbandonato et al. 2017).

As is the case with surveys of this type, the authors place some caveats on the data reported, these being:

- There is no single coordinating entity or agency responsible for regulating or collating data on the Australian native seed sector. It is therefore difficult to determine what proportion of those working in the sector completed the ANPC survey or whether the responses received are representative of the sector. Consequently, we recommend that for quantitative questions, readers focus on trends rather than the absolute numbers reported.
- It was also understood that some respondents may have been reluctant to participate due to perceived commercial sensitivities about the information being requested. Because of the difficulty in determining the extent to which this may have occurred, it is acknowledged that there may be gaps in sector information due to their omissions.

Despite these caveats, these data provide a sound and quantifiable sample of baseline data from the Australian native seed sector. The survey was detailed, time consuming and required considerable input to complete. The large number of respondents indicates a strong desire to have their views heard. Overall, the responses from participants reveal important trends and shed light on a range of beliefs and behaviours from the sector that, until now, have largely been anecdotal. Summaries of key survey findings and key risks for the sector are listed at the end of each of the following sections. The key risks listed are the authors' opinions and, in some cases, were derived from comments from survey respondents.

3.2 Who's who in the Australian native seed sector?

Almost half of the survey respondents identified as Seed Collectors (48%) with the remainder almost equally distributed among SPA Growers, Seed Purchasers and Other Users (Figure 3.1). This aligns with the intuitive perception that most people in the sector collect seed (for plant propagation or on-ground works) while fewer numbers produce, purchase, research or bank native seed. Not surprisingly, many respondents commented that they had multiple roles across a range of activities including seed collection, plant propagation, seed production, and restoration activities. A small number of respondents commented that their prime focus was on bush foods (seed or plant material).

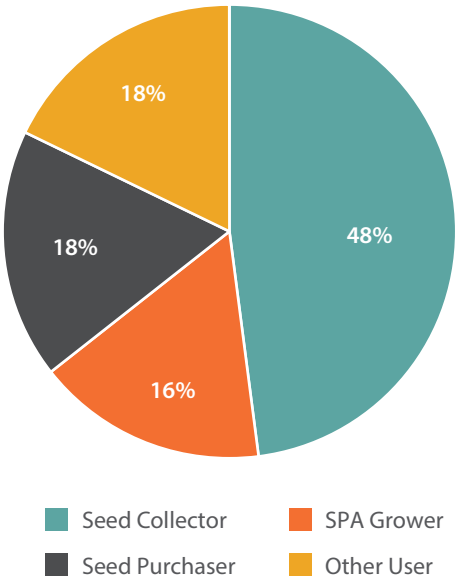

Figure 3.1. The proportion of respondents belonging to each group (Question 1. Appendix 1).

Most survey respondents (41%) were from New South Wales (NSW) and the Australian Capital Territory (ACT) followed by Victoria (VIC) (30%), Western Australia (WA) (14%), and then the other states and territories (Figure 3.2A). When the distribution of Groups within each State was examined (Fig. 3.2B), more respondents identified as Seed Collectors, Seed Purchasers and Other Users in NSW than in the other States. SPA Growers dominated responses from VIC with no responses from this Group in WA. These results probably reflect that different states and territories have different restoration or seed-use priorities and requirements that are particular to their regions.

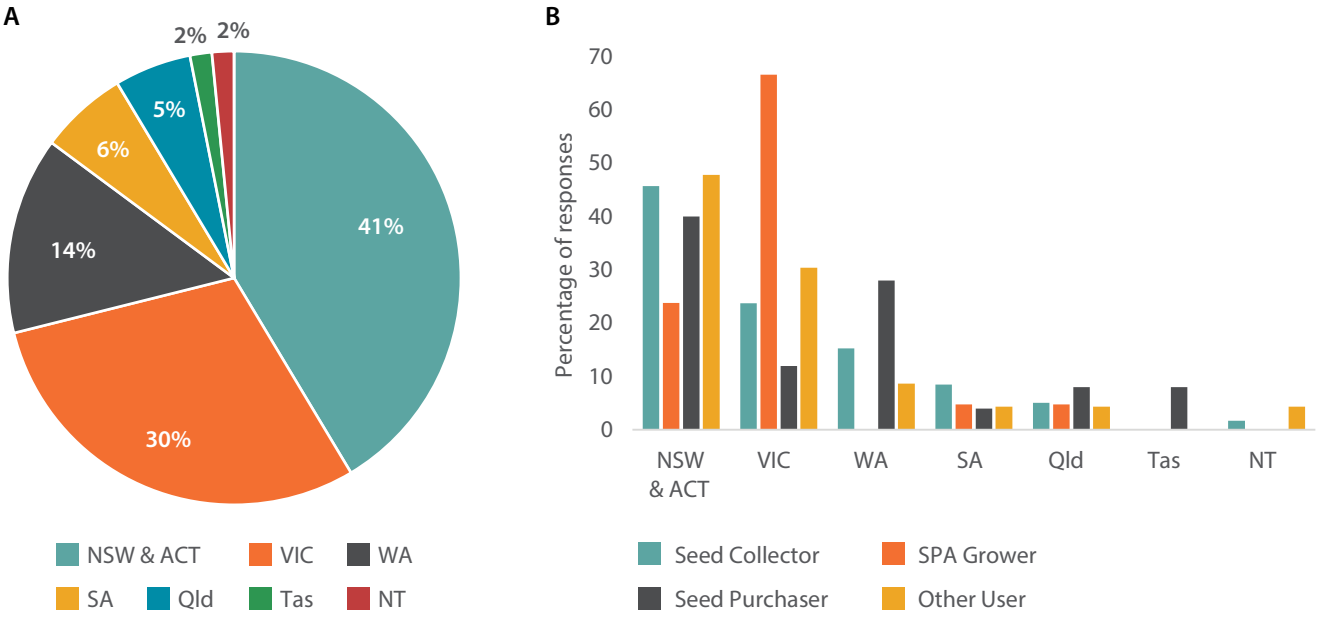

Figure 3.2. Percentages of respondents by jurisdiction (A) and by group (B) (Question 3. Appendix 1).

Irrespective of which Group the respondents identified with, the size of most enterprises (i.e. number of staff) was small (Figure 3.3). Collectively, just over 50% of respondents worked in very small organisations with almost one-third being sole traders (part-time 15%, full-time 14%) and a further 21% associated with businesses that employ <5 staff (Figure 3.3A). These findings are broadly in line with those found by De Vitis, Abbandonato et al. (2017) in their survey of the European Seed Sector, where most organisations employed from 1 to 9 people. However, these data contrast with the United States where native seed businesses routinely employ 20 to 100 staff (Gibson-Roy 2018). The Australian and European situations suggest that markets for native seed in these countries do not yet support larger enterprises or the associated infrastructure of the type found in the USA. While 9% of respondents in this survey identified as being associated with organisations with >50 staff, these responses are likely to include government agencies (primarily Seed Purchasers) or universities (Other Users) where large numbers of staff are employed but relatively few of these participate in the native seed sector. While the overall data suggest that most businesses in the native seed sector employ relatively few staff, there is considerable variation within each of the respondent Groups (Figure 3.3B). Almost 80% of Seed Collectors employ fewer than 10 staff compared with 61% of SPA Growers and 54% of Seed Purchasers are typically small (<10 people) whereas Other Users are often considerably larger.

This question seems to typify the complexity of the native seed sector. Some respondents from each response group, apart from SPA Growers, nominated more than one category to this question. One possible reason for this result is that some respondents, particularly for Seed Collectors, commented that they use volunteers (i.e. schools and environmental groups) and these types of volunteers may have accounted for two category answers being selected. Many respondents commented on the large number of volunteers contributing to the sector (e.g. for seed collection or in nurseries) expressing both positive and negative responses (see Section 3.3.2 below).

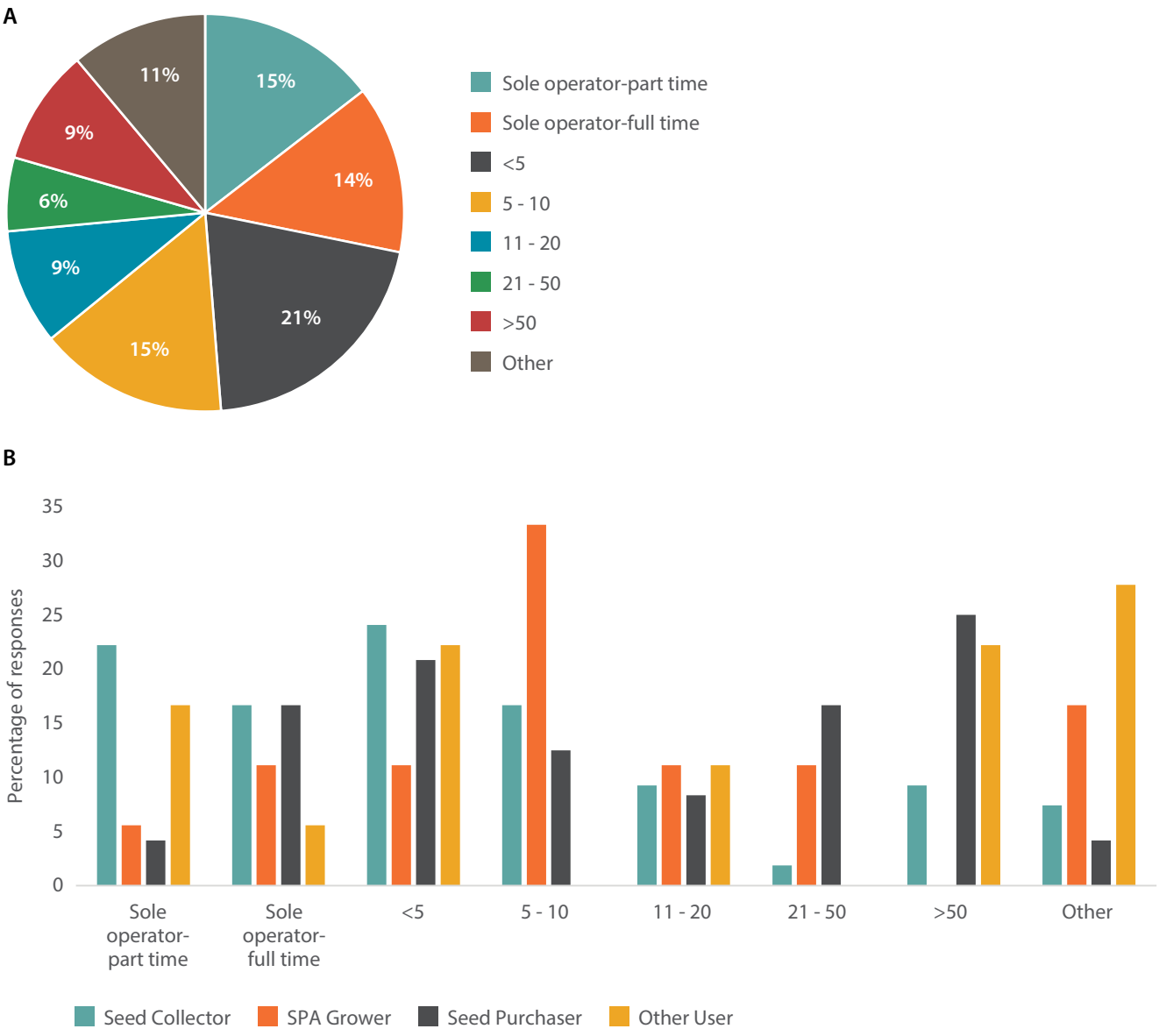

Figure 3.3. The percentage of respondents in each staffing category for (A) the combined groups and (B) for each group (Question 15. Appendix 1). Values are the percentage responses within each staffing category. Note that some respondents nominated more than one category. For this reason, percentages may sum to more than 100%.

The types of organisations with which respondents identified varied (Figure 3.4). Most Seed Collectors (43%) were commercial operators while 23% worked in non-government organisations (NGOs). Thirty-eight percent of SPA Growers identified as commercial operators, and 29% were affiliated with local or state governments. Almost half of Seed Purchasers (48%) were linked to local or state government agencies. This result is not surprising given governments across all levels are the primary funders of restoration in Australia. The remaining Seed Purchasers were equally split between commercial operations and NGOs (both 16%). The largest proportion of Other Users (30%) identified as 'individuals' or 'landowners' with a further 26% indicating that they were linked to universities.

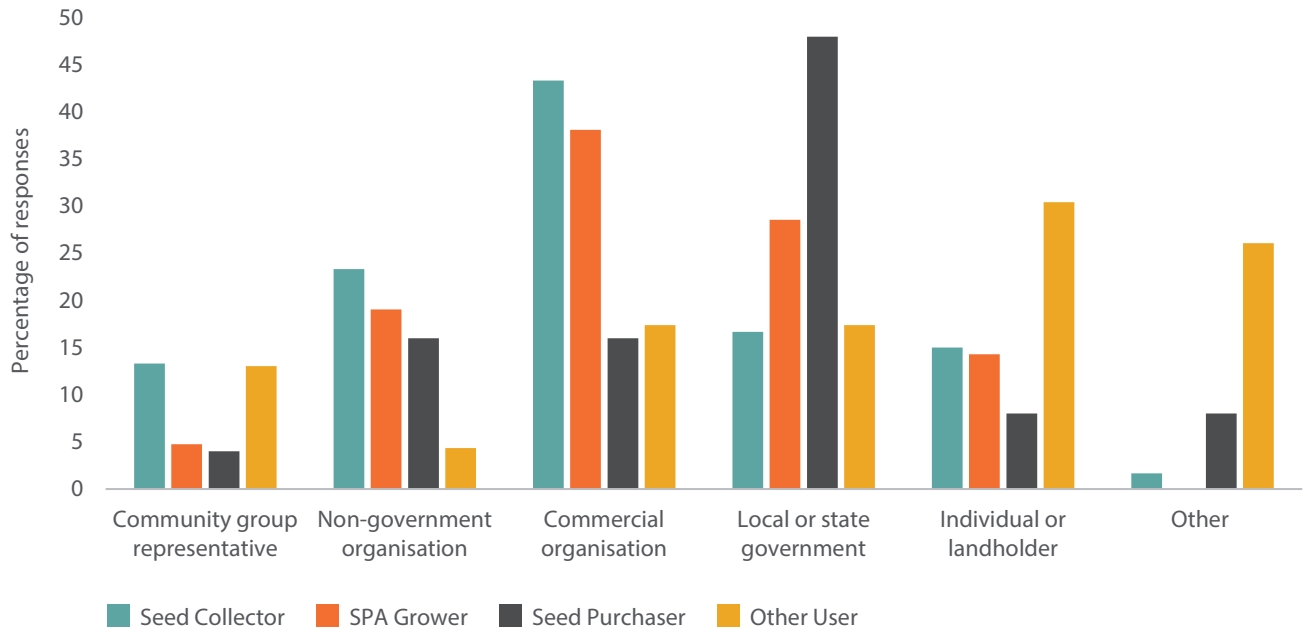

Figure 3.4. Respondent affiliation per group (Question 2. Appendix 1). Values are percentage of responses of total respondent group within each category choice.

1

Key finding 1: The Australian native seed sector is primarily comprised of small businesses, many of whom are sole traders.

Key risk: Restoration programs are largely reliant on a seed sector with a small workforce.

2

Key finding 2: Seed Purchasers are primarily affiliated with Local or State Government agencies suggesting that this is an important source of funding for the native seed sector.

Key risk: While the sector remains reliant on one major purchaser of seed and services it will be vulnerable to downturns in government environmental funding.

3.3 Sector issues

To better understand constraints faced by the native seed sector, respondents were asked to rank a series of thirteen statements citing potential issues for the sector on a scale of least important (1) to most important (5) (see Appendix 2 for all statements). The statements were constructed on the basis of anecdotal comments on potential issues within the sector from participants at various forums in the years leading up to the survey. Responses from all four groups were combined to identify overall statement rankings. The statement "*Future demand for seed will be difficult to meet from wild harvest*" was the highest ranked issue (weighted average (wa) 4.1/5) and "*Provenance range stipulations are too lax*" was the lowest (wa 2.7; Table 3.1). The top four potential issues were closely ranked in score (wa 4.1 to 3.9) and, of the thirteen issues posed, ten were ranked by respondents as very important, two were moderately important and only one was of low importance, suggesting that the sector is facing numerous issues.

Table 3.1. Ranking of thirteen potential issues (Appendix 2) across all Groups. Rankings range from 1 (least important) to 5 (most important). Values are weighted averages for each of the five categories of importance (1; 2; 3; 4; 5). Responses in the N/A category were not included).

Rating	Statement of potential issue	Weighted average (scale of 5)
Very important	Future demand for seed will be difficult to meet from wild harvest	4.1
	The market is unwilling to pay for the true cost of seed collection/ seed production	4.0
	Demand for seed is inconsistent &/or unpredictable	3.9
	There is a lack of seed available from a broad range of species	3.9
	Seed orders are made at too short notice	3.7
	To meet any shortfalls in demand for seed, seed should come from Seed Production Areas (SPA) rather than wild populations	3.7
	There is a lack of suitable seed collectors	3.6
	Seed supply is generally unreliable	3.6
	Provenance range stipulations are too restrictive	3.3
	Demand for seed is low	3.1
Moderate importance	There are too many difficulties in obtaining access to wild populations for collection	3.0
	There are too many difficulties in securing seed collection permits	3.0
Low importance	Provenance range stipulations are too lax	2.7

The top three sector issues for individual groups are in Table 3.2. Within each Group, the issues were differently ranked, highlighting the complexity of perceived risks across this sector. (Table 3.2 and Appendix 2). SPA Growers ranked their concerns higher than the other Groups, suggesting strongly held views or greater agreement by those respondents. The issue of most importance to SPA Growers, '*To meet any shortfalls in demand for seed, seed should come from Seed Production Areas (SPA) rather than wild populations*', scored a weighted average of 4.7 out of a possible 5.

Seed from multiple species in short-term controlled temperature and humidity storage (image credit Paul Gibson-Roy).

Table 3.2. The three most important potential issues nominated by each Group from the thirteen statements (Appendix 2). Rankings range from 1 (least important) to 5 (most important). Values are weighted averages for each of five categories (1; 2; 3; 4; 5. Responses in the N/A category were not included). *N* = number of respondents; weighted average of the potential issue in brackets.

	Issue 1	Issue 2	Issue 3
Seed Collectors ***N* = 60**	The market is unwilling to pay for the true cost of seed collection (4.2)	Seed orders are made at too short notice (3.8)	Future demand for seed will be difficult to meet from wild harvest (3.7)
SPA Growers ***N* = 21**	To meet any shortfalls in demand for seed, seed should come from Seed Production Areas (SPA) rather than wild populations (4.7)	Demand for seed is inconsistent & / or unpredictable (4.5)	Future demand for seed will be difficult to meet from wild harvest (4.4)
Seed Purchasers ***N* = 25**	Future demand for seed will be difficult to meet from wild harvest (4.1)	There is a lack of seed available from a broad range of species (3.9)	Demand for seed is inconsistent & / or unpredictable (3.7)
Other Users ***N* = 23**	There is a lack of suitable seed collectors (4.1)	There is a lack of seed available from a broad range of species (4.1)	Future demand for seed will be difficult to meet from wild harvest (4.1)

3.3.1 Sector issue 1. Future demand for native seed cannot be met by wild harvesting

There is limited data on the volumes of native seed used for restoration in Australia, although the Draft Victorian Native Seed Supply (Victorian Department of Sustainability and Environment 2004) is informative. This report estimated that between 2002 to 2003, 5.8 tonne of native seed were used to restore 9,550 ha in Victoria. A further 19 tonne were predicted to be required to achieve the forward goal of restoring 30,577 ha planned for 2004 and 2005. In a survey of 53 Victorian seed collectors, Mortlock (1999), found that each collector harvested an average of 52 kg of seed per annum (i.e. ~2.7 tonne in total), suggesting that many more collectors would be required to meet anticipated seed targets. In NSW, 300 kg of shrub seed was required to restore 100 NSW Travelling Stock Reserves (>1,000 ha of direct seeding) between 2012 and 2016 (Davidson 2016); this amount was only available because SPAs had been established some 15 to 20 years earlier (M. Driver, 2017, personal communication). Merritt and Dixon (2011) estimated that Pilbara mine rehabilitation in Western Australia would require 100 to 140 tonnes of native seed.

These sources suggest that in the past, high native seed volumes have been estimated for use in restoration programs but for at least one of the above-mentioned projects, the seed purchase goal may not have been realised. It is not surprising that the most consistently held potential issue across all groups was that wild harvest would not meet future demands for native seed with Seed Purchasers ranking this as their top potential issue (Table 3.2). This finding is not new, with similar concerns about potential shortfalls in seed supply in Victoria voiced in the early 2000s (Victorian Department of Sustainability and Environment 2004). This report further noted that Victoria's Net Gain strategy, which proposed net increases in extent and quality of native vegetation (to compensate for development activities), might, where the increase came through restoration (rather than conservation and management) create a demand for native seed that could not be met by collections from small and fragmented remnant populations. Responses in this survey corroborate anecdotal comments made over recent years by many at sector workshops and forums warning that future seed supply is not assured (P. Gibson-Roy, 2016, personal communication). Examples of pertinent comments from the survey include "*Over the past 20 years I have seen a significant decline in wild populations in my region*" and "*Limiting factors for my seed collecting are the availability of seed*" (*sic*).

3

Key finding 3: All Groups raised serious concerns about the capacity of natural plant populations to continue to provide enough native seed to support the seed sector into the future.

Key risk: Failure to address this concern jeopardises the capacity of the sector to meet increased future demand for native seed.

3.3.1.1 Current supply and demand – a snapshot

To build a snapshot of current trends in supply and demand, the survey asked respondents for quantitative data on current seed supply and demand. Seed Suppliers dominated the responses numerically and the commercial sensitivities associated with this question may have resulted in guarded and understated responses from other Groups, with some respondents choosing not to answer this question. These values, therefore, are not a definitive picture of seed quantities (supplied or purchased) across the sector and we recommend caution to readers when interpreting or reporting these data. However, the values provided by respondents suggest that at the time of this survey, supply and demand were more-or-less evenly matched. This does not preclude that future demand will outstrip supply (as predicted by respondents).

To gain finer insights into the nuances of supply and demand between the major plant types used in restoration, the survey asked two separate questions. Firstly, Seed Collectors and the Seed Demand Group (Seed Purchasers and Other Users) were asked to estimate volumes (as defined mass categories) of seed collected, or purchased from each plant type (trees, shrubs, grasses and wildflowers). In our snapshot, we found no indication that there was a major disparity between the supply and demand of seed for any of these plant types (Figure 3.5). We acknowledge that these data do not include the volume of seed being produced by SPA Growers and that the inclusion of this data (if available) is likely to increase the supply volume of grasses and non-woody wildflowers relatively more than for trees and shrubs (see Section 3.5).

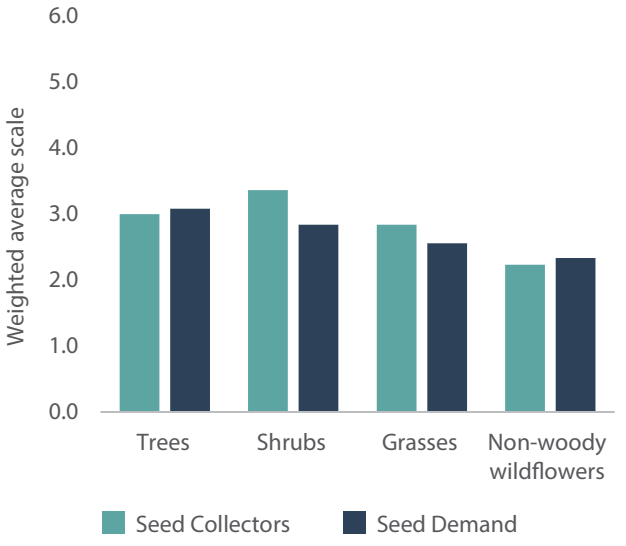

Figure 3.5. The volume of seed harvested by Seed Collectors and purchased or used by the Seed Demand Group (Seed Purchaser and Other Users) (Question 6. Appendix 1). Values are weighted averages of total respondent groups within each category choice.

The second supply and demand question asked each group of respondents for approximate quantities of seed collected/produced/sold or purchased each year for the different plant types. Across all plant types, most seed are collected and traded in very small volumes (i.e. <5 kg) and a relatively large proportion of respondents deal in only one or a few plant types, e.g. the high percentage of respondents in the 0 kg category for wildflowers indicates few purchasers for this plant type (Figure 3.6). However, there is a small proportion of respondents who deal in much larger seed volumes for each plant type.

Trees, shrubs and grasses were the most sought-after plant types for Seed Purchasers, respectively. For trees and shrubs, this demand is likely to be explained by the strong current focus on these plant types for restoration (e.g. *20 Million Trees* program). It is also possible that demand is being generated by an increase in plantings for carbon abatement schemes primarily using trees and shrubs, although this not yet a significant activity in Australia (Bush, Harwood et al. 2018). For shrubs, the small surplus of seed might be explained by the relative ease of their collection in comparison to trees. Supply also marginally exceeded demand for grasses.

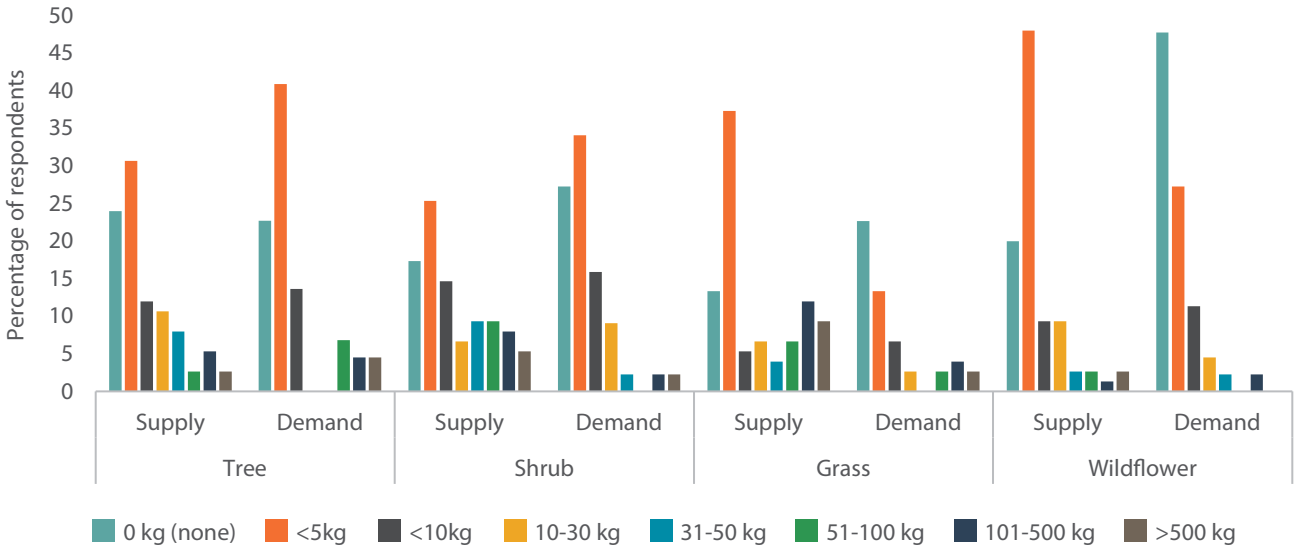

Figure 3.6. The quantities of native seed supply and demand: seed collected or sourced annually by the Seed Supplier Group (Seed Collectors and SPA Growers) and the Seed Purchaser Group (Seed Purchaser sand Other Users). (Question 10. Appendix 1). Values are percentages of total respondent groups within each category choice.

There is increasing interest across Australia in the use of native grasses to restore grassy ecosystems, to include native perennials within agricultural pastures, and as resilient, low-management cover on roadsides (Gibson-Roy and Delpratt 2015, Cuneo, Gibson-Roy et al. 2018). For non-woody wildflowers, the least demanded plant type, these findings present evidence of the use of this type of understorey, possibly to improve species diversity and ecosystem function in restoration projects. Indeed, in recent years there have been regular reports of species-rich wildflower mixes being used successful in grassy community restoration (e.g. The Grassy Groundcover Gazette; 2006-2018) and it is possible that any excess in supply might be absorbed quickly if interest in their use continues to gain momentum.

Mechanical harvesting of cultivated native grass stands can improve collection cost-effectiveness (image credit Paul Gibson-Roy).

4

Key finding 4: Trends for supply and demand of native seed at the time of this survey are broadly similar with some slight variation across plant types. The apparent synchronisation of demand and supply trends may reflect systemic conservatism from both sellers and purchasers imposed by uncertainty rather than needs and potentials being met. There nevertheless remain large gaps in our understanding of the demand for and supply of native seed in Australia.

Key risk: Without a better understanding of the supply of and demand for native seed it will be difficult to meet Australia's long-term conservation and restoration goals.

Key risk: Knowledge gaps limit forecasts for native seed supply and demand beyond very short time frames (i.e. 1-2 years) as required in a mature restoration industry or to develop strategies to ensure that sufficient volumes of appropriate species are available when required.

5

Key finding 5: The supply and demand data gathered in this survey suggests that overall volumes of native seed available or used for restoration (or other uses) are low.

Key risk: Low availably of seed limits the capacity to restore large areas of land should additional funding become available or to rapidly respond after natural disasters.

3.3.2 Sector issue 2. The market is currently unwilling to pay the 'true cost' of seed collection and seed production

This potential issue also ranked highly across all Groups (Tables 3.1 and 3.2) and was ranked highest by Seed Collectors with one respondent summing up by stating; "*the payment for the seeds does not meet the true cost of my time*" and another with "*I think the payment for seed collected is too low*". This situation is a significant risk to the sector since any failure to recoup the true cost associated with seed collection or production is an unsustainable business model and a disincentive to growth for this Group (see Box 3). A situation where suppliers cannot recoup costs or make a fair return on their effort erodes the sector's capacity to meet seed demand and also leads to a loss of expertise and often 'passion'. It may also contribute to low species diversity in restoration projects where funding only allows for the 'cheaper' species to be used. Limited returns on effort have already resulted in suppliers leaving the market or shifting their operations from full-time professional to part-time (P. Gibson-Roy, 2016, personal communication). For example, one collector wrote "*I do it mainly for interest*" while another described seed collection now only as a "*hobby*".

As a means to recoup costs, maintain cash flow and stock turnover, some sellers discount excess or stockpiled seed leaving them little or no capacity to pressure buyers into paying the true cost of that seed. This practice has the added impact of undermining suppliers who do not discount seed, losing sales to those who do. Views were expressed at a pre-Survey workshop (2017) that if collectors did receive fair payment for seed, they would be in a better position to allocate more resources to wages, training and improving their seed related infrastructure.

Another often-overlooked component of seed pricing is seed testing, which relates very closely to "value for money". Despite seed-lot characteristics (e.g. viability, germinability or purity) playing a critical role in restoration or propagation success (or failure), these attributes are seldom tested (see Section 3.6.2). The paucity of seed testing is likely to be a result of some seed suppliers unable to recoup the cost of testing and/or a lack of resources to enable testing (but see http://riawa.com.au/wordpress/wp-content/uploads/2019/10/01-RIAWA-Seed-Standards-191021.pdf).

Germination testing (image credit Richard Weinstein).

Interestingly, Seed Purchasers (arguably the 'market') also recognised that not paying a fair price for seed represented a risk to the sector (wa 3.6/5. Appendix 2). Most Seed Purchasers were from local or state governments (Figure 3.4) and their primary responsibilities are likely to include overseeing or implementing restoration programs that includes seed purchasing. It is possible that rather than being unwilling to pay appropriate prices for seed, these purchasers are simply unable to do so within the funding provided for projects (M. Driver, 2017, personal communication). This suggestion is consistent with feedback received from agency staff at sector forums (such as ANPC seed workshops and regional networks) where they report that budgetary constraints limit their capacity to adequately resource restoration programs (including the cost of seed). Several survey respondents also linked fair market pricing with suppliers having to wait extended periods of time for payments, a situation that increases financial stress in a sector where half of Seed Supplier respondents are sole-operators or small businesses (see Figure 3.3).

In related comments, some Seed Collectors expressed a view that volunteerism is disadvantaging their businesses by distorting the true cost of supplying seed (and other services). These respondents suggested volunteers or subsidised labour derived unfair benefits for some groups (i.e. NGOs, CMAs, LLSs, national parks or Landcare) over others (i.e. private operators). They also suggested this could be counter-productive to environmental outcomes. A situation could occur whereby private businesses are unable to compete with volunteer or subsidised work and exit the sector, thus decreasing sector capacity and expertise when (and if) subsidized or volunteer programs eventually end (P. Gibson-Roy, 2017, personal communication). While most in the sector accept that volunteerism makes a valuable contribution to the common good, this feedback highlights the complexities within the sector and the broader society when trying to meet the true cost of environmental and social obligations.

Box 3. A Seed Collector's view on the pricing of native seed

Seed collection is a challenging occupation with operators often travelling long distances under difficult conditions to locate and harvest seed, with little certainty that these efforts will be adequately compensated. The uncertain nature of the native seed market can lead collectors to speculate on future seed demand and harvest seed when it is available rather than when it is required. This a*d hoc* approach means that collectors take on considerable upfront speculative financial outlay and risk to meet possible future market demand.

Many native seed suppliers feel that buyers do not understand that a fair price for seed needs to reflect variables such as expertise and experience, equipment and facilities, processing, testing, storage, record keeping, and inventory management. They also feel that seed purchasers should consider both price and quality. If a supplier can provide clear evidence of a superior product, then purchasers should be prepared to pay more in the expectation that this will underpin a superior seed-use outcome. Overall seed pricing needs to reflect a complex chain of activities that are required to ensure that seed are appropriately collected, tested and stored (Offord and Meagher 2009).

Other cost-related comments suggested more of a divide between private- and publicly-funded organisations than just access to volunteer labour. The tenor of some of these comments suggested that private operators, who typically struggle to self-finance their operations in current markets, are at a distinct disadvantage to those groups who receive (or have access to) public funding for infrastructure and/or operating costs (e.g. "*Some Government funded sectors of the industry could be seen as undermining any foundation or formulation of a viable and sustainable Industry, by directly competing with the commercial sector*").

6

Key finding 6: There is general agreement among the sector that the true cost of seed is not being met by available funding.

Key risk: Failure to recognise the real costs of seed supply will result in a continued trend of seed suppliers (collectors and growers) leaving the market due to insufficient incomes to meet their business costs.

3.3.3 Sector issue 3. There is inconsistent and unpredictable demand for native seed

Inconsistent and unpredictable demand for seed was ranked highly as a concern-issue for all Groups (wa 3.9/5). The short-term and discontinuous nature of funding for environmental programs and shifts in the focus of programs over time are likely to contribute to marked fluxes in demand. SPA Growers (who ranked it highest of the groups at wa 4.5/5) need consistent and predictable seed demand to justify the investment required to create and maintain SPAs (noting Seed Collectors would also have ongoing financial commitments). Explaining the response from Seed Purchasers (wa 3.7/5), however, is more challenging but may reflect the experience of this Group who are often expected to deliver programs and projects within very short time frames.

The survey also asked respondents to nominate what proportion of their seed was collected, grown or purchased to-order or opportunistically. This revealed a slightly greater proportion of seed was pre-ordered than that sourced or purchased opportunistically (Figure 3.7). At the Group level, Seed Collectors (wa 3.9/6), Seed Purchasers (wa 4.0/6), and Other Users (wa 3.3/6) nominated pre-ordering as the more common approach. For SPA Growers, growing plants opportunistically (wa 3.9/6) was nominated slightly above growing pre-ordered plants (wa 3.8/6). The higher proportion of pre-ordering from Seed Purchasers might reflect their desire to lock in supplies in advance of restoration works rather than having to rely on field-sourced seed to be secured within project timelines, when field or market conditions may be unfavourable. That more Seed Collectors sourced seed for pre-orders seems to confirm Seed Purchaser behaviour (i.e. pre-order wa 4.0/6) and while SPA Growers represent a much smaller proportion of the supply market (i.e. participant number), even they establish near to half of their seed crops to order.

It is possible that seed collected or produced opportunistically comes from those species that are less commonly used in restoration and so less likely to be candidates for pre-ordering. Seed Collectors also ranked the related concern-issue of '*Seed orders are made at too short notice*' highly (Table 3.2). This situation was actively discussed by practitioners at the APCC11 workshop with several collectors and propagators speaking passionately about the difficulties they faced with short notice for seed orders.

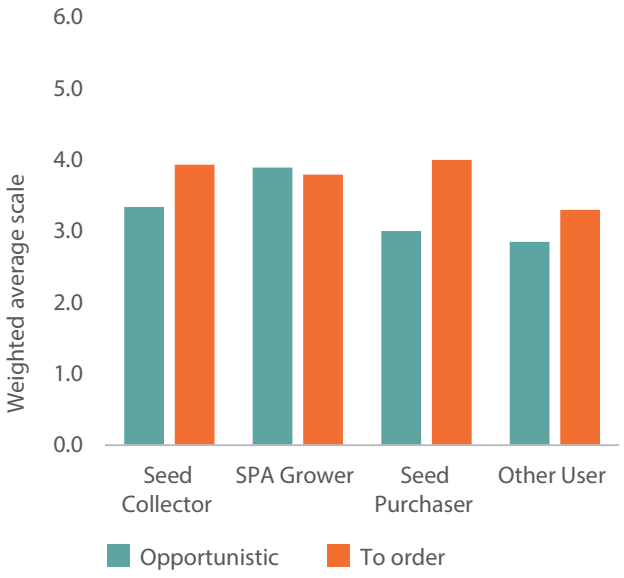

Figure 3.7. Seed ordering characteristics by Group (Seed collectors; SPA Grower; Seed Purchaser; Other User). (Question 8. Appendix 1). Values are weighted averages of total respondent groups within each category choice.

7

Key finding 7: Inconsistent and unpredictable seed demand is heightening insecurity among some seed suppliers.

Key risk: Some suppliers struggle to operate when demand for seed or plants is unpredictable. Where they leave the sector, this leaves a gap in capacity.

Box 4. An issue arising from market unpredictability: Seed stockpiling and the need for appropriate storage

When the demand for native seed is low, such as when planting conditions are poor or there is reduced funding available for restoration, many seed collectors and growers stockpile seed. Speculative seed collection can add to seed stockpiles. While stockpiled seed can be highly advantageous if there is a rapid increase in demand, it is essential that seed is stored under appropriate conditions to maintain its viability, in particular, low relative humidity and temperature, and freedom from granivores (Delpratt and Gibson-Roy 2015, Morgan and Salmon 2019). With many publicly-funded regional seed banks closing over the last decade (Broadhurst and Coates 2017), the responsibility and cost of maintaining well-housed, viable seed stockpiles has shifted towards individuals and small businesses, many/most of whom do not have the capacity or resources to provide appropriate seed storage (other than for very small quantities). This situation continues to be an issue for the sector with anecdotal evidence that some remaining regional seedbanks are being "mothballed" or are winding down activities (M. Driver, 2018, personal communication). One survey respondent wrote: *"Lack of government funding in recent years has dramatically reduced the scale of restoration works and hence seed needs across Victoria, cf. 1990's-early 2000's. Regional seedbanks reduced largely to very P/T staff & increasing volunteer management*".

3.3.4 Sector issue 4: There is a lack of native seed from a broad range of species

All respondents expressed concern about the lack of seed for a broad range of species (Table 3.1), particularly Seed Purchasers and Other Users (Table 3.2). Restoration relies on species and functional diversity (Standards Reference Group SERA 2017) and while some ecosystem services can be generated with relatively few species (depending on the focal species' traits), when higher levels of ecosystem function are required (such as for 'habitat for wildlife' specialists), then multi-species plantings are necessary (Lamb 2018). As an example, in Western Australia, some mining companies' restorations are legally required to be biodiverse (L. Commander, 2020, personal communication). Consequently, we explored the range of species being supplied and purchased for restoration.

Some 60% of Seed Collectors often received species-list requests for '*less than 20*' species while Seed Purchasers typically purchase in the <10, <20 and <50 species categories with a very small percentage from this latter Group purchasing <100 species (Figure 3.8). These data suggest that very few restoration programs focus on 'whole community' (i.e. species-rich) restoration. Several Seed Purchasers commented that while their ambitions were to undertake species-rich restoration and that this was included in their tender specifications, these goals were often thwarted by low species availability and the cost of assembling species-diverse seed mixes. This outcome typically resulted in a settling for less species rich plantings typically of fewer than 20 species.

SPAs are viewed by many as a way to overcome shortfalls in species diversity. The survey asked SPA Growers to nominate the typical number of species (from each of the four plant types) they grew in SPAs (Figure 3.9). The largest proportion of respondents grow only low numbers of species in SPAs (i.e. <10 species) with relatively fewer growing <20 species and <50 species indicating that only moderate species numbers are planted in SPAs. A very small proportion of growers nominated high species categories of <100 species and >100 species in their SPAs. Sixty-seven percent of SPA Growers grow no trees and 50% of them grow no shrubs. These findings therefore suggest that while SPAs might currently provide some reliability around seed quantity this is only for a limited range of species under current market conditions.

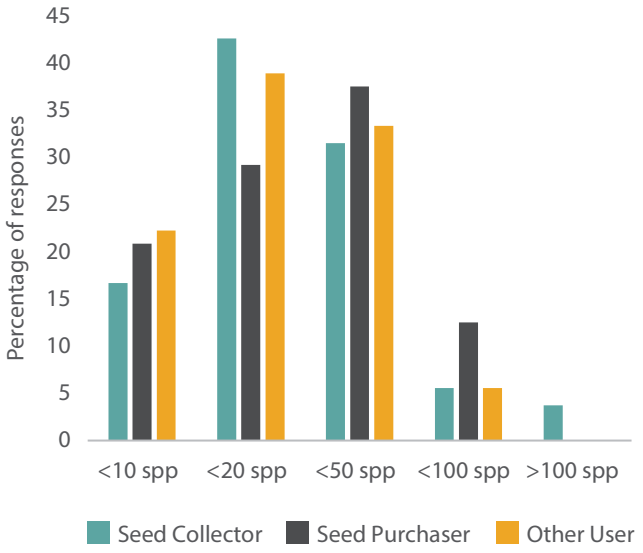

Figure 3.8. The typical level of species diversity that Seed Collectors are asked for when selling seed, and the diversity that is required by Seed Purchasers and Other Users (Question 11. Appendix 1). Values are percentages of total respondent groups within each category choice.

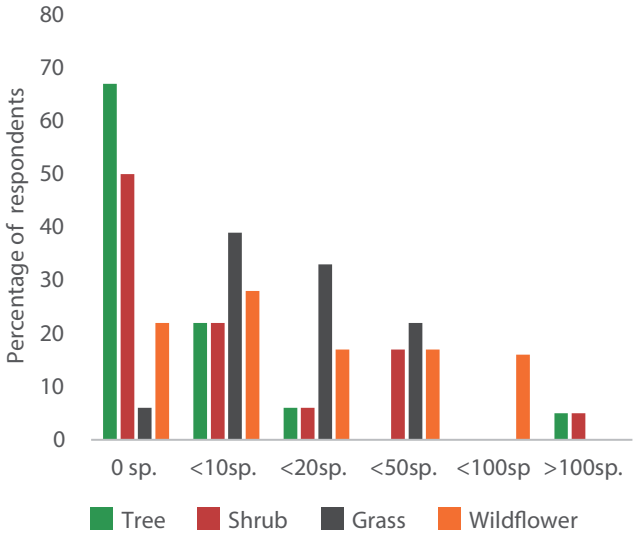

Figure 3.9. The typical level of species diversity grown by SPA Growers (Question 24. Appendix 1). Values are percentages of total respondent groups within each category choice.

Given that the native seed sector has had difficulty in sourcing or producing seed from a broad range of species, it is possible to speculate that successful broad-scale, complex ecological restoration has yet to be achieved under prevailing restoration programs. It is equally possible to speculate that future programs will be similarly compromised if 'business-as-usual' approaches that have led to this situation continue. Despite this concern about the lack of species diversity, all Groups nominated that the largest proportion of native seed was intended for use in biodiversity restoration (wa 4.7, 5.6, 4.9 and 3.2 / 7 for Seed Collectors, SPA Growers, Seed Purchasers and Other Users respectively) (Figure 3.10). Landcare-type projects claimed the second highest proportion of native seed utilisation and thereafter, the order of seed use differed among the Groups. Respondents also reported that seed is being used for residential/home gardens, erosion control and scientific purposes.

These results suggest that restoration program goals intend to use diverse mixes of tree, shrub, grass and non-woody wildflower species. However, the proposition that most seed is used in restoration is contradicted by the reality that the bulk of large-scale restoration publicly-funded programs such as *Caring for Our Country* and *20 Million Trees* programs focus primarily on tree and shrub strata. Perhaps this is more an issue about the use of the term 'biodiversity restoration' (Box 1). While it is clearly a concept that many in the sector intuitively want to embrace and undertake (funders and practitioners alike), what occurs is often at odds with a strict interpretation of the term.

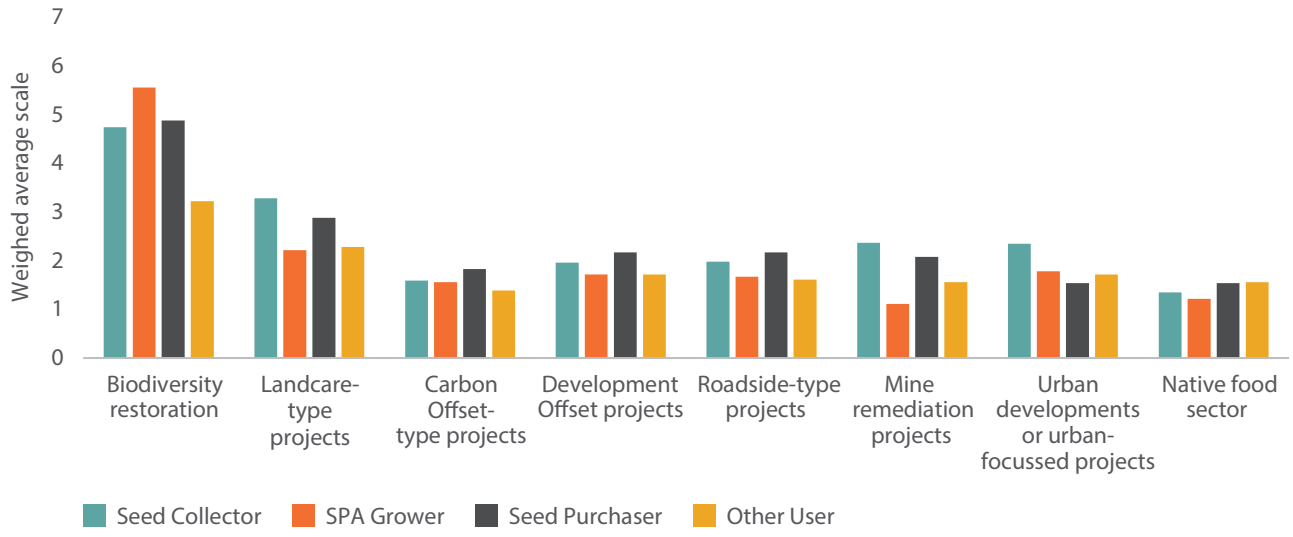

Figure 3.10. Typical seed end-use by Seed Collectors, SPA Growers, Seed Purchasers and Other Users (Question 14. Appendix 1). Values are weighted averages of total respondent groups within each category choices.

8

Key finding 8: There is an apparent disconnect between the aspirational goals for complex biodiverse restoration and the reality of access to, and availability of, native seed from a broad range of species to meet these goals.

Key risk: A lack of native seed from the range of species required undermines our capacity to achieve species-rich ecological restoration.

9

Key finding 9: The largest proportion of native seed is utilised for biodiversity restoration and Landcare-type projects, with the remainder used for a wide variety of other purposes.

Key risk: With such a wide range of end-uses, a failure to increase the availability of native seed has the potential to impact on a wide range of activities.

3.4 Seed collection practices

3.4.1 Seed provenance ranges

'Provenance', in the native seed context, is often used in a shorthand way to refer to the distance from the planting site to the origin of the seed collected for planting or seeding. Seed collected at or nearby the planting site is referred to as 'local' provenance, whereas seed collected more remotely is loosely termed 'non-local' or 'remote' provenance. A 'provenance range' is often used to express the maximum distance thought to be probabilistically 'safe' to avoid risks of (for example) genetic incompatibility or unfitness in the planted environment. However, there are many factors that may affect planting success or failure at a new site including genetic, epigenetic, abiotic or mutualistic (e.g. mycorrhizal) characteristics. Therefore, distance stipulations are only ever at best a surrogate metric for the range of different adaptational traits that may or may not exist along simple distance dimensions within a species.

Knowledge gaps about appropriate provenance 'domains' are still the rule for most native species, although advances in genetic analysis are beginning to remedy some gaps. The challenges faced by the native seed sector, as outlined in Sections 1.3.1 (the deteriorating state of the environment), 1.3.2 (vegetation fragmentation) and 1.3.3 (climate change) highlights the importance of appropriate provenance strategies under changing environmental conditions. The survey explored different facets of seed provenance ranges to better understand current sector attitudes and practices.

The four Groups ranked the statement that '*current provenance range stipulations are too restrictive'* higher than the statement '*provenance range stipulations are too lax*', which was the lowest ranked of the 13 potential issues (Table 3.1). However, comments provided by respondents on the subject revealed a range of opinions characterise the sector:

- *"Good access to provenance seed is very desirable";*
- "*I believe provenance seed is essential to avoid pollution";*
- "*Sectors of the industry probably err in both directions – too restrictive and too lax*";
- *"I would like seed collectors to keep better records on collecting areas and on the number of source plants used*";
- *"Inconsistent definitions for provenance";*
- "*Most projects (especially community focused ones) will obtain whatever seed they can get to complete a project especially when time constraints are pressing";*
- *"She'll be right attitude is prevalent*";
- *"It would be more ideal if the genetics of populations were more clearly understood and guidelines for provenance were more available and informative";*
- "*Issues related to provenance are species-specific*";
- "*No one audits the provenance or species of a completed project and if there was an error, who'd really care*";
- "*In our catchment, there is still widespread ignorance about what species are local. Many wrong species as well as wrong provenances are used*";
- *"Too much requirement is put on provenance (usually distance) rather than avoiding inbreeding through collection of many propagules from few parents*";
- *"I am very concerned we may have lost the genetics of many populations already";*
- *"If a good supply of provenance seed is collected and held in a seed bank then many of the above issues disappear*" (this comment was related to issues raised in Table 2);
- "*I follow composite provenance approach across a rainfall gradient after Broadhurst et al. 2008 and Gellie et al. 2016 (in press)";* and
- *"As well, with climate change, it is increasing complex sorting out appropriate species and provenances to sow at sites"* (sic).

To gauge where native seed is typically being planted relative to where it was collected from, respondents were asked to nominate which of the following categories best described where the bulk of their seed was used:

- Immediate region (i.e. local or adjoining council areas);
- Broad region (i.e. within Catchment Management or Local Land Service areas);
- State-wide;
- Interstate; and
- International.

Seed Collectors, SPA Growers and Other Users indicated that most of their seed is used in their immediate region (wa 4.4, 4.3 and 3.8 respectively), whereas Seed Purchasers were almost equally split between using seed at immediate (wa 3) and broad (wa 2.9) region scales (Figure 3.11). Unexpectedly, however, all four Groups were also found to be using native seed well beyond expectations of 'local' including state-wide, interstate and even

internationally (albeit at a very low level). The finding that native seed is overwhelmingly used (in some form) well beyond the strict interpretations of the 'local is best' provenance (e.g. <10 km from source) is extremely informative and signals that the sector is shifting towards a broader notion of provenance, or that stringent provenance boundaries were never adopted to the degree that past debate suggests. For example, the survey finding that native seed is most commonly taken from private land and roadsides (Section 3.4.2), where native vegetation is typically small and fragmented, supports the suggestion that local supplies would be limited and that harvesting from further afield is necessary to meet project commitments. This suggestion was corroborated by several survey responses who pragmatically noted that if 'local seed' was unavailable there is little choice but to source seed from more distant locations.

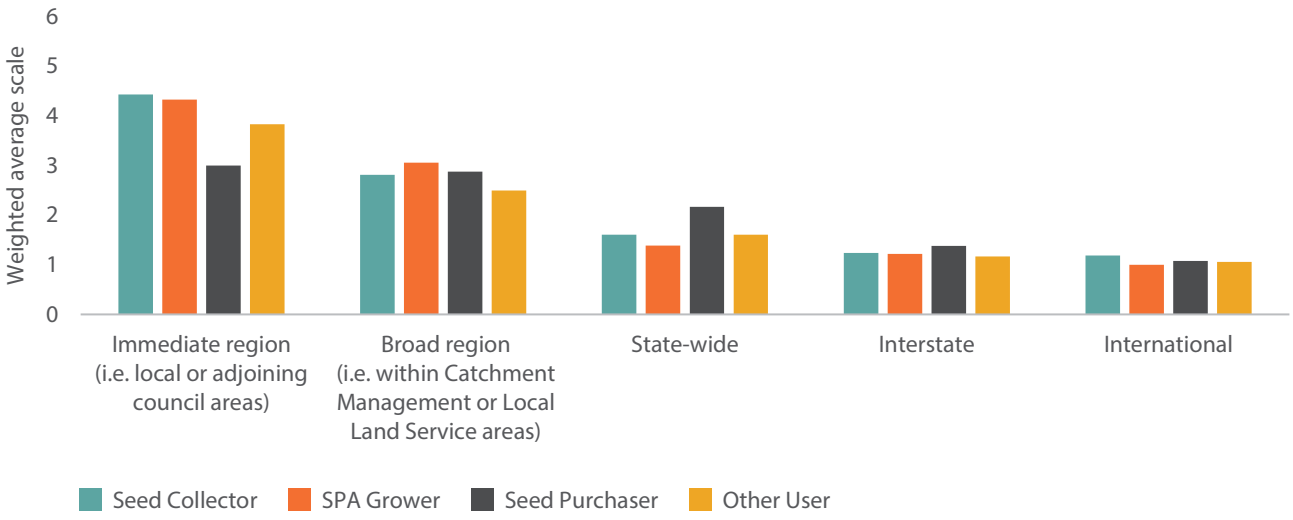

Figure 3.11. Seed use in relation to its sources (Question 12. Appendix 1). Values are weighted averages of total respondent groups within each category choice.

The survey also asked Seed Collectors and SPA Growers to nominate the geographical range over which their seed was collected and Seed Purchasers and Other Users were asked how far away they would accept seed from for use in their immediate region. The data from Other Users is not included in this analysis because of the large proportion of respondents affiliated with universities and individuals, where seed may be used for non-restoration purposes. Due to the large percentage of SPA Growers who do not grow trees and shrubs, the data for these plant types are not shown here (but see Section 3.5). Responses from all Groups (including Other Users) indicated that seed from a broad geographical range is being used and collected and that this range differed, depending on the plant type.

For trees, most seed is collected (60%) and purchased (84% of Seed Purchasers) in the <50km to <200km range (Figure 3.12a) with shrubs showing a similar pattern for collection (62%) and purchase (75%) (Figure 3.12b). Seed from these plant types is also collected and accepted from distances greater than 500 km by a small number of respondents, but perversely, tree seed is apparently not purchased in the less than 500 km category. Less than 15% of Seed Purchasers and Seed Collectors accept and collect tree and shrub seed that may be perceived as "local provenance" or the immediate region (i.e. <10 km or < 20 km).

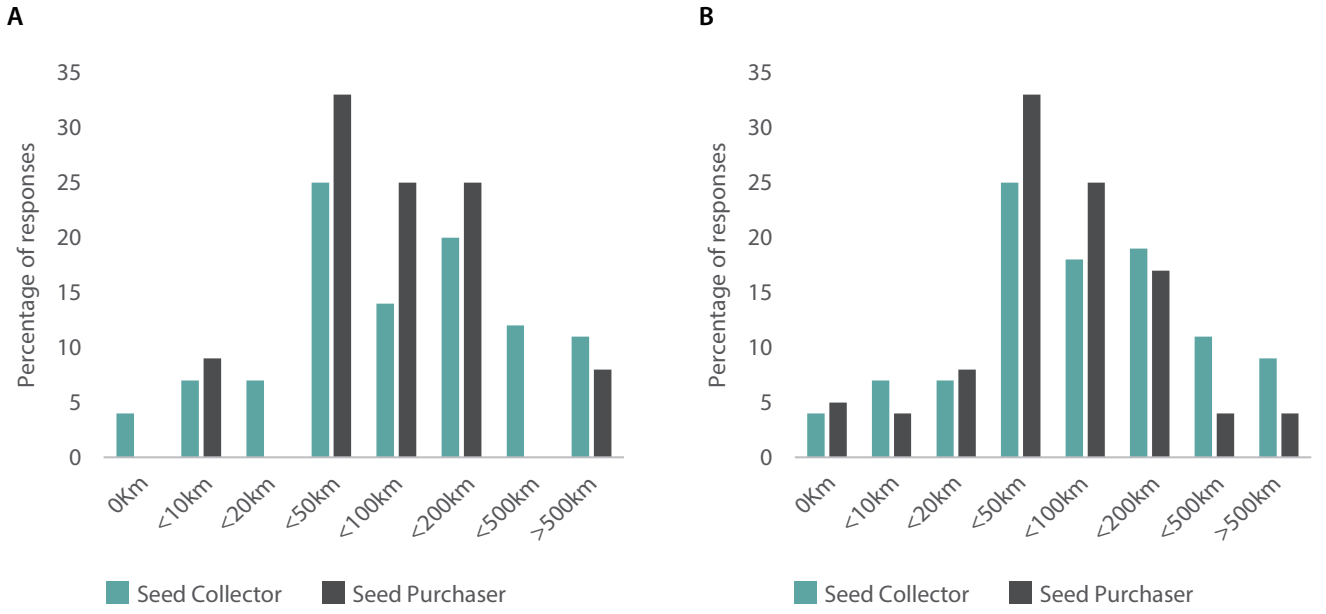

Figure 3.12. The geographic range that (A) tree and (B) shrub seed is collected by Seed Collectors and accepted by Seed Purchasers for use in their immediate region (Question 9. Appendix 1). Values are percentages of total respondent groups within each category choice.

For grasses, most Seed Purchasers (79%) accept seed between < 50 km and <500 km for use in their immediate region (Figure 3.13A) while only 12% of Seed Purchasers accept seed in the <10 km and <20 km ranges. Seed Collectors and SPA Growers do collect seed from these shorter distances, but the majority of Seed Suppliers collect from further afield. Nearly 70% of Seed Collectors and SPA Growers collect seed from the <50 km range to <500 km and the <20 km to 200 km range respectively.

For the non-woody wildflower seed that is purchased, most is sourced from ranges between <50 to <500 km rather than from tight local ranges (<10 km) (Figure 3.13(B)). Interestingly, for this plant group, the large proportion of responses for the 0 km class suggests this is not a critical plant type for Seed Purchasers – an observation that fits neatly with the argument that most funding programs are tree and shrub (and to a lesser degree grass) centric (see Section 3.3.1.1 and 3.3.4). Seed Collectors collect seed from a wide geographical range, with a large proportion (27%) collecting in the <50 km distance. Similarly, SPA Growers collect across a broad geographical range but are concentrated in the <100 km category.

Geographic seed sourcing preferences of the four Groups for the different plant types is summarised in Figure 3.14. The most noticeable mismatch is between the broad collection of non-woody wildflowers by SPA Growers and the narrower 'comfort zone' of the Seed Demand Group. It is also interesting that grasses are more widely collected and accepted than tree seed by SPA Growers and Seed Purchasers respectively.

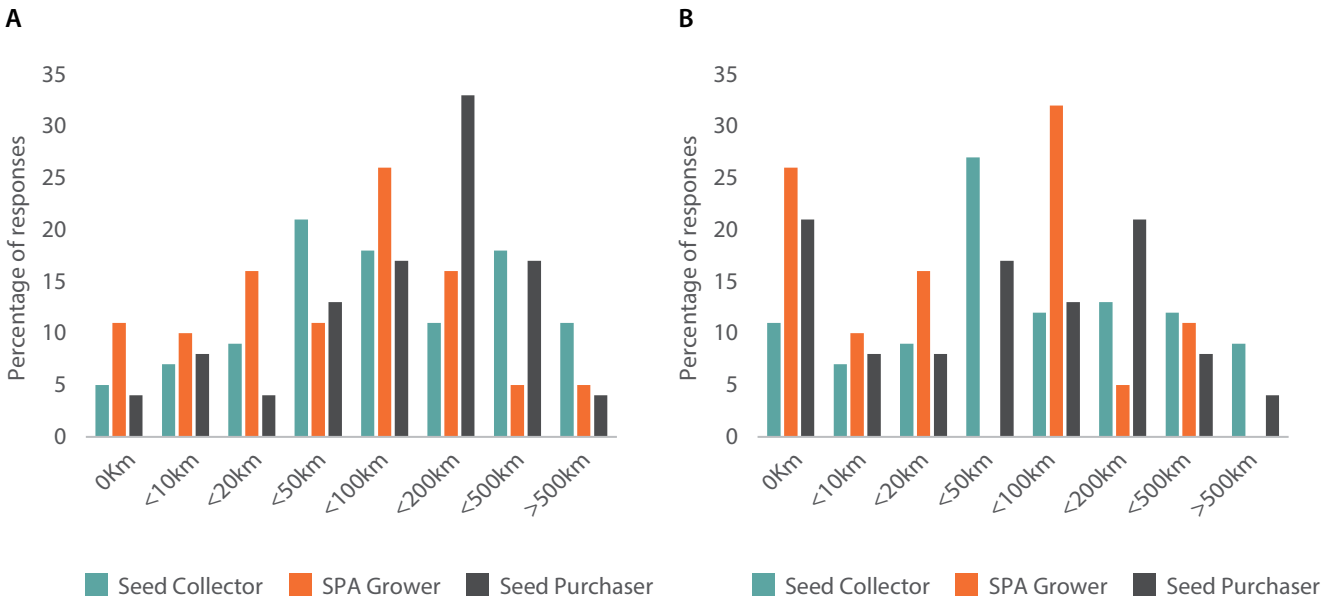

Figure 3.13. The geographic range that (A) grass and (B) non-woody wildflower seed is collected by Seed Collectors and SPA Growers and accepted by Seed Purchasers for use in their immediate region (Question 9. Appendix 1). Values are percentages of total respondent groups within each category choice.

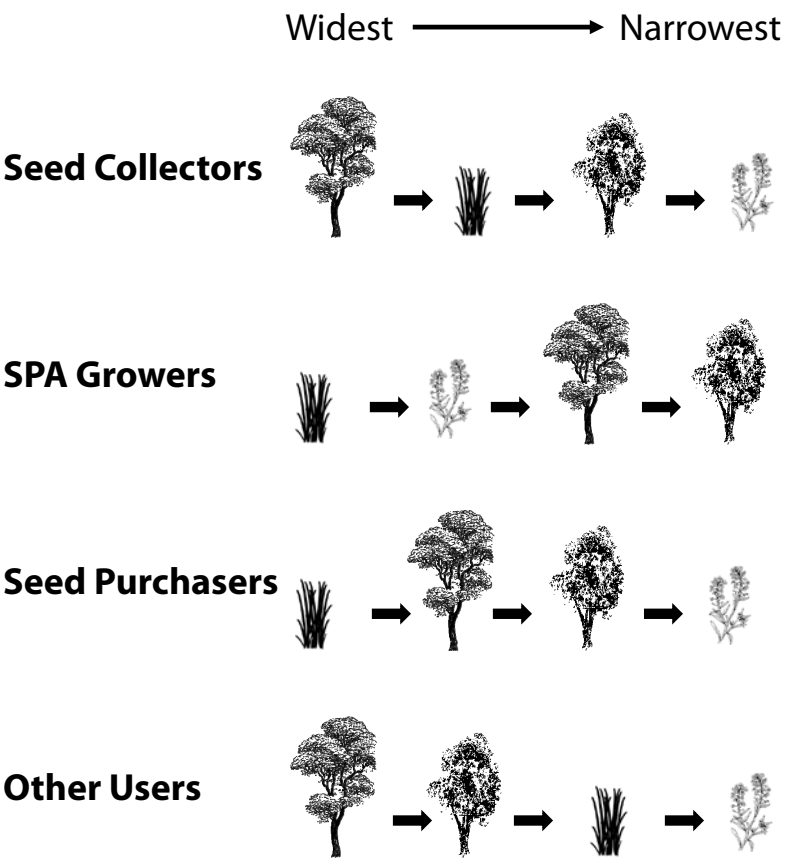

Figure 3.14. Geographic seed sourcing preference of the four Groups from the widest to the narrowest geographical range. Icons represent the four plant groups: Trees, shrubs, grasses and non-woody wildflowers (as shown in that order for Other Users).

These responses indicate that the geographic collection ranges for suppliers and purchasers of native seed are significantly beyond 'local is best' guidelines and are not being strictly adhered to by the sector. If these responses reflect whole of sector practice, the 'local is best' philosophy is apparently no longer widely accepted or adhered to. This does not suggest, however, that no local collections are being made, or that maintaining local collections for some species is inappropriate, only that these collections are apparently a small proportion of the overall seed market. This situation appears to be at odds with some commercial seed tender specifications (i.e. for mining or infrastructure projects) which continue to stipulate very tight collection ranges (i.e. <5 km). However, if such conditions are not strictly monitored and enforced, then seed might still be supplied from further afield. Anecdotally, many commercial seed buyers readily admit to relaxing collection range restrictions (or to substituting species) if insufficient seed is available to meet tender specifications. Finally, it is likely that these current practices will mean the sector is quite receptive to calls that climate-adapted principles be incorporated into collection strategies for restoring native vegetation.

10

Key finding 10: The native seed sector is supplying and using seed across larger geographic distances than generally thought within the sector.

Key risk: Widespread seed movement may pose potential risks to some localised species but may improve the genetic health and future (including climate) adaptiveness of others.

3.4.2 Seed collection tenures

The survey explored other issues in relation to seed collection practices, including the land tenure from which seed is being collected. There has been much debate in the sector over the years in relation to the tenure of land supporting the restoration sector, with concerns expressed about over-collection in general, but in particular from state and national parks. The survey asked respondents to nominate what proportion of the seed they collected, grew or used came from private property, public reserves, public roadsides, state parks, national parks, or other origins. For those in the Seed Demand Group who did not know the origin of their seed, the categories of "*I have no interest in its origin*" and "*I don't know its origin*" were included.

For all groups, weighted average trends showed that most seed originated from private property, followed by public reserves and roadsides, while little seed was harvested from state and national parks respectively (Figure 3.15). For most seed collectors, it is easier to gain access to private lands, roadsides and reserves than it is to more highly regulated state and national parks. Interestingly, a not insignificant proportion of seed is sourced by Seed Purchasers and Other Users from SPAs (wa 2.0/6 and wa 1.3/6 respectively), indicating the growing importance of SPAs as seed sources. A large proportion of the Seed Demand group had "*no interest in the origin*" of the seed they used or "*no knowledge of its origin*".

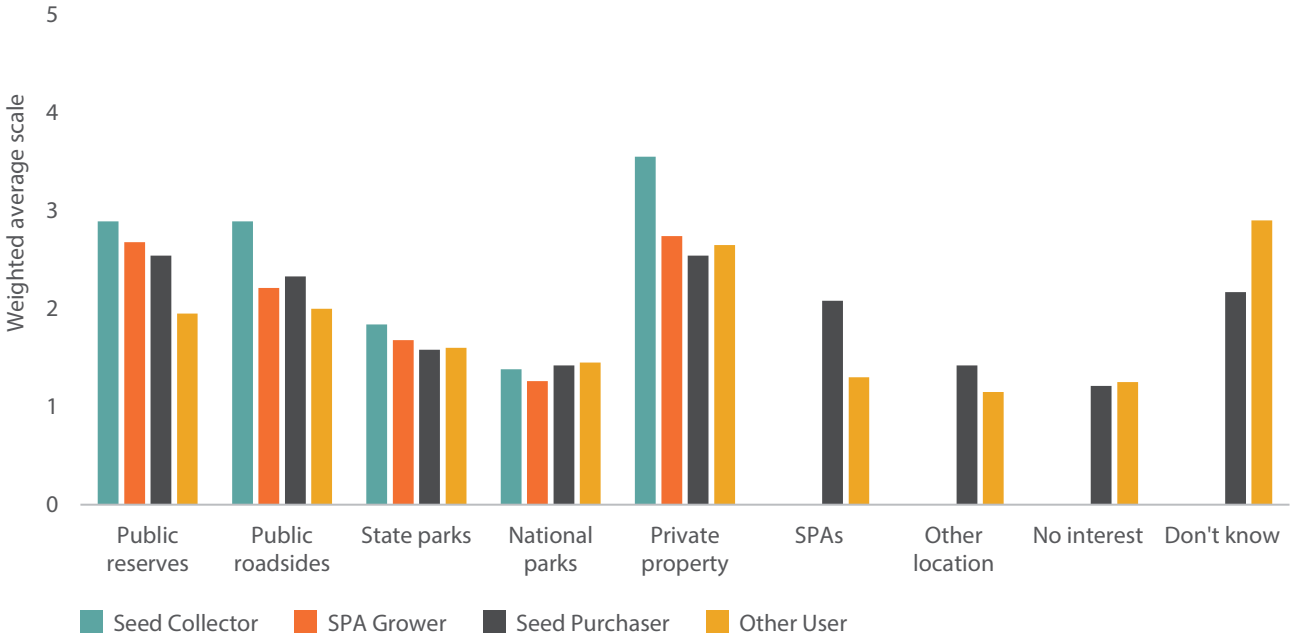

Figure 3.15. Land tenure of seed collected by Seed Collectors and SPA Growers and seed purchased or used by Seed Purchasers or Other Users (Question 7. Appendix 1). Values are weighted means of total respondent groups within each category choice.

These data support the concerns of many in the sector that there is a risk of overharvesting from small and fragmented populations that primarily exist on private land, road verges and small public reserves (e.g. http://morganvegdynamics.blogspot.com.au/2015/05/do-we-need-moritorium-on-seed.html). Given this finding, it may be that well-supervised and judicious collections of seed from large healthy populations of species from within state and national parks could provide an important resource of diverse and genetically healthy native seed for the restoration market.

3.4.3 Seed collection licensing

Seed collection from threatened species or communities requires a collector to hold a current and valid licence, typically issued by a state or territory government authority. A failure to gain regulatory approval for seed collection has important implications for individuals, businesses and projects across the sector. At the 2016 APCC11 native seed workshop, participants voiced serious concerns about the difficulties in obtaining seed collection permit approvals in some jurisdictions. Concerns were also raised about the restrictions imposed on where seed can be sourced and how much can be harvested. It was generally agreed there was a need for improved information from licensing agencies and better cross-sector communication on these issues among all those working with native seed. Two sector issue statements were also posed to explore licensing barriers: "*There are too many difficulties in securing seed collection permits"* and "*There are too many difficulties in obtaining access to wild populations for collection*" (Appendix 2) but despite sector workshop comments indicating high concern for these issues, survey respondents ranked both of equal but only moderate concern (wa 3.0/5).

Respondents were asked to provide information on their permit compliance and whether permits were required as part of seed contracts or tenders. Sixty-one percent of Seed Collectors held a current licence, 24% did not and 4% where unsure (Figure 3.16). This result suggests that most seed collectors are aware of the need for licences and have them in place. It remains unclear if those who do not hold licences (constituting almost one third of Seed Collectors) are not aware that these are required, are not active as collectors, are not required to hold a licence, or are collecting seed without a licence.

From the Seed Purchaser Group, 50% of respondents nominated that they required their seed collectors to hold a licence, 8% had no such requirement and a relatively large proportion (21%) were unsure if a licence was required. Some written comments from Seed Purchasers did suggest that they required seed suppliers to provide proof of current licences (e.g. "*licence number required*" or "*must prove they have current and relevant seed collection licence*") while others suggested they were comfortable with verbal assurances from suppliers that licences were in place (e.g. "*assumed reputable commercial collectors being appropriately licenced*").

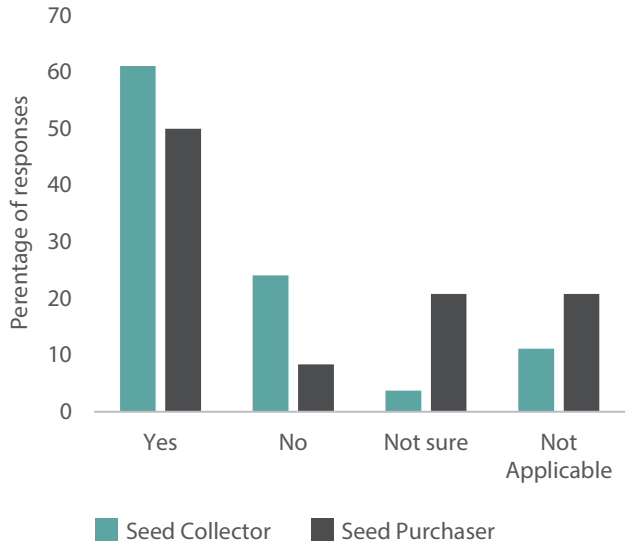

Figure 3.16. Seed licensing practice. The percentage of Seed Collectors and Seed Purchasers who hold and or require Seed Collectors to hold a current seed collector's licence respectively (Question 16. Appendix 1). Values are percentage values of total respondent groups within each category choice.

11

Key finding 11: Most native seed is sourced from private land, public reserves and roadside tenures.

Key risk: Seed from those tenures may be limited in quantity and genetic health and may represent an unsustainable source of seed into the future.

12

Key finding 12: The majority of Seed Suppliers have valid collection permits, but a sizable minority do not. The majority of Seed Purchasers require seed suppliers to hold valid licences, but a substantial proportion either do not, or do not know if they would be required.

Key risk: Without improved information from licensing agents and a better understanding by seed purchasers on seed collection permit requirements, there is a risk of increasing seed licencing non-compliance that may represent an unsustainable seed sourcing into the future.

3.5 Seed Production Areas

Seed Production Areas (SPAs) (see Box 5) focussed on restoration are a relatively recent development in Australia, although seed production methods have been developed earlier in the US and Europe (United States Department of Agriculture 2004, Laverick, Matthews et al. 2006, Tischew, Youtie et al. 2011). The survey provided an opportunity to gain insights into the growth and operation of Australian SPAs which have largely been driven by innovative practitioners and researchers, primarily from seed collection and restoration backgrounds. SPAs first began to emerge in Australia during the 1980s as interest in the use of native grasses and shrubs (fodder production or shelter plantings) increased (e.g. Cole and Metcalfe 2003). Since that time, the complexity of the growing systems used in SPAs and the range of species grown have increased (Delpratt and Gibson-Roy 2015).

Seed Production Area (SPA) on private land which forms part of the Murray Local Land Services (LLS) Seedbank SPA network (image credit Martin Driver).

Box 5. Seed Production Areas

Seed Production Areas (SPAs) are stand-alone locations specifically designed to cultivate native species for seed production. SPAs use horticultural and agricultural knowledge and technologies to cultivate and maintain native seed producing crops. 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.

Twenty-four respondents nominated as SPA Growers (16.5% of all respondents). Most of these operate as commercial growers (38%) or are affiliated with local or state government agencies (29%). Nineteen percent were associated with NGOs, 5% with community groups, and 14% nominated as individual landowners. A small number of respondents nominated more than one type of affiliation (Figure 3.4). Almost two-thirds of SPA-linked respondents were in Victoria with the next largest proportion based in NSW/ACT. There were no respondents from Western Australia, Tasmania or the Northern Territory. However, the survey may not have reached practitioners in those states rather than there being no SPAs. For example, over recent years there has been some publicity around the development of SPAs for the mining sector in WA (see https://www.decipher.com.au/blog/industry-news/australian-mining-companies-leading-the-way-in-rehabilitation/).

Survey responses revealed that SPAs typically have few employees. For example, 11% of respondents were full-time sole operators and 5% part-time sole operators, while another 11% worked in SPAs with <5 staff. The largest proportion of respondents (33%) came from SPAs with between 5-10 staff. Together, this represents a total of 60% of SPA-linked respondents in workplaces with 10 or fewer staff. Conversely, 22% of respondents were associated with SPAs with 11-50 staff. However, it's very likely that these SPAs are embedded within larger organisations such as botanic gardens, NGOs and government agencies where overall staff numbers are high but the number of staff directly associated with SPAs is quite small. Comments from two respondent illustrate this point: "*We are in Local Government and have over 400 staff - these staff all have very different roles however*" and "*Local government but there are 6 people in the immediate conservation team*". Comments from participants at sector forums suggest that most small-scale SPAs such as those run or managed by Landcare Groups, regional NRM agencies or NGOs have been established through public funding. The fewer, larger-scale farm-based SPAs (often focussed on grass production) are more likely to be privately financed and operated.

The survey found that most SPAs (63% of respondents) have been established on private property while the remainder are established on various public land tenures except, unsurprisingly, for national parks (0%) (Figure 3.17). Most SPAs are small, with 53% being <5 ha in area (Figure 3.18). Only 6% of SPAs have cropping footprints between 31-100 ha and none are larger than 100 ha, highlighting the current limited production capacity of Australian restoration SPAs. This is in stark contrast to SPAs in the USA, where cropping areas in a single enterprise can be well beyond 1000 ha (Gibson-Roy 2018). Respondents have adopted a range of growing models to produce seed (Figure 3.19). Field-grown cropping systems are the most commonly utilised approach (89%) followed by in-ground weed-mat systems (50%) and container-based systems (28%). Many growers reported they use more than one of these approaches within a single SPA (as shown by percent values exceeding 100%).

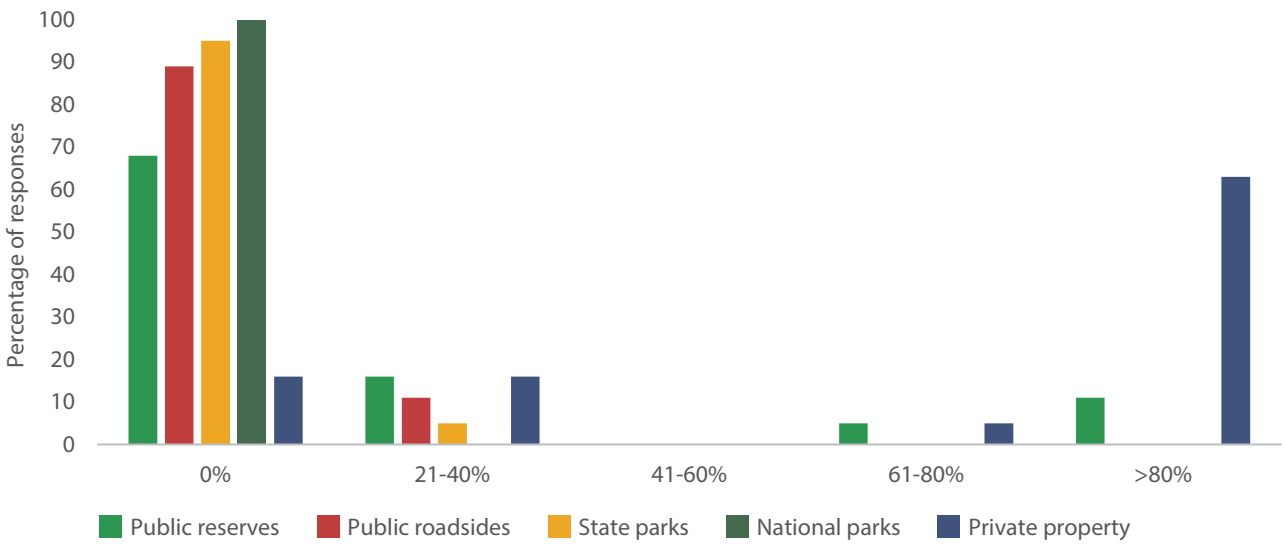

Figure 3.17. SPA land tenure (Question 23. Appendix 1). Values are percentage values of total respondent groups within each category choice.

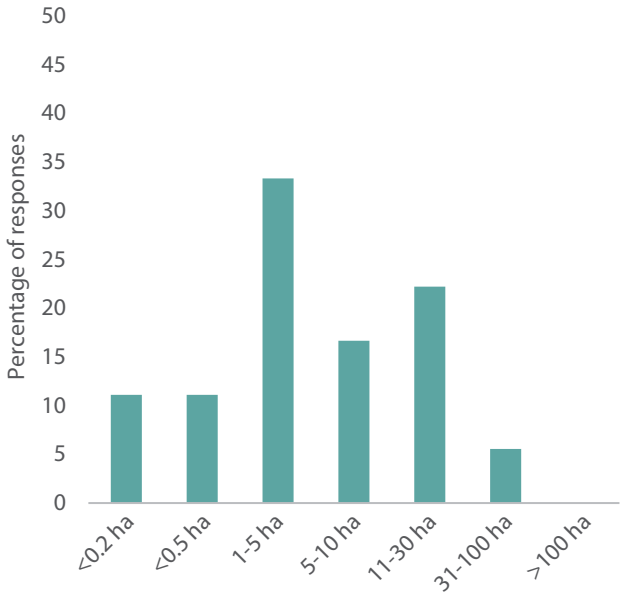

Figure 3.18. SPA size by SPA Growers (Question 27. Appendix 1). Values are percentage values of total respondent groups within each category choice.

Container seed production at Burnley Melbourne (image credit Paul Gibson-Roy).

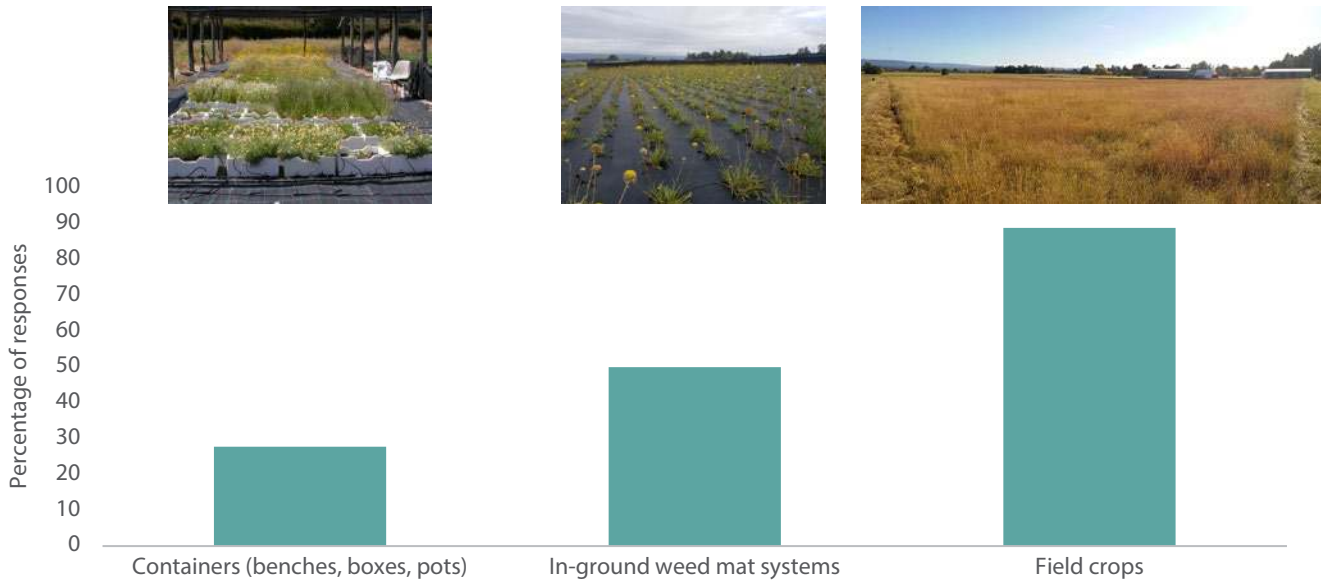

Figure 3.19 SPA growing systems by SPA Growers (Question 9. Appendix 1). Values are percentage values of total respondent groups within each category choice. Note: some respondents nominated more than one category and therefore percentages sum to more than 100 percent. (images credit Paul Gibson-Roy).

SPAs of each plant type (trees, shrubs, grasses, and non-woody wildflowers) exist in Australia with grasses being the most common (Figure 3.20). Thirty three percent of SPAs growing grasses and 17% of SPAs growing wildflowers indicated that these plant forms occupy > 80% of their SPA footprints. Trees and shrubs occupy smaller components of total SPA footprints with 78% of SPA Growers stating that they do not grow any trees, and 61% stating that they do not grow any shrubs.

Non-woody wildflowers and grasses provide most species diversity in SPAs (Figure 3.21). For grasses, 39% of SPAs grow up to 10 species, 33% up to 20 species, and 22% up to 50 species. For non-woody wildflowers, 28% of SPA Growers grow up to 10 species, 17% up to 20 species, 17% up to 50 species, and 16% grow up to 100 species. The greater number of wildflower species grown in SPAs is likely due to their suitability for cultivation in smaller footprints. Conversely, this might be explained by the emerging requirement for seed from a large range of species (in particular, ground layer species) for restoration in offset schemes, where greater diversity can create higher net-gain scores. For those SPAs that utilised trees and shrubs, most grow up to 10 (22%) or 20 (6%) species of trees and up to 10 (22%), 20 (6%) and to 50 species (17%) of shrubs. One respondent (i.e. representing 5% of responses) indicated that they cultivate more than 100 species of trees and shrubs. That only 33% of growers include trees and 50% shrubs in restoration SPAs perhaps indicates that trees and shrubs require higher investments in space, time, and resources than the native seed market can support (Broadhurst, Fifield et al. 2015). Alternatively, it may be that woody flora seed is more readily accessible from natural populations and consequently, investment in SPAs is not warranted or is less economically attractive.

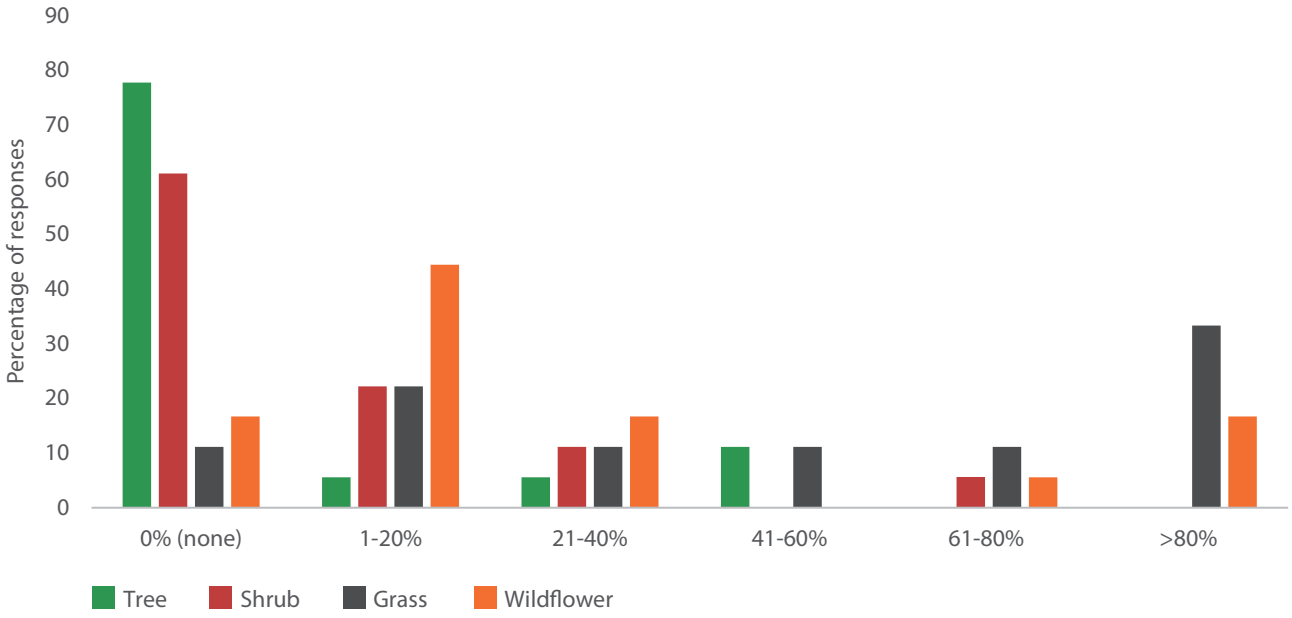

Figure 3.20. The proportion of SPAs devoted to four plant types (trees; shrubs; grasses; non-woody wildflowers. Question 25. Appendix 1). Values are percentage values of total respondent groups within each category choice.

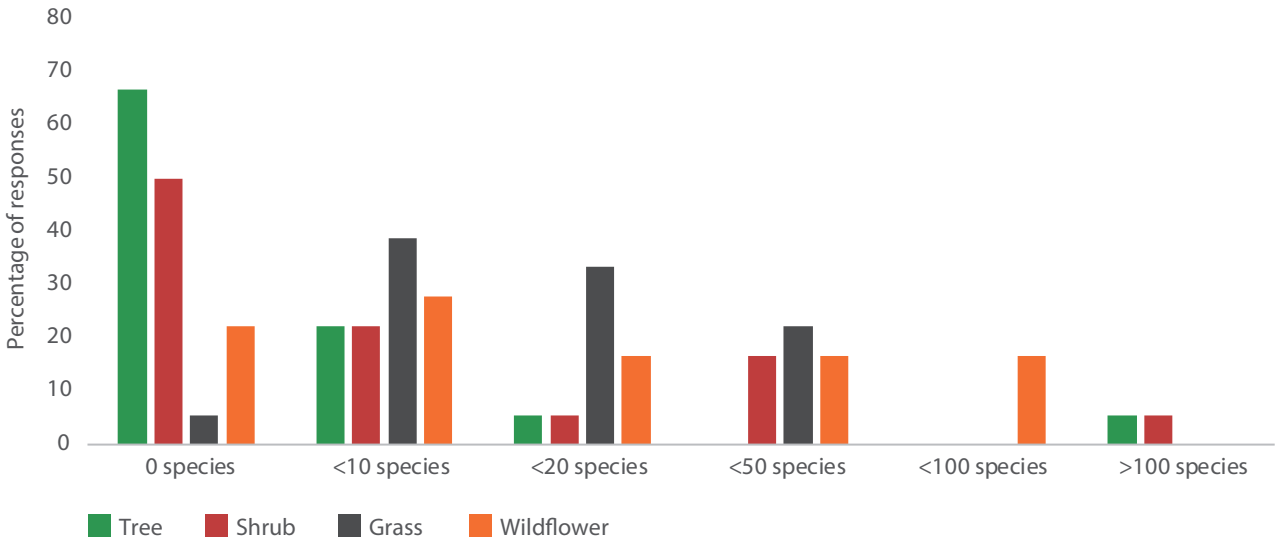

Figure 3.21. Species diversity in SPAs for each of the four plant types (trees; shrubs; grasses; non-woody wildflowers. Question 25. Appendix 1). Values are percentage values of total respondent groups within each category choice. Note: this graph is a duplicate of Figure 3.9 but is provided here to align with relevant text.

While trees are a smaller component of restoration SPAs, the native forestry/plantation sector has used native tree seed orchards for many decades to provide seed for planting stock, research, and breeding purposes. Indeed, virtually all native tree seed used in Australian plantation forestry originates from tree seed orchards rather than from wild harvest (the same is true in many other countries). Tree seed orchards differ from restoration SPAs in that they are designed to produce genetically refined seed targeting desirable plant traits of value for forestry, whereas restoration focussed SPAs are designed to produce seed that retains wild genetic diversity. However, there is a wealth of knowledge and experience in the forestry sector and tree seed orchards that could provide valuable insights for those growing native seed for other end-uses.

SPA Growers were also asked to nominate the geographic range they collect wild seed to initiate/establish their SPA crops. Similar to Seed Collectors, SPA Growers sourced material from wide geographic ranges and that for grasses and wildflowers (the most commonly grown plant types), the larger proportion of seed came from distances greater 20 km and, for some, greater than 100 km (Figure 3.22).

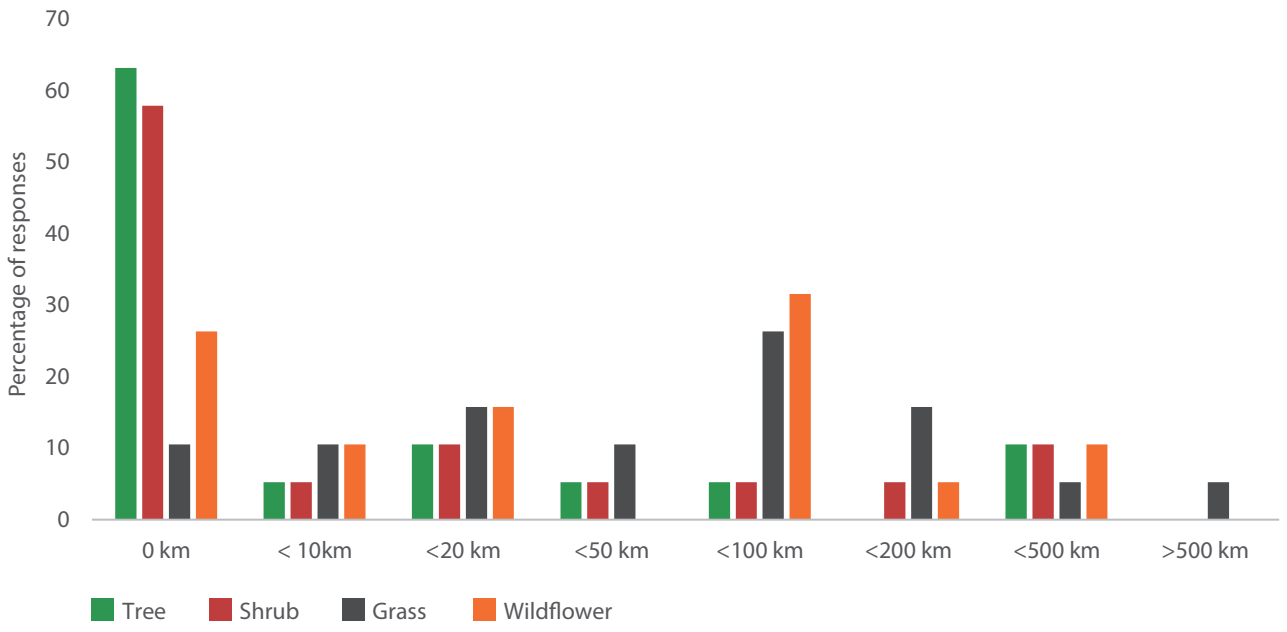

Figure 3.22. SPA seed founding range for the four plant types (trees; shrubs; grasses; non-woody wildflowers. Question 9. Appendix 1). Values are percentage values of total respondent groups within each category choice.

SPA Growers clearly felt that SPAs are necessary for meeting the requirements for native seed. Indeed, they ranked the statement "*To meet any shortfalls in demand for seed, seed should come from Seed Production Areas (SPA) rather than wild populations*" as their highest issue (wa 4.7/5- Table 3.2). However, some non-SPA Growers expressed apprehension and even negativity towards SPAs (similar views also being expressed in past sector forums). Their concerns broadly centred on the potential of SPAs to impact on seed supply markets (i.e. take market share from wild collectors), and the genetic quality of seed produced in SPAs (i.e. seed may be genetically unhealthy due to the use of inbred founding stock or because of selection pressures in the management of plants and seed). Conversely, many respondents from the other survey Groups were very positive about the potential of SPAs to improve the sector's ability to provide native seed for large-scale restoration and a range of other uses (e.g. "*Seed production areas are vital for rare & threatened species and provenances or species which do not yield prolifically under field conditions"* and, "*It is absolutely vital that native seed production, particularly of groundcover spp., continues to grow and be supported"*). There has also been growing calls to support the development of restoration SPAs across Australia from researchers (Broadhurst, Driver et al. 2015, Broadhurst, Jones et al. 2016, Nevill, Tomlinson et al. 2016). However, given the small number and footprint of Australian SPAs, unless there is a significant investment in their number, size, and capacity, Australian SPAs will be unable to fulfil their promise of playing a critical role in meeting future demands for native seed.

13 **Key finding 13:** Seed production areas in Australia are an important source of native seed from all major plant types, particularly grasses and non-woody wildflowers.

14 **Key finding 14:** Seed used as founder stock for SPAs is typically sourced from a wide geographic range.

Key risk: Since most SPAs are small in size and capacity and without clear incentives for investment in their development, it is likely that these will fail to fulfil their promise of supplying large volumes of high quality, low cost seed from a broad range of species for large-scale restoration or other end-uses.

3.6 Seed handling, testing and training

For agricultural, forestry and horticultural markets, there are strict industry standards and legislative obligations that dictate the viability of seed at sale and the requirement to provide labelled information on its quality. These frameworks or requirements are largely absent or not enforced in any meaningful way for the Australian native seed sector (but see http://riawa.com.au/wordpress/?page_id=1059%20%2001-RIAWA%20Seed%20Standards%20191.pdf). In the USA, federal and state laws regulate many facets of the native seed sector, including for testing and labelling (Jones and Stanford 2005). Such frameworks create clear obligations for growers and users of native seed, which in turn, helps build systems and structures for robust and transparent seed trading. For this reason, the survey explored issues relating to native seed handing, testing and training and the degree to which these practices are (or are not) undertaken by the sector.

3.6.1 Seed Handling

Most agricultural and horticultural seed is sold as pure or near pure product. In the native seed sector, there are no requirements for seed to be sold in a pure state. Preparing seed for sale in the pure state requires a high level of handling (i.e. cleaning and sorting). The survey asked Seed Suppliers "*How is the bulk of your seed prepared for sale or for your own use?*" and Seed Purchasers "*How is the bulk of your seed purchased?*" Perhaps surprisingly, the survey revealed that for Seed Collectors, most seed are prepared to a pure state (of the named species) (Figure 3.23). In contrast, SPA Growers prepare or use marginally more seed as seed and chaff than pure seed. Seed Purchasers and Other Users buy most seed in a pure state. It is surprising that a high proportion of seed is sold or purchased as pure product given the costs associated in seed cleaning are unlikely to be totally recouped in the sale price. It is possible this relatively high figure reflects that native seed is mostly purchased in small sized batches (i.e. <5 kg - Figure 3.6), which would require less labour and cheaper technology to clean to a pure state. A small percentage of seed is bought and sold in the state of 'Other'. 'Other' was not defined in the survey but some respondents indicated that grass seed is often in thatches (containing seed, stems, florets and other vegetative material), and that ramet (clonal) material is also an option.

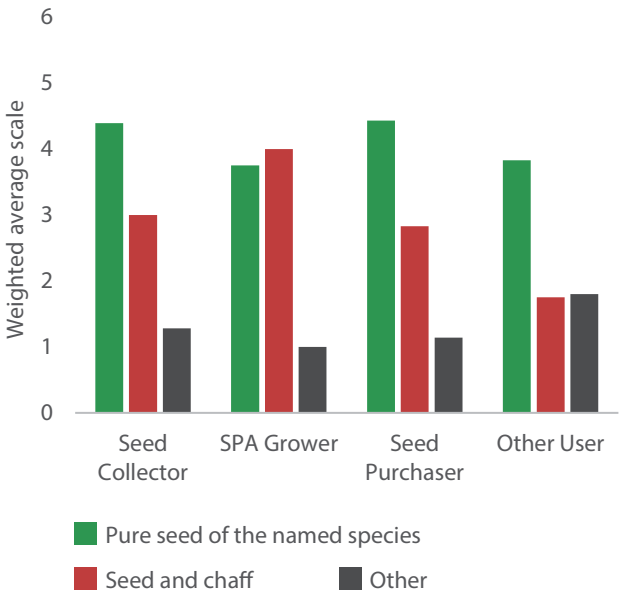

Figure 3.23. Seed state at sale or purchase for each respondent group (Seed Collectors; SPA Grower; Seed Purchaser; Other User. Question 13. Appendix 1). Values are weighted average values of total respondent groups within each category choice.

3.6.2 Seed Testing

Seed Purchasers were asked if they required seed testing information on purchased seed, and/or if they would pay extra for seed that had been tested. Almost half (46%) said that they require seed that has been tested and would pay extra for testing, 13% said that they require seed testing but would not pay extra for the service, and 25% said that they did not require testing information (Figure 3.24). Both these latter responses raise the issue that a relatively large proportion of Seed Purchasers may be more concerned with seed price than seed quality. However, several Seed Purchasers noted that they conduct their own testing.

A large proportion (73%) of the remaining component of the Seed Demand group, Other Users, said that they do not require seed testing (Figure 3.25). An explanation for this result may be that a large proportion work where there are facilities to test seed in-house (universities, conservation seed banks, and botanic gardens), rather than not believing that seed testing is important (comments included: "*I do my own seed quality testing with collected and purchased seed*", "*I don't require seed testing information because I test seeds myself*", and "*I do my own seed viability tests*").

Responding to the question, "*Do you provide seed testing information on the seed you sell?*" 50% of SPA Growers and 30% of Seed Collectors responded yes (Figure 3.26). Given that Seed Collectors make up the larger proportion of the Seed Supply Group, it is likely that a large proportion of native seed is sold without testing.

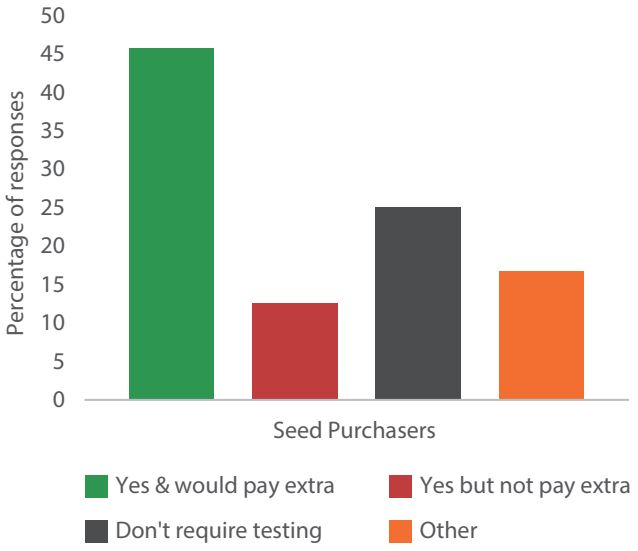

Figure 3.24. Seed testing requirement by Seed Purchasers (Question 20. Appendix 1). Values are percentage values of total respondent groups within each category choice.

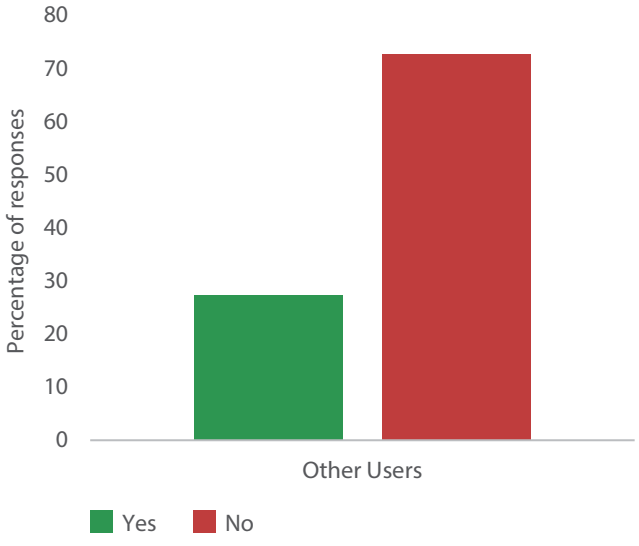

Figure 3.25. Seed testing requirement by Other Users (Question 20. Appendix 1). Values are percentage values of total respondent groups within each category choice.

Seed Collectors, SPA Growers and Seed Purchasers suggested that it is uncommon for seed testing information to be provided or requested (Figure 3.27). Broadly speaking, these responses suggest that seed quality testing is not a routine practice in the Australian native seed sector. One SPA Grower commented *"It's mostly only international buyers who want seed testing information"*, confirming that international seed buyers and markets expect or require stricter testing and labelling standards. Presumably, those Seed Purchasers who do not require seed testing trust their suppliers to provide seed that is of appropriate quality, invoke "make good" clauses in supply contracts to counter poor seedling establishment, or live with the consequences. Without a seed testing report, it cannot be determined whether planting failure is attributable to poor seed or to other causes, such as inadequate site preparation, poor sowing technique or adverse weather conditions.

For those respondents who do test seed, the survey explored where and how testing is conducted. Of the Seed Suppliers, 38% of Seed Collectors and 56% of SPA Growers use independent testing facilities. Of the Seed Demand Group, 29% of Seed Purchasers and 25% of Other Users also use independent testing. Having access to appropriate facilities to test in-house, rather than independently, is likely to be an issue for many seed suppliers more generally. A solution is to use simple tests such as seed purity (i.e. proportion of seed to chaff), cut seed, and nursery germination, rather than more complex testing such as tetrazolium-viability, temperature/light-controlled cabinet germination, or X-rays. The difficulty and/or expense of accessing an independent accredited laboratory that can provide standardised testing could also be a barrier (e.g. one respondent commented *"we need ISTA labs for tests"*).

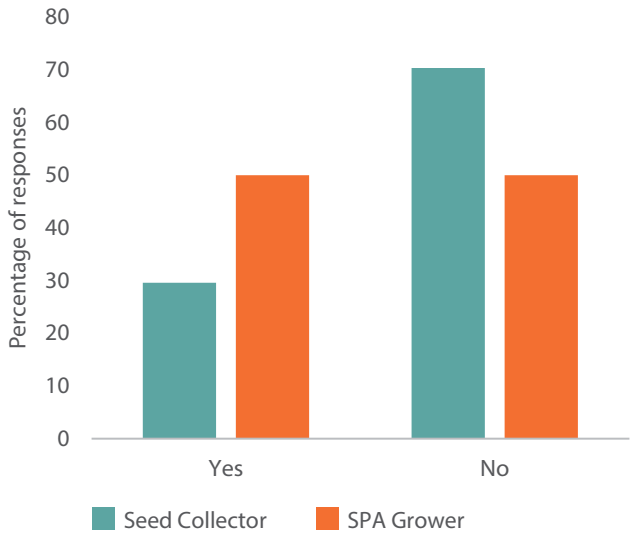

Figure 3.26. Provision of seed testing by Seed Collectors and SPA Growers (Question 20. Appendix 1). Values are percentage values of total respondent groups within each category choice.

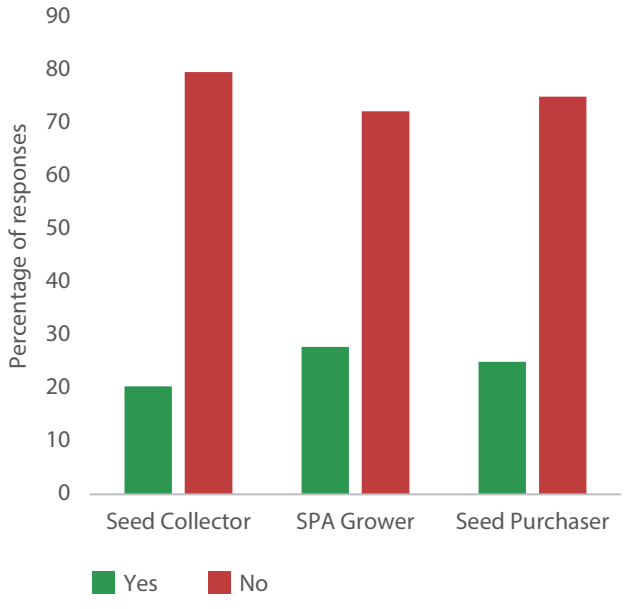

Figure 3.27. Affirmative or negative responses of Seed Collectors and SPA Growers that it is common for seed buyers to require seed testing information and from Seed Purchasers that they require seed testing information (Question 19. Appendix 1). Values are percentage values of total respondent groups within each category choice.

The International Seed Testing Association (ISTA) administers internationally recognised standards for seed testing. In 2016, there were five ISTA accredited laboratories operating in Australia (https://aseeds.com.au/australia-ista-laboratories/) as well as a small number of non-ISTA- accredited laboratories offering testing services. For example, one respondent commented "*I am a provider of seed testing, with the business expanding due to increasing demand in seed quality information. Half of the clients are mining companies [testing] seed they intend on purchasing and the other half are seed suppliers who want to have the information available before they sell their seed*". The relatively high cost of testing small batches of native seed may inhibit or discourage the widespread use of independent seed testing laboratories, especially for smaller suppliers or buyers with limited resources and/or small restoration projects with limited budgets. For example, at the time of preparing this report the cost of most seed tests (e.g. purity, germination, viability, vigour) from accredited laboratories was ~$200 per sample). If multiple tests were being conducted on large numbers of species, this could represent a very high cost relative to the value of the seed.

Of the various types of seed tests used by Seed Suppliers, purity, cut seed test and germination cabinet tests were the most commonly used approaches and for the Seed Demand group purity and germination tests (cabinet and nursery) were the most utilised approaches (Figure 3.28). Several respondents noted they used multiple test methods.

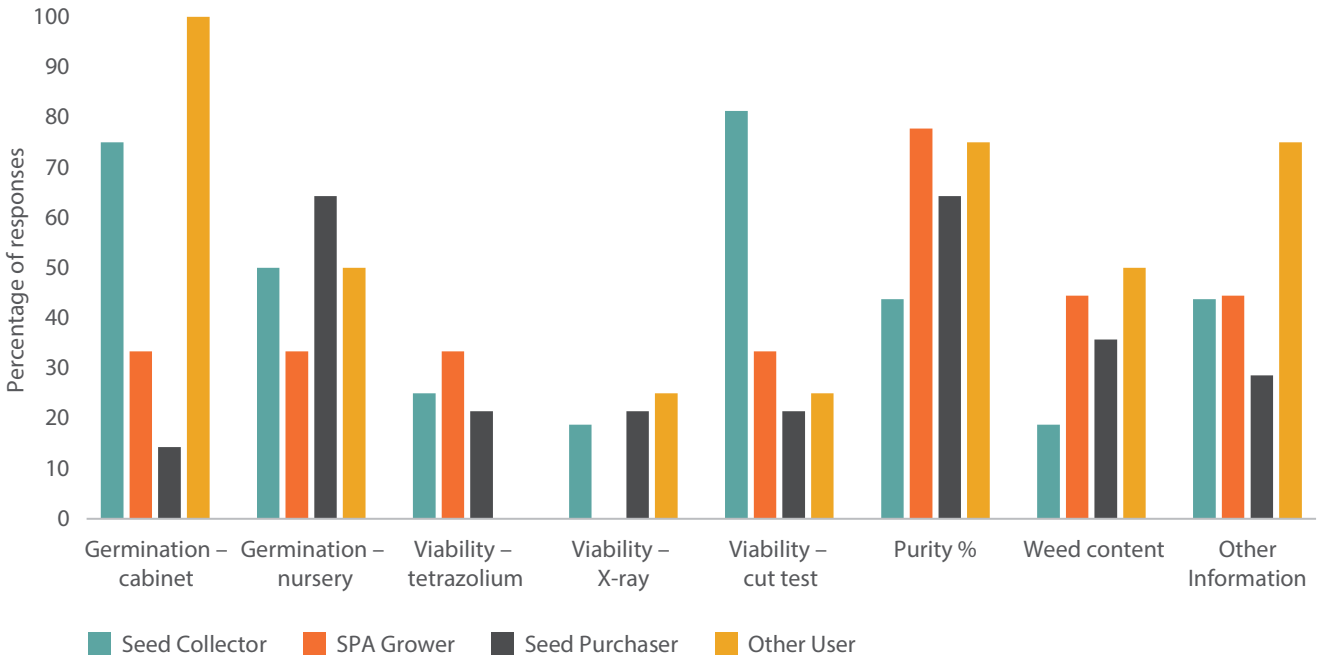

Figure 3.28. Seed testing methods utilised by Seed Collectors, SPA Growers, Seed Purchasers and Other Users (Question 21. Appendix 1). Values are percentage values of total respondent groups within each category choice. Note: some respondents nominated more than one category and therefore percentages sum to more than 100 percent.

15

Key finding 15: The quality characteristics of native seed are seldom tested prior to sale or use.

Key risk: In the absence of testing, purchasers and users of seed are taking possession of a product of unknown quality, which could mean spending significant amounts to purchase product of undetermined value or using product that will not give the desired outcomes.

Key risk: If up-front testing is not conducted, on-ground failures can seldom be accurately attributed to a lack of seed quality, because poor results might also be attributable to other causes.

3.6.3 Training and education

Throughout the survey, respondents made comments about the need for more and improved training opportunities for those in the native seed sector; these views were also expressed at APPC11. Training to improve sector practice were identified in areas such as plant identification, seed collection and handling, testing, labelling, and record keeping. In the early 2000s, Florabank ran a seed collector accreditation program that several respondents noted they had completed. Many respondents noted that their seed training/ experience had been gained "*on the job*" over years of working with seed. Others suggested that only improved training of participants in the sector would lift practice standards (e.g. "*Seed collectors need to attend short courses to become accredited like qualified builders and plumbers and be registered and given an industry card*").

There are numerous training events run across the country as one- or two-day regional workshops. These events are typically subsidised through public funding, organised by land management agencies or local governments, and delivered by sector specialist groups such as ANPC, AABR, or TAFE. These short events focus on practical aspects of plant identification, seed collection, seed handling and storage, and basic seed testing. Some modules qualify at certificate level in land management or revegetation courses run by TAFE or other registered providers, providing participants with a recognised qualification. Given the importance of more and better training in raising standards within the sector, it is disappointing that 79% of Seed Purchasers do not require Seed Collectors to have undertaken any training (accredited or non-accredited) and that a large proportion of Seed Suppliers have not undertaken training (Figure 3.29).

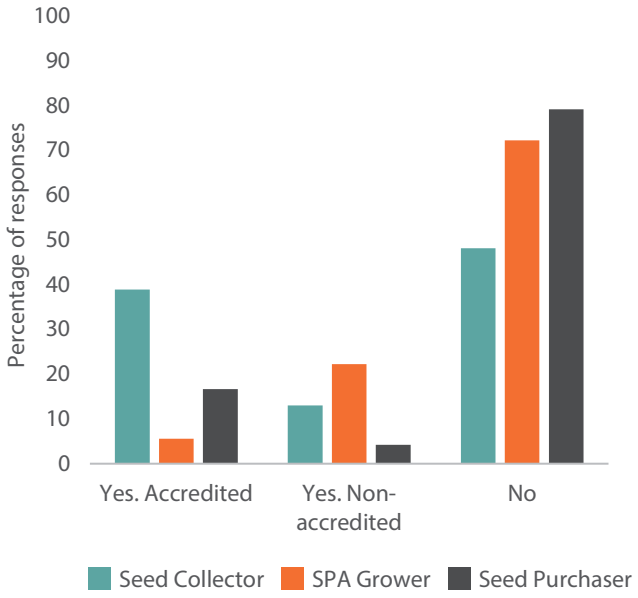

Figure 3.29. Seed training undertaken by Seed Collectors and SPA Growers and if required of the seed supply group by Seed Purchasers (Question 17. Appendix 1). Values are percentage values of total respondent groups within each category choice.

The survey also queried Seed Suppliers regarding their level of membership to seed-related associations. Seventy seven percent of Seed Suppliers do not hold memberships to organisations that typically provide a range of training, information and networking opportunities. This finding suggests that there may be financial or engagement barriers that limit practitioner support for, and uptake of, training.

ANPC Native Plant ID Training workshop (image credit Tricia Hogbin).

Some respondents voiced concerns about seed- or restoration-focused conferences or technical forums, that they felt often failed to meet the needs, or recognise the knowledge of, on-ground practitioners. Comments suggested that these forums were run more to provide opportunities for students or researchers to present their findings, or for agency staff to promote specific programs. It was suggested that there is an insufficient emphasis on providing sound practical advice to practitioners or to hear and learn from them. Respondents also identified the high cost of attending these events, which often precluded good representation from practitioners or the public, whereas participants from government and non-government agencies and/or universities were often paid to attend. Another complaint was that these events were typically held at times of the year that suited academic calendars (i.e. end of teaching periods), rather than at more convenient times for field practitioners (e.g. "*It is extremely disappointing that the academics within industry choose to conduct forums in inaccessible places like capital cities, at great expense, right at the start of the busy season*"). These sentiments were also strongly echoed at the APCC11 Native Seed Workshop discussion.

16 **Key finding 16:** A large proportion of Seed Suppliers do not undertake relevant training and Seed Purchasers do not require such training.

Key risk: Low levels of participation from the sector in seed-related training could undermine the quality of the product and seed-use outcomes.

17 **Key finding 17:** Many feel that seed and restoration conferences are run for the benefit of those from universities and government agencies and effectively exclude practitioners.

Key risk: Information presented at conferences will fail to reach those working on-ground if there is not more effort made to include practitioners.

3.7 Industry representation

Throughout the survey, many respondents made comments that spoke to a perceived lack of structure and cohesiveness in the sector. There was also a sense that there was little clear direction or progression towards key strategic goals at local, state or federal levels. These and similar concerns have been debated in the sector for many years and the survey included questions to gauge if the views of respondents represented a consensus.

3.7.1 The formation of a representative industry group

The survey posed the following question: ''*Do you think there should be a representative industry group that develops industry best practice protocols or standards for issues such as: seed collection, seed storage, seed testing, seed labelling and buying practices*?'' A key finding of this survey is that respondents from all sector Groups overwhelmingly supported this proposition (80-90% '*strongly agree*' or '*agree*') (Figure 3.30). It should be noted that, to date, 'sector best practice' has broadly been viewed as those actions prescribed under various Florabank practice guidelines, which were published in the early 2000s. Many aspects of those guidelines remain valid but more recent developments in areas such as genetics, seed production and seed-use suggest that updates are required, or that a new set of sector practice standards should be developed.

While there was a clear consensus for a national representative body, opinions on its form and structure were diverse. A number of respondents suggested that the now defunct Florabank should be reactivated to take on this role (e.g. "*Isn't this already Florabank to some extent? "; "Florabank was doing this in the past"; "I think the CSIRO/Florabank guidelines are sufficient"; "There was one already in place: Florabank"; "No need to reinvent the wheel again"; "Florabank filled that role for a while but they were issued in 1997. Policies e.g. offsets and funding options have moved on"*). At the time of preparing this report, no Florabank services were active other than as historic website documents. Revision of the Florabank Guidelines as they relate to seed, and for NSW only, is now part of a funded project by an ANPC-led consortium, for completion in 2020.

There are several organisations in Australia that currently operate with a focus on conservation and restoration. Of these, the two organisations most commonly mentioned as potentially capable of taking on the role of a national representative body were the Revegetation Industry Association of Western Australia ((RIAWA) http://riawa.com.au/wordpress/) and the Australian Seed Federation ((ASF) http://www.asf.asn.au). RIAWA was formed in 2003 by representatives from corporate, private and government groups to provide a voice for the revegetation industry in that state. It has developed a code of practice for revegetation and rehabilitation works, among other services it provides to members. Comments such as: "*In Western Australia this has been achieved by the revegetation Industry Association*"*;* and "*Revegetation Industry of WA is trying to fill this role*" and "*Agree, there already is in Western Australia*", suggest that RIAWA is viewed by some as a capable national representative of the native seed sector. ASF operates nationally as a peak industry body for the wider Australian seed industry and membership includes those from the agricultural, horticulture and native seed sectors. The ASF has developed a comprehensive national code of practice for labelling and marketing of seed (which does not discriminate between exotic or native seed) and a National Code of Practice for the use of seed treatments. Some respondents suggested that a native seed sub-group could operate under the auspices of the ASF to ensure there is focus on the specific needs of the native seed sector. Several respondents noted that they were, or had been, members of the ASF (e.g. "*We operate under the rules of the Australian Seed Federation, all others should do the same*").

Other organisations with potential to undertake this role were suggested by participants at the APPC11 workshop. These included the Society for Ecological Restoration Australasia (SERA) (and its linked international network for seed-based restoration – http://ser-insr.org/what-we-do), the Australasian Network for Plant Conservation (ANPC – https://www.anpc.asn.au) and the Australian Association of Bush Regenerators (AABR – http://aabr.org.au/). While these organisations focus on representing and connecting people engaged in conservation and restoration it is unclear whether they have the desire, capacity or sector support to develop and enforce standards or, as NGOs, if they can advocate and lobby actively on behalf of the sector.

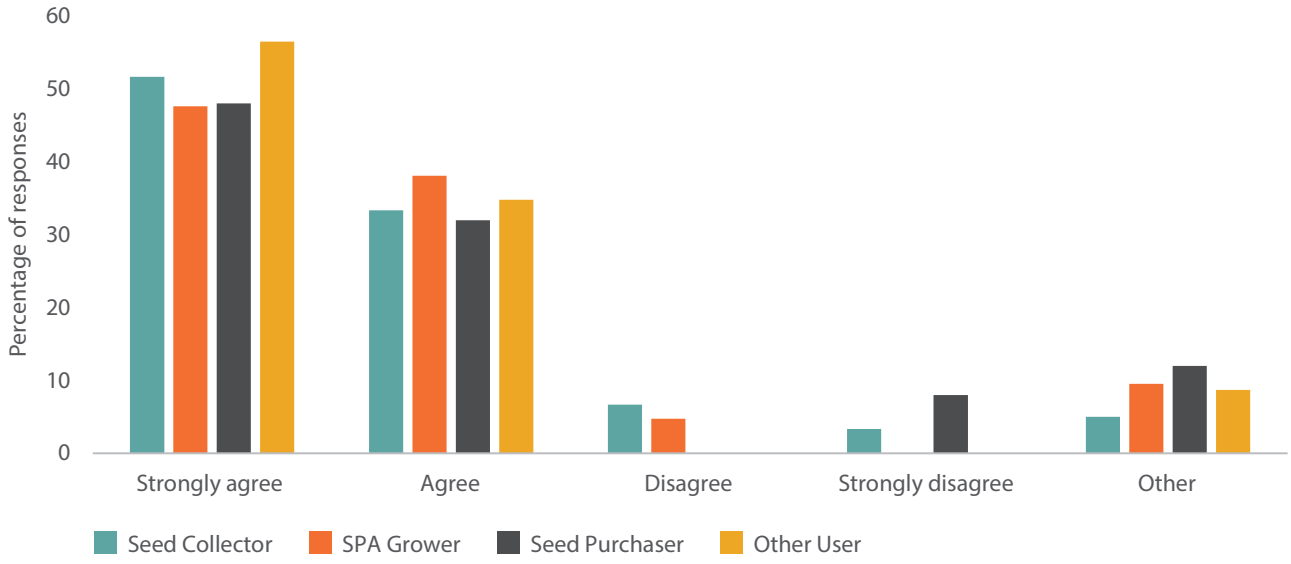

Figure 3.30. Level of support for a representative industry body form Seed Collectors; SPA Growers; Seed Purchasers; Other Users (Question 5. Appendix 1). Values are percentage values of total respondent groups within each category choice.

Even though there was majority consensus for a national representative body, some respondents raised questions or concerns about how an industry body would be funded or constituted. For example, some expressed concern about the cost of running such a body (i.e. "*If the cost is transferred to the seed producers, this might be a disincentive for participation/support, especially if it impacts the cost of seed for purchase*" and "*I agree but doubt that anyone will be willing to pay the extra costs involved*"). Others voiced concerns that a government/NGO-operated model would not necessarily service the needs of private/commercial operators ("*It should be fully controlled by private enterprise with Gov/Public funded bodies there to advise and assist with funding and R & D*") while others thought these groups did have a role to play ("*Could be government rather than industry; I think the CSIRO*"). Others raised concerns that standards might result in too much "red tape" that constrains rather than supports sector growth and improvement (e.g. "*We would rather the industry remain as it is as we currently work successfully. We definitely do not want additional legislation as it becomes restrictive*").

At the APPC11 workshop and in survey comments, some negative remarks were also directed towards scientists and academics, suggesting they were too often viewed by governments as the primary gatekeepers of knowledge regarding the seed sector, despite some having limited hands-on experience of the realities of the sector (i.e. "*As long as the group isn't run by boffins with no practical knowledge*"). Such sentiments indicate that there are practitioners who want experience-based representation in the formation and running of a representative body. These views indicate that there is some friction within the sector, highlighting the need for better inclusion and more meaningful discussion between all sections of the sector. These views also highlight the challenges of bringing people together to develop a national representative seed body. Successful examples include USA-based organisations (e.g. The Western Seed Association, the American Seed Trade Association, and the Atlantic Seed Association), and in Europe, the European Native Seed Producers Association. These organisations which were formed to create networking and business opportunities for members, provide training and education services, and importantly, lobby governments on behalf of members and the sector.

18

Key finding 18: The sector overwhelmingly supports the formation of a nationally representative body for the native seed sector.

Key risk: Because there remains no clear pathway to establishing an independent and funded representative body that satisfies the varied requirements of the many different sub-groups within the sector, it is likely that the unsatisfactory status quo will be maintained, and the benefits that could accrue from better industry organisation will remain unrealised.

4 Constraints, challenges, actions, goals, and recommendations

This report provides a snapshot of the Australian native seed sector including its structure, practice, and capacity to meet current and future demand for native seed (and other sector aspirations). The survey revealed that the native seed sector is a complex and multifaceted instrument attempting to meet the expectations of a broad range of restoration and other seed-use outcomes across Australia (Figure 4.1). The survey has also challenged some commonly held perceptions within and about the native seed sector. To meet these expectations, the sector will need to move to a significantly more mature and capable industry. This transition will require change, commitment, and resourcing.

The major constraints and challenges, necessary actions, and desired 'end-states' for a more mature and sustainable industry are briefly summarised below. These summaries are related to 11 cross-cutting Recommendations to enable the sector to realise its full potential to contribute to natural resource management, climate change adaptation, and biodiversity conservation. Not all of the issues and directions raised in these summaries were survey findings or discussed at APCC11, and therefore also represent the views and experience of the authors of this report. In contrast, it is important to stress that the lead Recommendations arise from the actual findings and perceptions of sector participants, as expressed in the survey and associated workshops, and are focussed specifically on the goal of growth and improvement of a native seed industry.

Implementation of the Recommendations will require adaptation to the specifics of Australia's multiple jurisdictions and the challenges associated with managing NRM arrangements across differing legislative frameworks and expectations. Some steps suggested for practical implementation are appended to each Recommendation. Again, these steps are suggested by the authors and do not necessarily represent a sector consensus but are proffered as a way forward.

In compiling these Recommendations, as with the development of the survey and workshop discussions, some extrinsic factors are taken as 'givens'. For example, the conservation of native biodiversity is a core goal of NRM and environmental policy in all Australian jurisdictions. However, there are other 'unknowns '– e.g. the shape of future NRM policy and investment especially in response to continuing water crises and climate change. Some attempt is made in the following summaries (Sections 4.1 – 4.3) to indicate how a healthy native seed industry would intersect with such wider issues.

4.1 Constraints and challenges of the future capacity of the Australian native seed sector

The findings of this survey and those voiced at APCC11 (and other similar sector forums), raise serious concerns about the ability of the sector, as currently constituted and resourced, to meet projected future increases in the demand for seed as well as achieving greater effectiveness and efficiency in ecological restoration. This is especially important if Australia is to achieve world's best practice restoration outcomes. The increased demand for seed is expected to come from local, industry, state, and national levels. Some of the various factors that underlie this concern are addressed below.

Despite calls to improve the efficiency and productivity of the native seed sector, as well as some articulation of how this could be achieved (Mortlock 1998, Mortlock 2000, Dodds, Dennis et al. 2002, Victorian Department of Sustainability and Environment 2004, Broadhurst, Driver et al. 2015), a comment often made by sector members during forums and workshops is that little constructive action leading to tangible improvement has occurred over the past two decades. The survey findings corroborate these concerns and highlight emerging disruptive factors that the sector must meet, manage and adapt to over the coming decades (Figure 4.1). These constraints must be addressed if the sector is to meet future environmental goals.

Figure 4.1. Schematic representation of the Australian native seed sector. Blue cogs indicate *challenges and constraints* for the sector, yellow cogs indicate *actions required*, and grey cogs indicate *desired end-states* to achieve a more mature sector.

Climate change impacts

The potential role of restoration (and specifically that of native species, ecosystems, and ecological function) remains an under-explored aspect of climate change adaptation strategy in Australia. Restoration, nevertheless, has enormous potential to contribute to minimising some of the expected impacts of climate change, e.g. the linkage of corridors between remnant vegetation to enable species' migration, landscape-scale water capture and retention, and soil conservation. For that potential to be realised, restoration at larger spatial scales and with more complexity than previously attempted would be required and contingent on high quality native seed. To date, the lack of a clear policy vision of how restoration can contribute to climate change adaptation constrains the ability of the sector to prepare for the process, and limits government and land managers' ability to draw upon the sector's expertise to meet these goals.

Whilst climate change was not the focus of this survey, signs are already appearing that a rapidly changing climate will disrupt many practices within the sector, as noted in many survey comments. The survey highlighted that respondents are starting to see declining seed crops from normally reliable populations (L. Broadhurst, 2017, personal communication). While this may reflect a range of variables, such as aging plant populations and current drought conditions and a drying climate across southern Australia, there are already calls for the development and deployment of more relaxed seed sourcing guidelines to improve adaptive capacity (Breed et al. 2013, Prober et al. 2015).

See Recommendations 1, 2, 3, 6, 7.

Low species diversity in most current restoration approaches

The survey highlighted that the sector has serious concerns about the capacity of remnant plant populations to meet the future demand for seed, and about the lack of species diversity available for restoration. These inadequacies are expected to seriously hamper our ability to meet goals for large-scale biologically-diverse restoration over the coming decades. In addition, the lack of requirement for high species diversity in many publicly funded restoration and revegetation programs imposes a negative feedback on suppliers. Firstly, it limits the incentive and ability of suppliers to source a diversity of species and to invest in diverse SPAs (to establish cultivated populations). Secondly, it diminishes the need to improve understanding and practice in relation to seed provenance and the maintenance of appropriate forms of genetic diversity and genetic health in both wild-sourced and SPA seed. Increased focus by planning and funding bodies on the need for species and genetic diversity, if phased-in sensibly to planning and contract processes, would contribute to an increased capacity for suppliers to meet these parameters.

See Recommendations 1, 2, 6, 7, 8.

Declining wild seed

As native vegetation declines across many landscapes, the sources for native seed in quantity and genetic quality also tend to diminish. A regional approach to tracking seed sourcing and seed use would contribute to the identification of problems and opportunities for healthy seed and reduce the risk of over-harvesting of populations. Expanding seed collection to include land tenures that are currently rarely collected from would help to overcome declining seed resources, improve species availability, and facilitate the maintenance of genetic diversity and health in both wild-sourced seed and SPA cropping. It is recognised that the potential use of conservation reserves as seed sources raises important questions of impact and precedent and that these require close analysis, although it is noted that this is already established practice for many threatened species recovery projects.

See Recommendations 1, 2, 3, 4, 5, 6, 7, 8.

Inconsistent/unpredictable demand

The survey found that while the demand for native seed has many end-uses across Australia, the market for seed is small, poorly co-ordinated, has few standards and is largely unregulated. Above all, it is subject to strong fluctuations in demand, often imposed by vagaries of governmental program funding in which the sustaining of an infrastructure for conservation and NRM is at best a minor consideration. This contrasts with the due regard for maintenance of infrastructural and human capabilities that tends to be better recognised in the Australian agricultural and horticultural industries. A regional approach and longer planning and funding timeframes for restoration projects on the part of Planning, NRM, and Conservation agencies, would assist in solving this problem. The ability of the native seed sector to demonstrate its potential (and thus increase and stabilise demand) is also hampered by the lack of regulation, structure and standards at levels suitable for and directed at the growth of this fledgling industry.

See Recommendations 1, 2, 3, 5.

Small workforce

The survey found that the native seed sector is underpinned by a remarkably small work force composed primarily of under-resourced and undercapitalised sole- or small-operators. This situation presents a clear risk to all users of native seed, not only in terms of current capacity, but also if there are large and rapid increases in demand in the future. A small workforce hampers the ability of and incentive for both seed providers and users to invest in skills improvement and training, and to present a clear industry voice.

See Recommendations 1, 2, 3, 4, 5.

Seed price does not cover true cost

The survey revealed that seed suppliers struggle with a market that fails to properly support the various costs associated with seed supply and where demand for native seed is linked to large cyclic shifts in environmental funding. Seed collection is a challenging occupation and collectors often work under difficult conditions to locate and harvest seed, often without the certainty that these efforts will be rewarded. Survey responses show there is a complex chain of activities prior to the sale of seed that include sourcing, harvesting, processing, cleaning, testing, storage, packaging and shipping. Many seed suppliers feel that they are not always compensated for their expertise and experience or for the cost of equipment and facilities required to produce native seed for sale. A review of native seed pricing, credible to the many government agencies that manage contracts, and conducted with due input from the sector, would assist the establishment of more realistic estimates in the planning and funding processes, and would pay dividends in terms of improved capabilities and supply.

See Recommendations 1, 2, 3, 4.

4.2 Actions required

Seed production areas (SPAs)

The potential for well-managed SPAs to deliver large quantities of high-quality seed for restoration is increasingly recognised (Delpratt and Gibson-Roy 2015, Nevill, Tomlinson et al. 2016) particularly in relation to herbaceous and sub-shrub species up till now rarely used in restoration but which could markedly increase the ecological value of such projects. Establishment and maintenance of native seed cropping systems depend on a sustained focus on developing infrastructure capacity, training, and market size. An audit and critical examination of success and failure factors in past SPA investment, and of their potential regional roles, would be a valuable guide for the establishment of better-founded and strategic SPAs in the future.

See Recommendations 1, 2, 4, 6, 7, 9, 10, 11.

Review programs/policies

Reviews of environmental and development planning processes, and of funding programs that support restoration in the NRM and conservation contexts, are desirable to (a) establish better modelling of realistic costs of seed supply and purchase; (b) consider the values (ecological, cultural and economic) that can be added to restoration projects by greater use of native seed; and (c) consider the benefits of alignment of projects and funding programs to encourage and stabilise the market for quality native seed. The multiplicity of agencies and programs in this space make a single process unlikely, but a carefully chosen case-study review with some broader applicability would be a valuable precedent.

See Recommendations 1, 2, 4, 5, 11.

Regional coordination

Greater coordination at regional scales in the planning and inception stages of restoration programs, with appropriate input from the native seed sector, would greatly increase the predictability of demand. This would involve regional or multi-regional reviews that consider restoration goals alongside current and predicted capacity to formulate realistic seed strategies which assist in planning for and delivery of restoration projects which would create greater certainty and transparency for those local sectors. In some jurisdictions, some NRM bodies with relatively stable investment in longstanding restoration programs are already practicing a degree of such coordination. These would be the best candidate areas in which to try to extend the regional approach to the greater production and use of native seed in such programs.

See Recommendations 1, 2, 5, 6.

Market incentives

The survey revealed that the sector is heavily reliant on government funded programs, while development approval offset programs (i.e. mining or urban development) are a secondary and growing area for restoration. However, with current seed supply and demand only modest well developed and targeted, market incentives would help to drive sustained growth in the seed sector (and thus restoration), as has been achieved in the United States (Gibson-Roy 2018). Incentives that lead to a larger and stable market will assist in promoting economically viable businesses for suppliers to risk investment in capacity building and training. Ambitious incentives from state and federal governments should promote diverse native ecosystem restoration for its own sake, or as a co-benefit for developing more sustainable farming systems, better managed transport corridors, meeting carbon emission reductions, soil and water security and generating employment and community wellbeing, especially in regional areas where seed is primarily collected and used.

See Recommendations 1, 2.

4.3 Desired end-states

Project alignment

Feedback from the survey and APCC11 suggest that despite best intentions, there is often a lack of alignment between the various groups and agencies focussed on environmental programs leading to inefficiencies and missed opportunities. Greater coordination and transparency from those involved in leading and undertaking environmental programs would lead to a more stable and resilient seed and restoration sector – allowing it to meet market demand.

See Recommendations 1, 2, 5.

Seed sourcing strategies

The survey revealed that native seed is sourced from and used across large geographical ranges. It is unclear if this move away from 'local provenance' is in response to greater understandings about genetic health, to mitigate climate change effects, or because ongoing clearing and fragmentation necessitates wider collections. Confirmation of these practices suggests the need for improved transparency of practice and definition of sourcing protocols, and updated seed sourcing guidelines to reflect the changes (and see 4.1 Climate change).

See Recommendations 2, 7, 10.

Market stability

Market stability, as found by the survey results, is lacking in the Australian native seed sector, despite the aspiration for its presence. Market stability, of any kind is difficult to achieve, and yet with well developed, targeted and administered incentives, markets can achieve mass and scale that creates more rather than less stability. In the United States of America, the Federal Conservation Reserve Program (in operation since 1986), which focusses on creating native vegetation on farmland through rental payments, is an example of a program that has created a national marketplace for native seed and restoration services (within set parameters). Similarly, Federal US directives for State Departments of Transport have created national markets for seed and restoration services that have resulted in significant outcomes (see Gibson-Roy (2018)). Consideration of, and development of those that are suited to the Australian political, economic and social landscapes are required to create similar opportunities for national marketplace efficiencies and outcomes seen in the US (and other European countries). Examples such as this can be found in the USA, where over many decades a stable market for restoration services has led to significant sector growth and corresponding environmental and capacity outcomes (Dunn, Stearns et al. 1993, Dunne and Dunne 2003). It is likely that similar outcomes could be achieved in Australia given similar mechanisms and trajectories, but perhaps most importantly, the will to do so.

See Recommendations 1, 2, 3, 4, 5, 6, 7, 8, 10.

Advocacy for native seed

The survey found that there is overwhelming support for an industry body to represent the native seed sector. Such a body would advocate on behalf of the sector at a national level and assist it to transition to a viable and mature industry that is able to meet increased future demands for native seed. It is envisaged that this body would help unify the sector across and within jurisdictions and provide a clear focus on elements critical to developing its capacity and capability. These would include developing guidelines and standards; supporting government policy development; exploring and building new markets; identifying research gaps; and providing support and training opportunities.

See Recommendations 2, 9, 11.

Standards/testing

The survey found that seed testing on native seed is infrequent and inconsistent. Seed testing is a critical component of quality assurance and a standard practice in agriculture and horticulture as well as in mature native seed markets in some other countries. More consistency of practice in relation to seed testing is critical to help the sector transition into a more viable, reliable, and sophisticated industry, and to provide quality assurance and better outcomes for both sector participants and end-users. Sector adherence to higher standards in relation to quality assurance will, however, come with an increased cost, which must be recognised and met by native seed end-user and/or funding bodies.

See Recommendations 4, 9, 11.

Training, accreditation, and information sharing

The survey found that while levels of training in the native seed sector are low, and many are dissatisfied with some aspects of the organisation and delivery of conferences and forums, there is strong support for increased training opportunities and information sharing within the sector. Opportunistic training includes seed collection, processing and handling and SPA development and operation. The current low levels of training are disappointing given that considerable funds were devolved under the NHT program for training delivered by a range of capable organisations including NGOs, research organisations, and TAFE colleges. This capacity building appears to have dissipated in the intervening years. The need and desire for higher standards of sector practice should be assisted by access to well-targeted and affordable, accredited training and information sharing (e.g. conferences, forums, workshops, and other means such as web-based resources).

See Recommendations 2, 9, 10, 11.

4.4 Recommendations

Maturing the Australian native seed industry

In recognition that a more mature native seed industry is indispensable for improving restoration outcomes, biodiversity recovery, ecologically sustainable NRM, and successful climate change adaptation, we recommend:

1. *Discussions among federal, state and regional government agencies with responsibilities for implementing large-scale national environmental programs, policies and procedures be initiated and thereafter conducted annually. The goal of these discussions should be to better align and refine policies and procedures and develop mechanisms to ensure that the native seed sector is embedded as a fundamental component of these activities.*
   - *To this end we recommend that:*
     - *a determination of the scale of infrastructure investment required to develop and maintain a sector capable of meeting future demand be undertaken.* ***IMMEDIATE.***
     - *the costs and benefits of short- versus long-term funding cycles be undertaken to determine if the shift to longer cycles by some jurisdictions warrants similar funding cycles at all levels of government.* ***MEDIUM TERM.***

- *an investigation of environmental programs, incentive schemes or legislative directives that are already successfully operating in the USA and Europe is required to determine whether these in whole or part would be appropriate to ensure that the Australian native seed sector can meet future demand.* ***MEDIUM TERM.***

These discussions and reviews must have representation from biodiversity conservation and NRM agencies, NGOs, researchers and other relevant sector participants and bodies. Given that the native seed sector is primarily rural in nature, representation from rural and regional industry development bodies may also warranted. A devolved process via regional symposia within existing sectoral/industry, policy and scientific forums and/or commissioned stand-alone workshops and expert appraisals could be invoked for this recommendation, noting that the participation of many in the native seed sector will require subsidised support to attend.

2. *Establishment of a national native seed industry body to represent and assist the sector (and government) to transition to one that can meet the needs of broad-scale, long-term environmental programs.* ***MEDIUM TERM****.*

   Establishing this body will require direct and in-kind resourcing from Federal, State and regional agencies. Over time, once the native seed market is stable and financially viable, a user-pays system may be more appropriate. This body would be responsible for

   - *advocating on behalf of the native seed sector on environmental program development, policies, and processes*
   - *developing agreed standards of practice for the native seed sector for seed-related activities not already covered by existing guidelines such as guidance on suitable geographic/ecotype ranges or seed transfer zones or the use climate-ready strategies*
   - *providing seed buyers with clarity around seed point-of-origin and sourcing practices including through an investigation of quality assurance systems developed in North America and Europe (e.g. capturing appropriate genetic diversity)*
   - *assisting seed suppliers to meet market requirements for seed volumes, seed quality and species diversity*
   - *in collaboration with and supported by agency-based biodiversity conservation, NRM and NLP strategies and programs, facilitate regionally-based forums for native seed providers and users*
   - *delivering sector information, information sharing, and networking opportunities through conferences, workshops, forums and other forms of delivery*
   - *overseeing the development of accredited (or similarly recognised) training in all aspects of native seed handling and end-use, including contracting and sale specifications.*
   - *transitioning from a body funded from outside sources to one that is independently viable.*

Sustainability

3. *More consistent and sustained funding for biodiversity recovery is required from conservation, restoration and NRM agencies, regional bodies, and other funding agencies to provide stable markets for native seed that will support viable businesses, stable workforces, continued skills development, and quality improvement.* ***MEDIUM TERM.***
4. *Native seed will need to be priced to reflect the full range of costs and standards obligations associated with the collection and/or production, processing, testing and storage to provide sustainability for seed suppliers. For this to be achieved, education on the advantages of high quality seed may need to be conducted.* ***MEDIUM TERM.***

5. *To ensure market sustainability for native seed suppliers, and the availability of adequate and quality seed for restoration goals, land management agencies must improve forward planning and coordination of seed requirements for regional restoration programs.* ***IMMEDIATE.***

Seed production areas

6. *Integration of Federal, State and regional environmental strategies to support the development and operation of regional SPAs to reduce the collection burden on remnant vegetation and provide the market with a more consistent supply of cost-effective, high-quality seed from a broader range of native species is required.* ***IMMEDIATE.***

Licencing

7. *Federal, State and Territory agencies should review current seed collection licensing requirements to determine whether land tenures such as state and national parks, and other listed or protected vegetation communities can be utilised to supplement and support native seed collections (particularly for SPA establishment). This will require strict regulation and compliance measures to protect the integrity of these populations from damage and/or overharvesting but judicious collections from such areas will provide important germplasm for restoration activities.* ***IMMEDIATE.***
8. *Federal, state and territory agencies should review the purpose, structure, and effectiveness of seed collection, permitting and licensing regulations, to provide better clarity on conditions and to improve compliance.* ***MEDIUM TERM.***

Seed testing and tracking

9. *Government and seed industry bodies must work together to establish minimum seed quality standards and a nationally consistent mechanism for native seed testing that provide affordable services for suppliers and purchasers.* ***MEDIUM TERM.***
10. *A national seed database and tracking system for seed sales is required to assist sellers and buyers more readily determine species and seed availability, allow for future auditing of seed-based restoration-based activities, and to provide the native seed sector with data on supply and demand.* ***MEDIUM TERM.***

Research

11. *Supporting research, especially that which includes and mobilises knowledge of the restoration sector, is critical to improving practices and maximising the success of ecological restoration. Ensuring that this knowledge is current and easily accessed is vital for practitioners.* ***MEDIUM TERM.***

5 Conclusions

This survey has established important base-line information on a range of areas of native seed sector practice and opinion that will help pave the way for the development of a more mature and efficient restoration sector. It has revealed valuable insights into its current capacity and operation. Many factors still limit the sector's ability to meet the challenge of any future increased demand for native seed. These factors include the small size and under-resourced nature of most organisations within the sector; that supplies from natural populations and SPAs, while meeting current demand, are relatively low and from a limited range of species; that seed is not routinely tested for quality assurance; that payment for seed rarely covers its cost of supply; that many in the sector are not suitably trained; and that there are no recognised national practice standards.

It is also clear from the number of respondents from all states and territories, together with those who contributed to APCC11, that people in this sector are passionate about their own and the sector's future. Participants within this sector are highly committed to helping facilitate better environmental outcomes but want to be able to do so in a more effective manner. They also want stable, productive and rewarding careers. It is hoped that the results and recommendations from this survey will assist governments and the sector to development and implement more effective and efficient environmental policies that better support people and markets focused on restoring Australia's biodiversity and other areas where native seed is fundamental. Decades of inefficient or under-resourced sector development means there is much to be done if the sector is to transition to a fully-fledged industry capable of delivering nation-wide outcomes for ecological restoration, on-farm benefits, plantation forestry, food products and improved urban landscapes.

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APPENDIX 1

Native seed survey questions.

The first five questions were identical for each group.

1.

From the list below, what is your primary role within the native seed industry?

You may feel that you fall into more than one of the following categories, but please choose the one which best describes your role and answer all questions accordingly. Do you:

A. Collect seed or hold seed collected by others on consignment (i.e. community seedbank), for sale, or for use in your own projects (i.e. nursery production or direct seeding)?

B. Grow seed in Seed Production Areas (i.e. plants grown in cultivation to produce seed) for sale or for use in your own projects?

C. Purchase seed for your own projects or for distribution to other projects?

D. Use seed for other purposes? Please comment.

2.

What is your affiliation?

A. Community group representative

B. Non-government organisation

C. Commercial organisation

D. Local or state government

E. Individual or landholder

F. Other. Please specify

3.

What is the name of the Council and the post code where your business is based?

4.

How important do you think the following potential issues are to the seed/restoration sectors? Rank your answers in order of preference with 1 being the least important and 5 being the most important.

A. Seed supply is generally unreliable

B. There is a lack of seed available from a broad range of species

C. Seed orders are made at too short notice

D. The market is unwilling to pay for the true cost of collection/production

E. There is a lack of suitable seed collectors

F. Provenance range stipulations are too restrictive

G. Provenance range stipulations are too lax

H. Demand for seed is inconsistent &/or unpredictable

I. Demand for seed is low

J. There are too many difficulties in securing seed collection permits

K. There are too many difficulties in obtaining access to wild populations for collection

L. Future demand for seed will be difficult to meet from wild harvest

M. To meet any shortfalls in demand for seed, seed should come from Seed Production Areas (SPA) rather than wild populations

Please comment on any other issues of concern

5.

Do you think there should be a representative industry group that develops industry best practice protocols or standards for issues such as seed collection, seed storage, seed testing, seed labelling and buying practices?

A. Strongly agree

B. Agree

C. Disagree

D. Strongly disagree

E. Other. Please comment in the space provided below

Hereafter, the questions were worded slightly differently so they would remain applicable to the group that the respondent identified with. The question posed to each group appears in the following order:

Seed Collector

SPA Grower

Seed Purchaser

Other User

6.

Of the seed you collect, approximately what percentage volume comes from the following plant groups?

What percentages of your seed production (SPA) crops are:

Of the seed you purchase, approximately what percentage volume comes from the following plant groups?

Of the seed you use each year, approximately what percentage volume comes from the following plant groups?

0%; 1-20%; 21-40%; 41-60%; 61-80%; >80%

A. Trees

B. Shrubs

C. Grasses

D. Non-Woody Wildflowers

E. Other. Please specify

7.

Approximately what percentages of your collection sites are on the following land tenures?

What percentage of the wild seed used to initiate your production crops has come from the following land tenures?

Approximately what percentage of the seed you purchase originates from the following land tenures? Tick 0% for the rows that are n/a

Approximately what percentage of the seed you purchase originates from the following land tenures? Tick 0% for the rows that are n/a

A. Public reserves 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
B. Public roadsides 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
C. State Parks 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
D. National Parks 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
E. Private property 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
Other: Please specify

8.

What percentages of your seed collections are done to meet opportunistic demand (i.e. I hope there might be a demand for this species) and what percentage is initiated for specific demand (i.e. I know there is a market for this species)?
What percentages of your seed crops are grown to meet opportunistic demand (i.e. I hope there might be a demand for this species) and what percentages are initiated for specific demand (i.e. I know there is a market for this species)?
What percentage of your seed is sourced opportunistically (i.e. I hope the seed I need is available somewhere), and what percentage is sourced specifically (i.e. I have placed orders in advance from a collector or grower for this seed)?
What percentage of your seed is sourced opportunistically (i.e. I hope the seed I need is available somewhere), and what percentage is sourced specifically (i.e. I have placed orders in advance from a collector or grower for this seed)?

Opportunistic 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
To order 0%; 1 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%
Other: Please specify

9.

For each category, what is the geographic range over which you collect seed?
For each category, what is the geographic range over which you collect wild seed to initiate seed crops?
If you were buying seed for use in your immediate region, for each category, from how far away would you accept seed?
If you were buying seed for use in your immediate region, for each category, from how far away would you accept seed?
0 km; < 10km; < 20km; <50km; <100km; <200km; <500km; >500km

A. Trees
B. Shrubs
C. Grasses
D. Non-woody Wildflowers
Other: Please specify

10.

What is the approximate quantity of seed you collect/sell each year for the following plant groups?
What is the approximate quantity of seed you produce annually in SPAs for the following plant groups?
What is the approximate quantity of seed you purchase each year for the following plant groups?
What is the approximate quantity of seed you purchase each year for the following plant groups?
A=0 kg. B=<5 kg. C=<10 kg. D=11-30 kg. E= 31-50 kg. F. 51-100 kg. G =100-500 kg. H = >500 kg.
I = Do not wish to disclose

A. Trees
B. Shrubs
C. Grasses
D. Non-Woody Wildflowers

11.

When selling seed for restoration projects (whatever vegetation-type/structure) what would be the typical level of species diversity asked for?

See last page for specific SPA Grower-related questions

If purchasing seed for restoration projects (whatever vegetation-type/structure) what would be the typical level of species diversity you require?

If using seed for restoration projects (whatever vegetation-type/structure) what is the typical level of species diversity you use?

A. <10 species
B. <20 species
C. <50 species
D. <100 species
E. >100 species

12.

Based on where most of your seed was collected, what is the percentage breakdown for where it is used?

What is the approximate breakdown where the seed you produce is used?

Relative to your business location, what is the percentage breakdown of where the bulk of your seed purchases are used?

What is the percentage breakdown where the bulk of your seed is used?

0; 1-20%; 21-40%; 41-60%; 61-80%; >80%

A. Immediate region (i.e. 1ocal or adjoining council areas)
B. Broad region (i.e. within Catchment Management or Local Land Service Areas)
C. State-wide
D. Interstate
E. International
Other. Please comment

13.

How is the bulk of your seed prepared for sale or for your own use?

How is the bulk of your seed prepared for sale or for your own use?

How is the bulk of your seed purchased?

How is the bulk of your seed you use purchased?

0%; 1-20%; 21-40%; 41-60%; 61-80%; >80%

A. Pure seed of the named species
B. Seed and chaff
C. Other Please comment

14.

Approximately what percentage of your seed is destined for use under the following categories (whether as direct seeding or plants)?

Approximately what percentage of your seed is destined for use under the following categories (whether as direct seeding or plants)?

Approximately what percentage of the seed you purchase is destined for use under the following categories (whether as direct seeding or plants)?

Approximately what percentage of your seed is destined for use under the following categories (whether as direct seeding or plants)?

0%; 1-10%: 11 – 20%; 21-40%; 41-60%; 61 – 80%; > 80%

A. Biodiversity restoration

B. Landcare-type projects

C. Carbon Offset-type projects

D. Development Offset projects

E. Roadside-type projects

F. Mine remediation projects

G. Urban developments or urban-focussed projects

H. Native food sector

I. Other purposes. Please comment

15.

How many staff are employed in your business?

How many staff are employed in your business?

How many staff are employed in your business?

How many staff are employed in your business?

A. Sole operator - part time

B Sole operator - full time

C. <5

D. 5-10

E. 11-20

F. 21-50

G. > 50

Other type of structure. Please comment

16.

Do you hold a current native seed collectors licence?

This question was not given to SPA Growers

Do you require seed collectors to hold a current native seed collectors licence?

This question was not given to Other Users

A. Yes

B. No

C. Not sure

D. Not applicable

17.

Have you undertaken any accredited or non-accredited seed collection training?

Have you undertaken any accredited or non-accredited seed collection training?

Do your require seed collectors to have undertaken any accredited or non-accredited seed collection training?

This question was not given to Other Users

A. Yes. Accredited. Please name the course and the delivery agent in the space below

B. Yes. Non-accredited. Please name the course and the delivery agent in the space below

C. No. I have not undertaken any accredited or non-accredited seed collection training

Comment

18.

Are you a member of a seed-related association?

Are you a member of a seed-related association?

This question was not given to Seed Purchasers

This question was not given to Other Users

A. Yes. Please name the seed association

B. No

Comments

19.

Is it common for seed buyers to require seed testing information for your seed?

Is it common for seed buyers to require seed testing information for your seed?

Is it common for seed sellers to provide seed testing information?

This question was not given to Other Users

Yes

No

Comment

20.

Do you provide seed testing information for your seed?

This question was only given to Seed Collectors and SPA Growers

Do you require and/or would you pay extra for seed testing information on purchased seed?

This question was only given to Seed Purchasers

Do you require seed testing information on purchased seed?

This question was only given to Other Users

A. Yes

B. No

Comment

21.

What type of seed testing is undertaken?

What type of seed testing is undertaken?

What type of seed testing is acceptable?

What type of seed testing is acceptable?

A. Germination - cabinet

B. Germination – nursery

C. Viability – tetrazolium

D. Viability – X-ray

E. Viability – cut test

F. Purity %

G. Weed content

H. Other Information (i.e. collection date, test date)

22.

If answering 'yes' to question 20,

Is your seed testing conducted by independent testers?

Is your seed testing conducted by independent testers?

Do you require seed testing to be conducted by independent testers?

Do you require that seed testing is conducted by independent testers?

A. Yes. Please name group

B. No

C. Other Please comment

Thank you for your participation. If you have any other comments, please use the space provided below.

The following additional questions were asked only of the SPA Grower group:

23.

What percentages of your seed production crops (not managed remnants) are located on the following land tenures?

Public reserves
Public roadsides
State parks
National parks
Private property

24.

How many species from each of the following plant groups do you grow?

A 0 species; B <10 species C <20 species D < 50 species E <100 species F >100 species

A. Trees
B. Shrubs
C. Grasses
D. Non-woody Wildflowers
Other. Please specify

25.

What percentage of your total Seed Production Area (SPA) is devoted to the following plant groups?

0%; 1-20%; 21-40%; 41-60%; 61-80%; >80%

A. Trees
B. Shrubs
C. Grasses
D. Wildflowers
Other. Please comment

26.

What type of SPA growing systems do you utilize?

Containers (benches, boxes, pots)
In-ground weed mat systems
Field crops
Other (please specify)

27.

What is the total size of your SPA?

End of survey

APPENDIX 2

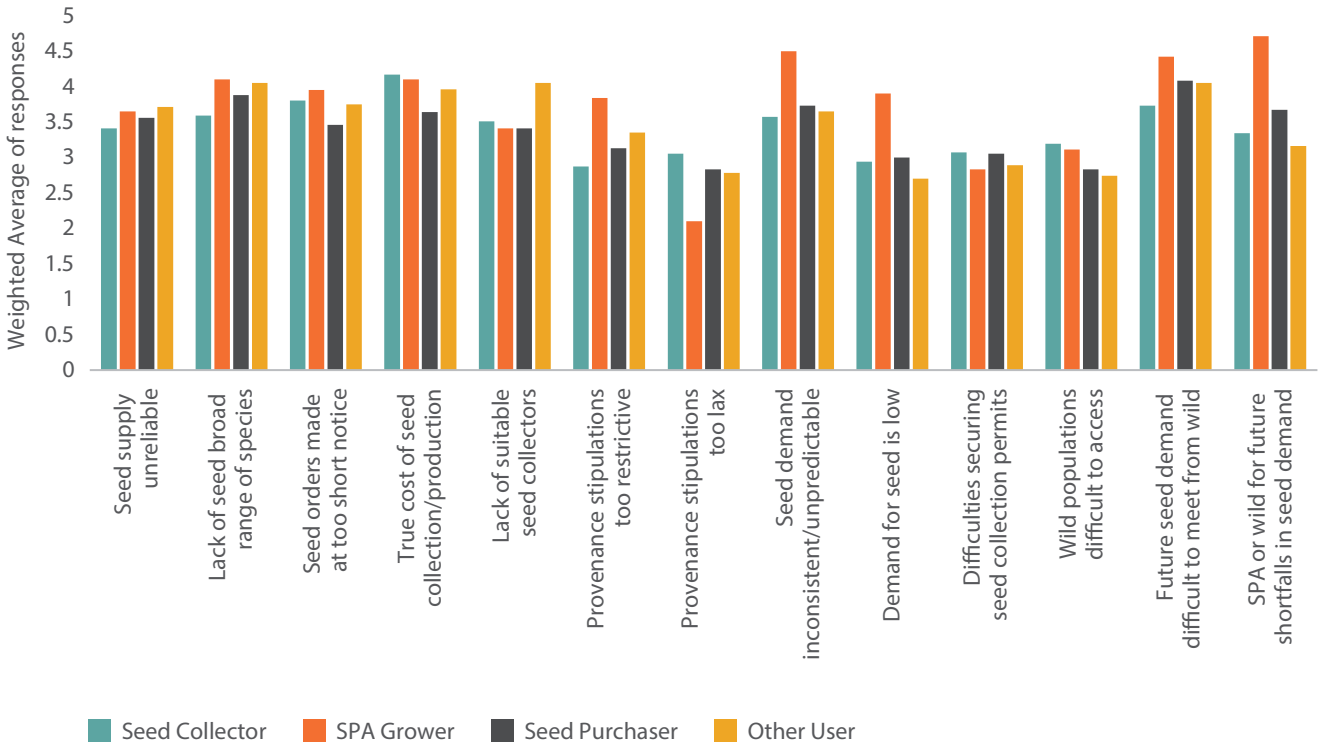

Figure A1. Weighted averages of the importance of potential issues in the seed/restoration sectors (Question 4). See Table 2 for the non-abbreviated potential issues.