Planning the integration of *ex situ* plant conservation in Tasmania

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Abstract: Tasmania has a strong record of successful *in situ* plant conservation but there will always be a role for the integration of various *ex situ* measures into a plant conservation program due to pressure by threatening processes on wild populations. This paper replaces a 15 year old strategy for *ex situ* conservation in Tasmania. Progress in *ex situ* measures for Tasmanian plants is described and broadly evaluated against the previous strategy. Rare and threatened species are considered to be a high priority group for resources if intensive management is required. Endemic species likely to be adversely impacted by climate change would be a high priority for *ex situ* conservation. Seed banking to capture as much genetic variation in these species is suggested. Eight *ex situ* methods are briefly described and their application in Tasmanian instances noted. The Tasmanian Seed Conservation Centre established at the Royal Tasmanian Botanical Gardens is a central part of Tasmanian *ex situ* conservation efforts for *ex situ* conservation programs. An ongoing role for this facility is considered fundamental.

Key words: Flora, Tasmania, ex situ, conservation, threatened, endemic, Millennium Seed Bank, recovery plans, program evaluation

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Introduction

The *in situ* conservation of habitats and entire ecosystems is often considered the best method to conserve species (Maunder *et al*. 2004). Consequently *ex situ* conservation measures are not as well developed as those undertaken for *in situ* conservation. Though there are potential problems with *ex situ* conservation in maintaining genetic variation, or achieving success with reintroductions of species into natural habitats, such measures can usefully assist in the temporary restoration of ecosystem services, wildlife corridors and general amenity. The mining industry in some parts of the world notably in Australia, has developed sophisticated methods for reconstruction of plant communities on strip-mined areas (e.g.see Roche *et al*. 1997).

Ex situ conservation is usually used in reference to plant conservation at the taxon level. An extensive literature is developing on *ex situ* conservation methods and techniques. Integrated conservation was proposed by Richardson (1992) as a term that covered both *ex situ* and *in situ* conservation on the basis that both were part of a spectrum of techniques rather than mutually exclusive methods.

Rare and threatened flora have been considered the priority group for intensive conservation measures. Resources have largely been directed at species listed on the Tasmanian *Threatened Species Protection Act 1995*, guided by recommendations in species recovery plans, some of which include *ex situ* measures (see Table 1).

The non-listed flora are a lower priority for intensive conservation measures, but reservation status has been considered for these, and poorly-reserved or un-reserved taxa are flagged as priorities for conservation. Lawrence *et al*. (2008) estimate that only 4% of Tasmania's vascular flora species are not known to be represented within the reserve system. Other groups such as endemic or uncommon species have high priority within this larger group.

An *ex situ* conservation strategy was prepared for Tasmania (Harris & Gilfedder 1992). Since then, significant changes have occurred in plant conservation science and understanding warranting a fresh examination. Since 1992, the *Threatened Species Protection Act 1995* has been proclaimed, the reserve system has vastly increased, botanical knowledge has expanded, and improved collaborations with international *ex situ* conservation efforts has occurred. This paper considers, within the current policy and resource framework, how *ex situ* conservation of Tasmania's flora can be integrated with other plant conservation programs and has been developed with wide consultation across government and research institutions.

Why do we need ex situ conservation measures?

Threatening processes such as extensive vegetation clearing and habitat fragmentation, inappropriate fire frequency and intensity, competition with exotic plants and animals, and the spread of plant diseases have had a significant impact on Tasmania's flora. Despite the extensive reserve system the plethora of different threats to some plant species has meant that *in situ* methods are not able to completely ensure the survival of all populations of significant species. It is now broadly recognised that reservation does not necessarily confer protection against broad scale systemic threats such as adverse climate change impact and diseases.

Species represented in conservation reserves may be buffered against many threats. However, inappropriate fire regimes and the potential threats of long-term climate change impacts will strongly determine the likelihood of long-term survival of some flora in some habitats. *Athrotaxis selaginoides* is a sub alpine species that may not regenerate after fire in many areas (Brown 1988). Climate change may also increase the range of the soil borne pathogen, *Phytophthora cinnamomi* which already threatens some susceptible taxa, particularly in the Ericeae, Fabaceae, Myrtaceae, and Proteaceae families, for example, *Epacris barbata* (Keith 1997).

The weed problem is illustrated in the Apsley River catchment, in a recognised Tasmanian centre of endemism for vascular flora (Kirkpatrick & Brown 1984a, b). *Ulex europaeus* (gorse), co-occurring with rare, threatened and endemic species, has formed dense thickets in native forest understorey on riparian flats. The formidably large build-up of long-lived gorse seed in the soil seed bank indicates a need for *ex situ* techniques. Such measures can be employed whilst rescuing the habitat of threatened species and attempting to control the gorse.

Intensive land use, especially urbanisation, makes habitat unsuitable for much native flora. Conversion of native grasslands to intensive cropping can lead to localised extinctions of native flora that may have co-existed favourably with more extensive agricultural practises such as sheep grazing. The local extinction of many orchid populations in the Midlands is attributed to the application of super-phosphate to some areas of grasslands in the early 1950s (Jones *et al*. 1999).

Evaluation of previous ex situ measures

Work by Harris & Gilfedder (1992) identified that only 23 species of the Rare or Threatened Australian Plants (ROTAP) listed Tasmanian vulnerable taxa (Briggs & Leigh 1988) were held in *ex situ* collections in Tasmania (22) and/or Australian National Botanic Gardens (14). A strategy based on an iterative scoring procedure was developed to identify *ex situ* priorities, and subsequently applied to the nationally

Table 1. Examples of existing recovery plans recommending *ex situ* conservation

Taxon	Propagation	Seedbank	*Ex situ* Collection	Recovery plan
Argentipallium spiceri			Holding	TSU 2006e
Barbarea australis	Seed		Seed orchards	Potts & Gilfedder 2000
Centrolepis pedderensis	vegetative propagation		Living	Lynch & Wells 1994
Discaria pubescens		seedbank		Coates 1991a
Epacris barbata	vegetative propagation		Holding	Lawrence 1993
Epacris stuartii	vegetative propagation		Planting	Keith & Ilowski 1999
Eucalyptus morrisbyi			Holding and Planting	Blackhall & Lynch 1992, TSU 2006b
Forest Epacrids	vegetative propagation		Holding	Keith 1997
Lomatia tasmanica	vegetative propagation – requires research		Holding – difficult Planting – research	Lynch 1991, TSU 2006c
Orchids	Seed	seedbank	Holding	TSU 2006d
Oreoporanthera petalifera			Holding	TSU 2006a
Pomaderris elachophylla		seedbank	Holding	Coates 1991b
Phebalium daviesii	vegetative propagation		Holding and Planting	Lynch & Appleby 1996
Ranunculus prasinus	Seed		Planting	Gilfedder *et al*.1997, TSU 2006f
Sagina diemensis			Holding	TSU 2006a
Spyridium microphyllum	Seed	seedbank	Planting	Coates 1991c
Spyridium obcordatum	Seed		Holding	Coates 1991d
Stenanthemum pimeleoides	Seed	seedbank		Coates 1991e
Tetratheca gunnii	Seed		Planting	Potts & Barker 1999

listed Tasmanian species. This resulted in 8 taxa having the highest scores (Harris & Gilfedder 1992). Of these, all except *Danthonia popinensis* have since been successfully managed with *ex situ* methods.

During the last 15 years, *ex situ* measures have been applied widely and have been an integral part of recovery plans (Table 1). Most recovery plans were developed when long-term seed storage facilities were not available and hence such a strategy was rarely invoked. The number of current rare and threatened species kept in the Royal Tasmanian Botanical Gardens living *ex situ* conservation collection (Table 2) had not changed between 1991 and 2006, although there have been changes in the native species included in the collection, which reflects changing priorities through this period. A concerted effort has been made since 2006 to deposit seed in the Seed Bank. There has been an obvious focus on eucalypts and trees with commercial application, through cooperative efforts by Forestry Tasmania (Brown 1995), University of Tasmania and the Department of Primary Industries and Water. *Eucalyptus gunnii* spp. *divaricata*, *E. morrisbyi*, *E. perriniana*, *E. vernicosa* and *E. risdonii* have been propagated and have living collections. Most of these eucalypt species and some other rare ones such as *Eucalyptus barberi* are in "conservation seed orchards" near Geeveston, Tasmania which have been established for research, conservation and seed production (pers. comm. Dr Dean Williams, Forestry Tasmania).

There are substantial *ex situ* plantings elsewhere in Australia and overseas (pers. comm. Neil McCormick). The Goy collection in Victoria has a comprehensive planting of *Acacia melanoxylon* with selections from many Tasmanian provenances. The Milligan collection in Southland, New Zealand has many of the rare and cold-hardy Tasmanian eucalypts in single provenance plantings including *Eucalyptus gunnii* spp. *divaricata*, *E. cordata*, *E. perriniana*, *E. morrisbyi*, *E. rodwayii*, and *E. vernicosa* amongst others. The New Zealand plantings are vigorous and fecund, probably due to the absence of their insect predators.

With the available facilities it is not economically feasible to undertake tissue culture storage or cryogenic storage on a large scale. The preservation of seed viability and the storage of a sufficient quantity of seed in seed banks to maintain genetic variation is an essential, but large task. This task has been successfully undertaken at the Royal Tasmanian Botanical Gardens.

There are drawbacks in using *ex situ* measures for conservation. For example a valuable collection of Tasmanian seedlings was killed by *Phytophthora* infection (pers. comm. Mr Mark Fountain, Royal Tasmanian Botanical Gardens). *Ex situ* genetic orchards can also be at risk of disease and pests, as the plantations are often located outside the natural range of the species and in concentrated monospecific stands. Pollination patterns may differ from an *in situ* stand, and pollen contamination also needs consideration.

Table 2. List of conservation priority plant species maintained in the *ex situ* living plant conservation collection at the Royal Tasmanian Botanical Gardens as at December 2006.

Taxon	No. of genotypes represented	Comments
Argentipallium spiceri	1	Propagated by cuttings
Barbarea australis	1	Seed re-collected annually and stored. Replacement plants sown every 2 years
Boronia hippopala	1	Propagated by cuttings
Boronia rozefeldii	3	Propagated by cuttings
Calystegia marginata	60	Plants grown from seed
Centrolepis pedderensis	4	Propagated by cuttings
Craspedia preminghana	1	Seed re-collected, stored and/or resown every 2 years
Chorizandra enodis	3	Propagated by division
Epacris apsleyensis	1	Propagated by cuttings
Epacris barbata	4	4 in poor health with very little propagation material available
Epacris exserta	1	Propagated by cuttings
Epacris limbata	1	Propagated by cuttings
Epacris stuartii	2	Propagated by cuttings
Lomatia tasmanica	1	Propagated by cuttings
Lycopus australis	15	Grown from seed
Mentha australis	1	Propagated by cuttings
Oreoporanthera petalifera	3	Propagated by cuttings
Phebalium daviesii	26	Propagated by cuttings on a 3 year rotation, 1 self-sown seedling in nearby pot collection
Philotheca freyciana	13	Propagated by cuttings and tissue culture
Stonesiella selaginoides	4	Propagated by cuttings
Tetratheca gunnii	40	Propagated by cuttings
Vittadinia australasica var. *oricola*	1	Propagated by cuttings

Current programs in Tasmania

Tasmania is assisting Australia's commitment to Article 8 of the Global Strategy for Plant Conservation (GSPC) by participating in the international Millennium Seed Bank Project, which aims to collect and conserve 10% of the world's seed bearing flora by 2010 (Tasmania's target is 50% of its native seed bearing flora) and to develop research into seed biology, germination and storage requirements for species including those scheduled as threatened in Tasmania. This is a collaboration of government agencies (e.g. Department of Primary Industries and Water (DPIW), Royal Tasmanian Botanical Gardens (RTBG), Tasmanian Museum and Art Gallery (TMAG), Forestry Tasmania, Forest Protection Authority, private industry (e.g. Tasmanian Electro Metallurgical Company (TEMCO)), and the Royal Botanic Gardens, Kew. Additionally, the Tasmanian Seed Conservation Centre (TSCC) has been set up to assist this program and existing *in situ* plant conservation programs. The TSCC receives and curates seed collections of Tasmanian plant species and develops protocols for reintroduction. This program will provide a means of conserving highly restricted taxa in the event that populations become threatened and/or their habitats transformed. The GSPC also provides a network for plant conservation activities at a regional, national and international level.

The integration of *ex situ* conservation in broader species reservation (such as rehabilitation and protection) not only provides a tool for recovery operations, but also increases knowledge of recruitment strategies and germination, phenotypic traits, seed biology and storage optima. Aesthetic appreciation is increased through living collections in gardens. The main *ex situ* methods currently used in Tasmania are living collections (including seed orchards) and seed banking. Although cryopreservation and tissue culture are considered important for the long-term storage of material for some species, these methods are currently little used in Tasmanian native plant conservation. As well as needing the facilities, there is a continuing need for development of nationally accepted protocols and guidelines.

Ex situ plant conservation methods

Appropriate methods are usually identified as recovery actions (prescriptions) in species recovery plans. In some cases, a priority species may be locally endangered by infrastructure works (e.g. road widening), in which case physical relocation of threatened plants may occur. The actual methods and techniques to be used will be determined by a number of factors particular to the species being considered. Unfortunately, post-transplant monitoring is often non-existent but informal observation indicates that the success rate is usually low.

Guerrant *et al*. (2004) outline *ex situ* plant conservation methods.

1. An ex situ living collection

This method can be used where suitable habitat is available for planting and where the taxon is easily propagated. It is important to consider population size and extent and structure of genetic variation when establishing an *ex situ* population due to the likelihood of inbreeding and genetic drift in new populations (Schaal & Leverich 2004). An advantage of an *ex situ* living collection is that plants can be closely monitored for health. On-going vegetative propagation is often easier due to increased vigour and health of specimens resulting in the availability of improved material for propagation.

Phebalium daviesii and *Epacris stuartii* plantings have been established in the wild (Lynch & Appleby 1996). Currently there are more genotypes of *Phebalium daviesii* held at the Royal Tasmanian Botanical Gardens than exist in the wild, and plans are in place to reintroduce the "lost" genotypes back into the previous range of the species.

There are a number of seed orchards in Tasmania, most of eucalypt species managed by Forestry Tasmania primarily for the purpose of seed production (e.g., *Eucalyptus globulus, E. morrisbyi, E. brookeriana, E. vernicosa, E. barberi, E. risdonii, E. archerii, E. perriniana, E. cordata, E. rubida, E. subcrenulata, Nothofagus cunninghamii,* and *Acacia melanoxylon*). Some plantations are for conservation purposes (e.g. plantations of King Island *Eucalyptus globulus*). The University of Tasmania, School of Plant Science, established *ex situ* plantations of *Eucalyptus gunnii* ssp. *divaricata, Eucalyptus cordata* and *Eucalyptus morrisbyi* in 1999. At one of the sites (Boyer plantation), 611 seedlings of *Eucalyptus morrisbyi* were planted in 1990 in the grounds of the paper mill on a reclamation area (pers. comm. Prof. Brad Potts, University of Tasmania). This is likely to be one the earliest conservation seed orchards in Australia designed to represent genetic variation in the wild. Monitoring of the population continues, with approximately 94% of the original seedlings surviving 15 years later.

2. Seed stored in a seed bank

The aim of *ex situ* seed banking is to complement conservation in the wild as the first priority, and provides back up to the conservation of wild populations. Seed bank material should contain genotypes of sufficient number and diversity to maintain population fitness. Each taxon has its own particular requirement but a guideline of capture of 95% of allelic variation applies to all species (Marshall & Brown 1975, Way 2003, Rogers & Montalvo 2004). Sampling methods should consider the preservation of genetic variation, although this will be very difficult to monitor. Hamilton (1994) highlighted the need for an integrated and thorough approach when attempting species conservation.

The Tasmanian State government has entered into an access and benefit sharing agreement with the Royal Botanic Gardens Kew to bank seed of 800 of the State's ~1700 native vascular plants in two collections. One collection will be stored under optimum conditions in the vault at the Millennium Seed Bank at Wakehurst Place in Sussex, England, while a duplicate collection would be stored under special conditions in the "Seed Safe" Joint Tasmania/ Millennium Seed Bank Project seed bank facility at the Royal Tasmanian Botanical Gardens. As many as possible of the Tasmanian endemic vascular taxa (300–330 species) will be stored. Under the terms of the current agreement with Kew, the priority is to obtain seed of a target number of taxa within the time of the contract. These practical constraints resulting from the Millennium Seed Bank's numerical target to satisfy the Millennium Commission Goals mean that genetic representativeness cannot be captured across a range of populations. This becomes less of a problem with taxa that have only one very restricted population.

The species that will be included in the Millennium Seed Bank Project will be determined by accessibility and expediency, but the priority is to include rare and threatened taxa, endemic taxa, other biogeographically significant taxa, primitive and relictual flora, and plants of ethnographic significance. The aim is to encompass as many taxa under these headings as possible. The program will run for six years; continued collection is required to represent genetic diversity for conservation purposes.

In addition to the GSPC and Millennium Seed Bank Project, native seeds in Tasmania are collected, stored and managed by various nurseries, two community seed banks (Mortlock 2000) and other agencies . The Tasmanian Seed Centre (a trading unit owned by Forestry Tasmania) conducts seed management of approximately 60 Tasmanian plant species and holds between 8 and 10.5 tonnes of seed at any one time. A seed database holds information on seed origin, storage and propagation. Forestry Tasmania has carried out research on seed management, including procedures for collection, handling and storage (Forestry Commission 1994, Lockett 1987, 1991).

The usefulness of long term seed storage became evident with the rapid decline of *Eucalyptus gunnii* subsp. *divaricata* in the wild. By the time its decline was noted (Potts *et al*. 2001) it was too late to collect seed as the trees had stopped flowering and the small amount of seed present was likely to be inbred. Luckily seed from some populations had been maintained at the University of Tasmania following on from population genetic studies. Some healthy, reproducing populations of this taxon have since been found in areas where possums are hunted (Calder & Kirkpatrick 2008).

3. Seed propagated and replanted in the wild

This method is used to increase wild populations of threatened species and has been used for *Barbarea australis* (pers. comm. Dr Wendy Potts, Department of Primary Industries and Water, Tasmania).

Germination requirements for many Tasmanian species are still unknown and cuttings have largely been used so far. Most of the *ex situ Tetratheca gunnii* has been propagated by cuttings with seed set supplemented *in situ* by manual pollination prior to a regeneration burn.

4. Physical removal of directly threatened wild plants into an offsite safe place

This method of plant translocation can be used for conservation, commercial, amenity and research purposes (Vallee *et al*. 2004). Various factors affect the success of plantings, such as ecological (e.g. suitability of receptor habitat, competition, and/or presence of pests or disease), genetic (e.g. inbreeding depression, hybridisation, inability to adapt to new habitat) and human (e.g. damage to plant, habitat management) factors (Hodder & Bullock 1997). In Tasmania, the main roads authority (DIER) has physically moved significant plants to safer sites when no other alternatives existed. However, no monitoring of the success or otherwise of these transplants has been documented.

An example has been the translocation of *Eryngium ovinum* (blue devil) from a road works site on the Tasman Highway at Black Charlie's Opening (Gillian 1995). The plants were initially stored at the RTBG before being planted at an alternative site.

5. Tissue storage

Researchers at the School of Plant Science, University of Tasmania have successfully propagated threatened species (Sands *et al*. 2003). A collaborative project between the Royal Tasmanian Botanical Gardens and the Department of Primary Industries and Water (Threatened Species Section) on tissue culture of *Lomatia tasmanica* and *Philotheca freyciana* is underway. Excluding the storage of important germplasm at the University of Tasmania, no recognised storage area for such samples exists at present. Proper curatorial procedures would need to be implemented were such a facility developed (Cochrane 2004, Merrit 2003), but it would be expensive because it has to be tailored for each individual species. There is potentially an opportunity for tissue storage to be incorporated in the longer term within the seed bank facility at the RTBG.

6. Bringing into cultivation for widespread distribution through the nursery trade

Market driven conservation may be effective in certain circumstances. For example, seed from one of the Pontos Hills populations of *Hardenbergia violacea* (Tasmanian form) was collected and propagated by the Plants of Tasmania Nursery and the Royal Tasmanian Botanical Gardens. Its propagation through a number of generations has proved to be simple and effective (Will Fletcher pers. comm.). However, diligent record keeping of individual progeny is essential to help maintain genetic diversity.

7. Cryopreservation

A long-term technique, where seeds, pollen or tissue are stored frozen in liquid nitrogen, and likely to be more expensive than some others because of the rigorous laboratory conditions under which plant material needs to be kept. No examples are known for Tasmanian plant taxa.

8. DNA gene-banking

The establishment of a gene storage facility (the Australian Plant DNA Bank Limited) at Southern Cross University (Lismore) provides an opportunity for DNA gene-banking of Tasmanian taxa. Genomic DNA is extracted and checked for quantity and quality using spectrophotometric techniques and gel electrophoresis. Samples are stored frozen at –20°C and –80°C. Dried voucher specimens are stored as a back up.

A policy and administrative framework

The strategic and policy framework for Tasmania's *ex situ* conservation program will require the following:

1. Prioritisation of target taxa

In Tasmania, *ex situ* conservation measures have been applied for targeted species where reservation may not ensure their continued survival (Brown & Podger 1999). However, effective *ex situ* programs require a high level of resources (financial, land or specimen banking facilities, staff, and stock of sufficient number and genetic variation). Therefore, prioritising effort is essential (e.g. Farnsworth *et al*. 2006).

Priority analyses require a good understanding of the population structure (number or populations, number of individuals, dispersal and population genetics), distribution (habitat condition, location, *in situ* reservation status) and threats (due to degrading processes, exploitation and exotic species). Sensitive species (restricted distribution, endemics, specialists etc) are assessed through the listing and review process for the Schedules of the *Tasmanian Threatened Species Act 1995*. The Act therefore provides a sound basis for assessing priority for *ex situ* conservation.

Since 1992 there has been a considerable development in policy and legislative imperatives for *ex situ* plant conservation. One of these is the corporate priority of the Department of Primary Industries and Water for climate change mitigation. In the face of climate change, certain taxa considered most at risk of adverse impact should be priorities. Groups we suggest as priorities for seed collections are the few Tasmanian endemic plants confined to areas above the treeline, and in other specialised habitats, endemic Gondwanan taxa and endemic threatened species. To maximise genetic variation the strategy should involve collections of seed from across the range of each taxa.

2. Identification of appropriate techniques

Appropriate techniques for *ex situ* conservation must be selected to achieve the goal of conserving plant diversity. There are many methods available, with various strengths, weaknesses and resource requirements. The suitability of these techniques depends on factors such as the biology of the targeted species (e.g. seed production and viability) and the resources and facilities available for storage. An integrated approach to *in situ* conservation, incorporating a variety of complementary *ex situ* techniques is likely to increase the probability of successful conservation.

3. Standardised approach and cooperation

As for any conservation strategy, the successful *ex situ* management of priority flora in Tasmania requires strategic alliances across government. This cooperation increases the efficient use of financial resources and the storage and availability of germplasm, facilitating the sharing of information, and increasing community awareness.

The RTBG Tasmanian Seed Conservation Centre (TSCC) should be the principal long-term site for *ex situ* conservation. The TSCC was commissioned in 2005 with a fully functioning drying room running at approximately 15°C and 15%RH to ensure that the material is dried to recommended storage moisture content. Cold storage is also available in two top mounted vertical freezers, which will store material sealed in foil laminates. The laboratory is equipped for seed cleaning, germination testing and viability monitoring. Additional capacity for storage of plant tissue culture could be developed in the future but due to maintenance costs, this would require cooperation and support from various government agencies, the University of Tasmania and possibly from the private sector.

4. Identification of protocols and guidelines

Ex situ conservation requires a national strategy, which could appropriately be developed by the Australian Network for Plant Conservation (ANPC) in consultation with participatory bodies. This would facilitate the production of formal agreements between stakeholders and a standardised approach to curation and storage.

Standards and protocols must govern the progress of germplasm from the wild through the entire process of *ex situ* conservation. For example, where propagation is recommended by a recovery plan, the protocols for transfer, propagation and replanting of such material should be accompanied by a protocol specifying minimum collection standards to ensure the broadest capture of genetic variation, propagation standards including hygiene measures, replanting methods, and recording protocols (e.g. Touchell *et al*. 1997).

Ex situ collections can be an important asset for biodiscovery because such collections would be properly documented and therefore able to show a chain of compliance for legal due diligence checks. Bioprospecting of *ex situ* collections could be mutually beneficial for both conservation and commercial purposes.

Conclusion

Many strategic documents urge the integration of *ex situ* measures into plant conservation programs. Maintenance of seed bank collections and other *ex situ* holdings requires continuing funding. As there are risks in *ex situ* conservation the emphasis should be on integrating such a strategy with sound *in situ* measures. Tasmania has resorted to *ex situ* conservation measures in the past with mixed success, for rare and threatened species and for commercially important provenances of some tree species. *Ex situ* conservation need not be expensive but priority should be given to endemic taxa that are at risk in the wild from major systemic threats such as climate change and disease. Habitat susceptibility will be a guide as to where such taxa would be targeted. Seed should be collected across the complete range of a taxon to capture as much genetic variability as possible. Otherwise, rare and threatened species or other significant taxa, should be targeted. The Millennium Seed Bank Project has resulted in the establishment of a seed bank facility at the Royal Tasmanian Botanical Gardens. The continuation of this facility beyond the life of the current joint Tasmanian Government partnership with Kew will be central to an ongoing *ex situ* capability for Tasmanian plant conservation. Further seed bank acquisitions should be from across the range of the targeted taxa, to better represent genetic variation and provide a better research resource. Targeted taxa might, for example, represent plants under pressure from climate change or other factors. *Ex situ* collections made in response to specifically identified threats such as climate change effects will be a key role of the seed bank. Ideally some *pro rata* benefit should accrue to the *ex situ* conservation of such taxa in a carbon credits market.

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