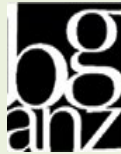




Council of Heads of
Australian Botanic Gardens



Botanic Gardens
Australia and New Zealand

Myrtle Rust survey of Australian ex situ collections

Supplementary Final Report

December 2023

Background

Myrtle Rust, a highly invasive plant disease caused by the introduced fungal pathogen *Austropuccinia psidii*, poses a serious and urgent threat to Australia's native biodiversity. Arriving in Australia in 2010, the fungus spread rapidly throughout the east coast of Australia and east to New Zealand, and has recently been found in Western Australia. Myrtle Rust affects plant species in the family Myrtaceae, which includes iconic Australian species such as paperbarks, tea-trees, eucalypts, guavas and lillipillies. These groups are key and often dominant species in many Australian ecosystems. To date the disease has proved capable of infecting around 400 native species and this number is likely to grow. Serious declines towards extinction are underway in some species, and broader ecological consequences are expected. The Australian Government recognises Myrtle Rust as a key threat to Australia's threatened species.

The disease is spread mostly via wind, but the thousands of spores can also be spread via wildlife, infected plant material, contaminated equipment, clothing and vehicles. Myrtle Rust can cause deformed leaves, fruits and flowers; heavy defoliation of branches; reduced fertility; dieback; stunted growth and plant death. Widescale management of the disease in the natural environment is untenable, particularly when considering the rate and mode of spread of fungal spores. Furthermore, the significant resources needed to manually treat infected wild populations to ameliorate fungal infection makes this approach unrealistic within current knowledge and resources.

Ex situ (off site) collections of Myrtaceae species in the form of whole plants, seeds, or other germplasm are held in small numbers in botanic gardens, arboreta, their nurseries and seed banks. These insurance populations can provide some level of hope for maintaining a species existence at the collection level, particularly when in situ populations are unable to reproduce due to infection. While ex situ living collections as whole plants usually require an intensive level of management to maintain their health, they present opportunities for regular monitoring to potentially identify the early signs of infection and improve interventions with timely application of fungicidal treatments. Collections held in long term storage as seeds don't require such treatments and can be stored for many years until required. With current advances in genetic tools, it is also possible to cost-effectively assess genetic representativeness in the ex situ collections and manage them to ensure the best chance of maintaining viable populations.

Project overview

The Australian Government's Department of Climate Change, Energy, the Environment and Water (DCCEEW) supported the Council of Heads of Australian Botanic Gardens (CHABG) and Botanic Gardens Australian and New Zealand (BGANZ) to develop a survey to develop a baseline for conservation collections (accessions of seed, whole plants, tissue culture) of Australian Myrtaceae species.

Methodology

BGANZ, CHABG and the Myrtle Rust Working Group developed a list of questions that framed the development of the survey (see Results section). It was open from 11 August 2022 to 31 November 2022, with institutions across the BGANZ network and beyond encouraged to participate through targeted contact, social media posts and in-person representations. Additionally, the survey was promoted at 7th Global Botanic Gardens Congress in Melbourne in September 2022.

Data was provided by 26 respondents, which was then cleaned and harmonised using the programming language R (version 4.3) and the '[APCalign](#)' package. The package utilises matching algorithms to pair species names from the survey responses to the accepted taxonomic names listed in the [Australian Plant Census](#) (APC). Analysis was then conducted in R for the harmonised data to answer the questions developed by our stakeholder group. For the purpose of consistency across analysis, only species that could be matched to an APC accepted name were counted, while 31 others were not included in the analysis.

Results

1. How many Botanic Gardens / Nurseries / Seed banks hold Myrtaceae accessions?

Of the 26 respondent organisations, all hold accessions of Myrtaceae species. A full list of organisations can be found in Table 1, with raw data available in [Appendix B](#). Note some respondent organisations are a mix of gardens, seed banks and nurseries while some may only hold individual facilities.

Table 1: Survey respondent organisations by location

Respondent organisation	Location
1. Australian Botanic Gardens (including the Australian Plant Bank)	NSW
2. Australian National Botanic Gardens (including the National Seed Bank)	ACT
3. Blue Mountains Botanic Gardens	NSW
4. Booderee National Park and Botanic Gardens	ACT
5. Botanic Gardens and Parks Authority (including the Western Australian Botanic Gardens, the Western Australian Seed Bank, Kings Park, and the Western Australian Seed Bank, Kensington)	WA
6. Botanic Gardens and State Herbarium of South Australia (including Adelaide Botanic Gardens, Wittunga Botanic Garden, Mount Lofty Botanic Gardens, and the South Australian Seed Conservation Centre)	SA
7. Brisbane Botanic Gardens (including the BBG Seed Bank)	QLD
8. Christchurch Botanic Gardens	NZ
9. Cooktown Botanic Gardens	QLD
10. Dunedin Botanic Gardens	NZ
11. Eurobodalla Regional Botanic Gardens	NSW
12. George Brown Darwin Botanic Gardens (including the GBDBG Seed Bank)	NT
13. Gold Coast Botanic Gardens	QLD
14. Inala Jurassic Garden	TAS
15. James Cook University	QLD
16. Millennium Seed Bank, Kew	UK
17. Royal Botanic Gardens Victoria (including the Victorian Conservation Seed Bank)	VIC
18. Royal Botanic Gardens, Sydney	NSW
19. Royal Tasmanian Botanical Gardens (including the Tasmanian Seed Conservation Centre)	TAS
20. Southern Cross University	QLD
21. The Tasmanian Arboretum	TAS
22. Tondoon Botanic Gardens Gladstone	QLD
23. University of Melbourne	VIC
24. Wakehurst Place, Kew	UK
25. Windsor Community Precinct native gardens	TAS
26. Wollongong Botanic Garden	NSW

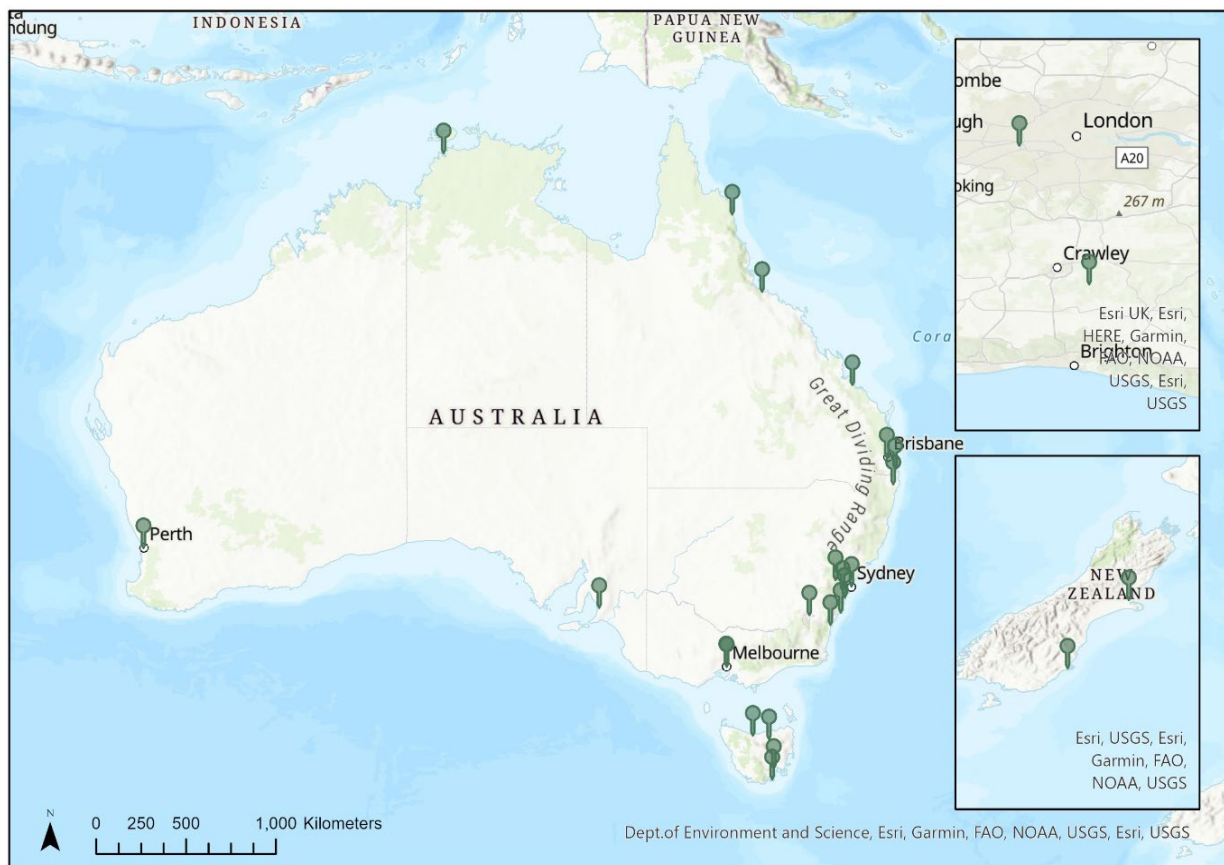
2. Where are respondents located?

The survey received a response from at least one organisation in every Australian state/territory, as well as institutions in New Zealand and the United Kingdom that hold Australian Myrtaceae accessions. The total number of respondents by location are outlined in Table 2 below, with Figure 1 showing their locations.

Table 2: Number of respondent institutions by location.

Australia								NZ	UK
ACT	NSW	NT	QLD	SA	TAS	VIC	WA		
2	6	1	5	1	4	2	1	2	2

Figure 1: Map showing respondent locations.



3. What proportion of institutions are actively monitoring for Myrtle Rust?

Of the 26 respondents, 19 (73 per cent) are actively monitoring for Myrtle Rust (Figure 2).

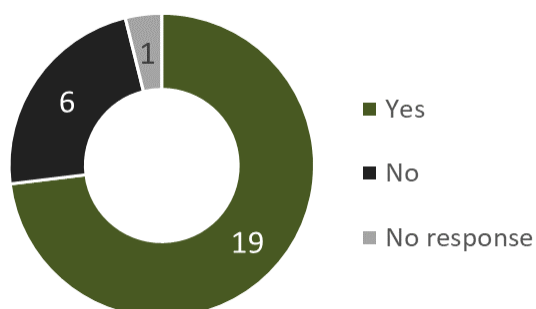


Figure 2: Proportion of institutions actively monitoring for Myrtle Rust.

4. What proportion of institutions are part of the International Plant Sentinel Network?

The International Plant Sentinel Network was established to facilitate collaboration amongst plant institutes around the world, to work together in order to provide an early warning system of new and emerging pest and pathogen risks. Of the 26 respondents, 11 (42 per cent) are part of the network (Figure 3).

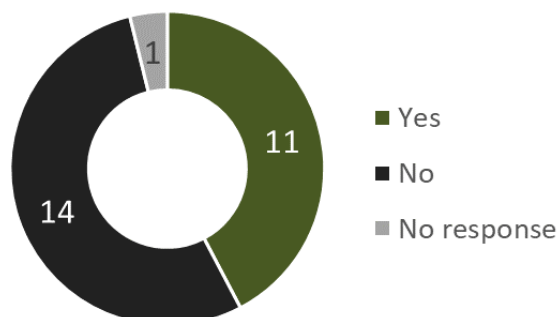


Figure 3: Proportion of institutions that are part of the International Plant Sentinel Network.

5. What proportion of institutions have reported previous observations of Myrtle Rust?

Of the 26 respondents, 12 (46 per cent) have reported previous observations of Myrtle Rust within 5 km of their boundaries (Figure 4).

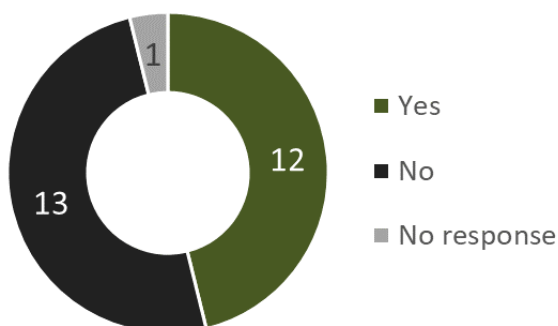


Figure 4: Proportion of institutions that have reported previous observations of Myrtle Rust.

6. How many institutions are funded to add additional species into their collections in the immediate future?

Of the 26 respondents, 10 (38 per cent) have reported that they are entirely or partially funded to add additional species to their collections in the immediate future (Figure 5).

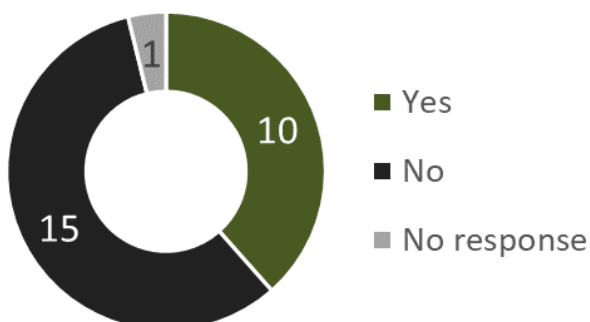


Figure 5: Proportion of institutions that reported there is funding to add additional species to their collections.

7. How many accepted Myrtaceae species are captured by the survey?

Ex situ accessions data from the 26 respondents was harmonised then compared to the list of accepted Myrtaceae species in the Australian Plant Census (APC) (current in December 2023). A total of 41,696 accessions were reported for 1,899 accepted Myrtaceae species in ex situ collections across the 26 respondents. Accessions from an additional 31 species were identified when comparing the consolidated species to the Australian Plant Name Index (APNI), however these have been excluded from the analysis, as the focus was on accepted taxonomic names in the APC.

8. What proportion of accepted Myrtaceae species are captured by the survey?

The total number of species held in ex situ collections (1,899 species) was compared to the total number of accepted Myrtaceae species in the APC in December 2023 (3,072 species). From this, the survey found that respondent institutions hold ex situ accessions for 62 per cent of accepted Myrtaceae species (Figure 6). This leaves 1,173 accepted species (38 per cent) that are yet to be secured, excluding additional species that are not in the APC, or that are yet to be described.

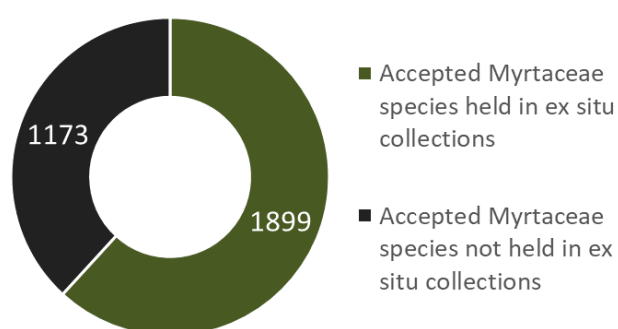


Figure 6: Proportion of described Myrtaceae species held in ex situ collections.

9. What proportion of the 30 priority plant species listed in the Threatened Species Action Plan 2022–32 have ex situ collections?

Four of the 30 'priority plant species' listed under the Australian Governments [*Threatened Species Action Plan 2022-2032*](#) (TSAP) are part the Myrtaceae family. These are *Eucalyptus imlayensis*, *Eucalyptus leprophloia*, *Gossia gonoclada* and *Rhodomyrtus psidioides*. From the survey, we found that all four species (100 per cent) are held in ex situ collections. The total number of accessions for each of these priority species are shown in Figure 7. The large number of accessions for *Rhodomyrtus psidioides* is likely due to the work being undertaken by the Australian Network for Plant Conservation on the [*Safe Custody of Native Guava Project*](#).

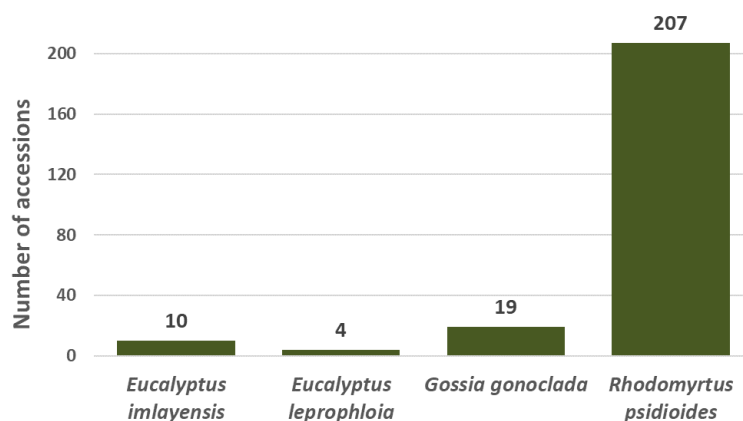


Figure 7: Number of ex situ accessions secured for four priority Myrtaceae species in the Threatened Species Action Plan 2022-2032.

This survey also compared Myrtaceae species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). As of writing, 182 Myrtaceae species were listed under this environmental legislation, and 158 (87 per cent) of these are captured by the survey. the remaining 23 (13 per cent) are listed below in Table 3.

Table 3: Myrtaceae species listed under the EPBC Act that are not in ex situ collections from this survey.

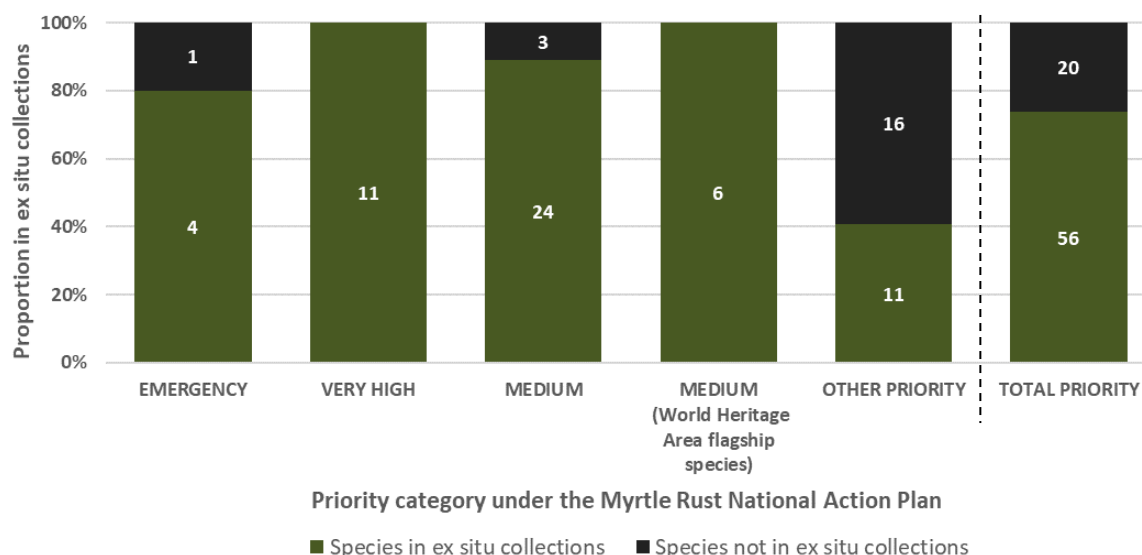
Species name	EPBC Status	Species name	EPBC Status
<i>Chamelaucium lullfitzii</i>	Endangered	<i>Kardomia granitica</i>	Vulnerable
<i>Eucalyptus alligatrix</i> subsp. <i>miscella</i>	Vulnerable	<i>Melaleuca kunzeoides</i>	Vulnerable
<i>Eucalyptus cryptica</i>	Critically Endangered	<i>Melaleuca</i> sp. Wanneroo (G.J. Keighery 16705)	Endangered
<i>Eucalyptus dalveenica</i>	Critically Endangered	<i>Ristantia gouldii</i>	Vulnerable
<i>Eucalyptus impensa</i>	Endangered	<i>Triplarina nitchaga</i>	Vulnerable
<i>Eucalyptus lateritica</i>	Vulnerable	<i>Verticordia apecta</i>	Critically Endangered
<i>Eucalyptus nudicaulis</i>	Endangered	<i>Verticordia crebra</i>	Vulnerable
<i>Eucalyptus phoenix</i>	Critically Endangered	<i>Verticordia densiflora</i> var. <i>pedunculata</i>	Endangered
<i>Eucalyptus robertsonii</i> subsp. <i>hemisphaerica</i>	Vulnerable	<i>Verticordia plumosa</i> var. <i>vassensis</i>	Endangered
<i>Homoranthus elusus</i>	Critically Endangered	<i>Verticordia spicata</i> subsp. <i>squamosa</i>	Endangered
<i>Hypocalymma</i> sp. Cascade (R. Bruhn 20896)	Endangered	<i>Verticordia staminosa</i> subsp. <i>staminosa</i>	Endangered
<i>Hypocalymma sylvestre</i>	Endangered	<i>Verticordia staminosa</i> var. <i>cylindracea</i>	Endangered

10. What proportion of priority Myrtaceae species listed in the Myrtle Rust National Action Plan (MRNAP) are secured?

The *Myrtle Rust National Action Plan 2020* (MRNAP) lists 49 species that require priority monitoring and germplasm capture, categorised by under four levels (emergency, very high, medium and medium world heritage flagship). For this survey, the Myrtle Rust Working Group identified a further 27 species of interest that have been classed as ‘other priority’. This amounts to 76 priority species that were analysed as part of the survey.

The analysis found that 45 of 49 (92 per cent) MRNAP priority species are present in ex situ collections, while only 11 of 27 (41 per cent) of the ‘other priority’ species are present. In total, 56 of 76 (74 per cent) priority species are currently held within ex situ conservation collections (see Figure 8). The 20 species without ex situ accessions are listed in Table 4.

Figure 8: Proportion of priority Myrtaceae species that are secured in ex situ collections.



11. What proportion of priority Myrtaceae species are absent or poorly represented in ex situ collections?

As described in Question 10, from a total of 76 priority species, 20 (26 per cent) are not secured in ex situ collections across our 26 respondents. The absent species are listed below in Table 4.

Table 4: Priority species not in ex situ collections from this survey.

Species name	Priority	Species name	Priority
<i>Lenwebbia</i> sp. Blackall Range (P.R.Sharpe 5387)	EMERGENCY	<i>Gossia punctata</i>	Other priority
<i>Backhousia oligantha</i>	MEDIUM	<i>Gossia retusa</i>	Other priority
<i>Gossia myrsinocarpa</i>	MEDIUM	<i>Gossia sankowskyorum</i>	Other priority
<i>Lithomyrtus retusa</i>	MEDIUM	<i>Gossia</i> sp. [<i>Gossia</i> N.Snow & Guymer]	Other priority
<i>Gossia bamagensis</i>	Other priority	<i>Rhodamnia fordii</i>	Other priority
<i>Gossia byrnesii</i>	Other priority	<i>Rhodamnia hylandii</i>	Other priority
<i>Gossia dallachiana</i>	Other priority	<i>Rhodamnia pauciovulata</i>	Other priority
<i>Gossia grayi</i>	Other priority	<i>Rhodamnia sharpeana</i>	Other priority
<i>Gossia lucida</i>	Other priority	<i>Rhodamnia</i> sp. [<i>Rhodamnia</i> Jack]	Other priority
<i>Gossia macilwraithensis</i>	Other priority	<i>Gossia punctata</i>	Other priority
<i>Gossia pubiflora</i>	Other priority	<i>Gossia retusa</i>	Other priority

Defining representativeness of an ex situ collection is challenging and may depend on a variety of interconnected factors for an individual plant species. This includes the number, quantity and quality of accessions, the genetic diversity and source populations of the collections, as well as the biology and distribution of the species. Typically, measures of representativeness in ex situ accessions would be approached on a species-by-species basis making use of the expertise of local plant scientists and accession data. Given this survey covers nearly 1,900 plant species from every state and territory, a proxy measure was instead applied to give a general idea of representation for the priority species. This measure defined a 'well-represented' species, as one with 10 or more accessions in the survey, and a poorly represented species as those with below 10 accessions in the survey.

Using this proxy measure, the analysis showed that of the 76 priority species, 39 (51 per cent) were well represented with over 10 accessions, 17 (22 per cent) were poorly represented with under 10 accessions, and 20 (26 per cent) are not secured in ex situ collections. Figure 7 also shows that one of the four priority threatened species from the TSAP (*Eucalyptus leprophloia*) is poorly represented. The poorly represented species are outlined in Table 5, and the 20 species with no reported accessions are in Table 4

Table 5: Priority species with less than 10 accessions in this survey.

Species name	Priority	Accessions	Species name	Priority	Accessions
<i>Rhodamnia angustifolia</i>	VERY HIGH	3	<i>Allosyncarpia ternata</i>	World Heritage Area MEDIUM	1
<i>Eucalyptus resinifera</i> subsp. <i>hemilampra</i>	MEDIUM	6	<i>Metrosideros sclerocarpa</i>	World Heritage Area MEDIUM	9
<i>Gossia lewisensis</i>	MEDIUM	1	<i>Syzygium fullagarii</i>	World Heritage Area MEDIUM	7
<i>Melaleuca lophocoracorum</i>	MEDIUM	2	<i>Gossia shepherdii</i>	Other priority	2
<i>Rhodamnia australis</i>	MEDIUM	1	<i>Rhodamnia arenaria</i>	Other priority	1
<i>Rhodamnia costata</i>	MEDIUM	1	<i>Rhodamnia blairiana</i>	Other priority	3
<i>Rhodamnia whiteana</i>	MEDIUM	1	<i>Rhodamnia glabrescens</i>	Other priority	1
<i>Rhodomyrtus pervagata</i>	MEDIUM	4	<i>Uromyrtus lamingtonensis</i>	Other priority	1
<i>Stockwellia quadrifida</i>	MEDIUM	6	<i>Eucalyptus leprophloia</i>	TSAP priority plant species	4

12. How many accessions have wild location information?

Of the 1,899 accepted Myrtaceae species that were captured by the survey, 1,633 species (86 per cent) have location information for wild accessions on record, while the remaining 266 (14 per cent) do not.

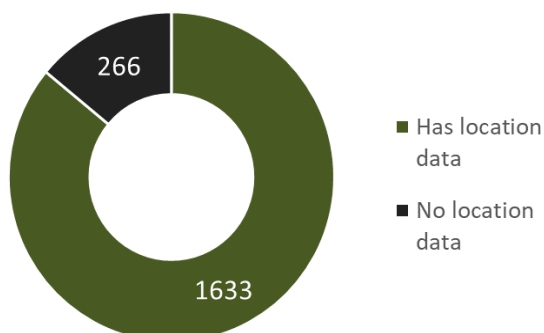
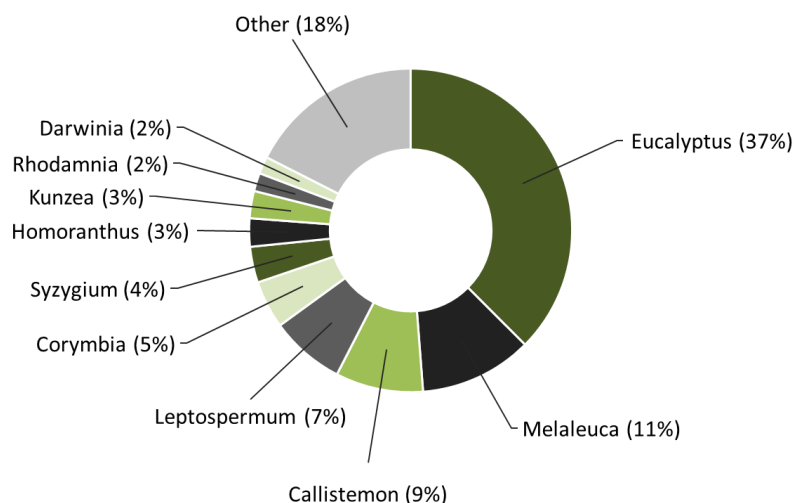


Figure 9: Number of accepted Myrtaceae species captured by the survey that have location data for wild accessions.

13. How many Myrtaceae genera are captured in ex situ accessions?

Analysis found that the 1,899 accepted species captured in the survey fall under 84 distinct genera. Figure 9 shows the proportion of accessions for the top 10 genera, with 74 other genera making up 18 per cent of the remaining accessions. Eucalyptus, Melaleuca and Callistemon species had the highest number of ex situ accessions, making up 57 per cent of all accessions in this survey.

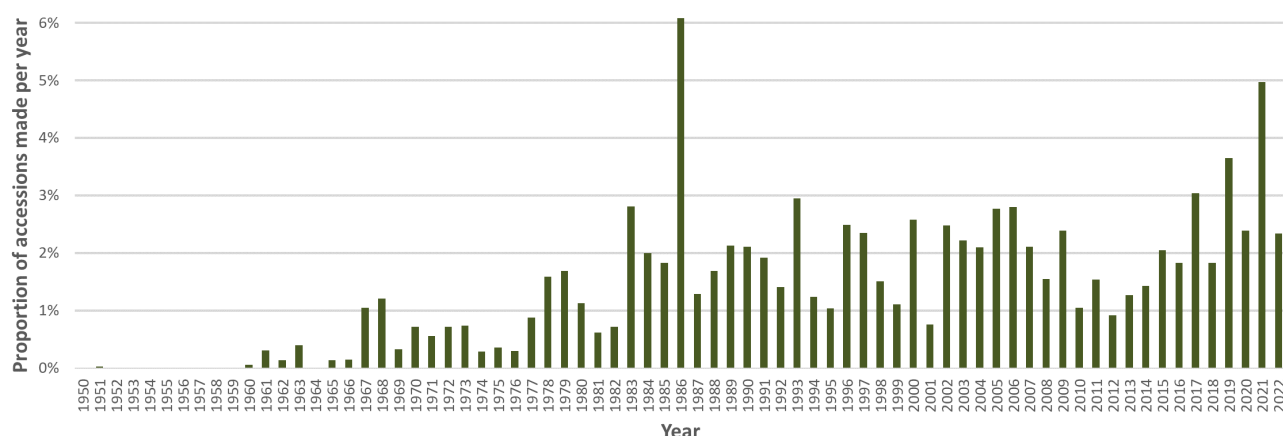
Figure 10: Proportion of accessions for the top ten genera captured under the survey.



14. When were the collections originally made?

Of the 41,696 accessions reported, 33,151 (80 per cent) of these had a data associated with their collection date. Figure 11 shows the proportion of these accessions that were collected per year since 1950.

Figure 11: Proportion of accessions made per year.



15. What proportion of the accessions fall under the different forms?

Of the 41,696 accessions reported, 31,919 (77 per cent) of these described what form the accession takes (whole plants, seeds, tissue culture etc). Figure 12 shows the proportion of these accessions by accession type, with most reported accessions represented by whole plants in the ground and seed collections.

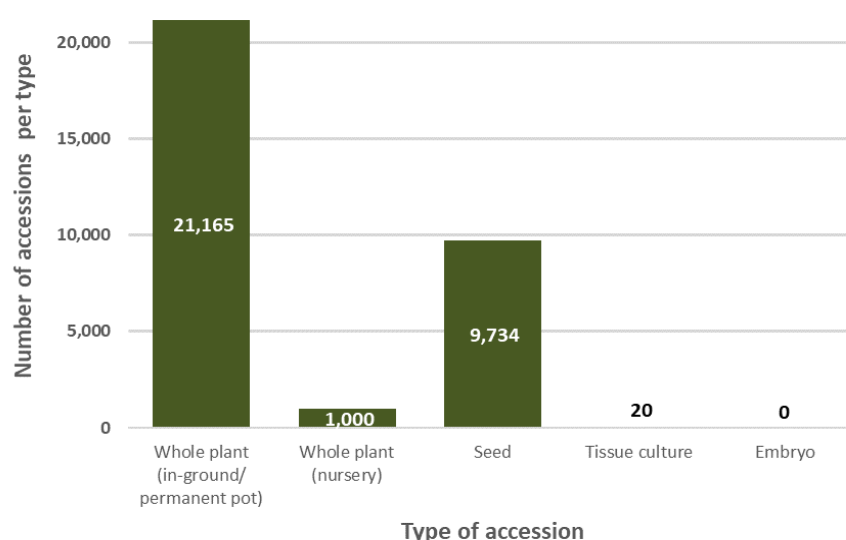


Figure 12: Proportion of collections as permanent whole plants, plants in the nursery, seed, embryo and tissue culture.

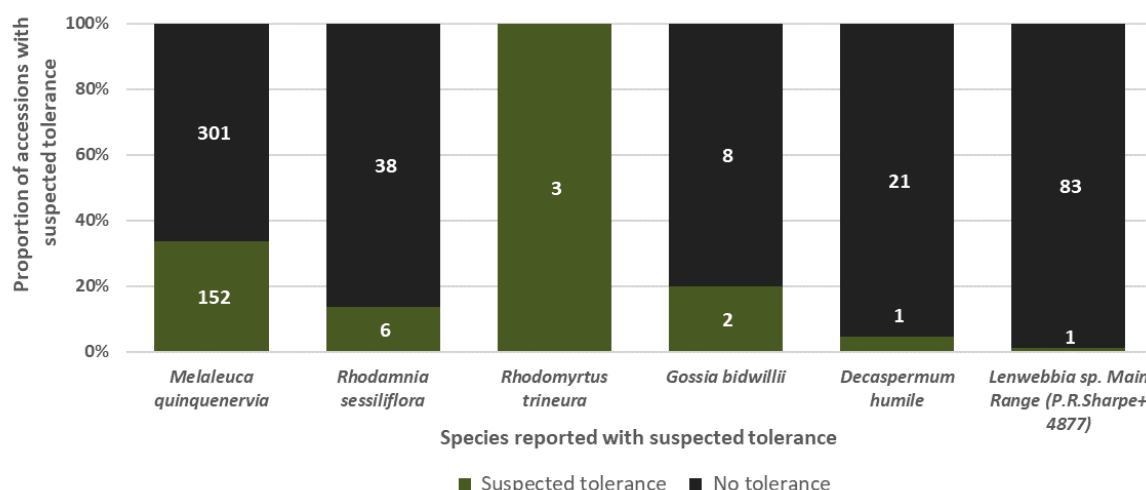
16. How many seeds are held in ex situ accessions?

Of the 1,899 accepted Myrtaceae species captured by the survey, 1,384 (73 per cent) of these have accessions made as seed. The species with the largest number was *Callistemon phoeniceus* with 3,985,951 seeds in long term storage, while the species with the smallest number was *Homoranthus lunatus* with only seven seeds. The total number of seeds from Myrtaceae species in the survey summed to 98,402,887, with an average collection size of 71,100 per accession.

17. How many accessions were acquired due to a suspected tolerance to Myrtle Rust?

Of the 1,899 accepted Myrtaceae species captured by the survey, accessions of six were acquired due to a suspected tolerance to myrtle rust (Figure 13). A total of 165 accessions across these species are secured in conservation collections for future investigation.

Figure 13: Proportion of accessions for Myrtaceae species with suspected tolerance to Myrtle Rust.



Conclusions

Results from this survey indicate that while the respondents have undertaken considerable work to secure ex situ insurance collections for Myrtaceae species, there is still significant work to be done. There are 1,173 (38 per cent) described Myrtaceae species yet to be secured, including 23 EPBC listed species and 20 of the priority species identified under the MRNAP. Of the 56 MRNAP priority species that are secured in ex situ collections, 17 were poorly represented with under 10 accessions each. While all four of the myrtaceous priority plant species in the TSAP are held in ex situ collections, one (25 per cent) is still poorly represented. The survey also showed that only 10 of the 26 respondents (38 per cent) have funding for additional collection work in the future. This highlights the urgent need for additional resources for plant conservation activities, especially to improve the number of species in ex situ insurance collections across the country, as well as accession representativeness to avoid extinctions from the ongoing impacts of Myrtle Rust.

Lessons learned

If the survey was to be repeated in the future, it is recommended that it be released between April to July rather than August to November. Many plant conservation activities occur in spring and summer due to the production of flowers and seed, and many institutions did not have the capacity to be involved in the survey. Additional responses may have been received if the request was made at a different time of year. A survey of this nature also requires time, resources and expertise to harmonise and analyse the data that was generously provided. To ensure timely review and circulation of results, a dedicated data analyst is required if the survey was to be repeated.

Next steps

The information collected through this survey will act as a baseline to enable botanic gardens, arboreta, nurseries, seed banks and researchers to strategically plan and manage their collections as well as supporting further research. The survey results will also be shared with governments, business and the philanthropic sectors so that policy makers and funding bodies have additional information to assist in the prioritisation of future resources. This includes the Threatened Species Commissioners office to inform the Threatened Species Action Plan, as well as the Myrtle Rust Working Group to implement the Myrtle Rust National Action Plan.

Acknowledgements

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- The Australian Government Department of Climate Change, Energy, the Environment and Water for provision of project funds, without which this work would not be possible.
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- All respondent institutions and staff who took time to provide their data for this survey.
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Attachments:

- Consolidated Myrtle Rust Survey Database.