

Guidelines for the development of *Banksia marginata* seed production areas

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Seed Production Areas (SPAs)

The diversity and demand for revegetation and restoration work continues to increase across Victoria and Australia more broadly. However, at present there are several key factors that limit our ability to meet these demands:

- 1) There is simply not enough native seed available
- 2) The quality and quantity of seed collected from wild populations is often unreliable
- 3) For many species remnant populations are in decline meaning that the availability, quality and quantity of seed will continue to diminish further

Seed Production Areas (SPAs) are areas where native plants of known seed source are grown to produce seed. The establishment of SPAs has several significant benefits:

- 1) Overcoming seed shortages through continuous supply of known provenance seed
- 2) Increased availability and genetic diversity of local native seed
- 3) Reduced pressure on wild populations for seed supply
- 4) Contributing to the improvement of regional biodiversity
- 5) Alternatives for land-use and income
- 6) Multi-functional benefits (e.g. windbreaks, soil improvement)

At present multiple groups across the state of Victoria are investing in the revegetation and restoration of *Banksia marginata*, an iconic and functionally important species which has suffered significant decline across much of its distribution in the last century. Part of the long-term conservation planning for Victorian *B. marginata* is to develop SPAs in various regions of the state.

Upon the request from several working groups and following the outcomes of recent population genetic research on *B. marginata* from the Victorian Volcanic Plains and Central Victoria, the following guidelines for the development of *B. marginata* SPAs have been

developed. We have provided added information needed to tailor the development of SPAs for additional species, however we encourage consultation with experts prior to the establishment of non-*Banksia* SPAs.

Seed Production Area design guidelines

Section1. *Selecting a site*

Site selection is critically important for maximising the functionality of the SPA and connectivity with natural remnants and key ecological interactions. When selecting a site for developing an SPA:

- Prioritise sites with connections to natural remnants / intact habitats to enhance connectivity, visitation of pollinators, and presence of mycorrhiza fungi and soil biology.
- Avoid long/narrow sites for plantations of insect pollinated plant species (i.e. *Banksia*). Sites that enable a square block design SPA is best for enhancing cross pollination within the plantation (see below).
- For wind pollinated species (i.e. Sheoaks), consider sites / planting arrangements aligned with the directionality of prevailing winds (particularly important if sites are on long/narrow strips) to encourage cross-pollination.
- Consider soil types and match the soil type to the species, most important!
- Some species may do better under canopy whereas others can handle open paddock/ woodland plantings. For *B. marginata*, we recommend open plantings.

Section 2. *Spatial arrangement of plantings*

The role of the SPA is to produce large volumes of seed, and to achieve this the optimal spatial arrangement / density of the planting needs to be identified. The idea is that plantings

are as close as possible and are kept trimmed to a manageable height for ease of seed collection. However, the optimal spatial arrangement of plantings does vary between species:

- Experienced practitioners from the Goulburn Broken Catchment Management Authority (GBCMA) suggest that *Banksia marginata* should be planted in rows separated by 8-10 meters with individual plants within rows being separated by 5m. This spacing avoids risks associated with canopy closure and competition, and will enhance the ease of seed collection when trees have matured.
- Experienced practitioners from CSIRO suggest that for many species other than *B. marginata*, rows can be 4 m apart with plants within rows at around 2 m spacing (i.e. *Bursaria spinosa*). This all depends on the species and expert advice should be sought prior to developing SPAs.
- As discussed below, we strongly recommend broadening the genetic base of SPAs through the inclusion of seed sources from multiple provenances. Ensure the seedlings from the various provenances are randomized throughout the planting (don't plant rows of single provenance only). This will enhance genetic mixing through cross-pollination, and our ability to reliably assess provenance performance.

Additional advice:

- For insect pollinated species (i.e. *Banksia*), plant as a single species block to homogenise cross-pollination among individual plants as much as possible, as insects are less likely to work among 1-few trees increasing the possibility of inbreeding.

Section 3. *How many plants should we include in the SPA?*

The objective is to develop a highly productive Seed Production Area, but also to secure the health and sustainability of the SPA, by minimizing risks of inbreeding and maximising genetic diversity into the distant future. Establishing large populations (100's to 1,000's) at each location should be the long-term aim. *Banksia marginata* as an example:

- Experienced practitioners from GBCMA suggests that working groups should aim to plant 500 -1,000 + *Banksia* seedlings at each seed production location. As a general rule of thumb, each 100 trees planted will reduce to 50 after 5 years due to mortalities in the establishment phase and later years due to overcrowding and competition for resources. In summary, if the target is 500 *Banksia* plants for a given site, we suggest that 1000 seedlings be planted and expect this number to reduce by <50% within 5-10 years.
- For this reason, target sites that are > 2 hectares when establishing *Banksia* SPAs.

Section 4. Provenance / genetic base for SPA

Selecting appropriate seed sources for the establishment of SPAs is very important. We want to avoid selecting seed from genetically depauperate and potentially inbred populations, and instead target genetically diverse sources from multiple provenances. This will ensure a broad genetic base for the SPA, enhancing the environmental resilience of the SPA itself, and future plantings established from SPA derived seed sources. To achieve this we recommend the following:

- Ideally collect seed from sites where the genetic profile has been characterised, to avoid targeting sites that are lacking genetic diversity and are inbred. When genetic data is not available, target the largest remnants as these are likely to be the most genetically diverse sources.
- Avoid collecting seed from old solitary trees in the landscape. The seed may have resulted from self-pollination and be genetically depauperate. Also, the genes of old trees (>100 yr old) may not be best suited to current day climates.
- Ideally, collect seed from as many parent plants as possible (20+) from larger remnants, ideally of known genetic condition (not inbred)
- Include seedlings from 5 to 10 or more provenances in the planting. These should include a good geographical spread of provenances from across the region.
- The proportion of seedlings from the different provenances to be included in the SPA should be relative to population size.

- Consider including provenances from further afield, using climate matching to identify provenances already persisting under climatic conditions that match expected future climates for your region. This is a powerful tool for helping combat climate change. Including seedlings from such provenances in low frequency will not compromise the genetic integrity of your local gene pools, but will introduce low frequency genotypes that may become increasingly important in future generations. As a general rule of thumb, you should include 10% of your seedlings from climate matched provenances (ideally more than one source population)

Section 5. Population / provenance tracking

This is a very important task. You will want to be able to track the performance of the various provenances represented in your SPA and keep a track of how well genetic diversity is being maintained in the SPA through time as some plants will inevitably die off. For this reason we recommend the following:

- Each seedling should be georeferenced (RTK GPS and mud map), and labelled, enabling reliable documentation and future tracking of provenances
 - A combination of paper mud maps, digitised mud maps, metal aluminium / or plastic coloured cattle tags, have been used previously.
 - RTK GPS should now be used also as this technology can provide precise (to the millimetre in real time) the geographical position of each seedling.
- The Goulburn Broken Seedbank records the populations/provenances included at each seed production site using its 'heritage tracking database', a database that records the provenances and numbers planted at each seed production site. Be sure to use a similarly reliable source for archiving your information.

Section 6. Using the next generation seed.

A successful seed production site provides a future seed resource that has an improved genetic base to be utilised in re-establishing the species back into the broader environment. This can be used for establishing new populations or bolstering existing remnants in the landscape. Practitioners should consider building 2nd generation seed production sites by combining the resulted seed/plants from multiple seed production sites. This will further strengthen the genetic diversity from the first-round seed production project into the future.