A checklist for risk identification and mitigation in *ex situ* metacollections of species impacted by Myrtle Rust

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This document is supporting (S2) material for Makinson et al. (2026) An extinction-emergency metacollection: maximising future recovery options for *Rhodomyrtus psidioides* (Myrtaceae) threatened by Myrtle Rust. *Plants People Planet* 2026.

This risk and mitigation checklist was originally developed by Makinson as an adjunct to the New South Wales Government's 2021 interal 'Response Plan for *Rhodamnia rubescens*, *Rhodomyrtus psidioides* and *Lenwebbia* sp. 'Main Range' since published as:

NSW Government and Department of Climate Change, Energy, the Environment and Water (2026) Myrtle rust operational response plan for Rhodamnia rubescens, Rhodomyrtus psidioides and Lenwebbia sp. Main Range. Download from https://www.environment.nsw.gov.au/publications/myrtle-rust-operational-response-plan.

A similar checklist was also used as one of a suite of operational guidance documents by a consortium led by the Australian Network for Plant Conservation Inc. (now Plant Conservation Australia) in 2022–5, that ran a pilot project for management and dispersal of a national metacollection of *Rhodomyrtus psidioides*.

The version here has been adapted to a more generic form applicable to other Myrtle Rust-affected species requiring large, dispersed, *ex situ* whole-plant metacollections as part of a recovery strategy. The checklist figure provides a visual summary of the primary considerations, which are discussed in detail throughout.

Figure 1 Summary of checklist considerations. Details of risks and subsequent remedial actions are outlined in the following document

Project risks are often summarised into a risk matrix table showing Impact vs Probability, variously scaled and often colour-coded. While graphically convenient for project summaries and grant applications, these highly compressed forms of risk and mitigation analysis are not optimal forms of guidance for project planning and actual risk anticipation and management – see, e.g. Cox (2008) What's Wrong with Risk Matrices?, (doi.org/10.1111/j.1539-6924.2008.01030.x). In the present case of ex situ conservation of Myrtle Rust-prone species, many of the risk and mitigation factors below are complex and contingent, and will vary in probability, severity, preventability and remediation according to species, site, and other factors. The teasing out of these multiple factors for planning and implementation is best served by analysis using an exhaustive checklist prior to summarisation or compression.

This checklist is structured as per Figure 1 and outline below.

Links to all sections

Risks to plant materials in transit

Specific risks of being a receiving institution

General risks of being a custodial institution (whether donor or recipient)

Plant disease and public perception risks

Microsite selection factors (for in-ground plant-out, and transitional or long-term potted collections)

Horticultural practice risks

Myrtle rust monitoring and infection-treatment risks

Risks associated with eventual use of plantings as seed production areas (SPAs)

Use of excess progeny

OVERARCHING RISK PROCESSES – BIOLOGICAL AND HUMAN

> "Unfortunately, *ex situ* collections face many of the same genetic hazards as small populations in the wild, such as genetic drift, mutation accumulation, and inbreeding depression, as well as some unique ones, such as artificial selection (for conditions in the *ex situ* collection) and outbreeding depression (the result of crossing among previously reproductively isolated populations of a species) … *Ex situ* collections need to be maintained to preserve representative levels of genetic diversity, to minimize deleterious genetic change, and to reduce genetic risk (Havens *et al*. 2004). Similarly, the initial propagule sampling itself … should represent the extent of adaptive genetic variation across the range of a given tree species. How this is accomplished depends on several factors, including the purposes for which the collection is made (long-term storage or restoration), the nature of the material available (e.g., number of populations, orthodox vs. recalcitrant seed), and whether the benefit of the collection is worth the cost to have enough material for use when needed (Guerrant *et al*. 2004)."

– Potter *et al*. (2017) Banking on the future: progress, challenges and opportunities for the genetic conservation of forest trees. *New Forests* 48:153–180 DOI 10.1007/s11056-017-9582-8

> "This one hasn't got a tag!"

– Most of us, at some time.

Starting premises:

1. *Goal of the dispersed collections*: Capture and maintenance of genetically and geographically representative germplasm in quantities sufficient for:

- Maintenance of healthy *ex situ* metacollections of original wild genotypes
- Research (including disease resistance trials and selective breeding)
- Establishment of propagule production lines (seed or other)
- Eventual augmentation or reintroduction in the wild of selected or reinforced genotypes approximating (in other respects) original regional/populational genotypes.

2. *Available techniques for medium to long-term ex situ maintenance*:

- *Seed banking*: preferred and best for space and cost; however numerous Myrtle Rust-impacted species from eastern Australia are known or suspected to have seeds not tractable to orthodox seed storage techniques, or short-lived in storage; for these, species-specific research is required.
- *Tissue culture (Tc)*: expensive in development phase; viable for most species, but each requires exploratory research. Tc will generally need to follow the stabilisation and health-optimisation of plant material ex situ and may require an intermediate stage of re-propagation. Revival reliability is critical. Plant-associated microbiota is likely to be lost.

- *Cryopreservation*: expensive in development phase; viable for many species, but each requires exploratory research following Tc. Advantages are compact storage. Revival reliability is critical. Plant-associated microbiota is likely to be lost.
- *Whole-plant collections*: pot-based (permanent or cycling), or planted out ('field gene bank'). Propagation from cuttings (root, aerial) or sucker units – the vigour of resultant plants may vary substantially with technique and as in the wild, some genets lack vigour and can be difficult to keep alive in cultivation. Seasonality issues. Repotting, re-propagation and pest and disease management to maintain optimal plant condition is labour-intensive for a large collection.

The current knowledge and resourcing base, and an anticipated future need for experimental (screening) and observational (field trial) plots for resistance-selected plants, dictate that whole-plant collections are the primary form of capture and maintenance for some high priority 'Myrtle Rust species' over the near and medium term. It is however recommended that scoping of new projects should always address parallel expansion of the tissue culture and cryogenic options, subject to further appraisal of costs, benefits, and drawbacks.

3. Risk management for all options dictates:

- *Duplication of whole-plant collections over multiple sites* to minimise loss-of-lineage risks from (e.g.) Myrtle Rust outbreaks and various stochastic disasters;
- *Housing of tissue culture and cryopreserved collection elements in specialised facilities* with high safeguard levels (duplication to at least one other institution may be desirable over the long term)
- *Full lineage (genetic pedigree) management from start of project*. Genomic analysis should be applied to identify distinct genetic lineages and clones, and to enable identification of most-diverse genotypes; where initial collections are of very few genotypes, this may need to be retrofitted as the collection develops, and systems adjusted accordingly. Gross genomic analysis may need to be

supplemented by allelic-scale analyses as screening and breeding options emerge.

- *Maintenance and control of diversity and demographic depth* over the whole metacollection.
- *Site or sub-site duplication* as needed, to enable future experimental and breeding work.

‘OVERALL RISKS’ and PROJECT MANAGEMENT CHALLENGES

- Project officer overload (especially if running multiple projects). There is a substantial workload in project control – partner liaison, data and collection standards management, direct data management and appraisal (or referral), data and materials audits (and remediation as needed), financial control, fundraising, maintaining project profile as a stakeholder in relevant research areas (resistance studies, etc). Upper managers need to allow for this.
- Anticipating, obtaining, and maintaining permissions, Memoranda of Understanding (MoUs) with collaborators, legislative permit, and First Nations Cultural Consultation/approval.
- Maintenance of records for lineage control (incl. clonal) across multiple institutional databases.
- Conduct of audits of records and where appropriate materials; negotiation of remedial actions as needed.
- Inadequate and short-term funding. (REMEDIES: Seek experienced outside help in drafting further funding applications, including beyond the usual competitive options; broaden funding base; maximise funds in carryover facilities).
- Tenure and management changes - e.g. changes of ownership or land-use of private tenures; changes of zoning or purpose or charter for public lands.

- Risks and obligations associated with different ownerships of, and rights to, the biological property involved. This may include ownership and permit conditions applied by governmental agencies on behalf of their jurisdictions (including secondary Plant Sharing Deeds or Material Transfer Agreements); First Nations Land Councils and/or Traditional Owners (TOs) from whose land plant material is sourced; and other property owners granting access for collection.
- Australian law and conservation agency practices allow the maintenance of centralised seed and live-tissue collections, if collected with appropriate permissions and subject to any conditions of collection. However, this does not negate enduring moral and some legal rights in the biological and genetic property, and associated intellectual property, held by First Nations peoples of the originating lands (whether those lands are part of a formal Indigenous tenure or simply part of the traditional lands of a nation or community). First Nations may have objections to biological material being moved off-Country or introduced/re-introduced to Country, especially in the absence of any explanation, permission, and negotiated benefits and conditions. There are numerous guidelines and codes of practice governing access to, and collection from, Indigenous lands, and the use of derived material and knowledge. Research of and adherence to these guidance documents is necessary, but in all cases direct liaison with the originating community or TOs through appropriate bodies is needed, as early as feasible and on at least a par with other key stakeholder interests.

Recommended ‘overall risk’ management approach:

- Embed thorough risk management/mitigation analysis in project planning and in MoUs and/or contracts with partners/providers. Discuss thoroughly and early, make sure no one feels ambushed by circumstances later. Seek to embed risk/mitigation awareness and options in management streams above the project level.
- Develop project-specific lower-level operational prescriptions incrementally, within first six months. For later out-of-immediate scope stages (e.g.

experimental breeding, seed production areas, etc), begin process of seeking advice and formulating approach well ahead of time; this will strengthen your next round of funding application.

- Risk scoping (this document or similar) to be kept open for addition and amendment – i.e. on agenda at each meeting of project management or whole consortium.
- A formal Risk Management strategy for the project to be developed, coincident with development of a genetic management plan and partnership MoUs.
- Establish an *ad hoc* external reference circle for technical review and advice.

ADMINISTRATIVE RISKS

Delays in recruitment/replacement of paid project personnel, and staff (or in-kind role) turnover. MITIGATION FOR RECRUITMENT DIFFICULTIES: Commence recruitment processes as early as possible; offer competitive salary to encourage the best candidate to apply; advertise nationally. MITIGATION FOR HIGH/UNEXPECTED STAFF TURNOVER: Identify the key aspects of roles that are most vulnerable and establish contingency strategies (including cross-skilling). Ensure more than one person within the lead organisation/s are fully familiarised with and committed to the project. Where possible, emplace succession planning for designated project roles (where project-funded), or contingency options (where not). Ensure thorough project documentation (all meetings and decisions minuted) in centrally maintained project archive.

Managing collaborations with multiple stakeholders – disengagement, communication breakdown. MITIGATION: Assign responsibility, budget, and time for consistent communication and stakeholder management. Early establishment of a project Steering Group with agreed schedule and scope of meetings, clear delegation of representatives of each partner in the project, and ability to co-opt experts or additional stakeholder representatives at need.

Budget blow-outs. MITIGATION: Competitive tender process for contracts where applicable; advance agreement among Steering Group of adaptive changes needed in financial management. Reportage to, and oversight by, Steering Group at every meeting. Regular monitoring of expenditure against budgeted funds.

Poor communication of project progress internally and to funders. MITIGATION: Establish clear lines of communication/reportage and communication plans. Regular and minuted steering committee meetings.

Activities not being completed on time. MITIGATION: Regular monitoring of progress against established timeline. Regular reporting to the Steering Group.

Recipient custodial sites find disease incidence too frequent, or chemical treatments too onerous or public/neighbour concern too great, forcing withdrawal from custodial role. MITIGATION: ensure initial short-list of custodial partners includes at least a couple additional to those finally selected; these should have confirmed sufficient capabilities and interest to be approached quickly at need. Embed in project plan and in Materials transfer agreements (or contracts) agreed general procedures for retrieval of samples of any unique germplasm and relocation to another site with lower risk.

Complexities of branding and publicity

- Risk of local branding and roles being lost in project-wide publicity; converse risk of project identity being lost in local publicity. REMEDIES: ensure publicity protocols embedded in MoUs/contracts to the degree feasible; ensure friendly interactions between potentially competing publicity teams. Have text formulations prepared for briefing sheets, signage, interviews

Risks relating to physical and electronic record systems

- Need to match identifiers from originating institution with local accession numbers
- Differences in accessioning procedures, database fields, definitions

- Import/export errors
- Backup errors
- Multiple operators working on project material – human errors
- Irretrievability (over time) of fragmented records across institutions or work units, preventing fully integrated reports and analysis across the whole project (remedials include thorough periodic reports from all partners in a consistent format, collated by project management and held centrally, in addition to partner-specific records).

Overarching principles of data management and interoperability need to be embedded in MoUs/contracts. Agreed project-specific protocols need to be developed and documented through dialogue between key hort and records officers at all participating institutions.

Manual data systems (tags, labels, worksheets) going missing etc. Protocols for labelling and handling to be developed, e.g. double-tagging for all live material after tube stage.

GENETIC AND BIOLOGICAL RISKS TO THE GERMPLASM COLLECTIONS

Genotype sampling and genomic analysis absent/inadequate to detect and correct genetic drift, inadvertent artificial selection, mutation accumulation, in/outbreeding risks, etc. RISK LEVEL AND REMEDIAL: Likely to be a low risk for Myrtaceae primary collections, given their long generation time, and if wild-type lineages are maintained, distributed in balanced form with demographic depth, and if paternal analysis is in place for those plantings that become seed production areas. Nevertheless, seek professional external guidance and analysis.

Loss of natural mycorrhizal associates; loss of endophytic and epiphytic microbiota. Risk of these two effects is likely to be higher in *ex situ* locations that are climatically or edaphically dissimilar to natural habitat; ‘climate’ in this context includes water availability/stress regimes and may be countered by irrigation. Loss of epi/endophytes is almost certain in tissue culture and cryo work. The diversity and functional roles of both these groups of microbiota in association with Myrtaceae are not well documented, and the effects of their loss on fitness and perhaps in resistance to pathogens, are uncertain. REMEDIAL: options are poorly explored to date, but whole-plant collections may preserve some; *ex situ* cultures may be possible for some; re-inoculation or passive reacquisition may be possible or likely at reintroduction sites. Seek expert advice and refer to relevant New Zealand literature.

Acquisition in cultivation of microsymbionts that are maladaptive in a recovery/rewilding context. Another poorly explored issue. Seek expert advice.

Inadvertent inclusion of wild-collected hybrids in collection (case in point from Myrtle Rust work: some collections made as *Lenwebbia* sp. ‘Main Range’ turned out to be hybrids or intergrades with *L. prominens*, suspected on morphological grounds, confirmed by genetics). RISK LEVEL is variable, and depends on target and related species and their distributions, e.g.:

- For all *Rhodomyrtus psidioides* natural provenances, the risk level is likely to be extremely LOW or ZERO as there is no wild distributional overlap with congeners, and hybrids with other genera are unlikely.
- For all *Rhodamnia rubescens* collected south of Hastings River (the southern limit of *R. argentea*), the risk level is likely to be extremely LOW or ZERO as congeners are lacking; for *R. rubescens* N from the Hastings to the Qld border, risk level is likely to be LOW (as there are no recorded hybrids) but three congeners are present in parts of the area.
- For plants secured from cultivation, especially if generated from seed that was set in cultivation, the risk may be higher.

  REMEDIAL: Ensure collectors of original samples are highly familiar with target species and its relatives; seek expert taxonomic scrutiny and advice (e.g. from State or Territory Herbarium experts); ensure scrutiny of grown healthy plants, not just vegetative cuttings; incorporate sample of related species into genomic analyses. Ensure genomic analysis prior to any use in seed orcharding or selective breeding.

Hybridisation in ex situ cultivation, or in ‘inter situ’ holding and field trial sites. RISK LEVEL is variable; presence of congeners (cultivated or wild) at or near potential custodial and trial sites should be part of early-stage assessments. REMEDIAL: may involve removal of congener specimens, or spatial separation on larger sites.

General remedies for genetic risks: Develop a Genetic Management Plan for the metacollection. A GMP would ideally be a prerequisite for a genetic salvage and recovery program. However, given the scale of the Myrtle Rust problem, the lack of baseline information on genetic structuring in most of the affected species, the shortage of in-hand DNA samples, and the urgency of germplasm salvage from rapidly declining populations, priority may need to be given to sampling strategies in the absence of genetic knowledge. For species in very steep decline, a lack of genetic knowledge should not become a reason for inaction, but the rescue sampling strategy will need to (a) allow in scale and intensity for various possible genetic scenarios, (b) should incorporate DNA sampling for each site visited, and (c) should include arrangements for skilled genomic analysis as soon as the accumulated samples allow for meaningful study.

It is possible for a ‘genetically un-informed’ but well-planned germplasm capture strategy to secure material that does turn out to be genomically representative (e.g. *Rhodomyrtus psidioides* project in NSW), or close to it. A first approximation of sampling zones can be based on past and extant records of the species (with an emphasis on authenticated and vouchered recent records – State Herbarium records and full associated label data should be used wherever possible rather than migrated and abbreviated records). Apparent (mapped) clustering of reliable records should be scrutinised for any correlation with major catchments, sub-regional microclimates, regional concentrations of certain vegetation types, particular substrates (soils, rock-types), or other habitat features thought to be strongly associated with the target species – these may help with prioritisation of areas for sampling.

The accumulating living collection provides a basis for assessing structuring, clonality, and possible hybridisation, and may inform future sampling strategy. GMP development should aim to maximise the options for future recovery and, in the context of strategies that envisage rust-tolerance breeding, should include at a very early stage expert advice on silvicultural breeding and disease resistance modes, dovetailed with the overall species recovery plan. Some non-genetic factors (mycorrhizal, endophytic, and epigenetic) could also conveniently be part of this plan.

General and specific pest and disease issues: Plants in cultivation may be subject to significant impacts from pests and diseases not usually a problem in the wild. Some (e.g. chronic presence at a site of *Phytophthora* or *Armillaria* pathogens) may be relatively intractable, especially for in-ground plantings. Scoping the site's history for these, and where necessary soil tests, should be part of the site short-listing process. Other more transitory problems (e.g. insect pests) may be relatively easy to treat, but need to be detected and responded to promptly; the site management must have capacity to do both. Some invertebrate pests with relatively low impact themselves may be vectors for more serious microorganisms.

Ex situ custodial sites in eastern Australia that have climates optimal for mesic forest species of Myrtaceae are likely to also be subject to some ambient spore load of the Myrtle Rust pathogen, and hence subject to periodic infections. Local spore load may be even higher, and more constant, at custodial sites with a high diversity of Myrtaceae species growing nearby. Frequent monitoring for symptoms, and prompt and effective control measures, are needed.

MYRTLE RUST-SPECIFIC RISK FACTORS

Risk of spreading Myrtle Rust propagules via project activities

Scenario 1: Risks associated with movement of project material within the Australian East Coast Myrtle Rust 'infected zone':

In eastern Australia the western edge of the zone of effective naturalisation of Myrtle Rust roughly corresponds to the Great Escarpment (the boundary between 'coastal' and ‘tableland’ elevations) but extends onto the tablelands in some areas (e.g. eastern Darling Downs, eastern Atherton Tableland) and may be subject to seasonal fluidity elsewhere (e.g. autumn outbreaks in Canberra); see discussion in Makinson 2018b *Impacts review*). Positioning of recipient sites in Victoria and Tasmania is not straightforward; the disease in those State is currently only known from cultivated situations but sporeload may be sporadically more widespread that known recent infection sites would imply.

- *Risk from spreading the Myrtle Rust ‘pandemic strain’ within its current zone of occurrence in NSW and Queensland*: This risk exists with movement of plant material between sites, but within the NSW/Qld Myrtle Rust zone its consequences are very low or zero, for as long as the pandemic strain remains the only one present in Australia and is not evolving significantly. Nevertheless, best practice is to minimise the risk of within-zone transfer of spores by treating plants with an appropriate fungicide shortly before transport between sites, keeping them under cover during transport, and close inspection and quarantine with monitoring for some weeks on arrival at the recipient site, before plant-out.
- *Risk of spreading potential new ‘pandemic strain’ sub-genotypes (of Australian autochthonous origin) to new areas within infected zone*: As at February 2026, no significant variants of the pandemic strain have been identified, and the level for this risk is low. This may change to ‘moderate’ over time if genetic diversity within the strain increases, although it is likely that human-assisted spread of new genotypes would only accelerate natural spread within the east Australian zone. The most dangerous situation would be a sudden ‘outbreak’ of recombinant reproduction and genetic diversification in a pathogen population assignable genetically to the pandemic strain; if this is detected by separate genomic monitoring projects, movement of species recovery project material should be paused pending specific expert risk assessment.

Scenario 2: Risk of spreading new strain genotypes (i.e. non-‘pandemic strain’ new arrivals in Australia): The pandemic strain is currently (2026) the only one in Australia, and while that situation continues this risk is accordingly ZERO. In the event of such new strain genotypes being detected either in Australia or elsewhere in the Indo-Pacific region (especially if on a likely arrival pathway to Australia), movement of project material should be paused pending specific expert risk assessment.

Scenario 3: Risk of viable spore transmission on non-plant substrates (vehicles, gear, clothing) after infected plant transport or contact, to points outside the current Myrtle Rust zone: This risk is HIGH for these substrates if they have been in contact with plant material infected with Myrtle Rust. The consequences may be LOW if movement is only to areas inhospitable to Myrtle Rust establishment, but HIGH if to South Australia, Western Australia, or to nursery or greenlife facilities growing Myrtaceae species. Before any transport event the question should be asked – where is car/gear/person going subsequently? Thorough disinfection by machine laundering (standard detergent), wash-down (truck detergent), or swabbing (70% methylated spirits in 30% water) will kill spores. Spore longevity without treatment has not been exactly determined outside the laboratory and will depend on ambient conditions, but should be treated as 3 months plus, as a precaution.

Scenario 4: Project plant material moved from within the East Coast MR 'infected zone' to a point outside that zone

As at 2026, domestic biosecurity regulations preclude movement of Myrtaceae plants to South Australia and Western Australia from other jurisdictions. Restrictions also apply to transport of plant material to Lord Howe Island, which thanks to tight biosecurity, strong vigilance, and prompt action has twice eradicated Myrtle Rust incursions – the only jurisdiction in the world known to have done so. Regulations for movement of plant material between any jurisdictions should be carefully checked, and decontamination procedures followed for non-plant material as a matter of best practice.

Future custodial sites within eastern Australian jurisdictions but outside the Myrtle Rust naturalisation zone (e.g. for selective breeding) are not ruled out, but would require separate and detailed risk analysis especially re fire, heat, and drought risks.

Risks and obligations of being an originating (donor) custodial institution

- Primary custodian has responsibility for material held in trust for conservation and the future; considerations include duty of care under permits, institutional charter, existing MoUs and other agreements, public accountability, obligations to staff, visitors, neighbours.
- Metacollection anchorage is an investment of effort in a long-term collaborative project dependant (in part) on other parties.
- Institution may blamed if plants sent to custodial partners are received in poor or unhealthy condition.
- Institution may retain primary responsibility for anchoring record keeping for multiple partners; this may include responsibility for detection of errors, liaison, advising on and participation in design and conduct of data- and materials audits. These responsibilities can involve significant time commitment.

Risks to plant materials in transit

- Differential risks and remedies for mail (e.g. cuttings) versus other forms of transport (closed van, open truck); also whether transport is by project personnel with an understanding of the value of the material, or by third parties with none.
- For material coming out of nursery or shadehouse, pre-transport hardening off is required.
- Proximal risk factors during transport phase may include heat, water stress, vibration (soil cavitation in tube or pot, with root system damage), exposure to infective agents or pests in pre-departure holding area or *en route*, loss of tags, mix-ups of material.

- Mis-delivery (wrong address or building – material effectively lost at least for a period).
- Environmental shock on arrival (different ambient conditions, exposure, watering regime).

Specific risks of being a receiving institution

- If in a low-risk area for Myrtle Rust, risk of being seen to be raising the risk of local arrival (by hosting).
- If in a low-frequency area for Myrtle Rust, and if occasional MR occurs on project plants, then risk of being seen to be harbouring low-level infection and hence local spore load ("my nursery got it from the Gardens").
- Actual increases in local spore load if outbreaks not promptly and adequately controlled.
- Changes to policy, funding, staffing levels, or staffing expertise, that compromise project role or prior levels of in-kind support.
- Hybridisation of project species (a) with co-located cultivated species; (b) with co-located or nearby wild species.

REMEDIALS

- Isolation facilities for arriving material, and staff resources for monitoring/treatment for an agreed post-arrival period – so can attest material arrived clean or was treated appropriately (hence infection not imported to local environment via project material).
- Ongoing resource provision/commitment for agreed levels of monitoring and record-keeping, and treatment as necessary.
- Public interpretation of project plants, including their role as sentinels for MR in area.

- Commitment by partner sites to project service levels affirmed via MoUs and/or contracts; project management to maintain agreed levels of funding support, and facilitate seeking more as agreed.
- Recipient-site project team and overall project team to continually workshop ideas for project promotion and fundraising.
- Hybridisation: pre-dispersal assessment of risk; possible removal of potentially hybridising species, or use a different project species. See comments under 'Genetic and biological risks to the germplasm collections' above.

General risks of being a custodial institution (whether donor or recipient)

Plant disease and public perception risks

- Risks associated with use of plantings as Myrtle Rust experimental and breeding or seed orcharding sites (e.g. need for prompt chemical treatment of disease); REMEDIAL: Plan and assess case by case.
- Risks of adverse public or sectoral perceptions associated with use of plantings as experimental sites for infra-species breeding on silvicultural model. Risk likely to be LOW. REMEDIAL includes clear and proactive public interpretation and promotion of project, stressing that this is classical breeding, not GMO.
- Risks of public or sectoral perception, associated with use of plantings as experimental sites for transgenic selection and breeding (i.e. between-species gene or trait transfer). No such projects are yet envisaged in Australia for Myrtle Rust-affected species, but it remains a theoretical pathway for recovery in some cases. Risk VARIABLE, partly associated with local human sociology and perhaps with unrelated issues. REMEDIAL: Engagement with stakeholders of influence early in project to secure endorsement of concepts/social license; plan and assess case by case.
- Unsuitable or marginal climate for received plant establishment, growth, and reproduction (see (Thomas et al., 2022).

Microsite selection factors (for in-ground plant-out, and transitional or long-term potted collections)

- Anticipated future role/s of the partner within the recovery strategy (simple wild lineage preservation, vs potential future seed orcharding, vs field-trialling of selected lineages).
- Current and future ease of maintenance and monitoring (space/access when plant fully grown).
- Public display and interpretation positioning, vs best microsites for plant survival (consider using redundant replicates for higher-risk display positions).
- Planting risks: poor handling during plant-out (root damage, bad soil fill, etc); failure to acclimatise material before permanent planting or pot location; 'transplant shock'.
- Site soil type; pot mix and refreshment.
- Soil moisture regime and winter warmth, incident solar radiation by season, shading, likely range of evaporative/transpiration stressors.
- Accessibility for supplementary watering during establishment phase or extreme events.
- Frost exposure (known, potential).
- Bushfire exposure.
- Flood/waterlogging exposure.
- Other pathogen or pest exposure (ambient and human-vector).
- Vandalism exposure (plants, labels/tags, signage).
- Other extreme event exposure.
- Direct human non-management impacts:

    - Accidental vehicle damage.
    - Accidental or deliberate physical damage (or drainage change, pathogen risk increase, etc) through direct or adjacent works: roadworks, firebreaks, drainage lines, hazard reduction burns, etc.
    - Chemical drift or unplanned application (pesticide, herbicide, fertiliser).

REMEDIALS may include:

- Planting site selection using syntheses of (a) risk aspects relating to non-conformity with species' preferred environmental parameters; (b) risk of extreme events with a high risk/consequence index; (c) other mainly human site risk factors.
- For potted collections: Are watering check regimes in place? Can collection be quickly relocated to a safer location at need (and is this likely, given other priorities e.g. during bushfire preparation)?
- For in-ground planting of *Rhodomyrtus*: consider some encouragement of root/rhizome suckers, or at least root spread, in case of loss of aerials.

Horticultural practice risks

- Lineage confusion - at every point (propagation, potting, repropagation)
- Inappropriate pruning (timing, severity, lack).
- Inappropriate chemical application (fungicide, pesticide, herbicide, fertiliser).
- Personnel – skills levels and project indoctrination lacking.
- Personnel – continuity, and commitment to project.
- Personnel – safety concerns, especially re fungicide application.
- 'Commitment drift' – institutional, senior management.
- Access to specialist advice within and outside the institution – are linkages in place?

- Embedding of metacollection project needs in institutional planning.
- Frequency of genetic or ramet refreshment (e.g. to achieve demographic depth) and horticultural refreshment (e.g. re-potting of permanent-pot or hedge-plants); associated labour-time commitments.

Myrtle rust monitoring and infection-treatment risks

- Unable to keep up monitoring frequency, e.g. due to labour constraints. Liaise with project management promptly; consider use of registered and reliable volunteer assistance (for monitoring only).
- Training requirements (including for new staff) and human-error issues for disease/health monitoring; liaise with project management.
- Unexpectedly severe or high-frequency outbreaks of Myrtle Rust.

REMEDIALS: Specific health monitoring and anticipated disease treatment protocols can be developed. Other remedials are context-determined.

- Actual or perceived safety or sustainability issues associated with chemical controls.
- Inadequate training of staff in chemical application and rotation.

REMEDIALS: Ensure safety issues are being promptly and appropriately flagged up the line management within the custodial institution and also are reported promptly to project consortium leadership. Safety is the responsibility of the individual custodial institution, but the project consortium should have, and be prepared to use, a pool of funding to help with essential training or equipment where local resources are strained. As part of early risk scoping, the consortium should also have clear factual materials or text to deal with perceived issues (e.g. by general public).

Risks associated with eventual use of plantings as seed production areas (SPAs)

- Sites selected for relatively small initial custodial stands may or may not be amenable to up-scaling for seed production later in the recovery process (noting that the latter stage would be likely to involve new plants). REMEDIALS: new locations within host grounds, or entirely new sites for SPAs.
- Lack of pollinators – assess pollination systems and known visitors of the subject plant species; assess any available pollinator/floral visitor lists for site. Risk is likely to be LOW for most Myrtaceae, as their floral form and phenology tends to favour multiple generalist visitors, and a range of generalist Myrtaceae pollinators are likely to occur in all areas likely to be considered for dispersed parts of the metacollection. Some shadehouse designs are however likely to discourage pollinator visitation.
- Lack of knowledge of breeding system applies for many Myrtle Rust-affected species. This may impair use of appropriate stands for seed production. Metacollections offer opportunities to remedy this through experimental work by (e.g.) institutional staff or staff/students of neighbouring universities; some experienced private growers may also have valuable knowledge. Precautionary fixes include ensuring mixed lineages (genotypes) planted together.
- Overdominance of pollen from some individual s may force genetic drift or other undesirable genetic issues (see, e.g., Havens *et al*., 2004). REMEDIES: preventive and corrective options (e.g. balanced breeding families, periodic paternity analysis of seed samples) should be identified in a Genetic Management Plan.
- Inability to relate seed to maternal lineages. PREVENTIVE: any seed collected for either short-term use or banking should always be registered and stored as maternal seedlots.

- Hybridisation with co-located cultivated species or with nearby wild species; if realised this risk has very high-consequence results for seed production area role.

Use of excess progeny

- Redundant genotypes/individuals – use as a source for display, educational/interpretational, and presentation (gift) plantings, research and MR inoculation/resistance assays.

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