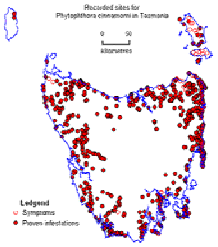

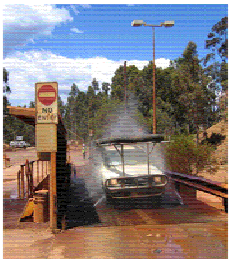

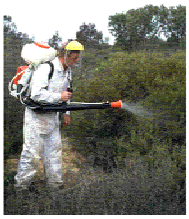

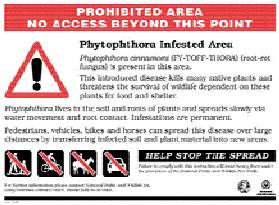

Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia

Part 1. A Review of Current Management and the Identification of Benchmarks for Best Practice

A report by:

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CPSM
Centre for *Phytophthora* Science and Management

for:

Australian Government
Department of the Environment and Heritage

'We know the cause of the disease and we know how it spreads. I believe that the phrase 'inadvertent spread' can no longer be used as an excuse when plants start dying in a previously healthy area'

(Dr Ian Colquhoun, Chairperson of the Western Australia Dieback Working Group in Managing Phytophthora Dieback: Guidelines for Local Government. Dieback Working Group, 2000)

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Mr Kevin Vear	Department of Conservation & Land Management	WA
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ABBREVATIONS

ACT	Australian Capital Territory
Alcoa	Alcoa World Alumina
ARC	Australian Research Council
CALM	Western Australian Government, Department of Conservation and Land Management
CPSM	Murdoch University, Centre for *Phytophthora* Science and Management
CRC PBMDS	Cooperative Research Centre for Plant Based Management of Dryland Salinity
CRC TREM	Cooperative Research Centre for Tropical Rainforest Ecology and Management
CRC TPP	Cooperative Research Centre for Tropical Plant Protection
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCC	Dieback Consultative Council of Western Australia
DEH	Australian Government Department of the Environment & Heritage
DPIWE	Tasmanian Government Department of Primary Industries, Water and Environment
DSE	Department of Sustainability and Environment
DWG	Dieback Working Group
EMS	Environmental Management Systems
EPBC Act	Australian Government Environment Protection and Biodiversity Conservation Act, 1999
EPPO	European and Mediterranean Plant Protection Organisation
GIS	Geographic Information Systems
GPS	Global Positioning System
GTSpot	Geo Temporal Species Point Observations Tasmania database, accessible through the Parks and Wildlife GIS Web Server
IUCN	The World Conservation Union
NAPSWQ	National Action Plan for Salinity and Water Quality
NGIA	Nursery & Garden Industry Australia
NHT	National Heritage Trust

NHT-RCC	National Heritage Trust Regional Competitive Component
NIASA	Nursery Industry Accreditation Scheme Australia
NRM	Natural Resource Management
NSW	New South Wales
NT	Northern Territory
NTAP	The National Threat Abatement Plan for Dieback Caused by the Root Rot Fungus *Phytophthora cinnamomi*
NWS	National Weeds Strategy
PCR	Polymerase Chain Reaction
PTG	*Phytophthora* Technical Group of South Australia
QPWS	Queensland Parks and Wildlife Service
RBGT	Royal Botanic Gardens Trust
SA	South Australia
SA DEH	South Australian Government Department for Environment & Heritage
SARDI	South Australian Research and Development Institute
SCRIPT	South Coast Regional Initiative Planning Team
TASVEG	Tasmanian floristic database
TPWS	Tasmanian Government Parks and Wildlife Service
TSSC	Threatened Species Scientific Committee
WA	Western Australia
WTMA	Queensland Government Wet Tropics Management Authority

1. INTRODUCTION

Disease in natural ecosystems of Australia, caused by the introduced plant pathogen *Phytophthora cinnamomi*, is listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Act requires the Australian Government to prepare and implement a threat abatement plan, for nationally coordinated action to mitigate the harm caused by *P. cinnamomi* to Australian species, particularly threatened flora, fauna and ecological communities. The 'National Threat Abatement Plan for Dieback Caused by the Root-Rot Fungus *Phytophthora cinnamomi*' (NTAP) was released in 2001 (Environment Australia 2001). The NTAP is designed to promote a common understanding of the national threat *P. cinnamomi* poses to biodiversity in Australia.

This project, funded by the Australian Government Department of the Environment and Heritage (DEH), is one of the most significant actions to be implemented from the NTAP to date. The project has two major components:

- the development of National best practice benchmarks for the management of sites that are, or could be threatened by *P. cinnamomi*
- the development of risk assessment criteria and a system for prioritising management of sites that are or could be threatened by *P. cinnamomi.*

The project has produced a three-part document entitled **Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia:**

> **Part 1** – A Review of Current Management and the Identification of Best Practice Benchmarks
>
> **Part 2** –Risk Assessment for Threats to Ecosystems, Species and Communities: A Review
>
> **Part 3** – Risk Assessment Models for Species, Communities and Areas

A model of best practice was developed in the current document (Part 1). The model includes all the components necessary for an informed and integrated approach to *P. cinnamomi*, from strategic through to on-ground management. A review of current *P. cinnamomi* management in Australia was undertaken, from which benchmarks for best practice in processes and procedures were identified.

What is best practice? Best practice are practices and procedures and methodologies that have been shown in other situations to be successful in achieving a specific objective, in this case, reducing the spread and impact of *P. cinnamomi* in natural ecosystems of Australia. The efficient and effective management of *P. cinnamomi* requires best practice to be applied at all levels of management, from legislation and policy at a strategic level, to the deployment of on-ground management options such as regulating access or the use of phosphite.

What are benchmarks? Benchmarks are criteria by which to measure something; standards or reference points. In the context of the current project, the benchmarks are those processes and practices identified as the best currently employed in Australia to manage *P. cinnamomi* for biodiversity conservation. These benchmarks will provide

a reference point for other organisations to compare or develop their own processes and practices, with the view to improving *P. cinnamomi* management outcomes.

A final note: the common use of the term 'States' rather than 'States/Territories' in this document reflects the fact that active management of *P. cinnamomi* in natural ecosystems occurs predominantly in the States, as *P. cinnamomi* is not considered a significant environmental issue in the wet/dry tropics of either northern WA (CALM 2003) or the Northern Territory.

2. A MODEL FOR BEST PRACTICE MANAGEMENT OF *Phytophthora cinnamomi*

A best practice model for *P. cinnamomi* management in natural ecosystems of Australia (Figure 1) was adapted from a model developed for best practice of cultural heritage management for parks and protected areas in Australia and New Zealand (Hague Consulting 2001). The model represents all the components of management that are necessary to achieve an integrated and consistent approach for the effective long-term management of *P. cinnamomi* for biodiversity conservation in Australia.

Best practice management of *P. cinnamomi* will be driven by strategic management which includes statutory provisions mainly at the Australian and State Government level, and non-statutory instruments led primarily by State Governments and relevant agencies. Strategic management involves the formal and official acknowledgement by governments that *P. cinnamomi* is a serious environmental and management issue, by providing guidance on how it will be managed, and making provisions for appropriate investment.

Effective strategic management paves the way for the development of the processes and procedures that are necessary for effective on-ground management including: a thorough assessment of the threat and the development of priorities for management, ensuring staff are suitably qualified to implement process and procedures, liaison with other stakeholders including the community, and implementation of standard prescriptions. A process, by which success in achieving management objectives is monitored and measured, will complete a feedback loop of continuous improvement to strategic management. A central core of coordinated and collaborative research underpins the entire management process.

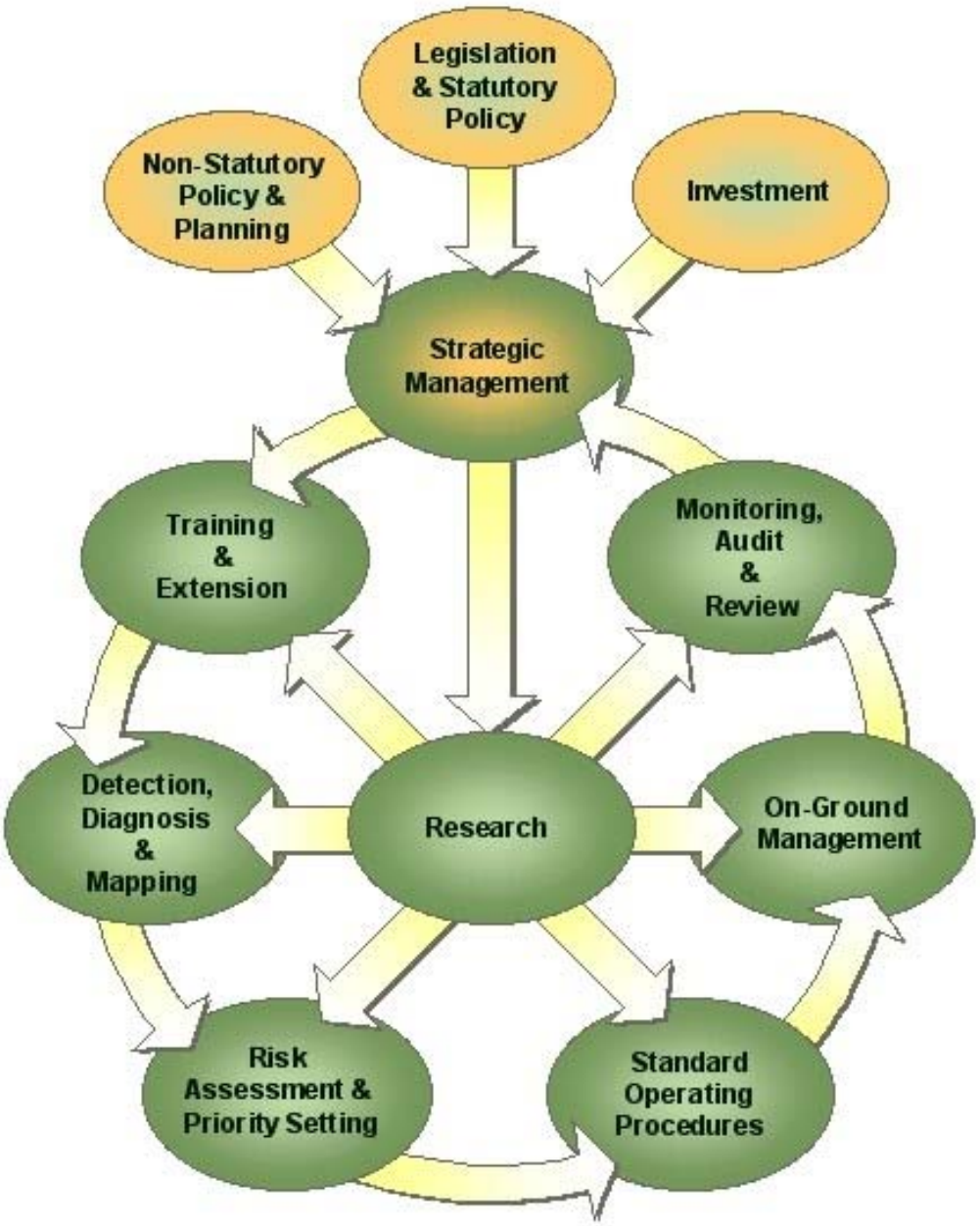


Figure 1. A best practice model for the management of *Phytophthora cinnamomi* for biodiversity conservation in natural ecosystems of Australia.

Strategic Management emcompasses legislation, statutory and non-statutory policy, planning, investment and management systems. Collectively the components of strategic management should provide formal and official acknowledgement by the Australian and relevant State/Territory Governments, either explicitly or implicitly, that *P. cinnamomi* is a 'key threatening process' to Australia's biodiversity. Acknowledgement should include clear statements of policy and demonstrated commitment through the development and deployment of processes and tools necessary for identification of the threat and effective on-ground management. State/Territory Governments need to provide leadership by ensuring that best practice management is deployed in a consistent and integrated fashion across relevant departments and agencies.

Although, Australian and State/Territory Governments have a key leadership role, they do not have jurisdiction over all lands. Consequently, managers of land of other tenure also need to have policy and processes in place to identify and manage the threat that *P. cinnamomi* poses to biodiversity.

Research refers to scientific investigation into all aspects of *P. cinnamomi*, the disease it causes, the consequences and management of the disease. It includes fundamental research into the biology, ecology, epidemiology, genetics, taxonomy, host-pathogen interactions and control of the pathogen, as well as applied research on the extent of the threat, economic analyses of the impacts of disease and management, and restoration methods. Best practice research requires close collaboration between scientists and land managers to ensure that research addresses management needs. Management of a threat such as *P. cinnamomi* requires a dynamic approach in which processes and procedures are constantly refined through the application of findings from rigorous scientific investigation. There is a need for long-term vision and sustained programs to ensure that limited research funding is utilised in the most effective manner and that questions requiring long-term study and monitoring are undertaken.

Training & Extension – Training refers to the development and delivery of technical information that promotes skilled and effective participation in the management of *P. cinnamomi*. Curricula should be tailored to specific audiences, should support key policy documents including Codes of Practice and be consistent with standard operating procedures. Extension refers to the communication of the latest knowledge of *P. cinnamomi* and its management to all stakeholders. Information needs to be channelled from leaders in the field with the capacity to collect and collate the necessary information and develop appropriate management processes and procedures, to those in need of the information but without the same capacity. Like training material, extension material must be tailored to specific audiences.

Detection, Diagnosis & Mapping – are the processes necessary for the identification of areas where *P. cinnamomi* occurs and is having an impact on biodiversity, and areas which are free of the pathogen. This information is crucial for effective on-ground management. The processes of detection and diagnosis include the demarcation of infestation boundaries in the field, and the management and collation of data in formats, primarily maps, that facilitate the deployment of management tactics.

Risk Assessment & Priority Setting – There will never be sufficient resources to fully implement all the management measures necessary to limit further spread of *P. cinnamomi* in the landscape or mitigate the impacts of disease (Environment Australia 2001). Consequently, limited resources must be focused where the benefits are greatest. Risk assessment refers to the processes in which the probability of an incursion by *P. cinnamomi* and the consequences of such an incursion are calculated and strategies to reduce the risks are identified. In best practice, the process of risk assessment enables priorities to be set for the allocation of resources to achieve the maximum benefit for biodiversity conservation.

Standard Operating Procedures – refers to the development and documentation of standard procedures and requirements for the performance of specific activities or tasks. They are referred to as standard operating procedures, management guidelines or operations manuals. They are a policy implementation tool, which form a link between the strategic objectives and the operational activities of an agency. Standard operating procedures are designed to achieve consistency in management at an operational level. Consequently, they should provide clear instruction, be regularly updated and readily available to agency staff, contractors and proponents of activities with the potential to spread the pathogen. Well written standard operating procedures will form the basis for compliance auditing.

On-Ground Management – is the deployment of specific tactics to control the physical spread and impact of *P. cinnamomi* in natural ecosystems of Australia. The overall objective of on-ground management is to prevent the introduction of *P. cinnamomi* to uninfested areas, to minimise the spread from infested areas and to mitigate the impacts of disease at infested sites. Management tactics to minimise the spread of *P. cinnamomi* focus on modifying the activity and behaviour of the major vectors of the pathogen, humans. Infestation of a site with *P. cinnamomi* is currently irreversible; therefore it is essential that not only land managers, but all humans who go upon the land adhere to tactics that minimise the risk of pathogen transmission.

Monitoring, Audit & Review – Monitoring, audit and review complete the continuous improvement loop of best practice management. Long-term and systematic monitoring of the spread and impact of *P. cinnamomi* in the landscape will enable evaluations to be made of the effectiveness of on-ground management measures. Auditing of compliance ensures procedures are being adhered to. The logical progression of monitoring and auditing is the review of processes and procedures for improved management outcomes.

3. REVIEW OF CURRENT MANAGEMENT

3.1. Strategic Management

Strategic Management refers to legislation, statutory and non-statutory policy, planning related to, and investment in, *P. cinnamomi* management. The Australian and State Governments have the key leadership role in the strategic management of a national key threatening process such as *P. cinnamomi*. Collectively, the components of strategic management provide: official acknowledgement that *P. cinnamomi* is a threat to Australia's biodiversity and the tools to manage it.

3.1.1. Legislation and Statutory Policy

Legislation that influences the management of *P. cinnamomi* is most commonly enacted by the Australian and State Governments. The mechanism for national protection of biodiversity is the Australian Government *Environment Protection and Biodiversity Conservation Act 1999*, under which *P. cinnamomi* is listed as a national 'key threatening process' and under the provisions of which the NTAP was developed in 2001. The NTAP is deigned to foster coordinated national management of *P. cinnamomi* and is due for review in 2006. Activities that may threaten species and communities listed under the EPBC Act must be referred to DEH. However, the capacity to assess the potential impact of *P. cinnamomi* is limited by a poor understanding of the extent to which *P. cinnamomi* affects biodiversity, particularly threatened taxa, and significant gaps in fundamental knowledge about the pathogen and its interaction in the environment.

Statutory tools for environment and biodiversity conservation differ from State to State. Within States, coordination between relevant agencies to manage *P. cinnamomi* is generally poor. However, WA is currently working toward a whole-of-government policy linked to the WA *Environmental Protection Act 1986* which will extend the powers to actively manage the pathogen beyond the conservation estate. As *P. cinnamomi* cannot be eradicated from a site, acting after an introduction has occurred, there is need for statutory powers to be proactive (triggered to prevent an introduction), rather than reactive (triggered after damage has occurred due to an introduction). As *P. cinnamomi* cannot be eradicated from a site, responding after an introduction has occurred is, in most instances, too late for the community being infested.

Currently, the ability to regulate access to public lands for environmental protection is one of the most powerful statutory tools for *P. cinnamomi* management. Although, legislation in a number of States provides for this, its use is limited in some States by poor public understanding of the issue, opposition to changes in land-use and the need for enforcement. A greater awareness is needed amongst land management agencies about the implications for *P. cinnamomi* management of interrelatedness of legislation. Some Australian Government legislation, governing the proponents of potentially high risk activities, overrides State legislation and greater engagement of such proponents is urgently needed.

Please refer to full review of Legislation and Statutory Policy for further information.

3.1.2. Non-Statutory Policy & Planning

Non-statutory policy and planning refers to documents that describe the voluntary course of action to be followed by an organisation to achieve its objective for *P. cinnamomi* management. The triggers necessary to ensure that *P. cinnamomi* is considered in planning processes are generally agreed to be inadequate in Australia.

There is little consistency between States in the scope or processes of *P. cinnamomi* management, although many States have looked to the considerable experience of WA in developing standard operating procedures and other policy and planning tools. CALM in WA has developed a range of policy and planning tools, initially for management of *P. cinnamomi* in forestry operations, but which have been extended in recent years to management of *P. cinnamomi* in the broader conservation estate.

Policy and planning in relation to the management of *P. cinnamomi* is very limited at a Local Government level in most States, with the exception of some Shires in WA. The non-government, community based WA Dieback Working Group has worked in an extension role to channel information and technologies produced by CALM and the mining industry in WA to other stakeholders, particularly Local Government, high risk industries and the general community. Codes of Practice have been developed in WA and Tasmania for, and in collaboration with, the extractive industries. However, Codes of Practice are needed in all States for a wider range of high risk industries, especially those operating in areas of high conservation value.

Please refer to full review of Non-Statutory Policy & Planning for more detail.

3.1.3. Investment

Investment refers to the commitment of resources to all aspects of *P. cinnamomi* management including research. The Australian Government has invested considerable amounts of funding through programs such as Australian Research Council (ARC), the first round of Natural Heritage Trust (NHT) funding, National Action Plan for Salinity and Water Quality (NAPSWQ), World Heritage funding and core funding for Threat Abatement Plans. These programs have yielded many benefits to the science, management and general awareness of *P. cinnamomi* in natural ecosystems. However, the *ad hoc* and short-term nature of the available funding precludes a strategic long-term approach to research and management necessary to i) determine the full extent of *P. cinnamomi* and its impact in Australia and ii) effectively abate the threat of the pathogen.

The investment by State and Local Governments in *P. cinnamomi* science and management varies from State to Sate but is generally very low. Relatively modest investments by the WA and SA State Governments in appointing personnel with specific *P. cinnamomi* management roles has led to greater coordination of activities in those States, although funds for on-ground management funds are limited.

It is widely recognised that *P. cinnamomi* is but one of the many competing demands on the limited funding available for management of serious environmental issues in

Australia. The core Australian Government funding for the eight approved Threat Abatement Plans is currently inadequate and the demands on the available funding is set to increase as new Key Threatening Processes are listed. National and State priorities need to be set to ensure that funding is directed where it is most needed and where it is likely to provide the greatest return. Secure alternative funding sources must be found.

Access to NHT and NAPSWQ funds through the Natural Resource Management (NRM) regions for *P. cinnamomi* research and management will depend on the priorities of the individual regions as identified in their strategic and investment plans. However, it remains to be seen how this regional delivery model will impact in the management of a national threat such as *P. cinnamomi*.

Please refer to full review of Investment for more detail.

3.2. Research

Research refers to scientific investigation into all aspects of *P. cinnamomi*, the disease it causes, the consequences and management of the disease. World class research is undertaken throughout Australia ranging in scope from cellular and molecular biology of *Phytophthora* spp. through to directly applied research into on-ground management methods.

Despite a dynamic research culture in Australia, many gaps in fundamental knowledge about *P. cinnamomi* remain, and these gaps are a significant impediment to effective management. Research on the potential to restore infested and highly impacted sites has been minimal, despite continual growth in the number of such sites and the fact that once infested, *P. cinnamomi* cannot be eradicated. Although these gaps have been identified in numerous reviews over the years, the *ad hoc* funding of research, the lack of coordination between research groups to prevent duplication and to set priorities, precludes a long-term and strategic approach to addressing the gaps.

The fact that a large proportion of research in Australia is being undertaken by postgraduate students, and therefore designed for completion in a three-year time frame, has meant that many of the gaps that require long-term monitoring are not being undertaken.

Two initiatives in WA to address long-standing knowledge gaps include: i) the setting of research priorities for WA by the State Government Ministerial-appointed Dieback Consultative Council, ii) the development of the Centre for *Phytophthora* Science and Management with a holistic and long-term vision for research on diseases caused by *Phytophthora* in natural ecosystems and collaborations with key stakeholder to ensure that research directly addresses on-ground management.

Please refer to full review of Research for more detail.

3.3. Training & Extension

Training refers to the development and delivery of technical information that promotes skilled and effective participation in the management of *P. cinnamomi*, in

accordance with standard operating procedures. Formal training for management of *P. cinnamomi* in natural ecosystems of Australia is not available in all States and there are no national standards for curricula.

Training is generally delivered on an *ad hoc* basis by State Government land management agencies. In WA, curricula are well developed by CALM in four competency-based courses ranging from strategic to on-ground management, and by Alcoa in a computer-based learning system. Training is compulsory for Alcoa staff and must be refreshed biannually. Only the detection, diagnosis and mapping course is compulsory for staff and contractors of CALM with 'disease interpretation' responsibilities. The WA DWG provides training, consistent with the CALM curricula, to Local Government and other stakeholders. However, the capacity of the group to provide training where it is needed is limited due to inadequate and insecure funding.

Extension refers to the communication of the latest knowledge of *P. cinnamomi* and its management to all stakeholders. In Australia, the level of awareness and understanding of *P. cinnamomi* and its impact on biodiversity, at all levels of government and the community, is inadequate to effectively abate the threat. Poor policy/planning by governments and public opposition to various on-ground management tactics, are just two of the consequences of poor knowledge that significantly hamper management. A State Communication Strategy is currently being developed by the WA DWG and other stakeholders, to develop a consistent message and provide recommendations to each stakeholder group on behaviours necessary to manage *P. cinnamomi* and its impacts in WA. A national communication strategy is needed and is listed as a priority action of the 2001 NTAP, but is yet to be developed.

Extension is undertaken primarily by Government, with the exception in WA where the DWG has worked with Local Government, industry and the community to increase awareness and knowledge of the threat. Extension efforts are more comprehensive in WA (CALM and DWG) and SA (SA DEH) where dedicated personnel coordinate *P. cinnamomi* management activities within and between agencies.

Please refer to full review of Training & Extension for more detail.

3.4. Detection, Diagnosis & Mapping

Knowledge about the location of *P. cinnamomi* in the landscape is essential in setting management priorities and in the deployment of on-ground management tactics. However, the detection, diagnosis and mapping of *P. cinnamomi* is expensive and maps showing *P. cinnamomi* infestation boundaries have limited temporal currency due to continual spread of the pathogen. Maps of disease occurrence can be developed at a lower cost through interpretation of aerial photographs, but they do not have the same level of detail as those produced through on-ground survey. Additionally, where disease occurs in the understorey of vegetation with a dense emergent layer, as is the case in Tasmania, aerial photography is of little use in disease detection.

In WA, CALM employ and train dedicated staff in the detection, diagnosis and mapping of *P. cinnamomi*. The process hinges on reliable disease expression in a suite of plant species and patterns of expression in infested areas. CALM undertake surveys and develop a range of map products to guide on-ground management of *P. cinnamomi* during forestry and mining operations in the jarrah forest. In recent years, the systematic disease interpretation process has been extended for use in the wider conservation estate. It is central to the identification of areas in WA deemed to be 'protectable' from *P. cinnamomi* in the medium to long-term and afforded priority management by CALM.

There has been no systematic program to map the extent of *P. cinnamomi* infestations in Australia. The collection of such data, primarily by State Government departments and in WA also by the WA DWG, is largely opportunistic or on a case-by-case basis. There are no standards in Australia for the collection and storage of data related to *P. cinnamomi* occurrence. However, Tasmania have produced a very valuable and readily accessible management tool by gathering *P. cinnamomi* survey data from a number of agencies in a centrally located database Geo Temporal Species Point Observations Tasmania (GTSpot), which is connected to other including the floristic databases TASVEG and WHA Veg.

There are no standard methods for the detection, diagnosis and mapping of *P. cinnamomi* in Australia. Some aspects of the process would be very difficult to standardise. For example, the 'disease interpretation' process developed by CALM is not directly transferable to areas where disease is cryptic and there are very few reliable indicator species, such as areas of NSW and the Wet Tropics World Heritage Area in Queensland.

Laboratory methods to detect *P. cinnamomi* in soil, plant and water samples have not been standardised in Australia, although the techniques are well established and it should be a relatively easy process. Currently, morphological methods are used in a vast majority of diagnostic laboratories, although molecular methods are also available and are more sensitive and are faster. The cost of processing samples using morphological methods is high enough to preclude large numbers of samples being processed. However, molecular diagnostics are more expensive again so that it is not yet a commercially viable option. Prices for either method are unlikely to come down until sample throughput increases.

Please refer to full review of Detection, Diagnosis & Mapping for more detail.

3.5. Risk Assessment & Priority Setting

With many competing demands on the limited resources available to natural resource management in Australia, there is a great need to prioritise management and to target resources where benefits can be maximised. Risk assessment and priority setting processes have been developed only recently or are still under development in *P. cinnamomi* management.

Although the risk of *P. cinnamomi* can be assessed at different scales using a range of methods, a common goal of risk assessment is to identify where the impact of the pathogen is likely to be greatest. An essential first step in risk assessment is the

mapping of areas of 'vulnerability' to disease. These have been identified in most States based on a variable range of factors including climate (particularly annual average rainfall), elevation, geology, soils and vegetation type. Some agencies have developed strategic or operational scale risk maps as a management tool using GIS technology.

In Tasmania, the presence of viable numbers of rare, susceptible, nationally and State listed plant species were criteria for the identification of 67 areas judged to be protectable in the long-term from *P. cinnamomi* (Shahinger *et al.* 2003). One of the aims of the current project is to develop a risk assessment methodology, suitable for national adoption, also using threatened taxa as the basis for setting management priorities (Part 3: – Risk Assessment Models for Species, Communities and Areas). A regional scale risk assessment process is being developed in south-west of WA by the South Coast Regional Initiative and Planning Team NRM Group, which aims to identify disease-free areas having regional and community significance for protection from *P. cinnamomi*.

The main gap in developing risk assessment methodologies is the lack of incomplete data on many aspects relating to the presence and impact of *P. cinnamomi* in Australia. Data on the impacts of *P. cinnamomi* on native fauna is particularly sparse. The current distribution of *P. cinnamomi* in Australia is not well known and distribution maps are expensive to maintain. Many States/Territories have inadequate records on the level of susceptibility of native vegetation, particularly the susceptibility of listed threatened taxa and communities. There is little data available on the effectiveness of current management tactics, particularly hygiene measures, due to inadequate monitoring.

Please refer to full review of Risk Assessment & Priority Setting for more detail.

3.6. Standard Operating Procedures

Standard operating procedures, sometimes referred to as management guidelines or operations manuals, provide directions to ensure consistency in the operational activities of an organisation. Standard operating procedures reflect the policy of an agency and can form the basis for compliance auditing.

Many high quality standard operating procedures for management of *P. cinnamomi* have been produced in Australia. The Nursery and Garden Industry Accreditation Scheme has produced national guidelines (NIASA 2003) for best management practice in production nurseries and growing media suppliers, with a strong emphasis on control of *Phytophthora* spp. However, as there are no powers to enforce accreditation the uptake has been slow and the availability of planting material produced by best practice still limited.

A number of State land management agencies have developed standard operating procedures to provide direction to staff and contractors. Documents developed in WA by the WA Department of Conservation and Land Management and the WA Dieback Working Group have provided benchmarks for a number of standard operating procedures produced elsewhere in Australia. The WA Dieback Working Group has developed detailed guidelines for Local Government (2000), bushland restoration

(Dunne 2005) and to support a Code of Practice for the extractive industries (DWG 2004b). The WA Department of Conservation and Land Management and the SA Phytophthora Technical Group have produced *P. cinnamomi* management guidelines for use across tenure in those States (CALM 2004b; PTG 2003). The current document brings together relevant procedures in each State to produce the first national best practice guidelines.

Currently standard operating procedures for *P. cinnamomi* management in Australia are largely 'stand alone' documents and integration of *P. cinnamomi* with general environmental management issues is poor.

Please refer to full review of Standard Operating Procedures for more detail.

3.7. On-Ground Management

Current levels of knowledge about *P. cinnamomi* in natural ecosystems preclude its eradication from infested sites. Consequently the objectives of on-ground management are to: i) limit the spread of *P. cinnamomi* and ii) to mitigate the impact of disease where the pathogen occurs.

On-ground management methods focus on reducing human vectoring to limit the pathogens spread of *P. cinnamomi* in the landscape. Containment methods include restricting human access to uninfested areas, and where access is permitted, the use of strict hygiene protocols to reduce the chance of infested soil, plant material and water being transferred from infested to uninfested sites. In South Australia, access may also be restricted to infested areas to reduce further spread of the pathogen. The effectiveness of containment methods, particularly of hygiene measures, is largely unknown due to a lack of monitoring.

The use of *P. cinnamomi*-free material is fundamental to preventing introduction of the pathogen to uninfested areas. However, 'clean' basic raw materials for road building and maintenance are difficult to obtain in Australia, and there are no standards for determining and certifying the disease status of the materials. The introduction of planting material to uninfested areas is also considered a high risk due to the unregulated production of plants for revegetation by some conservation groups, and poor uptake of NIASA accreditation by the wholesale and retail plant nurseries.

Impact mitigation methods for infested sites are currently extremely limited. Phosphite is used to protect endangered susceptible plant species or communities *in situ*, and to retard the spread of the pathogen at infestation boundaries in areas of high conservation value. Although research has also shown phosphite to be effective in Victoria, its use in management is largely limited to WA. Phosphite testing in other States is extremely limited. Even in WA, knowledge of the target and non-target effects is incomplete, and no alternative chemical treatments are known. Phosphite is currently not registered for use in native vegetation and consequently off-label permits are required for its use.

In WA, plant species at extreme risk of extinction and/or critically endangered by *P. cinnamomi* are conserved *ex-situ*. The germplasm is conserved as seed and the program is part of the Millennium Seedbank Project. The seed is used in species

recovery programs, and in research on the range and extent of susceptibility to *P. cinnamomi* in threatened taxa.

Disease mitigation includes restoration of sites affected by *P. cinnamomi*. However, programs to restore biodiversity values have been sporadic, largely confine to WA and mostly ineffective. Urgent work is needed in this area.

Please refer to full review of On-Ground Management for more detail.

3.8. Monitoring, Audit and Review

Monitoring, audit and review refers to the processes necessary to close the loop of continuous improvement in *P. cinnamomi* management. Monitoring provides information necessary for evaluating the risk *P. cinnamomi* poses to biodiversity and the effectiveness and efficiency of risk mitigation measures.

Monitoring to evaluate the spread and impact of *P. cinnamomi* is undertaken to some degree in all States, but has been insufficient to determine the direct and indirect long-term impacts of *P. cinnamomi* on biodiversity. Knowledge of the impacts of *P. cinnamomi* on native fauna is particularly poor. Monitoring of spread and impact is currently carried out under a range of programs, with varying objectives and methods, and often through the endeavour of dedicated individuals with no security of continuance. Monitoring for new incursions even where high conservation values have been identified has been inadequate to protect biodiversity in Australia.

Other than an evaluation in a bauxite mining operation in the *Eucalyptus marginata (*jarrah) forest by Alcoa World Alumina in WA, monitoring of the effectiveness and efficiency of *P. cinnamomi* management procedures has been extremely limited in Australia. Consequently, the effectiveness and cost-efficiency of measures, such as hygiene, is unknown. Although the effectiveness of phosphite in reducing the spread and impact of *P. cinnamomi* is being monitored, largely in WA, the target and non-target effects are still largely unknown.

An evaluation of the effectiveness and review of management requires knowledge of the level of compliance to standard operating procedures. Alcoa in WA has adopted an accredited Environmental Management System through which independent auditing of *P. cinnamomi* management procedures is undertaken every 4 years. Alcoa also undertake annual internal audits of operational performance and procedural compliance in relation to *P. cinnamomi* management.

Please refer to full review of Monitoring, Audit & Review for more detail.

4. BENCHMARKS FOR BEST PRACTICE

In this section 'benchmarks' in practices and procedures are identified for management of *P. cinnamomi* in natural ecosystems of Australia. Many of the benchmarks were identified from the review of current *P. cinnamomi* management practices around Australia. The benchmarks are presented under headings relating to the component of the best practice model (Figure 1) to which they apply.

It has not been possible to use 'metric benchmarking' because there is simply no data on the effectiveness and/or efficiency of the various management measures to apply numerical, statistical and economic methods of comparison. Consequently, the choice of benchmarks from existing practices was qualitative and subjective. However, the subjectivity of the benchmarks identified is open for discussion and debate through the consultative process.

Where significant gaps were identified in the current management of *P. cinnamomi*, benchmarks were sought from other pest management programs. Many were identified from the National Weeds Strategy (NWS) which was launched in June 1997 to address environmental and agricultural weeds of national significance, with an emphasis on the commitment of all governments in cooperation with other stakeholders (Anon 1997). The issue of weed management in Australia has many parallels to the management of *P. cinnamomi*, particularly in the mechanisms of spread, so the goals and objectives of the National Threat Abatement Plan for *P. cinnamomi* (NTAP) are not dissimilar to those of the NWS.

What are benchmarks?

The dictionary definition of 'benchmark' is 'a criterion by which to measure something; standard; reference point' (Collins English Dictionary, 1979). In the context of this project, the benchmarks are the best processes, practices and/or procedures identified from a thorough review of the current science and management of *P. cinnamomi* in Australia.

Why do we need the benchmarks?

Benchmarks enable organisations to measure their performance against what is considered best practice. As well as providing a point of comparison, the benchmarks identified provide a target for improved performance and new insights into managing *P. cinnamomi* for biodiversity conservation.

What are the limitations of these benchmarks?

The effectiveness and efficiency of the processes and procedures identified as benchmarks in *P. cinnamomi* management is largely unknown, as some are in the early stages of implementation, while insufficient monitoring has occurred for the evaluation of others. However, the processes and procedures identified are considered the *current* 'best practice' in the management of *P. cinnamomi* in natural ecosystems

of Australia. The benchmarks should be reviewed as information from monitoring becomes available.

4.1. Strategic Management

Legislation & Statutory Policy

Improving the Understanding and Effectiveness of Legislation: In each States there is one or more piece of legislation that either provides direct powers to protect threatened species or assets from threats such as *P. cinnamomi*, or which can be used to trigger action against trade and/or other activities that knowingly spread the pathogen. However, the interrelationships with national or other State legislation are complex and are generally poorly understood. This is of particular concern when the overriding legislation governs a high risk activity such as, for example, the laying of telecommunication cables which is governed by national legislation.

Many other problems with statutory provisions for *P. cinnamomi* management have also been identified in weed management and include: lack of clear and appropriate objectives for weeds legislation, the slowness of implementing legislation for preventing spread of weeds, lack of consistency of legislation within and between States and Territories and insufficient resources to implement weeds legislation effectively. The NWS produced a Discussion Paper explaining the rationale and mechanisms for government intervention in weed management and compared legislation in each State and Territory. The paper identifies nine core interlinked and achievable principles for effective State/Territory weeds legislation (Weeds Australia website – Newsletter and Papers, accessed 20/09/05). The WWF also acknowledges many gaps in weeds legislation and has formulated a '4 Point Plan' to make State and Territory laws more effective (Glaznig 2005). Similar projects are required to unravel the complexity of legislation relating to *P. cinnamomi*.

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act): The mechanism for national protection of Australian biodiversity is the EPBC Act, under which *P. cinnamomi* is listed as a national 'key threatening process'. Any actions that may threaten species and communities that are listed under the Act must be referred to DEH for approval, and such actions may be denied or may be granted with the inclusion of measures for risk mitigation of *P. cinnamomi*.

The National Threat Abatement Plan for Dieback Caused by the Root-Rot Fungus *Phytophthora cinnamomi* (NTAP): It is a requirement that a threat abatement plan is developed for each key threatening process listed under the EPBC Act. The NTAP for *P. cinnamomi* describes how the Commonwealth Government will act to abate the threat of the pathogen in Australia, through the declaration of the Commonwealth's goals, objectives and plans for coordinated actions (Environment Australia 2001). The Plan is due for review in 2006.

The National Weeds Strategy: In the five years to 2002, 15 of the 26 strategies had been fully implemented and significant progress made on another 10 (NWSEC 2002). The successful implementation can be attributed to allocation of resources for a dedicated national coordinator, and their in facilitating action and collaborations with and between relevant Australian and State/Territory Government Department as well as other key agencies including: Australia Quarantine and Information Service, Biosecurity Australia, Plant Health Australia, Nursery and Garden Industry Association of Australia, Cooperative Research Centre for Australian Weed Management and the Office of the Chief Plant Protection Officer.

Non-Statutory Policy & Planning

Policy and Planning by CALM in WA: The WA Department of Conservation and Land Management (CALM) provides a benchmark in non-statutory policy and planning through the development of the following processes that operate in an integrated fashion designed to improve management outcomes:

- a departmental policy statement on *P. cinnamomi* (CALM 2004a)
- best practice guidelines for the management of *P. cinnamomi* (CALM 2004b)
- public consultation on the development of the policy and best practice guidelines
- operational guidelines for: general management of *P. cinnamomi* (CALM 2003); detection, diagnosis and mapping of disease (CALM 2001); and phosphite application (CALM 1999a and 1999b)
- training (developed and delivered in-house) for staff and contractors (CALM 2004c)
- a departmental requirement that detection, diagnosis and mapping on lands managed by CALM or on other lands for purposes that relate to the Department's conservation responsibilities, be undertaken by qualified 'disease interpreters'
- a protocol for the identification of 'protectable areas' and setting management priorities (DCC 2000)
- support for a full-time position to coordinate the Department's *Phytophthora* management activities.

Policy and Planning by WA State Government: The WA Minister for the Environment appointed the Dieback Consultative Council (DCC) in 1997 to provide specialist advice on issues relating to *P. cinnamomi* in WA including: research, management and funding priorities for the State, policy revision and development for CALM and the State, and participation in the NTAP. Key stakeholders from government, industry, research and the community are represented on the Dieback Consultative Council.

The DCC assisted in the development of a State Government initiated Dieback Response Policy Framework, which was launched by the State Minster for the

Environment in 2004. Key strategies of the Framework which are currently being implemented include the development of:

- a dieback atlas for WA
- management guidelines for use on all land tenures
- a generic dieback risk assessment methodology
- an action plan specifically to tackle the dieback threat to areas such as the Fitzgerald River National Park
- a whole-of-government policy on dieback management.

Codes of Practice: Codes of Practice are needed for industries and activities that pose a high risk of spreading *P. cinnamomi*. Codes of Practice have been developed for, and in consultation with, the extractive industries of Tasmania and WA. The Tasmanian Quarry Code of Practice provides principles, acceptable standards and suggested measures on all aspects of the extractive process to improve environmental outcomes, including the management of *P. cinnamomi* (DPIWE/DIER 1999). The Code of Practice developed in WA with the extractive industry, specifically for management of *P. cinnamomi* (DWG 2004a), includes best practice guidelines (DWG 2005).

A Code of Practice for the management of reserves in Tasmania is designed to promote consistency in the application of management practices by staff of key land management agencies. It provides 'best practice operational standards' for all activities, including plant disease management, which reserve managers are required to adhere to. They must also refer to the Code when assessing applications for lease, permits or exemptions for activities. The Code refers to other relevant codes, key resources and databases to aid in the management of *P. cinnamomi*, which is regarded as one of the primary plant disease problems in Tasmania reserves (TPWS, FT & DPIWE 2003).

Cruisin'Without Bruisin' is a track guide and Code of Practice that was developed for those who undertake recreational vehicle use in parks and reserves of Tasmania. The Code is published on the TPWS website (TPWS website –4WD Recreation, accessed 18/02/05), and also available in pamphlet form.

Investment

No benchmark for investment in the science and management of *P. cinnamomi* was identified, indicating that the current inadequate and *ad hoc* methods of investment do not allow the necessary long-term, cohesive and strategic approach to the threat posed by *P. cinnamomi* to Australia's biodiversity.

Business Case Study on *P. cinnamomi*: The current lack of information on the economic impacts of degradation of environments by *P. cinnamomi* is a major impediment to attracting adequate funding for the necessary research and management of the pathogen. It has relegated *P. cinnamomi* management and research into the arena of 'public good' issues, which traditionally have a lower

priority for funding than issues with clear economic or commercial impacts. The Centre for *Phytophthora* Science and Management (CPSM) in WA has commissioned, as part of the State Government Dieback Response Framework, a case study to quantify the benefits of investing in the science and management of *P. cinnamomi* in WA, and conversely the risks of failing to invest or delaying investment (Economic Research Associates 2004). The Business Case Study will form the basis of a case for long-term and strategic investment to be put to the WA Government, Industry and the community. A recent economic assessment clearly demonstrated in exact dollar terms the benefits of prevention and early intervention to eradicate weed incursions, compared to the costs and benefits of containing established weeds (Barker 2005). Economic assessments of this nature are required for the national threat that *P. cinnamomi* poses.

NWS Investment Model: Investment in pest plants of national significance through the NWS provides a relevant model for investment in *P. cinnamomi* management and, in particular, the implementation of the NTAP. A position of Project Manager for the NWS was funded at a rate of $140,000 per annum for three years equally shared by the Australian Government Department of Agriculture, Fisheries and Forestry, and the Standing Committee on Agriculture, Fisheries and Forestry. The success of the NWS has been largely attributed to the extension and liaison of the Project Managers with all stakeholders. From 2000 to 2002 the project received $169,400 per annum for the implementation of the strategy from Environment Australia (50%) and State/Territory environment, conservation and forestry agencies. This investment model enabled the completion of over half the strategies, and significant work to be undertaken on the others, in five years (NWSEC 2002).

Cost-Sharing Between the Australia and State/Territory Government in Weed Management: Technical criteria developed as part of the NWS are used to determine the need for cost-sharing arrangements between the Australian and State/Territory Governments in the eradication pest plant incursions (NWSEC 2002; Panetta *et al.* 2002). Criteria are also needed to determine cost-share arrangements for the management *P. cinnamomi* between the Australian Government and affected State/Territory Governments particularly where the pathogen poses a threat to nationally significant assets.

4.2. Research

The Centre for *Phytophthora* Science and Management, Murdoch University (CPSM): The CPSM at Murdoch University in WA, while still in the development phase, provides a model for a strategic approach, with a long-term vision, to the research necessary to improve management of *P. cinnamomi* in natural ecosystems. The CPSM has developed collaborations and linkages with industry, government and non-government organisations within WA, nationally and internationally in the following research programmes:

- biology of *P. cinnamomi* in ecosystems
- disease management

- conservation, biodiversity and ecosystem restoration
- information dissemination and training
- disease diagnostics and extension.

The CPSM supports the State Government Dieback Policy Framework which is aiming for a whole-of-State policy for *Phytophthora* management. As well as conducting research, CPSM is a key participant in a number of the initiatives of the Policy Framework including the Dieback Response Group and the sub-committee of the DCC responsible for the development of the Communication Strategy for WA. Although CPSM is exploring a number of investment options, there is currently no core funding and the Centres' research and management activities currently depend on competitive grants and other *ad hoc* funding sources.

The Cooperative Research Centre (CRC) Programme: The Australian Government, Department of Education Science and Training, CRC Program fosters close interaction between scientists, private industry and public sector agencies in long-term collaborative arrangements which support research, development and education activities. Funding, ranging from $20 to $40 million, is provided to CRCs over seven years (DEST website – CRC, accessed 20/09/05).

The CRC Program has enabled a long-term strategic approach to research and management of weeds to be undertaken in Australia. The CRC for Australian Weed Management (CRC AWM) plays an integral role the implementation of the NWS (NWSEC 2002). The CRC AWM operates five programs which range from assessing risks to formal training and activities to raise community awareness of weeds, and the role they can play in managing them. The CRC AWM conducts research, provides extension services and technical advice on environmental and agricultural weed across Australia (Weeds CRC website, accessed 20/09/05).

4.3. Training & Extension

Training

Training by CALM in WA: CALM has developed and delivers four training courses that are accredited within the organisation and widely recognised in WA to staff and contractors:

- *Phytophthora cinnamomi* management
- *Phytophthora cinnamomi* detection, diagnosis and mapping
- *Phytophthora cinnamomi* field operators course
- *Phytophthora cinnamomi* phosphite operators course.

The competency-based training is consistent with the detailed manuals that have been developed for management (CALM 1999a, 2001 and 2003). CALM provides training to staff and contractors on a needs basis in the areas of *P. cinnamomi* management, field operations and phosphite operations, while training in detection, diagnosis and mapping is mandatory for Departmental 'Disease Interpreters'. As well as formal

classroom training (4 days), the detection, diagnosis and mapping course has a field experience requirement of up to 3 months before a trainee is considered qualified.

Training by Alcoa World Alumina in WA: Alcoa delivers training in *P. cinnamomi* management to staff via a computer-based Learning Management System, part of the company's overall Environmental Management System. The training modules were developed specifically for the WA mining operations by Alcoa's Senior Environmental Consultant.

The training covers biology and ecology of the pathogen, procedures for management during all mining operations and a self-test process. Office-based personnel receive a computer-generated reminder every two years to take a computer re-test. A successful re-test requires that all questions are answered correctly, and the test must be repeated (the test can be taken only once per day) until 100% is achieved. On successful completion of the re-test an electronic report is automatically generated and sent to the Senior Environmental Officer. Field-based personnel receive similar refreshers in a classroom setting which is triggered at appropriate intervals by the Senior Environmental Officer at the mine.

Tertiary Education in Weed Science and Management: Following a review of university weed management courses in Australia, the CRC AWM developed a course which meets the objectives of the NSW and which is available free of charge to any training institution (NWSEC 2002).

National Weed Management Training Competencies: National weed training competencies were incorporated into the Conservation and Land Management Package that was developed by the Rural Training Council of Australia, and endorsed by the Australian National Training Authority. The training competencies are predicted to have the greatest single impact of all the NWS actions. They will form the basis of consistent training across the nation, encourage professional standards for weed officers, and enable job mobility and promotional standards to be developed (NWSEC 2002).

A system of accreditation has been developed that recognises prior learning and performance on the job as the basis for accreditation. However, where a person does not have the required skills, it will be necessary for them to undergo additional training, which may or may not require the services of a formal training body (Weeds Australia website – National Competencies for Weed Management, accessed 21/09/05).

Extension

Communications Strategy in WA: A comprehensive communications strategy for WA was developed in late 2004. Although the Strategy has been developed under the auspices of the DCC, the WA Dieback Working Group is the main driver of the Strategy, and the goals are entirely consistent with those of the Group (see the section below in the extension activities of the WA Dieback Working Group). The three key goals of the Communications Strategy are:

- increased awareness of *P. cinnamomi* so that it becomes a major environmental priority for the people of WA
- identification of key stakeholders groups and ideal behaviours for each group
- simple messages and the identification of appropriate communication methods to evoke the necessary changes in behaviour.

Stakeholder groups have been divided into the following categories: political agencies, Government agencies and utilities, NRM/Catchment Groups, Regional and Local Government, Industry, Research Organisations, Non-Government Organisations and the community. The strategy is still in the early stages of implementation and 2005 will be the baseline against which the effectiveness of the strategy will be measured through a monitoring program.

The term 'dieback' is widely recognised in WA as being associated with disease caused by *Phytophthora.* To prevent confusion with the introduction of a 'new term' it has been decided to refer to the disease as '*Phytophthora* dieback' with full explanations and the added slogan that it is a 'biological bulldozer' to indicate the seriousness of the problem in the South-West of WA.

Extension Activities of the WA Dieback Working Group: The WA Dieback Working Group (DWG) was formed in 1996 by Perth metropolitan area Local Government authorities, community groups and State Government land management agencies concerned with the management of *P. cinnamomi*. Prior to the formation of the Group there was very little information filtering through to Local Government authorities, other industry and the community in regards to the *P. cinnamomi* management procedures developed by CALM and mining companies in the State.

The WA DWG works for the protection of remnant native vegetation by providing land managers (for example; Local Government, the community conservation groups or leaseholders) with the knowledge and tools necessary to manage *P. cinnamomi*. This includes mapping disease occurrence and developing dieback management plans for specific areas, providing training in dieback management procedures, conducting information days, and where necessary assisting in the application of phosphite.

Two key areas where the WA DWG worked to encourage the adoption of *P. cinnamomi* management policies and procedures, has been with Local Government and the extractive industries. Guidelines have been developed for Local Government in policy development and implementation, and further support is offered to Local

Government in the form of training for personnel and on-ground services such as mapping of reserves and the development of management plans for them. The WA DWG has worked with the extractive industries to develop a Code of Practice (DWG 2004a) and Best Practice Guidelines for the Industry (DWG 2005).

Extension Material in SA: A range of excellent extension material has been developed in SA and is available as either hardcopy or electronically on the SA Government Department for Environment and Heritage website. The fact sheets target what are considered high-risk activities such as bushwalking (SA DEH 2003b), horseriding (SA DEH 2002b) and plant propagation (SA DEH 2003c). The horseriding fact sheet was produced in collaboration with the Horse Federation of South Australia. More detailed booklets have also been produced for *P. cinnamomi* specifically (SA DEH 2004a) and other forms of dieback (SA DEH 2004b).

All the material produced provide a clear and consistent message about the risks the potential impacts of the pathogen, and instruction for simple methods to reduce the risk of introducing the pathogen to uninfested areas. The guidelines provide useful information on the known extent of the threat in SA, known susceptible species and contact details for further information. The text is liberally illustrated with clear diagrams and high quality photographs, and all are available in electronic format, free, from the SA Government Department for Environment and Heritage website.

4.4. Detection, Diagnosis & Mapping

Disease 'Interpretation' Processes of CALM in WA: A systematic process for the detection, diagnosis, demarcation and mapping of *P. cinnamomi* has been developed by CALM in WA. CALM policy states that detection and diagnosis of disease caused by *P. cinnamomi* on lands for which CALM has conservation responsibilities must be undertaken by a 'qualified disease interpreter'. CALM has developed a course (4 days in the classroom and a period of field experience) in which personnel are trained and become 'qualified'.

Detection is based on the identification of visible symptoms of disease in over 40 species of plant in WA that are reliably susceptible to *P. cinnamomi* (indicator species), and confirmation of its presence through laboratory analysis of soil and plant tissues. The interpretation of visible symptoms of disease relies heavily on the evidence produced by the chronology and pattern of plant death, coupled with knowledge and information about environmental factors, site characteristics, and other potential causes of death including fire, drought, abiotic or other biotic diseases (CALM 2001).

Initial interpretation is done wherever possible from aerial colour photographs (1:4,500 nominal scale) followed by confirmation by on-ground survey. Where use of aerial photography is not possible, on-ground survey is undertaken. The physical demarcation of infestation boundaries has been standardised and all staff and contractors are trained to recognise the cues as triggers for particular management procedures.

Data collected during interpretation is included in the Departmental database. The interpretation process culminates in the production of a disease occurrence map, which in turn is used to produce 'protectable areas' and 'hygiene management' maps. Maps are considered out of date and unusable if over 3 years old.

Diagnostic Kit Developed by CRCTPP: A DNA-based *Phytophthora* identification kit (Phytophthora-IDENTIKIT^{TM}) was developed by the CRC for Tropical Plant Protection and released in 2004 for use by PCR licensed laboratories. It can detect and identify 26 different *Phytophthora* species from plant material (CRCTPP website - IDENTIKIT, accessed 21/01/05).

Diagnostic Protocol for *P. cinnamomi* by the European and Mediterranean Plant Protection Organisation (EPPO): In the absence of a standard protocol in Australia for the laboratory diagnosis of *P. cinnamomi*, the European standard has been identified as an appropriate benchmark. The EPPO is an intergovernmental organisation responsible for cooperation in plant protection in the European and Mediterranean region (EPPO website, accessed 20/05/05). The EPPO have produced a standard that describes in detail, diagnostic protocols for *P. cinnamomi* including examination of symptoms, isolation, identification of the pathogen through morphological characteristics, immunological and molecular methods, and reporting (OEPP/EPPO 2004).

Data Management in Tasmania: In Tasmania, DPIWE manages a database called GTSpot to which the States leading land managers (DPIWE, Tasmanian Parks and Wildlife Service and Forestry Tasmania) contribute data relating to *P. cinnamomi*. The information is readily accessible in electronic format to government, industry and the private sector, and can be interrogated for specific information for plotting or the creation of models. Pathogen isolation records are based on spot sampling of soil by Forestry Tasmania since 1972. Symptom distribution data consists of polygons assessed visually by trained observers. The database also contains maps of areas susceptible to *P. cinnamomi*, and *P. cinnamomi* management areas in Tasmania. State-wide mapping units within the Tasmanian floristic database, TASVEG, have been categorised on the basis of perceived susceptibility to *P. cinnamomi*, as either; reliably highly susceptible, reliably not susceptible or having low susceptibility, or having variable susceptibility (Rudman 2004; Schahinger 2003; DPIWE website – GTSpot User Guide accessed 03/03/05).

4.5. Risk Assessment & Priority Setting

A range of tools have been developed to assist in planning and setting priorities for management of *P. cinnamomi* in natural ecosystems. The tools range from decision rules based on the vulnerability to disease and the likelihood of introduction, to risk assessment processes that require analysis and evaluation of the likelihood and consequences of *P. cinnamomi* introduction or spread. The various methods in use are a reflection of the variable environmental, political, financial and social contexts

in which *P. cinnamomi* occurs and must be managed, as well as differences in the amount and quality of data available to drive the various processes.

A note on inconsistencies in the use of 'risk' is warranted at this point, as the term is used variably in the benchmarks below. In some processes risk is used to describe vulnerability to disease and/or likelihood of introduction, while in others it used to describe the potential consequence of an introduction. 'Risk' as defined by Standards Australia (AS/NZS 4360: 1999) is: 'The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood'.

The Protection of Threatened Species and Communities

Risk Assessment Process developed through NTAP for *P. cinnamomi*: In the current project a methodology, suitable for national adoption, was developed for assessing the risk of *P. cinnamomi* to threatened species, communities and areas, and ranking them as the basis for setting management priorities (Part 3 – Risk Assessment Models for Species, Communities and Areas). The models identify the source of risk, the likelihood of occurrence and the magnitude of the consequences. The models are semi-quantitative (i.e. qualitative criteria are assigned scores) and therefore produce indicative assessments. The models are based on current scientific knowledge, but rely on expert judgements where there are significant knowledge or data gaps. As knowledge of the epidemiology increases and datasets improve, revision with quantitative criteria will make the models more accurate. Recommendations on the use of the models include a review after 12-24 months of use, but in the meantime institute programs to gather necessary datasets particularly for the susceptibility of listed taxa to *P. cinnamomi*.

Identification of '*P. cinnamomi* Management Areas' in Tasmania: The Tasmanian process of setting management priorities identified 67 '*P. cinnamomi* Management Areas' based on the presence of viable numbers of rare and susceptible plant species and communities and the capacity to provide long-term protection against infection by *P. cinnamomi* (Barker *et al.* 1996; Schahinger *et al*., 2003). Priorities for management included 12 species listed in the Commonwealth Government's EPBC Act. However, also targeted were areas which contain species that are listed under the Tasmanian *Threatened Species Protection Act 1995*, and plant communities perceived to be reliably highly susceptible according to the Tasmanian floristic database TASVEG (Schahinger *et al*., 2003).

CALM Protocol for Identification of 'Protectable Areas': 'Protectable areas' are defined as uninfested areas, occurring in the vulnerable zone, that have good prospects of remaining uninfected over the next 2-3 decades. The highest priority for management is afforded to areas with very high conservation values at risk e.g. listed species, communities and habitats.

The Protection of Significant Disease-Free Areas

Regional Scale Project in WA: A regional scale project, funded under the Commonwealth Government Natural Heritage Trust–Regional Competitive Component, is currently being undertaken in WA by the South Coast Regional Initiative and Planning Team (SCRIPT) Natural Resource Management Region in WA. The primary goal is to protect, in the long term and regardless of land tenure, the biodiversity of areas assessed as significant, valued by the community and at risk from dieback caused by *P. cinnamomi*. The process initially involves the identification of significant disease-free areas, followed by an assessment of those areas for risks of *P. cinnamomi* introduction, and the manageability of those risks. Community input is being sought in the nomination of areas for assessment. Ultimately, management plans will be developed for specific areas identified as having regional and community significance.

Vulnerability Mapping

Although the benchmarks below are sometimes referred to as 'risk mapping', a more accurate description, based on Standards Australia terminology described above, is the mapping of areas that are vulnerable to disease based on environmental parameters, and in some cases the likelihood of *P. cinnamomi* being introduced to an area based on human access and land-use.

The Potential Distribution and Impact of *P. cinnamomi* in Victoria: A strategic level map was developed for Parks Victoria showing the potential distribution and impact of *P. cinnamomi* in the State. The risk map was constructed with GIS overlays of; topographic and climatic parameters suitable for the pathogen, known distribution of the pathogen, distribution of susceptible species and the distribution and density of roads and tracks as a surrogate for the probability of pathogen transmission (Gibson *et al.* 2002). The risk classification system has been incorporated as a layer in the Parks Victoria electronic Environmental Management System (Parks Victoria 2004).

Correlation Between Disease and Site Characteristics in the Wet Tropics World Heritage Area: As *P. cinnamomi* is uniformly distributed in the soils of the Wet Tropics World Heritage Area but disease associated with *P. cinnamomi* is not a project was undertaken to determine if there is any site specificity to the outbreaks. Patches of canopy disturbance observed from aerial photographs were transferred onto topographic maps, digitised and overlain with environmental attributes recorded in GIS and data derived from multi-spectral aerial imagery. This analysis showed that areas of disease were correlated with acid-igneous geology, flat areas where drainage is impeded, notophyll dominant vegetation and elevations of 750 m and greater (Gadek *et al.* 2001; S. Worboys *pers. comm.*).

The Shire of Mundaring, WA: As mapping the distribution of *P. cinnamomi* is beyond the resources of the Shire of Mundaring, road reserves are assigned a 'risk category' based on an assessment of the integrity and health of the vegetation by a qualified ecologist (for example, vegetation in excellent condition would be considered a 'high' risk of becoming infected with *P. cinnamomi*). In the Shire's GIS database the risk category for an area is combined with relevant site factors to produce a *P. cinnamomi* 'risk rating' which appears on operational scale maps and triggers the deployment of appropriate management tactics (McCarthy 2005b).

Decision Rules

Decision rules have been developed to assist in management planning by identifying vulnerable areas and applying some criteria by which on-ground management options are deployed.

Tasmania: the management system in Tasmania recommends management measures according to the likelihood of *P. cinnamomi* being introduced to vulnerable uninfested areas. The likelihood of an introduction is considered high if i) public access to the area is unlimited or ii) low if access is restricted (Rudman 2004).

South Australia: 'Risk' ratings are assigned to areas in SA according to the disease status of the site and the likelihood of *P. cinnamomi* spread from it, or the potential for the pathogen to be introduced to the site and become established. In contrast to other affected States, infestations in SA are largely localised. Consequently, 'High Risk Zones' are those confirmed or suspected to be infested and for which strict *P. cinnamomi* management guidelines will apply to ensure the pathogen remains localised and is not spread from the site (PTG 2003).

4.6. Standard Operating Procedures

A number of guidelines for *P. cinnamomi* management have been developed around Australia for a range of audiences and applications. Each is a benchmark in its own right. The application or audience is self-evident from most of titles listed below, although where this is not the case the application is briefly described.

- **Assessment of Guidelines for Best Practice Management of *Phytophthora cinnamomi* in Parks and Reserves across Victoria (Cahill *et al.* 2002):** Not currently available electronically. Contact Parks Victoria on 13 1963 for further information.
- **Best Practice Guidelines for the Management of *Phytophthora cinnamomi* (CALM 2004b):** The purpose of the best practice guidelines is to provide the staff of CALM in WA with a clear and concise statement of the best practice methods and standards for managing the threat posed by *P.*

cinnamomi. The guidelines are also designed to be adapted by other land management organisations and proponents of activities in vulnerable areas.

- **Guidelines for reducing the spread of *Phytophthora cinnamomi* during earth moving operations (Smith 2002)**

- **Interim *Phytophthora cinnamomi* Management Guidelines (Rudman 2004):** This document is recommended for planners, land managers and contractors across the different sectors of the community and tenures. It provides provides the planning framework, assessment tools and recommended prescriptions necessary for a standard approach to management of *P. cinnamomi* in Tasmania.

- **Management of Phytophthora Dieback in Extractive Industries (DWG 2005)**

- **Managing Phytophthora Dieback: Guidelines for Local Government (DWG 2000)**

- **Managing Phytophthora Dieback in Bushland: A Guide for Landholders and Community Conservation Groups (Dunne 2005)**

- **Nursery Industry Accreditation Scheme, Australia. Best Management Practice Guidelines (NIASA 2003):** Available for purchase at the Nursery and Garden Industry website, http://www.ngia.com.au/accreditation/niasa.asp

- ***Phytophthora cinnamomi* and disease caused by it. Volume 1 – Management Guidelines (CALM 2003):** Primarily a guide for the staff of CALM in WA, on Departmental legislative responsibilities, policy and procedures in relation to the management of *P. cinnamomi* on CALM estate. However, it is freely available from the CALM website and therefore provides guidance to any interested party on the best current management practices.

- ***Phytophthora cinnamomi* and disease caused by it. Volume 2 - Interpreter's Guidelines for Detection, Diagnosis and Mapping (CALM 2001):** Not currently available electronically. Contact CALM on (08) 9334 0333 for further information.

- ***Phytophthora cinnamomi* and disease caused by it. Volume 3 - Phosphite Operations Guidelines (CALM 1999a)**

- ***Phytophthora:* Fire Response Team Handbook, Kangaroo Island (SA DEH 2003a)**

- ***Phytophthora cinnamomi* causing dieback in plants (SA DEH 2004a)**

- ***Phytophthora* Management Guidelines (PTG 2003):** These Guidelines were developed by the cross-agency Phytophthora Technical Group of SA. They have stated that the aims of the Guidelines is to provide a framework for the management of Phytophthora, by Government and non-

government organisations, landholders, c ommunity groups and individuals in order to achieve the best outcomes in *P. cinnamomi* management.

- **Rainforest Dieback: Risks Associated with Roads and Walking Tracks (Worboys and Gadek 2004)**
- **Tasmanian Washdown Guidelines for Weed and Disease Control (Rudman *et al.* 2004)**

4.7. On-Ground Management

Best Current On-Ground Management Options Identified in the Current Project: *P. cinnamomi* cannot be eradicated from a site with current levels of knowledge about the pathogen. Therefore, on-ground management in natural ecosystems focuses on: i) limiting the spread and, ii) mitigating the impacts of the pathogen in the landscape. The best current on-ground management options from around Australia are compiled in section 5 On-Ground Management Options.

On-Ground Management of High-Risk Activities by Alcoa in WA: Alcoa have integrated a range of tactics for *P. cinnamomi* management in their mining operations in jarrah forest that is largely uninfested. The effectiveness of the management is underpinned firstly by accurate maps of pathogen distribution, followed by careful planning of operations, appropriately trained staff and contractors, auditing of compliance and regular monitoring. The objective is to ensure that mining is economic, but the risk of spreading *P. cinnamomi* is low. The following management tactics (Colquhoun and Hardy 2000) are employed :

- the boundary between infested and uninfested sites or materials is known at all times, and visually demarcated, during each stage of the mining operation
- many of the high-risk operations (e.g. exploration drilling) are scheduled for the hot/dry months in which the probability of transmitting infested soils is lowest
- careful planning goes into the positioning of roads, the sequence of mining and the location of stockpiles
- access is restricted to uninfested areas
- main haul roads are constructed of uninfested material under strict hygiene procedures and form ‘bridges’ across infested areas
- vehicles must be cleaned upon entry to the mine from public roads or forest tracks
- vehicles entering the mine are cleaned via an automated and monitored washdown, and within the mine portable washdowns are used where necessary
- infested and uninfested materials are handled and stored separately so that cross-contamination is minimised
- surface water discharge is always controlled through drainage channels or bunds, and is never allowed to drain freely into the forest.

The Use of Phosphite by CALM to Mitigate Impacts in WA: Phosphite is currently used in WA to i) protect critically endangered flora species on infested sites from disease and, ii) as part of an integrated management program to contain the spread of *P. cinnamomi* from a localised infestation, Bell Track, in Fitzgerald River National Park. This infestation in Fitzgerald National Park is currently confined to a poorly defined micro-catchment. However, if it spreads from the current position, approximately 7000 ha of highly diverse ecosystem containing rare and endangered flora and fauna species is under imminent threat. In both cases, phosphite has been applied aerially which is a cost effective method for the application over large areas and rough terrain.

Experimental work on the target and non-target effects of phosphite in natural ecosystems is ongoing in WA. In the meantime however, using the latest research information, CALM is using phosphite to protect critically endangered susceptible assets from *P. cinnamomi*. Training courses and standard operating procedures for the application of phosphite have been developed for (CALM 1999a). As the budget available for phosphite application in any one year is limited, CALM have also developed a protocol to enable priorities to be set amongst competing demands, and annual application programs to be established (CALM 1999b).

The use of *Ex-situ* Conservation and Translocation of Germplasm to Mitigate Impacts in WA: CALM is the key agency in an integrated strategy for the conservation of threatened flora in WA. The *ex-situ* conservation program, which was established in 1992, provides critical support to *in situ* measures by improving the understanding of regeneration techniques, the safekeeping of genetic material in the form of seed, and the provision of that material for translocation programs. In contrast to other tissue types, conservation of seed has many advantages including: simple technology, costs and space requirements are low, most flowering plants produce seeds which can be stored for long periods with little loss of viability, the technique is applicable over a wide range of species, and there is wider genetic representation in seed than in vegetative material. Collaborating agencies including the WA Botanic Gardens and Park Authority and Millennium Seed Bank Project (Millenium Seedbank Project Website, accessed 18/04/05), based at the Royal Botanic Gardens Kew, hold duplicate collections (Cochrane 2004).

Initially, a major focus of the seed conservation program in WA was on species at risk from *P. cinnamomi*, and currently half the species stored are threatened by the pathogen (Cochrane 2004; Shearer *et al.* 2004). The program has expanded in recent years to include species threatened by habitat fragmentation, changes in hydrology and naturally rare species. Since 2000 the *ex-situ* program has also provided material to the Senior *Phytophthora* Research Scientist in CALM for trials to extend knowledge on the susceptibility of rare and endangered flora in WA to *P. cinnamomi* (Cochrane 2004; Shearer *et al.* 2004).

Translocation, of plants raised from seed provided by the *ex-situ* conservation program, is being used experimentally as part of Interim Recovery Plans for WA-listed critically endangered taxa (Cochrane 2004; Monks and Coates 2002). Translocation, usually by ‘introduction’ and ‘conservation introduction’, is one of the management measures applied as part of recovery plans for critically endangered plant species for which *P. cinnamomi* is a key threat (L. Monks *pers. comm.*).

4.8. Monitoring, Audit & Review

Monitoring

No benchmark for monitoring was identified. This is not to say that none occurs, but it does indicate that there has been a failure to invest in strategic, sustained and coordinated programs of monitoring. Consequently, the full extent of the pathogens impact and the effectiveness of management measures are largely unknown. 'Best guess' and surrogates are still being employed to predict the long-term consequences of *P. cinnamomi* to the environment, the economy and society (Part 2 –Risk Assessment for Threats to Ecosystems, Species and Communities: A Review).

Audit & Review

Environmental Management System of Alcoa in WA: Alcoa undertake annual internal audits for operational performance and procedural compliance in *P. cinnamomi* management. The accredited EMS (AS/NZS ISO 14001:1996) adopted by Alcoa is audited by an independent auditing contractor every 4 years, and in recent years has been extended to *P. cinnamomi* management procedures. Alcoa is in the process of integrating the audit of *P. cinnamomi* management procedures with the broader environmental audit which is more efficient, but also ensures that management of the pathogen is considered central to the Company's environmental policy rather than a 'side issue' (I. Colquhoun *pers. comm.*).

All operations associated with mining and rehabilitation are audited including: exploration and drilling, clearing vegetation prior to mining, landscaping, control of access to the mine, maintenance of roads and tracks, washdown procedures, demarcation of infested areas, drainage and soil movement records. Environmental Officers, Supervisors and on-ground workers are interviewed and the mine physically inspected. The auditors assign a rating to performance, make recommendations and list actions for improvement. Each action is assigned to a responsible individual to complete, and a tracking system ensures that it is acted upon (I. Colquhoun *pers. comm.*).

5. ON-GROUND MANAGEMENT OPTIONS

In this section, options for on-ground management have been compiled from current practices around Australia aimed at limiting the spread and mitigating the impact of *P. cinnamomi* in natural ecosystems (Table 5.1 to 5.7). The microscopic pathogen *P. cinnamomi* can be readily moved from one location to another in infested soil, plant material or water. Consequently, the options developed to reduce the probability of spreading *P. cinnamomi* focus on minimising the movement of these materials.

The management options are presented according to the following range of activities that may be undertaken in natural areas by either owners, managers or users of the land:

Table 5.1 Ecosystem and biodiversity conservation

Table 5.2 Research, survey, rehabilitation and conservation activities

Table 5.3 Recreational land use

Table 5.4 Construction and maintenance of road/tracks and other infrastructure

Table 5.5 Fire control and emergency rescue operations

Table 5.6 Low impact commercial activities (e.g. apiary, flower and seed collecting)

Table 5.7 High impact commercial activities (e.g. mining, extractive industries, forestry, establishment and maintenance of utilities).

A decision flow diagram (Figure 5.1) is provided as a guide to the appropriate application of the management options, based on the suitability of the site for the persistence and establishment of *P. cinnamomi*, and according to whether the site is infested, uninfested sites or where the disease status is unknown.

If the disease status of the site is unknown, a survey is required. Current methods of detection, diagnosis and mapping have been discussed in detail in section 3.4 of the review of current practice. However, surveys may fail to establish the disease status of a site for many reasons including: a failure to detect *P. cinnamomi* from soil and/or tissue samples, poor knowledge of susceptible species in the area, the absence of susceptible species from the site, or the masking of disease symptoms by other factors such as recent fire or drought. If the disease status of the site cannot be determined after a survey, the 'unknown' column should be consulted. The 'unknown' column includes management options to both protect uninfested sites, and prevent transmission of the pathogen from infested sites.

Important Caveats on the Use and Interpretation of Tables 5.1 to 5.7

The deployment of any of the options from the tables should form part of a coordinated plan for the management of *P. cinnamomi* in a site/area or region. The efforts of managing *P. cinnamomi* during site restoration and conservation activities, will be quickly laid to waste if the pathogen is not similarly managed during the

construction or repair of road and tracks at the site. Consequently, management of *P. cinnamomi* should in the first instance be approached strategically, should form an integral part of the management plan for an area, and include processes of monitoring to ensure that the management options are deployed properly and are effective.

While integrating a number of appropriate management options from a single table will result in more effective management of *P. cinnamomi*, it will be not be practical to deploy all of the management options listed for a particular activity or site. In all cases, the risk of introducing or spreading *P. cinnamomi* at a particular site for a particular activity will need to be assessed, and the tables consulted to determine which combination of the options will most effectively reduce those risks. The ability to deploy the management options identified will then depend on socio/political considerations and available resources.

As previously explained the tables provide options for infested, uninfested sites and sites of unknown disease status. A '+' in a cell relating to a particular option indicates that this is an appropriate option to employ. Users will note that the majority of cells containing '+' are unshaded, but a proportion are shaded in the column of options for infested sites. These shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread into the surrounding uninfested landscape.

Important Information and Caveats on the Use of Phosphite

The application of phosphite is an extremely valuable management tool and is currently used, primarily in WA, to protect areas or species of high conservation value from *P. cinnamomi*. .The use of phosphite is presented as a management option for ecosystem and biodiversity conservation in Table 5.1. However, it is strongly recommended that before it is used in other States/Territories, that the information and caveats presented here be carefully considered.

Currently, the autonomous spread of *P. cinnamomi* cannot currently be controlled. However, treatment of susceptible vegetation with phosphite, the anionic form of phosphonic acid (HPO_3^{2-}) and also referred to as phosphonate, has been shown in WA and Victoria to slow the spread and reduce the impact of the pathogen. Phosphite is considered environmentally benign, although knowledge about the target and non-target effects is far from complete, and an experimental link between phosphite and reduced pollen fertility has been made (Fairbanks *et al.* 2001). Refer to section 3.7. On-Ground Management for a more detailed review of phosphite use in natural ecosystems of Australia.

The beneficial properties of phosphite include:

- the induction of resistance to *P. cinnamomi*, in otherwise susceptible plant species (Guest and Bompeix 1990)
- its mobility in phloem and xylem (Ouimette and Coffey 1990) enabling application by trunk injection to Australian native trees and large shrubs (Hardy *et al.* 2001)
- the uptake of phosphite through foliage which enables it to be applied to Australian native vegetation as a foliar spray, either manually or by broad scale aerial application (Barrett 2003)

- it has simple chemical structure and current data indicates that it has low mammalian toxicity and breaks down rapidly in the soil (Guest and Grant 1991).

Phosphite application is presented in this document as a management option for the protection of biodiversity values from *P. cinnamomi*, particularly for the protection of susceptible rare and threatened plant species and communities Despite the predominance of WA and Victorian data on its use in native vegetation, and incomplete knowledge of the target and non-target effect; phosphite is an extremely important tool in the management of *P. cinnamomi*, for which there currently are very limited control options. Faced with the continued threat that *P. cinnamomi* poses to a significant proportion of Australia's native vegetation, the most responsible recommendation for other States/Territories is that, after reference to research results from WA and Victoria, that phosphite be used judiciously, results monitored and data collected to increase the national body of knowledge.

A protocol for setting treatment priorities was developed by CALM in WA, as the need for phosphite treatment regularly exceeds the available resources. The following broad priorities apply in WA:

PRIORITY A

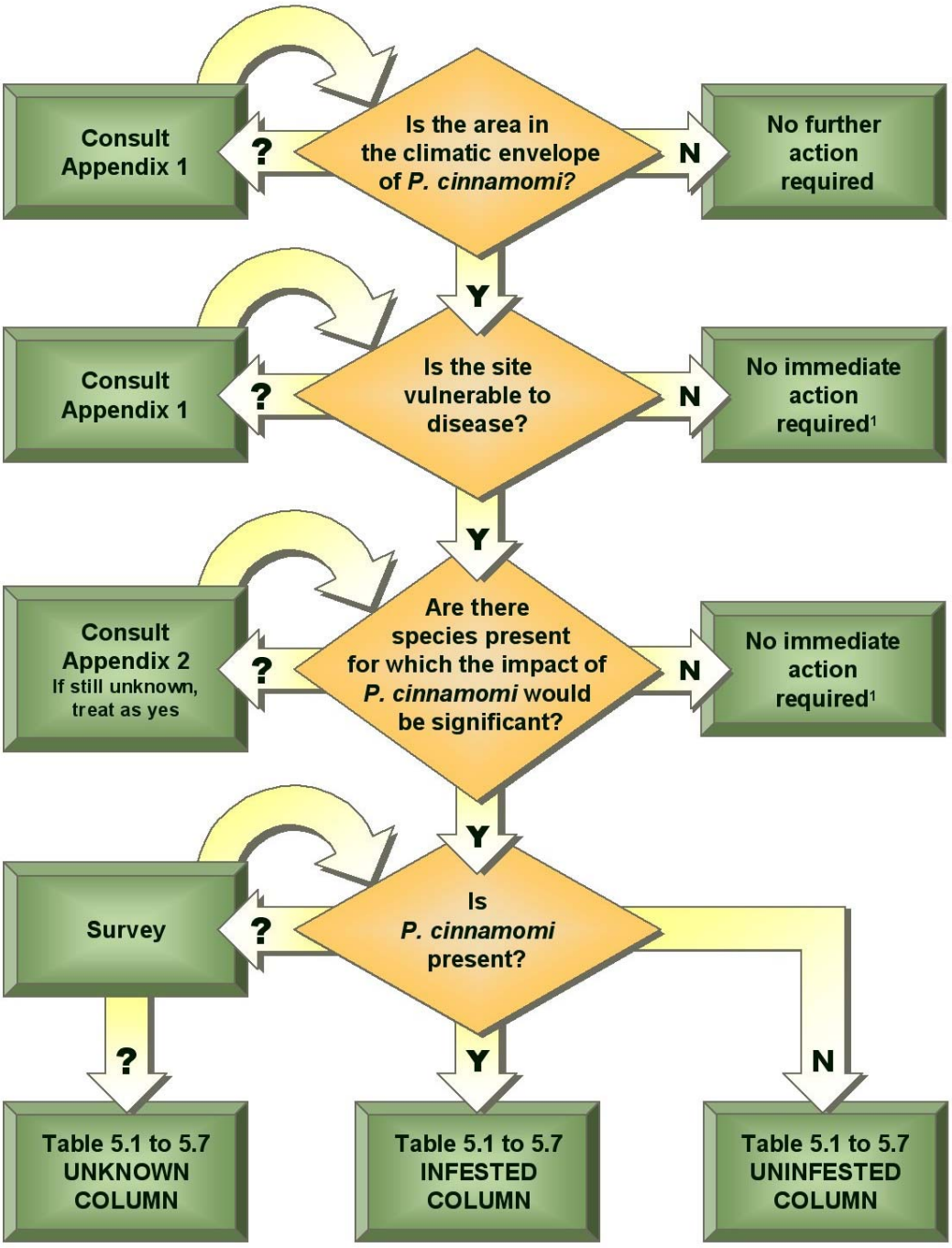
- protect threatened and priority flora, fauna and ecological communities
- strategic applications to protect other conservation, landscape and heritage values and local endemic representations of flora or fauna habitat

PRIORITY B - Rehabilitation projects and commercial values such as timber, recreation and/or wildflowers.

A scoring system has been developed to rank and further prioritise assets that meet the criteria of 'Priority A'.

CALM have also produced detailed Phosphite Operation Guidelines which provides background information on the compound, and covers all methods and aspects of application, and are provided courtesy of CALM as an attachment to this document.

The Australian Pesticides and Veterinary Medicines Authority (APVMA) administer the National Registration Scheme for Agricultural and Veterinary Chemicals (NRS) in partnership with the States and Territories. Phosphite is currently not registered for use in native vegetation, and therefore an 'off-label permit' may be required from the APVMA before use. However, as legislation can vary between states/territories it is recommended that the APVMA or the relevant APVMA State/Territory Co-ordinator is contacted for advice on permit requirements before use.



[1] Although no immediate action is required, there is a responsibility, statutory in WA & Vic, not to spread the pathogen to uninfested areas that may contain susceptible species.

Follow links to Appendix 1 and Appendix 2

Figure 5.1. A decision flow chart to determine the need for management of *P. cinnamomi* and the appropriate management options, based on the disease status of the site, to be deployed.

Table 5.1. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* for ecosystem and biodiversity conservation. Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
identify susceptible plant species and communities that are listed as 'threatened' under the *Australian Government Environment Protection and Biodiversity Conservation Act 1999*, relevant State legislation, those that may not be listed but fulfil IUCN criteria as 'threatened', or those with the potential to become threatened in the near future	+	+	+
set management priorities by undertaking a risk assessment for threatened or near threatened species, communities or areas that are susceptible to disease	+	+	+
conserve critically endangered species *ex-situ*	+	+	+
treat threatened plant species or communities with phosphite	+	+	+
educate staff, contractors and volunteers on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
where appropriate, consult with traditional owners prior to implementing management controls	+	+	+
restrict human access permanently	+	+	+
restrict human access temporarily (e.g. during wet weather)	+	+	+
restrict access to ranging livestock and other animals	+	+	+
manage drainage so that water is not discharged into uninfested areas, or is directed to the lowest point in the landscape		+	+
install or improve drainage sumps that are sealed to prevent animal and human access to the contents, that allow evaporation and that will contain a 1 in 10 year rainfall event	+	+	+
maintain drains and sumps regularly and dispose of contents ensuring infested material is disposed of hygienically	+	+	+

Table 5.2. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* during research, survey, restoration and conservation activities. Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
assess all operations for the likelihood of introducing or spreading *P. cinnamomi*, modify operations and apply hygiene to reduce the risks	+	+	+
schedule activity for periods with the highest likelihood of dry soil conditions	+	+	+
schedule activity in uninfested areas before moving to infested	+	+	+
educate staff, contractors and volunteers on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
where appropriate, consult with traditional owners prior to implementing management controls	+	+	+
define clear roles and responsibilities for staff and contractors in *P. cinnamomi* management procedures and prescriptions	+	+	+
supervise staff, contractors and volunteers to ensure compliance with *P. cinnamomi* management procedures and prescriptions	+	+	+
write specific *P. cinnamomi* management procedures and prescriptions into contracts and licence agreements, and monitor compliance	+	+	+
inform all land users and neighbouring landholders of the disease status of the area, management objectives and procedures and prescriptions	+	+	+
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+
restrict human access permanently	+	+	+
restrict human access temporarily (e.g. during wet weather)	+	+	+
restrict access to ranging livestock and other animals	+	+	+
minimise activities that cause soil disturbance (for example mow, slash or spray weeds rather than plough them under)	+	+	+
minimise the number of entry points	+	+	+
control unauthorised access	+	+	+

maintain natural barriers to *P. cinnamomi*	+		+
avoid watercourses or sites prone to flooding or ponding	+	+	+
avoid the importation of basic raw material, but if unavoidable use disease-free or low-risk construction materials	+	+	+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	+	+
vehicles, equipment, materials and footwear, clean on entry	+		+
vehicles, equipment, materials and footwear, clean on exit when moving to uninfested areas		+	+
construct hygiene station at border with uninfested area		+	+
employ a 'barrier system' if working across infestation boundaries is unavoidable	+	+	+
minimise the amount of water used on the site	+	+	+
use water from mains or deep bore for all activities (ensure no contamination with organic matter), or sterilise/disinfect water before use	+		+
manage drainage so that water is not discharged into uninfested areas, or is directed to the lowest point in the landscape		+	+
install or improve drainage sumps that are sealed to prevent animal and human access to the contents, that allow evaporation and that will contain a 1 in 10 year rainfall event	+	+	+
maintain drains and sumps regularly and dispose of contents ensuring infested material is disposed of hygienically	+	+	+
avoid the introduction of plants for revegetation. As an alternative, consider direct seeding or regeneration of vegetation by fire	+		+
if the introduction of plants is unavoidable, obtain them from a nursery accredited by NIASA	+		+
if the introduction of plants is unavoidable, obtain plants resistant to disease caused by *P. cinnamomi* from a nursery accredited by NIASA		+	
implement appropriate disease monitoring programs for new outbreaks of disease, spread of existing infestations and effectiveness of disease management procedures and prescriptions	+	+	+

Table 5.3. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* **during recreational land use**. Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
permanently restrict public access where threatened or potentially threatened species or communities have been identified	+	+	+
restrict access during periods of wet soil conditions	+	+	+
restrict movement of traffic from infested to uninfested areas	+	+	+
educate land users on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
where appropriate, consult with traditional owners prior to implementing management controls	+	+	+
educate local tourist operators and equipment hire companies on the threat of *P. cinnamomi*, management objectives and the promotion of responsible recreation by their customers	+	+	+
promote minimal soil disturbance	+	+	+
promote the avoidance of watercourses or sites prone to flooding or ponding	+	+	+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	+	+
restrict human access temporarily (e.g. during wet weather)	+	+	+
promote hygiene on entry	+		+
promote hygiene on exit when moving to uninfested areas		+	+
construct hygiene station at border with uninfested areas and erect clear information and instructions for use		+	+
provide adequate parking and turn-around points for vehicles on hard, well drained surfaces that do not impinge or drain into surrounding vegetation	+	+	+

Table 5.4. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* during the construction and maintenance of road/tracks and other infrastructure. Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
use existing roads and tracks wherever feasible, before constructing new ones	+	+	+
plan new or re-route existing roads/tracks so that they do not traverse infection boundaries or occur on ridges that form boundaries between infested and uninfested areas	+	+	+
plan new or re-route existing tracks to avoid watercourses, or sites prone to flooding or ponding	+	+	+
plan new or re-route existing tracks that are hard and well-drained with no water ponding	+	+	+
plan new or re-route existing tracks so they do not pass above susceptible and/or threatened communities	+		+
plan new or re-route existing tracks so that they pass through areas of non-susceptible vegetation	+		+
assess all operations for the likelihood of introducing or spreading *P. cinnamomi*, modify operations and apply hygiene to reduce the risks	+	+	+
schedule activity for periods with the highest likelihood of dry soil conditions	+	+	+
schedule activity in uninfested areas before moving to infested	+	+	+
educate staff, contractors and volunteers on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
where appropriate, consult with traditional owners prior to implementing management controls	+	+	+
define clear roles and responsibilities for staff and contractors in *P. cinnamomi* management procedures and prescriptions	+	+	+
supervise staff, contractors and volunteers to ensure compliance with *P. cinnamomi* management procedures and prescriptions	+	+	+
write specific *P. cinnamomi* management procedures and prescriptions into contracts and licence agreements, and monitor compliance	+	+	+
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+
minimise activities that cause soil disturbance	+	+	+

grade from upslope to downslope	+		+
do not grade wider than existing road/track or wider than prescribed	+		+
angle grader blade to avoid carrying soil/gravel long distances	+	+	+
maintain natural barriers to *P. cinnamomi*	+		+
avoid watercourses or sites prone to flooding or ponding	+	+	+
avoid the importation of basic raw material, but if unavoidable use disease-free or low-risk construction materials	+	+	+
plan for hygienic earth-movement and stock-piling of soil and other basic raw materials on site	+		+
control unauthorised access to work site	+	+	+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	+	+
vehicles, equipment, materials and footwear, are to be clean on entry	+		+
vehicles, equipment, materials and footwear, are to be clean on exit when moving to uninfested areas		+	+
provide parking and turn-around points for vehicles and machinery on hard, well drained surfaces	+	+	+
construct hygiene station at border with uninfested areas		+	+
employ a 'barrier system' if working across infestation boundaries is unavoidable	+	+	+
minimise the amount of water used on the site	+	+	+
use water from mains or deep bore for all activities (ensure no contamination with organic matter), or sterilise/disinfect water before use	+		+
manage drainage so that water is not discharged into uninfested areas, or is directed to the lowest point in the landscape		+	+
install or improve drainage sumps that are sealed to prevent animal and human access to the contents, but that allow evaporation	+	+	+
maintain drains and sumps regularly and dispose of contents ensuring infested material is disposed of hygienically	+	+	+
when cleaning drains direct spoil onto surface such as paved roads where it can be removed and transported to a designated disposal site	+	+	+
construct wooden walkways over areas prone to ponding or mud	+	+	+

Table 5.5. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* during planning and preparation for wildfire control and other emergencies. While the priorities of life and property in the management of any emergency situation are recognised, *P. cinnamomi* management options can be employed during preparations and planning for emergency events which can significantly reduce the risk of pathogen spread. Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
identify areas at high risk from *P. cinnamomi* and avoid these whenever possible during planning for prescribed burns, wildfires and emergency rescue operations	+	+	+
assess all emergency preparedness activities for the likelihood of introducing or spreading *P. cinnamomi*, and modify operations and apply hygiene to reduce the risks	+	+	+
plan for hygienic aircraft access during wildfire response	+		+
use existing roads and tracks wherever feasible before constructing new ones. If new roads/tracks are necessary refer to Table 5.4 for prescriptions.	+	+	+
wherever possible schedule emergency preparedness activities for periods with the highest likelihood of dry soil conditions	+	+	+
wherever possible schedule emergency preparedness activities in uninfested areas before moving to infested	+	+	+
educate staff, contractors and volunteers on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
define clear roles and responsibilities for staff and contractors in *P. cinnamomi* management procedures and prescriptions	+	+	+
supervise staff contractors and volunteers to ensure compliance with *P. cinnamomi* management procedures and prescriptions	+	+	+
write specific *P. cinnamomi* management procedures and prescriptions into contracts and licence agreements, and monitor compliance	+	+	+
wherever possible minimise activities that cause soil disturbance	+	+	+
wherever possible grade from upslope to downslope	+		+
do not grade wider than existing road/track or wider than prescribed	+		+
angle grader blade to avoid carrying soil/gravel long distances	+	+	+

wherever possible maintain natural barriers to *P. cinnamomi*	+		+
avoid watercourses or sites prone to flooding or ponding during activities	+	+	+
avoid the importation of basic raw material, but if unavoidable use disease-free or low-risk construction materials	+	+	+
wherever possible restrict movement of vehicles and pedestrians to formed roads and tracks	+	+	+
maintain aircraft, vehicles and equipment in clean condition for emergency deployment	+	+	+
vehicles, equipment, materials and footwear, clean on entry	+		+
wherever possible vehicles, equipment, materials and footwear, clean on exit when moving to uninfested areas		+	+
provide parking and turn-around points for vehicles and machinery on hard, well drained surfaces	+	+	+
wherever possible construct hygiene station at border with uninfested areas		+	+
employ a 'barrier system' if working across infestation boundaries is unavoidable	+	+	+
use water from mains or deep bore for all non-emergency activities (ensure no contamination with organic matter), or sterilise/disinfect water before use	+		+

Table 5.6. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* during low impact commercial activities (e.g. apiary, flower and seed collecting). Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
assess all operations for the likelihood of introducing or spreading *P. cinnamomi*, modify operations and apply hygiene to reduce the risks	+	+	+
schedule activity for periods with the highest likelihood of dry soil conditions	+	+	+
schedule activity in uninfested areas before moving to infested	+	+	+
educate staff, contractors and volunteers on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
where appropriate, consult with traditional owners prior to implementing management controls	+	+	+
define clear roles and responsibilities for staff and contractors in *P. cinnamomi* management procedures and prescriptions	+	+	+
supervise staff, contractors and volunteers to ensure compliance with *P. cinnamomi* management procedures and prescriptions	+	+	+
write specific *P. cinnamomi* management procedures and prescriptions into contracts and licence agreements, and monitor compliance	+	+	+
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+
minimise activities that cause soil disturbance	+	+	+
avoid watercourses or sites prone to flooding or ponding	+	+	+
avoid the importation of basic raw material, but if unavoidable use disease-free or low-risk construction materials	+	+	+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	+	+
vehicles, equipment, materials and footwear, clean on entry	+		+
vehicles, equipment, materials and footwear, clean on exit when moving to uninfested area		+	+

Table 5.7. Management options to limit the spread and mitigate the impact of *Phytophthora cinnamomi* during high impact commercial activities (e.g. mining, extractive industries, forestry, establishment and maintenance of utilities). Note: the shaded cells denote options deployed when the infested area is localised and the management objective is to ensure the pathogen remains localised and is not spread to surrounding uninfested areas.

	Uninfested	Infested	Unknown
Management Options			
assess all operations for the likelihood of introducing or spreading *P. cinnamomi*, modify operations and apply hygiene to reduce the risks	+	+	+
schedule activity for periods with the highest likelihood of dry soil conditions	+	+	+
schedule activity in uninfested areas before moving to infested	+	+	+
educate staff and contractors on the threat of *P. cinnamomi*, management objectives, procedures and prescriptions	+	+	+
where appropriate, consult with traditional owners prior to implementing management controls	+	+	+
define clear roles and responsibilities for staff and contractors in *P. cinnamomi* management procedures and prescriptions	+	+	+
supervise staff and contractors to ensure compliance with *P. cinnamomi* management procedures and prescriptions	+	+	+
write specific *P. cinnamomi* management procedures and prescriptions into contracts and licence agreements, and monitor compliance	+	+	+
use existing roads and tracks wherever feasible before constructing new ones. If new roads/tracks are necessary refer to Table 5.4 for prescriptions.	+	+	+
plan new or re-route existing roads/tracks so that they do not traverse infection boundaries or occur on ridges that form boundaries between infested and uninfested areas	+	+	+
plan new or re-route existing tracks to avoid watercourses, or sites prone to flooding or ponding	+	+	+
plan new or re-route existing tracks that are hard and well-drained with no water ponding	+	+	+
plan new or re-route existing tracks so they do not pass above susceptible and/or threatened communities	+		+
plan new or re-route existing tracks so that they pass through areas of non-susceptible vegetation	+		+
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+

minimise activities that cause soil disturbance	+	+	+
grade from upslope to downslope	+		+
do not grade wider than existing road/track or wider than prescribed	+		+
angle grader blade to avoid carrying soil/gravel long distances	+	+	+
maintain natural barriers to *P. cinnamomi*	+		+
avoid watercourses or sites prone to flooding or ponding	+	+	+
avoid the importation of basic raw material, but if unavoidable use disease-free or low-risk construction materials	+	+	+
plan for hygienic earth-movement and stock-piling of soil and other basic raw materials on site	+		+
minimise number of entry points	+	+	+
control unauthorised access to site	+	+	+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	+	+
vehicles, equipment, materials and footwear, clean on entry	+		+
vehicles, equipment, materials and footwear, clean on exit when moving to uninfested areas		+	+
provide parking and turn-around points for vehicles and machinery on hard, well drained surfaces	+	+	+
construct hygiene station at border with uninfested areas		+	+
employ a 'barrier system' if working across infestation boundaries is unavoidable	+	+	+
minimise the amount of water used on the site	+	+	+
use water from mains or deep bore for all activities (ensure no contamination with organic matter), or sterilise/disinfect water before use	+		+
manage drainage so that water is not discharged into uninfested areas, or is directed to the lowest point in the landscape		+	+
install or improve drainage sumps that are sealed to prevent animal and human access to the contents, that allow evaporation and that will contain a 1 in 10 year rainfall event	+	+	+
maintain drains and sumps regularly and dispose of contents ensuring infested material is disposed of hygienically	+	+	+
avoid the introduction of plants for revegetation. As an alternative, consider direct seeding or regeneration of vegetation by fire	+		+

if the introduction of plants is unavoidable, obtain them from a nursery accredited by NIASA	+		+
if the introduction of plants is unavoidable, obtain plants resistant to disease caused by *P. cinnamomi* from a nursery accredited by NIASA		+	
implement appropriate disease monitoring programs for new outbreaks of disease, spread of existing infestations and effectiveness of disease management procedures and prescriptions	+	+	+

Follow links to Questionnaire: Benchmarks and Questionnaire 2: National Threat Abatement Plan

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APPENDIX 1

AREAS VULNERABLE TO DISEASE CAUSED BY *Phytophthora cinnamomi*

This section provides information necessary to navigate the decision flow chart (Figure 5.1) in On-Ground Management Options (Section 5). It provides information on the broad climatic envelope of *P. cinnamomi* in Australia, based on current knowledge of rainfall and temperature requirements for pathogen establishment. More detailed criteria for the vulnerability of areas to the development of disease are also provided based on other environmental parameters such as geology, soil and elevation.

Climatic Envelope of P. cinnamomi *Australia*

Figure A1.1 depicts areas of Australia where, based on current knowledge, some of the conditions (i.e. rainfall and minimum temperatures) are conducive to the proliferation of *P. cinnamomi* and the establishment of disease. The dark shading around much of the coast shows areas where average annual rainfall exceeds 600 mm, and the lighter shading denotes 400-600 mm rainfall. The unshaded areas of central, southern and western Australia, indicate areas where average annual rainfall is less than 400 mm. Small areas of Tasmania and the Southern Highlands of NSW shaded in orange indicate where the maximum average daily temperature is less than 12ºC, which is considered too low for pathogen establishment.

P. cinnamomi has been shown to have the greatest and most widespread impact in areas where the average annual rainfall exceeds 600 mm (see section below on criteria on vulnerability), but it has also been shown in WA that the pathogen can cause disease in stream zones and water-gaining sites in the 400-600 mm zones (CALM 2003). While rainfall is a key factor influencing the distribution of disease caused by *P. cinnamomi*, there are many other components of the 'disease pyramid' (Figure A1.2) that affect its ability to persist and establish. A disease epidemic will develop over time when the pathogen is present in a conducive environment (i.e. suitable rainfall, temperature, geology and soil) with susceptible plant hosts.

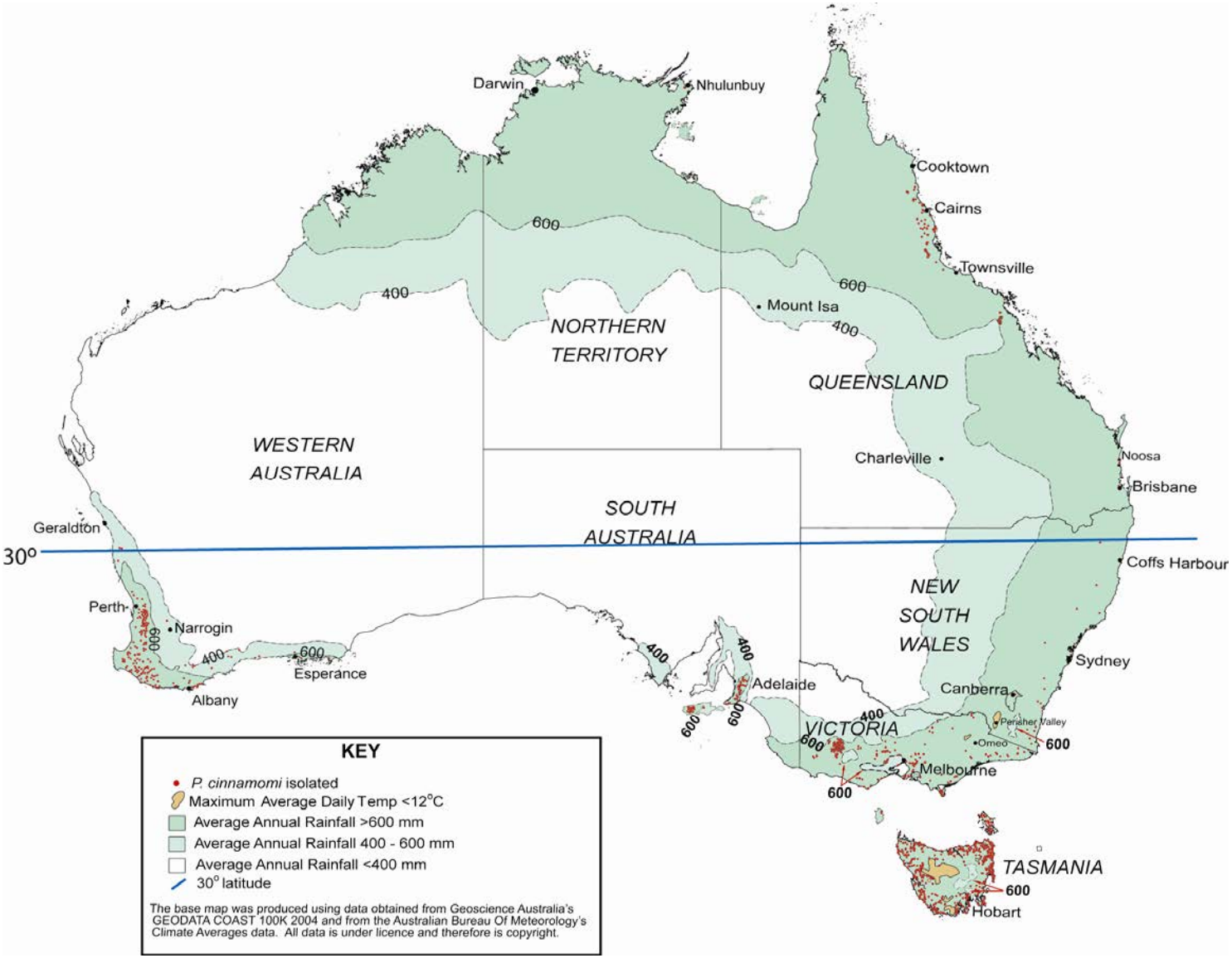

Figure A1.1. Map of Australia indicating the broad climatic envelope of *P. cinnamomi* in Australia, based on current knowledge of rainfall and temperature requirements for pathogen establishment. Red spots indicate non-agricultural sites from which *P. cinnamomi* was isolated. Please refer to the main body of text for further explanation of the map.

Sources of *P. cinnamomi* isolation data: WA - Podger (1999); SA – BDBSA (2005); Tasmania – Peters *et al.* (1998); Victoria – Gibson *et al.* (2002); NSW – McDougall (unpublished data), Summerell (unpublished data), Pratt and Heather (1973), McDougall and Summerell (2003b); Queensland (Brisbane) - O'Dwyer *et al.* (1999); Queensland (Noosa/Coolum region) - Pegg and Alcorn (1972), Pratt *et al.* (1973); Queensland (Wet Tropics) – Data obtained under licence and copyright from the Cooperative Research Centre for Tropical Rainforest Ecology and Management; NT – Weste (1983).

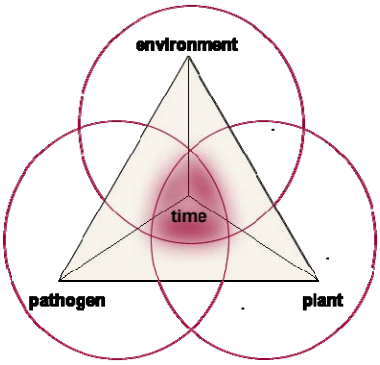

Figure A1.2. Disease pyramid showing disease epidemic (red shading) resulting from the convergence of virulent pathogen, susceptible host, suitable environmental conditions and time.

Knowledge of current epidemics caused by *P. cinnamomi* indicates that the components of the disease pyramid are most likely to converge in the temperate south of the continent, generally south of latitude 30º, which is marked on Figure A1.1. Although rainfall is clearly sufficient for the establishment of *P. cinnamomi* in the wet/dry, true and sub-tropical north of Australia, there is little data to indicate that *P. cinnamomi* is a problem in undisturbed native ecosystems of northern WA or the NT, and there is insufficient knowledge of pathogen epidemiology to predict its potential to become a problem in the future. *P. cinnamomi* is a serious concern in the Wet Tropics World Heritage region of Far North Queensland, where the syndrome is complex, differs considerably from that in the temperate south of the continent and appears to be related to prior significant disturbance of sites (Gadek and Worboys 2003).

Phytophthora cinnamomi *Isolation Records*

P. cinnamomi isolations records at non-agricultural sites are marked on Figure A1.1. Isolation records do not indicate the extent of the infestation or the impact of disease, merely the confirmed presence of the pathogen at each site from soil and/or plant material. Some data from NSW were not available and are thus missing from the map, however *P. cinnamomi* is suspected to be widespread on the entire coastal strip of that State.

Criteria for the Vulnerability of an Area to Phytophthora cinnamomi *in Australia*

In Australia, *P. cinnamomi* does not usually cause severe damage in undisturbed vegetation at sites that receive a mean annual rainfall of less than 600 mm, and are north of latitude 30º. Therefore the areas of Australia vulnerable to disease caused by *P. cinnamomi* can be separated into three broad climatic zones:

- all elevations in those areas of Mediterranean climate where annual rainfall exceeds 600 mm – in southern WA and SA, and southern Victoria as far east as Wilson's Promontory

- the temperate uniform, but erratic rainfall regimes at low elevations of the coastal plain and foothills between Wilson's Promontory and south of the border area between Victoria and NSW
- winter dominant rainfall areas in maritime climates of coastal and sub-montane Tasmania.

Speculation still exists over the role of *P. cinnamomi* in damage to undisturbed montane regions above 800 m such as those found in the southern Great Dividing Range, the Central Highlands of Tasmania, and the upland and highland rainforests of central and Far North Queensland.

Some States in Australia have identified broad zones where biodiversity is vulnerable to the threat of *P. cinnamomi*, due to the coincidence of susceptible vegetation and environmental conditions that are conducive to the establishment and persistence of *P. cinnamomi*. The environmental criteria used to identify zones of vulnerability vary from State to State and are summarised below. The biomes that appear to be least threatened are the wet-dry tropics and the arid and semi-arid regions of the continent (Environment Australia 2001).

Western Australia

In WA, the vulnerable zone is defined by CALM (2003) as:

- the parts of the South West Land Division and areas adjoining it to the north-west and south-east that receive an average annual rainfall greater than 400 mm
- those areas receiving rainfall above 400 mm that do not have a calcareous substrate and in which susceptible native plants occur in conjunction with the environmental factors required for *P. cinnamomi* to establish and persist.

A decision flow chart to assist in determining the vulnerability of a site to disease in WA has been developed by CALM (CALM website – Protectable Areas Flowchart, accessed 17/03/03).

Tasmania

The vulnerable zones of Tasmania include areas where there is a coincidence of:

- susceptible native vegetation in open communities
- non-calcareous soils
- elevation below 700 m
- average annual rainfall greater than 600 mm.

Victoria

Where susceptible native species or communities of plants occur, the following areas in Victoria are considered vulnerable to the threat of *P. cinnamomi*:

- all elevations in those sites of Mediterranean climate from the west of the State across to Wilson's Promontory where average annual rainfall exceeds 600 mm
- the temperate rainfall regimes at low elevations of the coastal plain and the foots hills between Wilson's Promontory
- south of the border between Victoria and NSW.

South Australia

In SA, any site with susceptible vegetation growing on neutral to acid soils and an average annual rainfall greater than 500 mm is considered vulnerable to the threat of *P. cinnamomi* (PTG, 2003).

Queensland

The average annual rainfall in the wet tropics of Far North Queensland is rarely limiting for the establishment of *P. cinnamomi.* As with NSW and the ACT, the pathogen tends to have a cryptic nature, and is frequently isolated from soils beneath symptom-free vegetation. However, dieback attributed to *P. cinnamomi* in natural tropical ecosystems of Far North Queensland is commonly associated with some prior disturbance (particularly roads) on sites that have the following characteristics:

- elevation above 750 m
- notophyll dominant vegetation
- acid-igneous geology (Gadek *et al.* 2001; Worboys and Gadek 2004)

Although dieback related to *P. cinnamomi* is reported from upland subtropical rainforests of the Eungella Plateau, west of Mackay, and from the wallum heathlands of the south-east of the State, there has been no assessment of what criteria may be useful in categorising vulnerable vegetation (S. Worboys *pers. comm.*).

New South Wales & Australian Capital Territory

Clear criteria for what constitutes an area's vulnerability to the threat of *P. cinnamomi* in NSW and ACT are not available for 2 major reasons:

1. there is insufficient knowledge of the susceptible species in NSW & ACT
2. there is variable susceptibility of plant species depending on climatic conditions, i.e. some species only appear susceptible during sustained periods of unusually high rainfall.

Anecdotal evidence suggests that sites that receive less than 600 mm average annual rainfall are not vulnerable to the threat of *P. cinnamomi*. Beyond that, and because of the apparently cryptic nature of the disease in NSW & ACT, a precautionary approach should be adopted and the pathogen assumed to be absent unless it can be proven to be present (McDougall and Summerell 2003).

Northern Territory

To date there is no unequivocal record of *P. cinnamomi* being associated with disease in undisturbed native vegetation in the NT. It is generally accepted that the environmental conditions are not conducive to the establishment and persistence of *P. cinnamomi* in susceptible native plant communities.

APPENDIX 2

THE RESPONSES OF NATIVE AUSTRALIAN PLANT SPECIES TO *Phytophthora cinnamomi*

A list of Australian plant responses to *Phytophthora cinnamomi* has been compiled[1] (Table A2.1) from published material and the unpublished records and observations of individual researchers. Comments, corrections and suggested additions should be sent to e.ogara@murdoch.edu.au

Important Caveats on the Use of the Information in Table A2.1

Table A2.1 is **not solely a host list.** Whilst it does contain the known Australian native hosts of *P. cinnamomi*, the fact that a species can be a host does not mean that it will display symptoms of infection in the wild. The responses of native plants to infection by *P. cinnamomi* are many and various:

- hosts of *P. cinnamomi* in the wild may show no obvious symptoms of infection
- the response of a species in the wild may depend on static site conditions (e.g.. substrate and pH) and temporal conditions (e.g. rainfall and disturbances such as fire)
- species may be affected in some situations (e.g. in cultivation or glasshouse experiments) but largely unaffected in others (e.g. in the wild)
- there may be spatial variation in the response (e.g.. *Hibbertia hypericoides* is highly susceptible to infection on the Swan Coastal Plain of WA but rarely affected in the adjoining jarrah forest)
- species may not be hosts of *P. cinnamomi* at all but may be affected nonetheless by changes in habitat caused by the death of surrounding plants.

An effort has been made in Table A2.1 to indicate the field susceptibility of species to infection and spatial variation in susceptibility where they are known. **The list is indicative and not defintive.** We suggest that it is used as an indication of the potential impact of *P. cinnamomi* on native plants and vegetation, and **should not replace careful site evaluation** (e.g. sampling of roots and soil for the presence of the pathogen and long-term monitoring). As the list will require some interpretation it is strongly recommended that the following points are noted prior to consulting or using the information in Table A2.1:

- the listing of a taxon in Table A2.1 as a host or as a susceptible species in one State or Territory does not necessarily mean that it is a host or is susceptible to infection across its range
- no attempt has been made in the list to evaluate the veracity of susceptibility ratings. Please read the cited reference to make this assessment yourself

[1] The list was compiled by Dr Keith McDougall, Environment Protection and Regulation Division, Department of Environment and Conservation, PO Box 2115, Queanbeyan NSW 2620. Last updated 12th September 2005.

- references provided in the list should be sought to clarify issues of variable susceptibility. In addition, the list s a work in progress - many more species will be added in the future, and many of the susceptibility ratings will be altered as we gain a better understanding of the effects of the pathogen over a greater time and over the entire area that it is capable of reaching
- Table A2.1 contains species that range from highly susceptible to field resistant. In response to the question posed in the Decision Flowchart (Figure 5.1) 'Are there susceptible species present for which the impact of *P. cinnamomi* would be significant?', it is suggested that the answer is 'yes' if:
    1. the species are listed in the table as moderately (MS) or highly susceptible (HS)
    2. the species and communities are threatened (see section below on Threatened Species and Communities) and the extent of susceptibility to *P. cinnamomi* is unknown.

Threatened Species and Communities

The Australian Government *Environmental Protection & Biodiversity Conservation Act 1999* (EPBC Act) is national legislation that promotes the conservation of Australia's biodiversity. Nationally threatened taxa, listed in schedules of the EPBC Act, are denoted in Table A2.1. General and spatial information on nationally listed taxa is available from the Protected Matters Search Tool on the Australian Government DEH website.

Each Australian State and Territory has its own environmental legislation for listing threatened taxa based on State/Territory boundaries. The status of species in individual States and Territories does not appear in Table A2.1, therefore the determination of the potential impact of *P. cinnamomi* at a site should also include consultation of the relevant State/Territory lists. Links to each of the State and Territory sites relating to listing of threatened taxa are provided below:

Australian Capital Territory

New South Wales

Profiles of flora and fauna of NSW are available in a Wildlife Atlas

Northern Territory

Queensland

- *Vegetation Management Act 1999* – Vegetation Management Regulation 2000
- *Nature Conservation Act 1992/State Penalties Enforcement Act 1999* – Nature Conservation and other Legislation Amendment Regulation (No. 1) 2000

South Australia

Tasmania

Victoria

Western Australia

Explanatory Notes on Table A2.1

Species nomenclature
In the list the name given to a taxon is that currently shown as accepted in the Australian Plant Name Index. Taxa that have been split since the referenced work was published or for which no indication was given in a reference of the subspecific rank, are indicated by s.l. (*sensu lato*, in the broadest sense). Nationally threatened taxa, listed in schedules of the EPBC Act, are denoted in the table as **CE** (critically endangered), **E** (endangered) or **V** (vulnerable).

Distribution
The distribution of taxa is indicated by the State or Territory in which they have been recorded: n = New South Wales and the Australian Capital Territory, nt = Northern Territory, q = Queensland, s = South Australia, t = Tasmania, v = Victoria, w = Western Australia; saf = South Africa (plantation species).

References
The numbers in the body of the Table refer to the numbered references in the References section.

Isolation
Species from which *P. cinnamomi* has been isolated have been separated into; those growing in the wild, those grown in cultivation (mostly botanic gardens), and those used in experiments to test for susceptibility. Experimental isolations were generally performed in a glasshouse environment. A few, indicated by a *, were obtained by inoculating propagated plants in the field.

Susceptibility rating
The susceptibility of a taxon, where known, is indicated by a rating adapted from previously used systems:

- **HS** – highly susceptible, i.e. species that are frequently and consistently killed in the wild following infection by *P. cinnamomi*, and / or appear to decline or be rare on infested sites (includes scale categories 10, 11, and 12 of Wills[40] and Barrett[59], and groups 3 and 5 of Shearer and Dillon[14])
- **MS** – moderately susceptible (or variable susceptibility), i.e. species that are often killed following infection by *P. cinnamomi* in the wild but many plants of which commonly survive (includes scale categories 7, 8 and 9 of Wills[40] and Barrett[59], and group 4 of Shearer and Dillon[14])
- **LS** – low susceptibility, i.e. species that are rarely but occasionally found dead on infested sites (includes scale categories 4, 5 and 6 of Wills[40] and Barrett[59], and group 2 of Shearer and Dillon[14])
- **S** – susceptible and thought to be affected, but degree of susceptibility not documented
- **SP** - susceptible but persistent, i.e. species that are frequently killed following infection by *P. cinnamomi* in the wild but which persist on affected sites through effective reproductive strategies
- **SV** – variable susceptibility; plants may be commonly killed on some infested sites but appear unaffected on others – this may be attributable to genetic differences between populations or differences in site characteristics that influence plant responses

- **FR** - field resistant (or tolerant), i.e. species that appear to be unaffected by *P. cinnamomi* in the wild when it is present and for which deaths in the field can rarely be associated with infection by *P. cinnamomi* (includes scale categories 1, 2 and 3 of Wills[40] and Barrett[59], and group 1 of Shearer and Dillon[14])
- **Q** – not known to be directly affected by *P. cinnamomi* but rarely found on affected sites (and may be affected either directly through infection or through changes in habitat)

Table A2.1. A list of Australian native plants that are potential hsost of *Phytophthora cinnamomi*. Pleass consult the accompanying text before using this list.

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
ADIANTACEAE					
Cheilanthes austrotenuifolia	nt,s,t,v,w				FR[59]
AGAVACEAE					
Cordyline murchisoniae	q	16			
AMARANTHACEAE					
Ptilotus declinatus					FR[21]
Ptilotus manglesii	w	24			FR[24]
ANNONACEAE					
Goniothalamus australis	q				FR[36]
ANTHERICACEAE					
Borya mirabilis **E**	v	25	44		HS[44]
Chamaescilla corymbosa var. *corymbosa*	n,s,t,v,w	25			S[43],FR[21]
Laxmannia grandiflora subsp. *stirlingensis*	w				FR[58]
Laxmannia jamesii **V**	w				FR[58]
Laxmannia orientalis	s,t,v	25,29			
Laxmannia sessiliflora	n,s,t,v,w				
Laxmannia squarrosa	w				FR[21]
Thysanotus dichotomus	w	24			FR[24]
Thysanotus multiflorus	w			21	Q[21]
Thysanotus thyrsoides	w				Q[21]
APIACEAE					
Actinotus bellidioides	t,v	17		33	FR[61]
Actinotus helianthi	n,q	1			
Actinotus rhomboideus	w				FR[59]
Hydrocotyle hirta	s,t,v,w	25			
Pentapeltis peltigera	w	24			FR[24],Q[21]
Platysace compressa	w	14,15			FR[59],S[54],HS[14,21]
Platysace heterophylla s.l.	s,v	25			
Platysace lanceolata s.l.	n,q,v				FR[22]
Platysace sp. Stirling	w				FR[58,59]
Platysace tenuissima	w	24			FR[24]
Xanthosia atkinsoniana	n,w	24			FR[21,24]
Xanthosia candida	w	24			FR[21,24]
Xanthosia dissecta	n,s,t,v	25,29			
Xanthosia huegelii	w				FR[21]
Xanthosia rotundifolia s.l.	w				FR[40,59]
Xanthosia tridentata	n,t,v	1			
APOCYNACEAE					
Alstonia muelleriana	q				S[36]
AQUIFOLIACEAE					
Sphenostemon lobosporus	q				FR[36]
ARALIACEAE					
Polyscias australiana	nt,q				FR[36]
Polyscias murrayi	n,q,				S[36]
ARAUCARIACEAE					
Wollemia nobilis	n		12	11	
ARECACEAE					
Archontophoenix cunninghamiana	n,q	16			
Oraniopsis appendiculata	q				S[36]
ASTELIACEAE					
Astelia australiana	t,v	30			

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
ASTERACEAE					
Argentipallium obtusifolium	n,s,t,v,w	25,29			S[43]
Brachyscome uliginosa	s,v	25,29			S[43]
Cassinia aculeata	n,q,s,t,v	2,3,17			
Helichrysum collinum	n,q	3			
Helichrysum macranthum	w				FR[59]
Hyalosperma cotula	s,v,w				FR[21]
Ixodia achillaeoides subsp. *alata*	s,v	20			
Lagenophora huegelii	s,t,v,w				FR[21]
Millotia tenuifolia s.l.	n,s,t,v,w				FR[21]
Olearia axillaris	n,s,t,v,w				LS[40]
Olearia ciliata s.l.	n,q,s,t,v,w	29			
Olearia pannosa s.l.	s,v	32			MS[32]
Olearia paucidentata	w				FR[21]
Olearia teretifolia	s,v		3		
Olearia sp. aff. *axillaris* (Stirling Range)	w				FR[59]
Ozothamnus obcordatus s.l.	n,q,t,v		3		
Podolepis gracilis	w				FR[21]
Podotheca angustifolia	n,s,t,v,w				FR[21]
Pterochaeta paniculata	w				FR[21]
Trichocline spathulata	w				Q[21]
Waitzia nitida	w				FR[21]
BALANOPACEAE					
Balanops australiana	q				FR[36]
BLANDFORDIACEAE					
Blandfordia punicea	t	17,34			HS[34]
BLECHNACEAE					
Blechnum wattsii	n,q,s,t,v	17			
BRUNONIACEAE					
Brunonia australis	n,nt,q,s,t,v,w	25			
CAESALPINIACEAE					
Labichea punctata	w			21	Q[21]
CAMPANULACEAE					
Isotoma hypocrateriformis	w				FR[21]
Lobelia gibbosa	n,q,s,t,v,w				FR[40]
Lobelia rhytidosperma	w				FR[21]
CASUARINACEAE					
Allocasuarina acutivalvis s.l.	w		3		
Allocasuarina campestris s.l.	w		3		
Allocasuarina crassa	t			9	MS[9]
Allocasuarina decussata	w				FR[59]
Allocasuarina duncanii	t			9	HS[9]
Allocasuarina eriochlamys subsp. *grossa*	w				LS[41]
Allocasuarina fibrosa **V**	w				MS[41]
Allocasuarina fraseriana	w	2,14,15, 24,28			SP[21,46, 51,53],HS[40,59]
Allocasuarina globosa	w				LS[41]
Allocasuarina grevilleoides	w				MS[41]
Allocasuarina helmsii	s,w		3		
Allocasuarina humilis	w	40	3		S[37,46,53],FR[40]
Allocasuarina lehmanniana s.l.	w	40			FR[40]
Allocasuarina littoralis	n,q,t,v				SV[42]
Allocasuarina microstachya	w	40			FR[40]
Allocasuarina monilifera	t,v	17,34			S[60]
Allocasuarina muelleriana s.l.	s,v	25,29			S[43]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Allocasuarina paludosa	n,s,t,v	25			S[43]
Allocasuarina pinaster	w		3		
Allocasuarina pusilla	s,v	25,29			S[43]
Allocasuarina ramosissima	w				MS[41]
Allocasuarina rigida s.l.	n,q		3		
Allocasuarina tessellata	w				MS[41]
Allocasuarina thuyoides	w				S[56],MS[40]
Allocasuarina tortiramula	w				MS[41]
Allocasuarina torulosa	n,q	2			
Allocasuarina trichodon	w		3		FR[59]
Allocasuarina verticillata	n,s,t,v	2,8			FR[60]
Casuarina cunninghamiana subsp. *cunninghamiana*	n,q	2			
Casuarina obesa	n,s,v,w	50			FR[50]
CENTROLEPIDACEAE					
Centrolepis aristata	s,t,v,w				FR[21]
CLUSIACEAE					
Garcinia sp. (Davies Ck JG Tracey 14745)	q				FR[36]
COLCHICACEAE					
Burchardia multiflora	w	40			FR[40]
Burchardia umbellata	n,q,s,t,v,w	40			FR[40]
CUNONIACEAE					
Anodopetalum biglandulosum	t	17			S[60]
Bauera rubioides	n,q,s,t,v	8,17,34		33	LS[61]
Bauera sessiliflora	v		44		LS[44]
Geissois biagiana	q				FR[36]
Gillbeea adenopetala	q				S[36]
Gillbeea whypalliana	q				FR[36]
CUPRESSACEAE					
Actinostrobus pyramidalis	w	2a			S[54]
Callitris preissii	w		3		
Callitris rhomboidea	n,q,s,t,v	29			FR[60]
CYPERACEAE					
Caustis dioica	w	20			FR[40]
Cyathochaeta avenacea	w				FR[21,40]
Cyathochaeta clandestina	w	24			FR[24]
Evandra aristata	w				S[46],LS[40]
Gahnia grandis	n,t,v	17			FR[60]
Gahnia trifida	s,t,v,w				FR[40]
Gymnoschoenus sphaerocephalus	n,s,t,v	17			FR[61]
Lepidosperma angustatum	w				FR[21]
Lepidosperma brunonianum	w				FR[59]
Lepidosperma concavum	s,t,v	17			FR[42]
Lepidosperma effusum	w				FR[59]
Lepidosperma gladiatum	n,s,t,v,w				FR[59]
Lepidosperma laterale s.l.	n,q,s,t,v	2			FR[60]
Lepidosperma longitudinale	n,q,s,t,v,w				FR[58]
Lepidosperma scabrum	w	24			FR[24]
Lepidosperma squamatum	w				FR[21,59]
Lepidosperma tenue	w	24			FR[24]
Lepidosperma tetraquetrum	w				FR[53]
Lepidosperma urophorum	n,q,v				FR[42]
Lepidosperma viscidum	s,v,w				FR[40]
Mesomelaena graciliceps	w				Q[21]
Mesomelaena stygia s.l.	w				FR[40]
Mesomelaena tetragona	w				FR[21,24]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Ptilothrix deusta	n,q				FR[42]
Schoenus efoliatus	w				FR[58,59]
Schoenus imberbis	n,v				FR[42]
Schoenus sp. Stirling	w				FR[58,59]
Tetraria capillaris	n,q,s,t,v,w				FR[21,40]
Tetraria octandra	w				FR[21]
DASYPOGONACEAE					
Chamaexeros serra	w	40			FR[40]
Dasypogon bromeliifolius	w	24			S[37,46],LS[40,59]
Kingia australis	w				FR[22]
DENNSTAEDTIACEAE					
Pteridium esculentum	n,q,s,t,v,w	2			FR[40,59],Q[21]
DILLENIACEAE					
Hibbertia acerosa	w	48,15,28			S[48]
Hibbertia acicularis	n,q,s,t,v	17,34			
Hibbertia amplexicaulis	w	14,28			S[21,24,48],HS[14]
Hibbertia australis	s,v	25			
Hibbertia calycina	n,t,v			9	HS[9]
Hibbertia commutata	w	28		21	LS[40,59],HS[21]
Hibbertia cunninghamii	w	15			
Hibbertia desmophylla	w	51			S[51]
Hibbertia empetrifolia	n,t,v	17,34			
Hibbertia furfuracea	w				S[56]
Hibbertia glomerata s.l.	w				HS[21]
Hibbertia huegelii	w			21	Q[21]
Hibbertia humifusa					FR[44]
Hibbertia hypericoides	w	14,24			S[37,46],SP[21], MS[40],HS[14]
Hibbertia inconspicua	w				S[46]
Hibbertia lineata	w	14,24			S[24]
Hibbertia montana	w	14,48,24			S[24,48],HS[14]
Hibbertia obtusifolia	n,q,t,v	3			
Hibbertia procumbens	n,t,v	17,34			S[60]
Hibbertia prostrata	s,t,v	17,25,29,34			S[43]
Hibbertia quadricolor	w	14			S[24],HS[14,21]
Hibbertia rhadinopoda	w	26		21	SP[21]
Hibbertia riparia	n,q,s,t,v	17,20,25,29,34			S[60]
Hibbertia sericea s.l.	n,q,s,v	17,34			
Hibbertia silvestris	w	14,24			FR[24]
Hibbertia stricta	s,v	4,7,25			S[43]
Hibbertia subvaginata	w	14,15,24,37			HS[14]
Hibbertia virgata	n,s,t,v	5,25		9	S[43], HS[9]
DROSERACEAE					
Drosera erythrorhiza s.l.	w				FR[21,40]
Drosera huegelii	w				FR[59]
Drosera macrantha s.l.	w				FR[21]
Drosera pallida	w				FR[40]
Drosera platystigma	w				FR[21]
Drosera stolonifera s.l.	w				FR[59],Q[21]
ELAEOCARPACEAE					
Elaeocarpus eumendi	n,q				FR[36]
Elaeocarpus foveolatus	q				S[36]
Elaeocarpus holopetalus	n,v				MS[22]
Elaeocarpus largiflorens subsp. *retinervis*	q				FR[36]
Elaeocarpus sericopetalus	q				S[36]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Sloanea australis subsp. *parviflora*	n,q				S[36]
Sloanea macbrydei	q				FR[36]
EPACRIDACEAE					
Acrotriche cordata	s,t,v,w			9	HS[9]
Acrotriche fasciculiflora	s				S[57]
Acrotriche halmaturina	s	19			
Acrotriche patula	s,w				HS[41]
Acrotriche serrulata	n,s,t,v	4,17,25, 29			S[43]
Andersonia auriculata	w				HS[41]
Andersonia axilliflora **E**	w	58			S[49],HS[41,58,59]
Andersonia bifida	w				HS[41]
Andersonia caerulea	w				S[46,51],HS[40,59]
Andersonia carinata	w				HS[41]
Andersonia echinocephala	w	58			HS[41,58,59],MS[40]
Andersonia ferricola	w	39			S[39]
Andersonia grandiflora	w				HS[41],MS[58]
Andersonia heterophylla	w	37			S[37,46]
Andersonia lehmanniana	w				S[37,46]
Andersonia longifolia	w				HS[41]
Andersonia macranthera	w				HS[41]
Andersonia pinaster **V**	w	58			HS[40,41,58]
Andersonia setifolia	w				HS[41]
Andersonia simplex	w	51			S[51],MS[40]
Andersonia sprengelioides	w				HS[40,59]
Astroloma baxteri	w				LS[40]
Astroloma ciliatum	w	48,28			S[48]
Astroloma conostephioides	s,v	25,29			S[43]
Astroloma foliosum	w				HS[41]
Astroloma humifusum	n,s,t,v,w	17,25,34			S[43],HS[10]
Astroloma microcalyx	w	14			
Astroloma microphyllum	w				LS[41]
Astroloma pallidum	w				FR[21,24]
Astroloma pinifolium	n,t,v	17,34			S[60]
Astroloma xerophyllum	w	37			S[37,46,55]
Astroloma sp. Cataby (EA Griffin 1022)	w				HS[41]
Astroloma sp. Eneabba (N. Marchant s.n.)	w				HS[41]
Astroloma sp. Fitzgerald (GJ Keighery 8376)	w				LS[41]
Astroloma sp. Grass Patch (AJG Wilson 110)	w				LS[41]
Astroloma sp. Mt Lindesay	w				HS[59]
Astroloma sp. Nannup (RD Royce 3978)	w				HS[41]
Astroloma sp. 2504	w				HS[40]
Brachyloma ciliatum	s,t,v	25			S[43]
Brachyloma daphnoides s.l.	n,q,s,v	3,25,29			S[43]
Brachyloma depressum	t,v	29			HS[29]
Coleanthera coelophylla	w				HS[41]
Coleanthera virgata	w				LS[41]
Conostephium marchantiorum	w				LS[41]
Conostephium minus	w				HS[41]
Conostephium pendulum	w	14,24,37			S[46]
Conostephium uncinatum	w				LS[41]
Cosmelia rubra	w				MS[40]
Cyathodes glauca	t	2,17,34			
Epacris acuminata **E**	t	34			
Epacris apsleyensis **E**	t				HS[9]
Epacris barbata **CE**	t				HS[61]
Epacris corymbiflora	t	17		33	HS[61]
Epacris curtisiae	t			9	HS[60]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Epacris exserta **E**	t			9	MS[9]
Epacris glabella **E**	t			9	MS[9]
Epacris grandis **E**	t			9	HS[9]
Epacris gunnii	n,q,s,t,v	8,17			
Epacris impressa	n,s,t,v	2,4,13,17,18,25,29,34	3		S[43],LS[60]
Epacris lanuginosa	t	17,34			S[60]
Epacris limbata **CE**	t			9	HS[9]
Epacris marginata	t			9	HS[9]
Epacris myrtifolia	t			9	HS[9]
Epacris obtusifolia	n,q,t,v	17			S[60]
Epacris paludosa	n,t,v			9	HS[9]
Epacris purpurascens	n	1			
Epacris stuartii **CE**	t			9	MS[9]
Epacris virgata	t			9	HS[9]
Epacridaceae gen. nov. (aff. Melichrus)	w				HS[41]
Gaultheria hispida	t	17,34			
Leptecophylla juniperina	t	17			S[60]
Leptecophylla pendulosa	t			9	HS[9]
Leucopogon amplectens	w				HS[41]
Leucopogon apiculatus	w				HS[41]
Leucopogon atherolepis	w	58			HS[59],MS[58]
Leucopogon australis s.l.	t,v,w	14,17,25			S[37,43,46,53],LS[40,59]
Leucopogon blepharolepis	w				HS[41]
Leucopogon bracteolaris	w				HS[41]
Leucopogon brevicuspis	w				HS[41]
Leucopogon breviflorus	w				HS[41]
Leucopogon capitellatus	w	14,28			S[24,37,46,48],MS[21,40]
Leucopogon collinus	s,t,v	17,34			HS[60]
Leucopogon concinnus	w				S[46]
Leucopogon concurvus	s				S[20]
Leucopogon conostephioides	w	14,24,37			S[46],LS[40],HS[14]
Leucopogon cordifolius	s,v,w				HS[41]
Leucopogon corifolius	w				MS[40]
Leucopogon cryptanthus	w				HS[41]
Leucopogon cucullatus	w				LS[40]
Leucopogon cymbiformis	w				MS[40]
Leucopogon denticulatus	w				HS[41]
Leucopogon distans var. *contractus*	w				S[40]
Leucopogon distans s.l.	w				HS[40]
Leucopogon elegens	w	51			S[51]
Leucopogon ericoides	n,q,s,t,v	17,25,29,34	3		S[43],HS[60]
Leucopogon esquamatus	n,t,v			9	MS[9]
Leucopogon flavescens	w				S[46,51]
Leucopogon florulentus	w				HS[41]
Leucopogon gibbosus	w				HS[40,59]
Leucopogon glabellus	w	15			
Leucopogon glacialis	s,v	25,29			S[43]
Leucopogon glaucifolius	w				HS[41]
Leucopogon gnaphaloides **E**	w	58			HS[58,59]
Leucopogon gracillimus	w				S[46]
Leucopogon interruptus	w				HS[41]
Leucopogon lanceolatus s.l.	n,q,s,t,v	2		9	FR[22]
Leucopogon lasiophyllus	w				MS[40,59], HS[41]
Leucopogon lasiostachyus	w	15			LS[40,59]
Leucopogon macrcraei	n,v		3		

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Leucopogon marginatus **E**	w				HS[41]
Leucopogon microphyllus var. *pilibundus*	n,v	3			
Leucopogon multiflorus	w				HS[41]
Leucopogon nutans	w	14,22			S[24,46],HS[14], LS[40],SP[21]
Leucopogon obtectus **E**	w				S[52],HS[41]
Leucopogon oliganthus	w				HS[41]
Leucopogon oxycedrus	w	48,28			SP[21,48],HS[40]
Leucopogon parviflorus	n,q,s,t,v,w				LS[59], S[46]
Leucopogon pendulus	w				FR[40]
Leucopogon pleurandroides	w				HS[41]
Leucopogon plumulifolius	w				HS[41]
Leucopogon pogonocalyx	w				HS[41]
Leucopogon polymorphus	w				S[37,53]
Leucopogon polystachyus	w				HS[41]
Leucopogon propinquus	w	14,28			FR[59],S[24,37,46,48]
Leucopogon pulchellus	w	15			S[54]
Leucopogon revolutus	w				S[46]
Leucopogon tamariscinus	w				HS[41]
Leucopogon unilateralis	w				LS[59]
Leucopogon verticillatus	w	14,15,28			S[24,46,48],HS[14,21]
Leucopogon virgatus	n,q,s,t,v	3,17,18, 25,29			S[43]
Leucopogon sp. Cascades (MA Burgman 3700)	w				HS[41]
Leucopogon sp. Clyde Hill (MA Burgman 1207)	w				HS[41]
Leucopogon sp. Condingup (MA Burgman 1377)	w				HS[41]
Leucopogon sp. Coujinup (MA Burgman 1085)	w				HS[41]
Leucopogon sp. Dundas (MA Burgman 1482)	w				HS[41]
Leucopogon sp. Kau Rock (MA Burgman 1126)	w				HS[41]
Leucopogon sp. Munglinup (KR Newbey 8123)	w				HS[41]
Leucopogon sp. Peak Charles (MA Burgman 1476)	w				HS[41]
Leucopogon sp. Roberts Swamp (KR Newbey 8173)	w				HS[41]
Leucopogon sp. Yanneymooning (F Mollemans 3797)	w				HS[41]
Leucopogon sp. 4	w				LS[40]
Lissanthe strigosa s.l.	n,q,s,t,v	4,25			
Lysinema ciliatum	w			37	S[37],HS[40,59]
Lysinema conspicuum	w				MS[40]
Lysinema elegans	w				MS[41]
Lysinema lasianthum	w				LS[41]
Melichrus urceolatus	n,q,v	3			
Monotoca elliptica	n,t,v	17,34			S[60]
Monotoca glauca	t,v	2,17,34			S[60]
Monotoca leucantha	w				HS[41]
Monotoca linifolia susbp. *linifolia*	t	34			
Monotoca oligarrhenoides	w				HS[59]
Monotoca scoparia	n,q,t,v	3,25,29			
Monotoca submutica s.l.	t	17,34			
Monotoca tamariscina	w	15			S[46]
Monotoca sp. aff. *elliptica* (D. Albrecht *pers.*	n,v	13			HS[13]

FAMILY	Distribution	Isolation			Susceptibility
Species		In wild	In cultivation	By experiment	Rating
comm.)					
Monotoca sp. Mt Maxwell (KR Newbey 4727)	w				LS[41]
Prionotes cerinthoides	t	17			
Richea dracophylla	t	34			
Richea milliganii	t	17,34			
Richea pandanifolius	t	17,34			HS[60]
Sphenotoma dracophylloides	w				HS[40,59]
Sphenotoma drummondii **E**	w	58			HS[58,59],LS[41]
Sphenotoma gracilis	w				HS[40]
Sphenotoma parviflora	w				LS[41]
Sphenotoma squarrosa	w	15	53		S[53],HS[40,59]
Sphenotoma sp. Stirling	w	58			HS[58,59]
Sprengelia incarnata	n,s,t,v	8,13,17,25,34		33	SP[61]
Styphelia adscendens	n,s,t,v	25,29,34			S[60]
Styphelia pulchella	w				LS[41]
Styphelia tenuiflora	w	14,24,46			S[24,46],Q[21],HS[22]
Trochocarpa disticha	t	17			
Trochocarpa gunnii	t	17			
Trochocarpa parviflora	w				LS[41]
Woollsia pungens	n,q	1			
ESCALLONIACEAE					
Anopterus glandulosa	t	17,34			
EUCRYPHIACEAE					
Eucryphia lucida	t	17			
Eucryphia milliganii	t	17	3		
Eucryphia moorei	n		3		
EUPHORBIACEAE					
Amperea ericoides	w	15			
Amperea xiphoclada	n,q,s,t,v	17,25,34			S[43,60], FR[22]
Antidesma erostre	q				FR[36]
Hylandia dockrilii	q				FR[36]
Macaranga subdentata	q				FR[36]
Mallotus polyadenos	q				S[36]
Monotaxis occidentalis	w				Q[21]
Phyllanthus calycinus	s,w	24			FR[21,24]
Phyllanthus hirtellus	n,v	3			
Poranthera corymbosa	n,q,v				
Poranthera microphylla	n,nt,q,s,t,v,w	25			
Ricinocarpus glaucus	w		3		
Ricinocarpus pinifolius	n,q,t,v	17			
Stachystemon vermicularis	w				FR[21]
FABACEAE					
Aotus ericoides	n,q,t,v,w	15,17,25,34			S[37,43,53,54],HS[60]
Aotus genistoides	w				MS[59],S[58]
Aotus passerinoides	w	15			S[53,54]
Bossiaea aquifolium	w	14			SP[21]
Bossiaea cinerea	n,s,v	17,25,34			S[43],HS[60]
Bossiaea eriocarpa	w	14,15,24			S[51]
Bossiaea linophylla	w	40			FR[40]
Bossiaea obcordata	n,q,t,v			9	LS[9]
Bossiaea ornata	w	14,28			S[46,48],SP[21]
Bossiaea prostrate	n,q,s,t,v	25,29			S[43,60]
Bossiaea rufa	w	40			FR[40]
Bossiaea webbii	w	40			FR[40,59]
Castanospermum australe	q			16	

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Chorizema aciculare s.l.	w	40			FR[40]
Chorizema carinatum	w				MS[40]
Chorizema rhombeum	w				Q[21]
Daviesia brevifolia	n,s,v	25,29			S[43]
Daviesia bursarioides **E**	w				MS[41]
Daviesia chapmanii	w				MS[41]
Daviesia debilior subsp. *sinuans*	w				MS[41]
Daviesia decurrens	w	15			S[24], SP[21]
Daviesia dielsii	w				MS[41]
Daviesia epiphyllum	w				MS[41]
Daviesia euphorbioides **E**	w				MS[41]
Daviesia glossosema	w	58			HS[58]
Daviesia incrassata s.l.	w				S[37]
Daviesia inflata	w				S[56],HS[40]
Daviesia latifolia	n,q,t,v	17,25,34			S[43]
Daviesia lineata	w				MS[41]
Daviesia megacalyx **E**	w				S[49],LS[41]
Daviesia mesophylla	w				HS[58]
Daviesia microcarpa **E**	w				LS[41]
Daviesia microphylla	w				LS[41]
Daviesia mimosoides s.l.	n,q,v	2,3			
Daviesia oppositifolia	w				LS[40]
Daviesia obovata	w	58			HS[58]
Daviesia ovata	w				LS[41]
Daviesia oxylobium	w				MS[41]
Daviesia pauciflora	w				LS[41]
Daviesia physodes	w				S[56],MS[41]
Daviesia polyphylla	w	14			
Daviesia preissii	w				HS[21]
Daviesia pseudaphylla **E**	w	58			MS[58],S[49],LS[41]
Daviesia pteroclada	w				MS[41]
Daviesia purpurascens	w				LS[41]
Daviesia rhombifolia	w	14,24			S[24]
Daviesia speciosa **E**	w				MS[41]
Daviesia spiralis	w				MS[41]
Daviesia ulicifolia	n,q,s,t,v,w	2,17,25, 34			S[43,60]
Daviesia wyattiana	n,q,v				HS[13]
Daviesia sp. [CAM] (KR Newbey 8162)	w				LS[41]
Daviesia sp. [PLE] (AS George 10288)	w				LS[41]
Daviesia sp. 4	w				HS[40]
Dillwynia glaberrima	n,t,v	17,25,29,34	3		S[43],HS[60]
Dillwynia phylicoides	n,q,v	2,3,25			S[43]
Dillwynia sericea	n,q,s,t,v	17,25,29,34			S[43],HS[60]
Dillwynia uncinata	s,v,w	15			
Dillwynia sp. A	w				FR[21]
Eutaxia densifolia	w				LS[40]
Gastrolobium bilobum	w				FR[59]
Gastrolobium crenulatum	w				S[58]
Gastrolobium leakeanum	w				HS[58,59],LS[40]
Gastrolobium luteifolium	w	58			HS[58]
Gastrolobium mondurup	w				HS[58],MS[59]
Gastrolobium papilio	w				S[49]
Gastrolobium pulchellum	w	58			HS[58], MS[59],S[46]
Gastrolobium spinosum	w				LS[40]
Gastrolobium tetragonophyllum	w				MS[40]
Gastrolobium rubrum	w				MS[58,59]
Gompholobium capitatum	w	24			FR[24]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Gompholobium confertum	w	15			S[58],HS[40]
Gompholobium ecostatum	s,t,v	25,29			
Gompholobium huegelii	n,q,t,v	17,25,34			
Gompholobium knightianum	w	14			SP[21]
Gompholobium marginatum	w				FR[21]
Gompholobium polymorphum	w			21	FR[21]
Gompholobium preissii	w				FR[21]
Hovea chorizemifolia	w	24		21	FR[24,59],Q[21]
Hovea corrickiae	t,v			9	MS[9]
Hovea elliptica	w	15,54			S[54]
Hovea linearis	n,q,s,t,v	25,29			S[43]
Hovea pungens	w		53		S[53]
Jacksonia alata	w				FR[21]
Jacksonia calycina	w				S[58]
Jacksonia carduacea	w				MS[41]
Jacksonia floribunda	w	37			S[37,46,54]
Jacksonia furcellata	w	24			HS[24]
Jacksonia grevilleoides	w				MS[40]
Jacksonia horrida	w				S[46]
Jacksonia sericea	w				MS[41]
Jacksonia spinosa	w	51			S[51],LS[40]
Jacksonia sternbergiana	w	24			HS[24]
Jacksonia sp. aff. furcelata	w				MS[40]
Kennedia coccinea	w	14,24		21	FR[24],MS[21]
Kennedia prostrata	n,s,t,v	29,24			FR[24]
Latrobea genistoides	w				S[51]
Latrobea hirtella	w				S[51]
Mirbelia dilatata	w	24			FR[24]
Oxylobium arborescens	n,q,t,v	2,8,17			
Oxylobium ellipticum	n,t,v	2,17,35			FR[22]HS[35]
Oxylobium ilicifolium	n,q,v	2			
Phyllota diffusa	t	17,34			HS[34]
Platylobium formosum	n,q,t,v	25,34			S[43],HS[60]
Platylobium obtusangulum	s,t,v	4,17,29, 34			S[43]
Pultenaea altissima	n,v		3		
Pultenaea benthamii	n,v	13			
Pultenaea cunninghamii	n,q,v	2			
Pultenaea daphnoides	n,q,s,t,v	2,13,17,34			HS[22,34]
Pultenaea ericifolia	w				FR[40]
Pultenaea graveolens	v	32			HS[32]
Pultenaea gunnii	s,t,v	17,25,34			S[43],HS[34]
Pultenaea hibbertioides	t,v			9	HS[9]
Pultenaea humilis	n,t,v	4,25,29			S[43]
Pultenaea involucrata	s	18			
Pultenaea juniperina s.l.	n,t,v	17,34			HS[34]
Pultenaea mollis	v	9,25			S[43]
Pultenaea palacea var. *sericea*	n,t,v			9	HS[9]
Pultenaea pedunculata	n,s,t,v	4,25,34			S[43]
Pultenaea procumbens	n,v	3			
Pultenaea prostrata	s,t,v			9	HS[9]
Pultenaea pycnocephala	n,q	13			
Pultenaea reticulata	w	2,15			HS[40,59]
Pultenaea scabra	n,s,v	25			S[43]
Pultenaea stricta	s,t,v	17,25,34			S[43],HS[34]
Pultenaea subalpina	v		3,44		HS[44]
Pultenaea subspicata	n,v		3		
Pultenaea trifida	s	19			

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Sphaerolobium acanthos	v		44		MS[44]
Sphaerolobium medium	w				FR[21]
FAGACEAE					
Nothofagus cunninghamii	t,v	2,17,25			S[43]
GLEICHENIACEAE					
Gleichenia dicarpa	n,q,t,v	25			S[43]
GOODENIACEAE					
Coopernookia barbata	n,v				
Dampiera alata	w				S[37]
Dampiera fasciculata	w				FR[59]
Dampiera linearis	w	15			FR[21]
Goodenia caerulea	w				FR[21,40,59]
Goodenia geniculata	n,q,s,t,v	25			
Goodenia hederacea s.l.	n,q,v	25,29			S[43]
Goodenia humilis	n,s,t,v	25,29			S[43]
Goodenia lanata	t,v	25,29			S[43]
Goodenia ovata	n,q,s,t,v	25			
Goodenia scapigera	w				FR[40,59]
Lechenaultia biloba	w	14,24	3		FR[21,24]
Lechenaultia floribunda	w		3		
Lechenaultia formosa	w		3		
Lechenaultia hirsuta	w		3		
Scaevola calliptera	w			21	Q[21]
Scaevola striata s.l.	w	24			FR[24]
Scaevola thesioides s.l.	w		3		
Velleia foliosa	w				FR[58]
GROSSULARIACEAE					
Polyosma alangiacea	q				FR[36]
HAEMODORACEAE					
Anigozanthus flavidus	w				FR[54]
Anigozanthus manglesii	w				FR[22]
Anigozanthus rufus	w				FR[54]
Conostylis aculeata s.l.	w	24			FR[24]
Conostylis misera **E**	w				FR[58]
Conostylis pusilla	w	24			FR[24]
Conostylis serrulata	w	24			FR[21,24]
Conostylis setigera s.l.	w	15			FR[21,40]
Conostylis setosa	w	24			FR[21,40]
Macropidia fuliginosa	w		54		FR[54]
HALORAGACEAE					
Gonocarpus benthamii subsp. Stirling	w				FR[58]
Gonocarpus mezianus	s,v	25			S[43]
Gonocarpus rudis	w				FR[58]
Gonocarpus tetragynus	n,q,s,t,v	17,34			
Gonocarpus teucrioides	n,q,t,v	2,17,34			FR[42]
Haloragodendron monospermum	n		3		
ICACINACEAE					
Apodytes brachstylis	q				FR[36]
Citronella smythii	q				FR[36]
Irvingbaileya australis	q				FR[36]
IRIDACEAE					
Diplarrena moraea	n,t,v	8,13,17			
Isophysis tasmanica	t	34			HS[61]
Patersonia babianoides	w				Q[21]
Patersonia fragilis	n,q,s,t,v	17,34			

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Patersonia glabrata	n,q,v				S[42]
Patersonia occidentalis	s,t,v,w	14,24			FR[59],S[24,37,46,53], FR[60]
Patersonia pygmaea	w	28			HS[28],FR[21,24]
Patersonia rudis	w	14			S[46],SP[21]
Patersonia sericea	n,q,v	2			
Patersonia umbrosa	w	14			FR[59],S[46]
LAMIACEAE					
Gmelina fasciculiflora	q				FR[36]
Hemigenia curvifolia	w	24			FR[24]
Hemigenia ramosissima	w				FR[21]
Prostanthera cuneata	n,t,v		3		
Prostanthera decussata	v	32			S[32]
Prostanthera lasianthos	n,q,t,v	17	3		
Prostanthera ovalifolia	n,q		3		
Prostanthera ringens	n,q		3		
Prostanthera saxicola var. *montana*	n		3		
LAURACEAE					
Beilschmiedia bancroftii	q				S[36]
Beilschmiedia collina	q	16			
Beilschmiedia tooram	q				S[36]
Cassytha glabella	n,q,s,t,v,w				FR[22]
Cinnamomum oliveri	q	16			HS[45]
Cryptocarya angulata	q				FR[36]
Cryptocarya corrugata	q				FR[36]
Cryptocarya densiflora	q				FR[36]
Cryptocarya corrugata	q	16			FR[36]
Cryptocarya glaucescens	q	16			
Cryptocarya leucophylla	q				FR[36]
Cryptocarya lividula	q				FR[36]
Cryptocarya mackinnoniana	q				S[36]
Cryptocarya putida	q				FR[36]
Endiandra bessaphila	q				S[36]
Endiandra dichrophylla	q				FR[36]
Endiandra monothyra subsp. *monothyra*	q				FR[36]
Endiandra montana	q				FR[36]
Endiandra sankeyana	q				FR[36]
Endiandra wolfei	q				FR[36]
LENTIBULARIACEAE					
Utricularia multifida	w				FR[40]
LINDSAEACEAE					
Lindsaea linearis	n,q,s,t,v,w				FR[40,60]
LOGANIACEAE					
Logania serpyllifolia s.l.	w			21	FR[40,59],Q[21]
Mitrasacme pilosa	n,s,t,v	17			
LORANTHACEAE					
Nuytsia floribunda	w				FR[22]
LYCOPODIACEAE					
Lycopodium deuterodensum	n,q,s,t,v	35			SV[22]
MELIACEAE					
Synoum glandulosum subsp. *paniculatum*	q			16	FR[36]
MIMOSACEAE					
Acacia aculeatissima	n,v	25			
Acacia axillaris **V**	t			9	MS[9]
Acacia barbinervis s.l.	w	24			FR[21,24]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Acacia baxteri	w				FR[56]
Acacia browniana s.l.	w	24			FR[24]
Acacia browniana var. intermedia	w				FR[40]
Acacia buxifolia subsp. *buxifolia*	n,q,v	3			
Acacia campylophylla	w	24			S[24]
Acacia cyclops	w				FR[40]
Acacia dealbata	n,t,v	2			FR[60]
Acacia drummondii s.l.	w	24			FR[24,59]
Acacia extensa	w				FR[24]
Acacia genistifolia	n,t,v	2,3			
Acacia horridula	w	3			
Acacia lateriticola	w				FR[24],Q[21]
Acacia melanoxylon	n,q,s,t,v	17			FR[60]
Acacia mitchelli	n,s,v	25			S[43]
Acacia mucronata s.l.	n,q,t,v	17,25			S[43]
Acacia myrtifolia	n,q,s,t,v,w	17,18,25,29			S[43,55],MS[40,59]
Acacia nervosa	w				FR[21,24]
Acacia obovata	w				FR[21]
Acacia oxycedrus	n,s,v	25			S[43]
Acacia paradoxa	n,q,s,t,v,w				S[57]
Acacia pataczekii	t			9	LS[9]
Acacia preissiana	w				FR[24]
Acacia pulchella s.l.	w	24, 50	3		FR[50],LS[40]
Acacia retinodes s.l.	s,v			34	
Acacia siculiformis	n,t,v			9	MS[9]
Acacia stenoptera	w	14,24			
Acacia suaveolens	n,q,s,t,v	17,25			S[43],FR[42],LS[60]
Acacia terminalis s.l.	n,t,v				
Acacia ulicifolia	n,q,t,v	17			
Acacia urophylla	w			21	FR[24,53],Q[21]
Acacia veronica	w				FR[58,59]
Acacia verticillata s.l.	n,s,t,v	2,8,17,25			
Paraserianthes lophantha	w				FR[22]
MONIMIACEAE					
Atherosperma moschatum	n,t,v	17			
Daphnandra repandula	q				FR[36]
MYRISTICACEAE					
Myristica insipida	q			16	
MYRSINACEAE					
Rapanea achradifolia	q				S[36]
MYRTACEAE					
Acmena resa	q			16	FR[36]
Agonis floribunda	w				LS[59]
Agonis hypericifolia	w	15			MS[40,59]
Agonis linearifolia	w	51			S[51],LS[40]
Agonis parviceps	w				LS[40,59]
Agonis spathulata	w				LS[40,59]
Angophora costata	n,q	12			
Angophora hispida	n				
Astartea fascicularis	w	40	3		FR[40]
Astartea heteranthera	w	50	3		FR[50]
Austromyrtus sp. (Gillies BG 1484)	q				FR[36]
Baeckea camphorosmae	w				FR[21,24,50]
Baeckea leptocaulis	t	17,34		33	HS[34],MS[61]
Baeckea pachyphylla	w	20			FR[40]
Euryomyrtus ramosissima subsp. *prostrata*	n,t,v	25			

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Beaufortia anisandra	w	51			S[51],MS[40,59]
Beaufortia decussata	w				LS[40,59]
Beaufortia elegans	w	37			
Beaufortia emprtrifolia	w				LS[40]
Beaufortia eriocephala	w				LS[41]
Beaufortia micrantha	w				MS[40]
Beaufortia sparsa	w	15	3		
Calothamnus affinis	w	40			FR[40],LS[58]
Calothamnus crassus	w	58			LS[58,59]
Calothamnus quadrifidus	w	40			FR[40]
Calothamnus sanguineus	w	40			FR[40]
Calothamnus villosus	w				S[37]
Calytrix alpestris	s,v		3		
Calytrix asperula	w	40			FR[40]
Calytrix flavescens	w	15			FR[40]
Calytrix leschenaultii	w	40			FR[40]
Calytrix tenuiramea	w	40			FR[40]
Calytrix tetragona	n,q,s,t,v,w	17,25,29,34	3		S[43],SV[60]
Chamelaucium ciliatum	w		3		
Chamelaucium erythrochlora	w				S[52]
Chamelaucium griffinii	w				S[52]
Chamelaucium roycei	w				S[52]
Corymbia calophylla	w			21	FR[24,50,53]
Corymbia ficifolia	w				FR[50]
Corymbia gummifera	n,q,v	2			SV[42]
Corymbia maculata	n,q,v			31	FR[22]
Corymbia tesellaris	n,q			31	
Darwinia citriodora	w				FR[50]
Darwinia collina **E**	w	58			MS[58],S[49,52]
Darwinia hypericifolia	w				LS-MS[58]
Darwinia leiostyla	w				FR[40],LS-MS[58]
Darwinia macrostegia	w				S[49]
Darwinia meeboldii	w				S[49,52]
Darwinia oxylepis **E**	w				HS[58],S[46,52]
Darwinia squarrosa **V**	w				LS[59],MS[58],S[46]
Darwinia vestita	w				FR[40]
Darwinia wittwerorum **E**	w	58			MS[58],S[46]
Darwinia sp. Stirling Range **V**	w				MS[58]
Eremaea pauciflora s.l.	w	37	3		
Eucalyptus accedens	w				FR[50]
Eucalyptus acmenoides	q	2			
Eucalyptus amygdalina	t	2,17			FR[60]
Eucalyptus andrewsii s.l.	n,q			31	
Eucalyptus angulosa	w				FR[40]
Eucalyptus aromaphloia	n,v	25			S[43]
Eucalyptus astringens	w				FR[50]
Eucalyptus baxteri	n,s,v	2,4,18,25,29	3	31	S[43]
Eucalyptus botryoides	n,v			31	
Eucalyptus buprestium	w				FR[40]
Eucalyptus camaldulensis	n,q,s,v,w			31	FR[50]
Eucalyptus cladocalyx	s			31	
Eucalyptus cloeziana	q			31	
Eucalyptus coccifera	t	17			FR[60]
Eucalyptus conferruminata	w				FR[50]
Eucalyptus consideniana	n,v	25			S[43]
Eucalyptus cordata	t	17			FR[60]
Eucalyptus dalrympleana s.l.	n,t,v			31	FR[60]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Eucalyptus decipiens s.l.	w				LS[40]
Eucalyptus decurva	w				FR[40]
Eucalyptus delegatensis	n,t,v	8,17,25			S[43],FR[60]
Eucalyptus diversicolor	w	2			
Eucalyptus dives	n,v	2,25			S[43]
Eucalyptus doratoxylon	w				FR[59]
Eucalyptus erectifolia	w				FR[59]
Eucalyptus eugenioides	n,q	2			
Eucalyptus falcata	w				FR[40]
Eucalyptus fastigata	n,v,saf	25	27		S[43],HS[27]
Eucalyptus fibrosa s.l.	n,q			31	
Eucalyptus forrestiana	w				FR[50]
Eucalyptus fraxionoides	n,v,saf		27		HS[27]
Eucalyptus gardneri	w				FR[50]
Eucalyptus globoidea	n,v	2,25			S[43]
Eucalyptus globulus s.l.	n,q,s,t,v	2		31	FR[60]
Eucalyptus gomphocephala	w				FR[50]
Eucalyptus goniocalyx	n,s,v			31	
Eucalyptus grandis	n,q	2			
Eucalyptus imlayensis **E**	n				?HS[22]
Eucalyptus krusana	w				FR[50]
Eucalyptus laeliae	w				FR[50]
Eucalyptus lehmanniii	w				FR[56]
Eucalyptus ligulata subsp. *stirlingica*	w				LS[58]
Eucalyptus macrorhyncha	n,s,v	2,4,25,29			S[43]
Eucalyptus mannifera	n,v	2			
Eucalyptus marginata	w	2,14,15, 24	46,53	31	S[46,53],MS[24],LS[40, 59]
Eucalyptus megacarpa	w				FR[50]
Eucalyptus niphophila	n,v		3		
Eucalyptus nitens	t,v	8,25			S[43],LS[60]
Eucalyptus nitida	t	17			FR[60]
Eucalyptus oblique	n,q,s,t,v	2,17,18, 19,25,29		31	S[43],LS[60]
Eucalyptus occidentalis	w				FR[50]
Eucalyptus ovata s.l.	n,s,t,v	17			FR[60]
Eucalyptus pachyloma	w				FR[40]
Eucalyptus paniculata	n,q			31	
Eucalyptus patens	w				FR[50]
Eucalyptus pauciflora s.l.	n,t,v	25		31	FR[22]
Eucalyptus pilularis	n,q	2		31	
Eucalyptus piperita s.l.	n	2			
Eucalyptus polyanthemos	n,v	3			
Eucalyptus preissiana	w				FR[40]
Eucalyptus pulchella	t	17			FR[60]
Eucalyptus racemosa s.l.	n			31	
Eucalyptus radiata	n,q,t,v	2,4,25		31	S[43]
Eucalyptus regnans	t,v	2,25			S[43],FR[60]
Eucalyptus rossii	n	2			
Eucalyptus rudis	w,				FR[50]
Eucalyptus saligna	n,q	2			
Eucalyptus sieberi	n,t,v	2,17,25		31	S[43],LS[60]
Eucalyptus smithii	n,v,saf		27		HS[27]
Eucalyptus spathulata	w				FR[50]
Eucalyptus staeri	w				LS[40,59]
Eucalyptus talyuberlup	w				FR[59]
Eucalyptus tenuiramis	t	17	3		

FAMILY	Distribution	Isolation			Susceptibility
Species		In wild	In cultivation	By experiment	Rating
Eucalyptus todtiana	w		37,53		S[37,53]
Eucalyptus uncinata	w				FR[40]
Eucalyptus viminalis	n,q,s,t,v	2,25		31	FR[60]
Eucalyptus wandoo	w				FR[50]
Eucalyptus willisii s.l.	s,v	25			S[43]
Homalospermum firmum	w				FR[59]
Hypocalymma angustifolium s.l.	w	15,28,24	3		FR[21,24]
Hypocalymma cordifolium s.l.	w	15			
Hypocalymma myrtifolium	w				FR[40,59]
Hypocalymma phillipsii	w				FR[59]
Hypocalymma robustum	w	14,15,24 46, 37, 24			S[24,37,46]
Hypocalymma speciosum	w				FR[40]
Hypocalymma strictum s.l.	w				HS[40]
Kunzea ericifolia	v	14,24	3		
Kunzea montana	w	58			LS[58,59]
Kunzea parvifolia	n,q,v	25			
Kunzea pomifera	s,v		3		
Kunzea preissiana	w				FR[40]
Kunzea recurva s.l.	w		3		MS[40]
Kunzea sulphurea	w				S[46]
Leptospermum continentale	s	25			S[43]
Leptospermum coriaceum	n,s,v		3		
Leptospermum ellipticum	w	15			
Leptospermum erubescens	w				FR[40]
Leptospermum glaucescens	t	17,34			HS[34], VS or MS[60]
Leptospermum juniperinum	n,s,v	13,18,19	3		
Leptospermum lanigerum	n,q,s,t,v	3			
Leptospermum myrsinoides	n,s,v	4,25			S[43]
Leptospermum scoparium	n,t,v	8,17			FR[22]
Leptospermum trinervium	n,q,v				LS[42]
Lophostemon confertus	n,q	2			
Melaleuca cuticularis	w				FR[40]
Melaleuca diosmifolia	w				FR[50]
Melaleuca elliptica	w		3		
Melaleuca gibbosa	s,t,v,w	17			
Melaleuca holosericea	w				FR[56]
Melaleuca incana	w		3		
Melaleuca lanceolata	w				FR[50]
Melaleuca laxiflora	w				FR[53]
Melaleuca macronychia	w		3		FR[50]
Melaleuca microphylla	w				FR[59]
Melaleuca nesophila	w				FR[50]
Melaleuca pentagona s.l.	w		3		FR[50]
Melaleuca pritzellii	w				LS[58]
Melaleuca pulchella	w				FR[50]
Melaleuca scabra	w	37			S[37,46]
Melaleuca seriata	w				FR[40]
Melaleuca spathulata	w				FR[50]
Melaleuca squamea	n,s,t,v	17,34	3	33	HS[34]
Melaleuca squarrosa	n,s,t,v	17,25			S[43],FR[21]
Melaleuca suberosa	w				FR[40]
Melaleuca subfalcata	w				S[40]
Melaleuca thymoides	w	14,24			MS[59]
Melaleuca uncinata	n,nt,s,v,w		3		
Melaleuca violacea	w				FR[50]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Pericalymma ellipticum	w	14,24	37,53		S[37,53]
Phymatocarpus maxwellii	w		3		
Regelia inops	w		3		LS[40]
Rhodamnia blairiana	q				S[36] FR[36]
Rhodamnia sessiliflora	q				FR[36]
Scholtzia involucrata	w	37			S[46]
Syzygium cormiflorum	q				FR[36]
Syzygium erythrodoxum	q			16	
Syzygium kuranda	q				S[36]
Syzygium johnsonii	q				FR[36]
Syzygium wesa	q			16	FR[36]
Thryptomene calycina	s,v	2	44		MS[44]
Thryptomene micrantha	s,t,v	34			HS[60]
Thryptomene saxicola	w				S[37]
Verticordia carinata **V**	w	58			LS-MS[58]
Verticordia chrysantha	w		3		
Verticordia densiflora	w	14,49, 37, 53			S[37,49,53]
Verticordia habrantha	w				FR[40]
Verticordia huegelii	w	14		37, 53	S[37,53]
Verticordia nitens	w	37			S[37,46]
Verticordia plumosa	w	14	3		
Waterhousia unipunctata	q				FR[36]
Wehlia coarctata	w		3		
OCHNACEAE					
Brackenridgea nitida subsp. *australiana*	q	16			FR[36]
OLACACEAE					
Olax benthamiana	w				Q[21]
Olax phyllanthi	w				FR[40]
OLEACEAE					
Chionanthus axillaris	q				FR[36]
ORCHIDACEAE					
Caladenia flava	w				FR[21,59]
Cryptostylis ovata	w				FR[40]
Drakea confluens **E**	w				FR[58]
Elythranthera brunonis	w				FR[21,59]
Eriochilus dilatatus	w				FR[40]
Leporella fimbriata	s,t,vw				FR[40]
Mecopodum parvifolium	w				FR[21]
Pterostylis concinna	n,s,t,v	25			S[43]
Pterostylis vittata	s,v,t,w				FR[59]
Pterostylis aff. *nana*	w				FR[59]
Pyrorchis nigricans	w				FR[21]
Thelymitra crinita	w				FR[21]
Thelymitra pauciflora s.l.	n,q,s,t,v,w				FR[59]
PHORMIACEAE					
Agrostocrinum scabrum	w			21	FR[59]S[21]
Dianella longifolia s.l.	n,nt,q,s,t,v,w	25		9,34	
Dianella revoluta s.l.	n,q,s,t,v,w	14,24			S[24]
Dianella tasmanica	n,t,v	8,17			
Johnsonia lupulina s.l.	w				FR[40]
Tricoryne elatior	n,nt,q,s,t,v,w				FR[21]
PHYLLOCLADACEAE					
Phyllocladus aspleniifolius	t	17,34	3		
PITTOSPORACEAE					
Billardiera drummondiana	w				FR[24]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Billardiera fraseri	w				FR[21]
Pittosporum phillyreoides	n,nt,q,s,v,w				FR[50]
Rhytidosporum procumbens	n,q,t,v		2		
Sollya drummondii	w				FR[58,59]
POACEAE					
Agrostis aemula	n,q,s,t,v,w				FR[59]
Amphipogon amphipogonoides	w				Q[21]
Amphipogon laguroides s.l.	w				FR[59]
Anisopogon avenaceus	n,v				FR[42]
Austrostipa compressa	w				FR[40]
Austrostipa flavescens	n,s,t,v,w				LS[40]
Deyeuxia drummondii **E**	w				FR[58]
Entolasia stricta	n,q				FR[42]
Neurachne alopecuroidea	s,v,w				FR[21]
Poa poiformis	n,q,s,v,w				FR[54]
Poa porphyroclados	w				FR[59]
Poa sieberiana	n,q,t,v		44		FR[44]
Tetrarrhena juncea	n,q,t,v				FR[22]
Tetrarrhena laevis	w			21	FR[59],Q[21]
Themeda triandra	n,nt,q,s,t,v,w	29			S[43]
PODOCARPACEAE					
Microstrobos fitzgeraldii	n		3		
Podocarpus druoynianus	w	15,46, 53	3		S[46,53]
Podocarpus lawrencei	n,t,v	17	3		
Pruminopitys amara	q			16	
POLYGALACEAE					
Comesperma calymega	s,t,v,w	40			FR[21]
Comesperma confertum	w	40			FR[40]
Comesperma ericinum s. l.	n,q,t,v				
Comesperma virgatum	w			21	Q[21],FR[24]
PROTEACEAE					
Adenanthos apiculatus	w		3		
Adenanthos barbiger	w	14,28			S[46],HS[14]
Adenanthos cacomorphus	w				HS[41]
Adenanthos cuneatus	w				S[46,51],HS[40],LS[59]
Adenanthos cunninghamii **E**	w				S[49,52],MS[40,41]
Adenanthos cygnorum s.l.	w				S[37,46],HS[40]
Adenanthos cygnorum subsp. *chamaephyton*	w				HS[41]
Adenanthos detmoldii s.l.	w				S[46],HS[41]
Adenanthos dobagii **E**	w				S[49],HS[41]
Adenanthos ellipticus **V**	w				S[52],HS[41,59]
Adenanthos eyrei **E**	w				HS[41]
Adenanthos filifolius	w	58			S[56],MS-HS[40,58,59]
Adenanthos glabrescens subsp. *exasperatus*	w				HS[41]
Adenanthos gracilipes	w				HS[41]
Adenanthos ileticos	w				S[52],HS[41]
Adenanthos labillardierei	w				HS[41,59]
Adenanthos linearis	w				HS[40,41]
Adenanthos macropodiana	s	19			
Adenanthos meisneri	w				S[46]
Adenanthos obovatus	w	2,14,15, 24			S[37,46,53],HS[40,59]
Adenanthos oreophilus	w				S[56],HS[40,59]
Adenanthos pungens subsp. *effusus* **E**	w				S[49],HS[41]
Adenanthos pungens subsp. *pungens* **V**	w				S[49],HS[41]
Adenanthos sericeus	w				S[46]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Adenanthos terminalis	s,v				S[57]
Adenanthos velutinus **E**	w				HS[41]
Agastachys odorata	t	17,34			HS[34]
Banksia aculeata	w				MS[40],S[58]
Banksia ashbyi	w	47	47		S[47]
Banksia aspleniifolia	q		3		
Banksia attenuata	w	14,15,24,37	3	23*	S[46,53],HS[23,40]
Banksia audax	w			23*	
Banksia baueri	w	46, 47,		23*	HS[59],S[23,46,47],MS[40]
Banksia baxteri	w	46, 47		23*	S[46,47],HS[40,59]
Banksia benthamiana	w			23*	HS[23,41]
Banksia brownii **E**	w	58	49, 47, 52,	23*	S[49,47,52],HS[23,40,41,58,59]
Banksia burdettii	w		47,	23*	S[47]
Banksia caleyi	w		47, 3	23*	S[47],MS[40]
Banksia candolleana	w		47,	23*	S[47]
Banksia chamaephyton	w				HS[41]
Banksia coccinea	w		46, 47,	23*	S[46,47],HS[23,40,59]
Banksia cuneata **E**	w		52,	23*	S[52],HS[23,40,41]
Banksia dryandroides	w			23*	HS[40]
Banksia elderiana	w		3	23*	
Banksia elegans	w		3		HS[41]
Banksia epica	w				HS[41]
Banksia ericifolia	n	3,6		23*	SV[42]
Banksia gardneri var. *brevidentata*	w				MS[40]
Banksia gardneri var. *gardneri*	w				MS[40]
Banksia gardneri var. *hiemalis*	w			23*	
Banksia goodii **V**	w				S[49,52],MS[41]
Banksia grandis	w	14,15,21,24,28	3	21,23*	S[24,46,47,53],HS[14,23,40,59]
Banksia hookeriana	w		47,	23	S[47],HS[23]
Banksia ilicifolia	w	14,15,24,37,46,53			S[46,53],HS[23,40]
Banksia integrifolia s.l.	n,q,t,v	2		23*	
Banksia laevigata	w			23*	S[23],HS[41]
Banksia laricina	w	37	47,	23*	S[47],HS[23,40]
Banksia lemanniana	w		3	23*	
Banksia lindleyana	w		47,	23*	S[47]
Banksia littoralis	w	14,15	46, 53	23*	S[46,53],HS[40]
Banksia lullfitzii	w			23*	HS[41]
Banksia marginata	n,s,t,v	2,4,8,13, 17,18,19,25,29,34		23*	S[43]
Banksia media	w		46	23*	S[46]
Banksia meisneri var. *ascendens*	w				HS[41]
Banksia menziesii	w	14,15,24,37		23*	S[46,47,53],HS[23,40]
Banksia micrantha	w				MS[40,41]
Banksia nutans	w			23*	S[46, 47],HS[40]
Banksia oblongifolia	n,q			23*	
Banksia occidentalis s.l.	w		3	23*	S[40,46,47],HS[40,41]
Banksia oligantha **E**	w				S[49,52],HS[41]
Banksia oreophila	w	58			HS[40,58,59]
Banksia ornata	s,v		3	23*	HS[23]
Banksia paludosa subsp. *paludosa*	n			23*	SV[42]
Banksia petiolaris	w			23*	
Banksia pilostylis	w			23*	

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Banksia preamorsa	w			23*	S[46]
Banksia prionotes	w			23*	S[46,47],HS[23,40]
Banksia pulchella	w			23*	HS[23]
Banksia quercifolia	w	15		23*	S46, 51,HS[40,59]
Banksia repens	w			23*	MS[40]
Banksia saxicola	v		44		HS[44]
Banksia scabrella	w				HS[41]
Banksia sceptrum	w			23*	HS[23]
Banksia seminuda	w				S[46],HS[40]
Banksia serrata	n,s,t,v	2,17,25,34			S[43],SV[42,60]
Banksia solandri	w	58			MS[40], HS[41,58,59]
Banksia speciosa	w		3	23*	S[46,47],HS[23,40]
Banksia sphaerocarpa s.l.	w		3	23*	S[46,47], MS[59],HS[23,40,41,58]
Banksia spinulosa var. *cunninghamii*	n,q,v	13,25			S[43]
Banksia telmatiaea	w	37			S[37,46]
Banksia tricuspis	w				S[52],HS[41]
Banksia verticillata **V**	w			23*	S[52],HS[40,41,58,59]
Banksia victoriae	w			23*	HS[23]
Banksia violacea	w			23*	HS[40,59]
Buckinghamia celsissima	q			16	
Cardwellia sublimis	q				S[36]
Carnarvonia araliifolia var. *montana*	q	16			
Cennarrhenes nitida	t	17,34			HS[34]
Conospermum caeruleum s.l.	w				MS[59]
Conospermum coerulescens subsp. *dorrienii*	w				MS[59]
Conospermum eatoniae	w				LS[41]
Conospermum hookeri	t	34			MS[60]
Conospermum mitchellii	v	25,29			S[43]
Conospermum scaposum	w				LS[41]
Conospermum spectabile	w				S[58]
Conospermum stoechadis	w				S[37,46]
Conospermum todii	w				S[52]
Conospermum triplinervium	w	37		37	S[37]
Conospermum undulatum	w				LS[41]
Darlingia darlingiana	q	16			S[36]
Dryandra acanthopoda	w				HS[41]
Dryandra anatona **E**	w	58			S[49],HS[41,58]
Dryandra arctotidis	w				S[46],MS[40]
Dryandra armata s.l.	w	14			HS[59],S[46]
Dryandra baxteri	w				HS[59]
Dryandra bipinnatifida	w				S[46]
Dryandra calophylla	w				MS[58]
Dryandra carduacea	w	14			
Dryandra cirsioides	w				MS[40]
Dryandra comosa	w				HS[41]
Dryandra concinna	w	58			HS[58,59]
Dryandra conferta var. *parva*	w				HS[58]
Dryandra cynaroides	w				HS[41]
Dryandra erythrocephala var. *inopinata*	w				HS[41]
Dryandra falcata	w				HS[40]
Dryandra ferruginea subsp. *pumila*	w				HS[58]
Dryandra foliolata	w	58			HS[58,59]
Dryandra foliosissima	w				HS[41]
Dryandra formosa	w	46**,** 51,58			S[46,51],MS-HS[40,58,59]
Dryandra fraseri var. *oxycedra*	w				HS[41]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Dryandra hirsuta	w	58			MS[40,58]
Dryandra horrida	w				HS[41]
Dryandra idiogenes	w				HS[41]
Dryandra ionthocarpa **E**	w				HS[41]
Dryandra kippistiana var. *paenepeccata*	w				HS[41]
Dryandra lepidorhiza	w				HS[41]
Dryandra lindleyana s.l.	w				S[46],SP[21]
Dryandra mimica **E**	w				S[52],HS[41]
Dryandra montana **E**	w	58			S[49],HS[41,58,59]
Dryandra mucronulata	w				HS[40]
Dryandra nivea s.l.	w	14,28			S[37,46,53],MS[40,59]
Dryandra octotriginta	w				HS[41]
Dryandra plumosa subsp. *denticulata*	w				MS-HS[40,58,59]
Dryandra polycephala	w				MS[41]
Dryandra porrecta	w				HS[41]
Dryandra praemorsa	w		3		
Dryandra preissii	w				HS[41]
Dryandra pseudoplumosa	w				HS[58],MS[40]
Dryandra pteridifolia	w				S[46],HS[40]
Dryandra pulchella	w				HS[41]
Dryandra quercifolia	w				HS[40,59]
Dryandra sclerophylla	w				HS[41]
Dryandra seneciifolia	w				S[46],MS-HS[41,58]
Dryandra serra	w				S[46],HS[41,58]
Dryandra serratuloides subsp. *perissa*	w				S[49]
Dryandra serratuloides s.l.	w				S[49,52],HS[41]
Dryandra sessilis	w	14,28			SP[21],S[46],MS[40]
Dryandra shanklandiorum	w				HS[41]
Dryandra speciosa	w				HS[41]
Dryandra squarrosa subsp. *argillacea*	w				S[49]
Dryandra squarrosa s.l.	w				S[46]
Dryandra subpinnatifida	w				HS[41]
Dryandra tenuifolia	w				HS[40]
Dryandra tortifolia	w				HS[41]
Dryandra trifontinalis	w				HS[41]
Dryandra wonganensis	w				HS[41]
Franklandia fucifolia	w				MS[40]
Franklandia triaristata	w				LS[41]
Grevillea acrobotrya susbp. *uniformis*	w				LS[41]
Grevillea alpina	n,v	2,25,29			S[43]
Grevillea aneura	w				LS[41]
Grevillea annulifera	w				LS[41]
Grevillea aquifolium	s,v	25,29			S[43]
Grevillea asparagoides	w				LS[41]
Grevillea astericosa	w				LS[41]
Grevillea batrachioides **E**	w				LS[41]
Grevillea baxteri	w				LS[41]
Grevillea brachystylis subsp. *australis* **V**	w				LS[41]
Grevillea brachystylis subsp. *brachystylis*	w				LS[41]
Grevillea bracteosa	w				LS[41]
Grevillea calliantha **E**	w				S[52],LS[41]
Grevillea candicans	w				LS[41]
Grevillea christinae **E**	w				LS[41]
Grevillea chrysophaea	v	32			HS[32]
Grevillea cirsiifolia	w				S[52]
Grevillea confertifolia	v		44		MS[44]
Grevillea costata	w				LS[41]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Grevillea crowleyae	w				LS[41]
Grevillea curviloba s.l.	w				LS[41]
Grevillea decora	q		3		
Grevillea depauperata	w				LS[41]
Grevillea donaldiana	w				LS[41]
Grevillea dryandroides s.l.	w				LS[41]
Grevillea erectiloba	w				LS[41]
Grevillea eriobotrya	w				LS[41]
Grevillea fasciculata	w				FR[40],MS[59]
Grevillea fistulosa	w				LS[41]
Grevillea flexuosa **V**	w				LS[41]
Grevillea fulgens	w				LS[41]
Grevillea fuscolutea	w				LS[41]
Grevillea georgeana	w				LS[41]
Grevillea glabrata subsp. *dissectifolia*	w				LS[41]
Grevillea glabrata subsp. *ornithopoda*	w				LS[41]
Grevillea globosa	w				LS[41]
Grevillea granulosa	w				LS[41]
Grevillea hookeriana	w				FR[50]
Grevillea inconspicua	w				LS[41]
Grevillea infundibularis **E**	w				LS[41]
Grevillea involucrata **E**	w				LS[41]
Grevillea irrasa subsp. *irrasa*	n	13			HS[22]
Grevillea juniperina s.l.	n		3		
Grevillea kenneallyi	w				LS[41]
Grevillea lanigera	n,v		3		
Grevillea latifolia	w				LS[41]
Grevillea lavandulacea s.l.	s,v				S[20]
Grevillea leptopoda	w				LS[41]
Grevillea lissopleura	w				LS[41]
Grevillea longistyla	q		3		
Grevillea lullfitzii	w				LS[41]
Grevillea makinsonii	w				LS[41]
Grevillea manglesioides subsp. *papillosa*	w				LS[41]
Grevillea marriottii	w				LS[41]
Grevillea maxwellii **E**	w				LS[41]
Grevillea microstegia	v		44		LS[44]
Grevillea miniata	w				LS[41]
Grevillea minutiflora	w				LS[41]
Grevillea miqueliana s.l.	n,v		3		
Grevillea mucronulata	n		3		
Grevillea murex **E**	w				LS[41]
Grevillea nana subsp. *abbreviata*	w				LS[41]
Grevillea oleioides	n				S[22]
Grevillea olivacea	w				LS[41]
Grevillea phanerophlebia	w				LS[41]
Grevillea phillipsiana	w				LS[41]
Grevillea pieroniae	w				MS[58]
Grevillea pilosa subsp. *dissecta*	w				LS[41]
Grevillea pilulifera	w				FR[21]
Grevillea pimeleoides	w				LS[41]
Grevillea polybractea	n,v		3		
Grevillea prostrata	w				LS[41]
Grevillea psilantha	w				LS[41]
Grevillea quinquenervis	s	19			
Grevillea rogersii	s	19			
Grevillea rogersoniana	w				LS[41]

FAMILY	Distribution	Isolation			Susceptibility
Species		In wild	In cultivation	By experiment	Rating
Grevillea rosieri	w				LS[41]
Grevillea rosmarinifolia s.l.	n,s,v		3		
Grevillea roycei	w				LS[41]
Grevillea rudis	w				LS[41]
Grevillea saccata Benth.	w				S[52]
Grevillea scabra	w				LS[41]
Grevillea scabrida	w				LS[41]
Grevillea scapigera **E**	w				LS[41]
Grevillea secunda	w				LS[41]
Grevillea spinosissima	w				LS[41]
Grevillea steiglitziana	v	25			S[43]
Grevillea stenostachya	w				LS[41]
Grevillea subtiliflora	w				LS[41]
Grevillea synapheae	w	24			FR[24]
Grevillea tenuiloba	w				LS[41]
Grevillea tetrapleura	w				LS[41]
Grevillea thelemanniana	w				LS[41]
Grevillea triloba	w				LS[41]
Grevillea tripartita	w				MS[40]
Grevillea victoriae s.l.	n,v		3		
Grevillea williamsonii **E**	v		44		HS[44]
Grevillea wilsonii	w				FR[21]
Grevillea wittweri	w				LS[41]
Hakea aculeata **V**	w				LS[41]
Hakea ambigua	w				MS[40,59]
Hakea amplexicaulis	w	24			FR[24]
Hakea bakeriana	n		3		
Hakea baxteri	w				S[46],MS[40,59]
Hakea bicornata	w				LS[41]
Hakea ceratophylla	w				LS[40,59]
Hakea conchifolia	w		3		
Hakea corymbosa	w				FR[40]
Hakea crassifolia	w				MS[40,59]
Hakea crassinervia	w				LS[41]
Hakea cucullata	w				S[46],MS[40,59]
Hakea dactyloides	n,q,v				S[22]
Hakea elliptica	w				MS[59]
Hakea flabellifolia	w				S[56]
Hakea kippistiana	w		3		
Hakea lasiantha	w				MS[40]
Hakea lasiocarpha	w				MS[58]
Hakea laurina	w				LS[40]
Hakea lehmanniana	w				MS[40]
Hakea lissocarpha	w	24,28			FR[21,24]
Hakea longiflora	w				LS[41]
Hakea marginata	w				HS[40]
Hakea megalosperma **V**	w				LS[41]
Hakea myrtoides	w				LS[41]
Hakea neurophylla	w				LS[41]
Hakea nodosa	s,t,v	25			S[43]
Hakea oleifolia	w		3		S[46]
Hakea pendanicarpa subsp. *crassifolia*	w				S[40,46]
Hakea pendens	w				LS[41]
Hakea petiolaris	w				FR[50]
Hakea platysperma	w		3		
Hakea prostrata	w				S[46]
Hakea rigida	w				LS[41]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Hakea rubrifolia	w				LS[40]
Hakea ruscifolia	w	14			FR[21],LS[40]
Hakea salicifolia	n,q				
Hakea sericea	n,t,v	2,17,25			
Hakea spathulata	w				LS[41]
Hakea stenocarpa	w				FR[21]
Hakea trifurcata	w				S[46],LS[40]
Hakea tuberculata	w				LS[58]
Hakea ulicina	n,t,v	25,34		9	S[43]
Hakea undulata	w		3		S[46],MS[40]
Hakea varia	w				LS[40,59]
Hakea victoria	w		3		LS[40,59]
Isopogon alcicornis	w				HS[41]
Isopogon anemonifolius	n				SV[42]
Isopogon asper	w		3		
Isopogon attenuatus	w	15		54	LS[59],S[54]
Isopogon axillaris	w				S[46],HS[40]
Isopogon baxteri	w				HS[58],LS[59],MS[40]
Isopogon buxifolius var. *obovatus*	w				HS[40,59]
Isopogon ceratophyllus	s,t,v	18,25,29,34			S[43]
Isopogon drummondii	w				HS[41]
Isopogon formosus	w	15,46			HS[59],S[46],LS[40]
Isopogon heterophyllus	w				MS[40]
Isopogon latifolius	w	58			HS[58],MS[40]
Isopogon petiolaris	n,q		3		
Isopogon polycepahlus	w		3		
Isopogon scabriusculus	w				MS[40]
Isopogon sphaerocephalus	w	14,28			S[24,46,48],MS[40,59]
Isopogon teretifolius var. petrophiloides	w				MS[40]
Isopogon tridens	w				HS[41]
Isopogon trilobus	w				HS[40]
Isopogon tripartitus	w				MS[40]
Isopogon uncinatus **E**	w	58			S[49,52],HS[41,58]
Lambertia echinata subsp. *echinata* **E**	w				S[46,49,52],HS[41,58]
Lambertia echinata subsp. *occidentalis*	w				S[49]
Lambertia ericifolia	w				HS[58],MS[40]
Lambertia fairallii **E**	w	58			S[49,52],HS[41,58,59]
Lambertia formosa	n				SV[42]
Lambertia inermis s.l.	w				S[56],HS[40,59]
Lambertia multiflora	w				S[56]
Lambertia orbifolia **E**	w	58			S[49,52],HS[40,41,58]
Lambertia rariflora s.l.	w				LS[41]
Lambertia uniflora	w				HS[40,59]
Lomatia fraseri	n,v	13			
Lomatia fraxinifolia	q				S[36]
Lomatia ilicifolia	n,q,v	25			S[43]
Lomatia tasmanica **CE**	t			34	S[61]
Opisthiolepis heterophylla	q				S[36]
Orites diversifolia	t	17			
Persoonia baeckeoides	w				LS[41]
Persoonia brachystylis	w				LS[41]
Persoonia brevirhachis	w				LS[41]
Persoonia chapmaniana	w				LS[41]
Persoonia cornifolia	n,q				HS[22]
Persoonia elliptica	w				S[46],HS[22]
Persoonia gunnii	t	17			
Persoonia hakeiformis	w				LS[41]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Persoonia juniperina	s,t,v	17,25,29			S[43], S[60]
Persoonia kararae	w				LS[41]
Persoonia leucopogon	w				LS[41]
Persoonia levis	n,v	3,6			FR[22]
Persoonia linearis	n,q,v				FR[22]
Persoonia longifolia	w	14,15,28			S[46,53,54],HS[21,40,59]
Persoonia micranthera **E**	w	58			HS[58,59],LS[41]
Persoonia microcarpa	w				LS[40]
Persoonia muelleri var. *densifolia*	t			9	HS[9]
Persoonia papillosa	w				LS[41]
Persoonia rudis	w				LS[41]
Persoonia scabra	w				LS[41]
Persoonia silvatica	n,v				S[22]
Persoonia sulcata	w				LS[41]
Persoonia trinervis	w				MS[40]
Petrophile anceps	w				HS[58]
Petrophile biloba	w		53		S[53]
Petrophile biternata	w				MS[41]
Petrophile canescens	n,q				
Petrophile crispata	w				MS[41]
Petrophile divaricata	w				HS[40,59]
Petrophile diversifolia	w				S[46],HS[40,59]
Petrophile drummondii	w	37			S[37]
Petrophile ericifolia	w				HS[40]
Petrophile fastigiata	w		3		
Petrophile incurvata	w				MS[41]
Petrophile linearis	w	14,24			S[37,46]
Petrophile longifolia	w				HS[40]
Petrophile media	w				HS[40]
Petrophile multisecta	s	19			
Petrophile plumosa	w				MS[41]
Petrophile pulchella	n	1			
Petrophile seminuda	w		3		MS[40]
Petrophile serruriae	w				S[46],HS[40]
Petrophile sessilis	n,q	3,6			
Petrophile squamata	w		3		S[46],HS[40]
Petrophile striata	w	14			SP[21]
Petrophile stricta	w				S[37]
Stenocarpus sinuatus	n,q				FR[36]
Stirlingia latifolia	w	14,24			S[46],MS[40]
Stirlingia tenuifolia s.l.	w				S[40]
Stirlingia tenuifolia var. *anethifolia*	w				MS[40]
Stirlingia tenuifolia var. *tenuifolia*	w				MS[40]
Synaphea petiolaris s.l.	w	24			S[46],FR[24]
Synaphea polymorpha	w				S[40],MS[40,59]
Telopea mongaensis	n		3, 12		
Telopea speciosissima	n		3, 12		
Telopea truncata	t	17			
Xylomelum angustifolium	w				S[46]
Xylomelum occidentale	w	15			S[37,46]
RANUNCULACEAE					
Clematis pubescens	w				FR[24],Q[21]
RESTIONACEAE					
Anarthria gracilis	w	40			FR[40]
Anarthria prolifera	w	40			FR[40]
Anarthria scabra	w	40			FR[40]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Calorophus exsulcus	w				FR[21]
Chordifex abortivus **E**	w	58			FR[58]
Chordifex isomorphus	w				FR[58]
Chordifex monocephalus	w	17		33	
Desmocladus fasciculatus	w				FR[21],LS[40],MS[59]
Desmocladus flexuosa	w				FR[21,59]
Harperia confertospicata	w				FR[58]
Leptocarpus tenax	w				FR[40]
Lepyrodia scariosa	n,q				FR[42]
Restio confertospicatus	w				FR[40]
Restio laxocarya	w	14			MS[21]
RHAMNACEAE					
Alphitonia petriei	n,q				S[36]
Alphitonia whitei	q				S[36]
Cryptandra pumila	w				LS[41]
Cryptandra tomentosa	s,t,v	25			S[43]
Pomaderris intermedia	n,t,v	3			
Trymalium floribundum	w		3		
Trymalium ledifolium	w	14,28			S[48,53],SP[21]
ROSACEAE					
Acaena echinata	n,s,t,v,w	25			
RUBIACEAE					
Antirhea sp. (Mt Lewis BG 5733)	q				S[36]
Atractocarpus fitzalanii subsp. *tenuipes*	q				FR[36]
Opercularia echinocephala	w	28			Q[21]
Opercularia vaginata	w				Q[21]
Opercularia varia	n,s,t,v	25			
RUTACEAE					
Acronychia oblongifolia	q	16			
Antirhea sp. (Mt Lewis BG 5733)	q				
Asterolasia phebalioides **V**	s,v		44		HS[44]
Boronia anemonifolia	n,t,v		3		
Boronia baeckeacea	w		3		
Boronia citriodora	t,v	17,34	3		HS[34]
Boronia crenulata s.l.	w	40			FR[40,59]
Boronia crenulata subsp. *viminea*	w		3		
Boronia fastigiata	w			21	S[21]
Boronia microphylla	n,q				
Boronia nana var. *hyssopifolia*	v	25			
Boronia nana var. *nana*	v	25			
Boronia parviflora	n,q,s,t,v	17,34			HS[34], LS or SV[61]
Boronia pilosa s.l.	s,t,v	17,34	3		HS[34], MS[61]
Boronia revoluta	w				S[49]
Boronia spathulata	w				FR[24]
Brombya platynema	q				FR[36]
Correa decumbens	q		3		
Correa pulchella	s	20			
Correa reflexa	s	17,20,25,29			S[43]
Crowea angustifolia s.l.	w				S[46]
Crowea angustifolia var. *platyphylla*	w		3		
Crowea exalata	n,v		3		
Crowea saligna	n,q		3		
Flindersia bourjotiana	q				S[36]
Flindersia brayleyana	q			16	
Flindersia pimenteliana	q				FR[36]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Leionema phylicifolium	n,v		3		
Leionema ralstonii **V**	n		22		MS[22]
Melicope elleryana	q				FR[36]
Muiriantha hassellii	w				FR[58]
Nematolepis squamea s.l.	n,q,t,v	2,8,17,34			HS[34]
Phebalium daviesii	t			9	HS[9]
Philotheca myoporoides	n,q,v		3		
Philotheca spicata	w	24	3		FR[21,24]
Philotheca virgata	n,t,v	17			
Zieria laevigata s.l.	n,q		3		
SANTALACEAE					
Exocarpus cupressiformis	n,q,s,t,v	3			
Leptomeria cunninghamii	w	24			FR[24],Q[21]
Leptomeria eriocoides	w				FR[40]
SAPINDACEAE					
Dodonaea boroniifolia	n,q,v		3		
Dodonaea viscosa s.l.	n,nt,q,s,t,v,w	3			FR[50]
Jagera pseudorhus	q			16	
Mischocarpus macrocarpus	q				FR[36]
SAPOTACEAE					
Pouteria brownlessiana	q				S[36]
Pouteria euphlebia	q				FR[36]
Pouteria papyracea	q				FR[36]
Pouteria pearsoniorum	q				FR[36]
SELAGINELLACEAE					
Selaginella uliginosa	n,q,t,v	25			S[43]
SOLANACEAE					
Anthocercis racemosa	w		3		
Solanum oldfieldii	w		3		
STACKHOUSIACEAE					
Tripterococcus brunonis	w				FR[21]
STERCULIACEAE					
Argyrodendron actinophyllum	q			16	
Franciscodendron laurifolium	q				S[36]
Lasiopetalum floribundum	w	15,28			S[24,48,53],MS[21]
Lasiopetalum glabratum	w	14			
Lasiopetalum membranifolium	w				FR[58]
Thomasia grandiflora	w	15		37	S[37]
Thomasia pauciflora	w	15			
Thomasia sp. Toolbrunup	w				FR[58,59]
STYLIDIACEAE					
Levenhookia pusilla	s,w				FR[21]
Levenhookia stipitata	s,w				FR[21]
Stylidium amoenum	w	26		21	HS[21]
Stylidium brunonianum	w				FR[40]
Stylidium calcaratum	s,v,w				FR[21]
Stylidium graminifolium s. l.	n,q,s,t,v	17,34	3	33	MS[60]
Stylidium imbricatum	w				FR[40,59]
Stylidium hispidum	w				FR[21]
Stylidium junceum	w			21	Q[21]
Stylidium keigheryi	w				FR[59]
Stylidium piliferum subsp. *minor*	w				FR[40]
Stylidium repens	w				FR[21]
Stylidium scandens	w				FR[40]
Stylidium schoenoides	w				Q[21]

FAMILY	**Distribution**	**Isolation**			**Susceptibility**
Species		In wild	In cultivation	By experiment	Rating
Stylidium spathulatum	w	51			S[51]
Stylidium spinulosum subsp. *montanum*	w				FR[59]
Stylidium verticillatum	w				FR[40,58,59]
Stylidium sp. Stirling Range	w				FR[59]
SYMPLOCACEAE					
Symplocos ampulliformis	q				FR[36]
Symplocos cochinchinenis var. *gittonsii*	q				FR[36]
Symplocos stawellii	q	16			
TAXODIACEAE					
Athrotaxis selaginoides	t	17			FR[60]
THYMELAEACEAE					
Pimelea ferruginea	w		3		
Pimelea hispida	w				FR[40,59]
Pimelea humilis	n,s,t,v				
Pimelea imbricata var. *piligera*	w		3		
Pimelea ligustrina s.l.	n,q,s,t,v	25			
Pimelea linifolia s.l.	n,q,s,t,v	25,29			S[43],FR[22]
Pimelea pagophila **V**	v		44		HS[44]
Pimelea rosea	w				MS[40]
Pimelea suaveolens	w	14**,**24			S[24],SP[21]
TREMANDRACEAE					
Tetratheca ciliata	n,s,t,v	25,29,34			S[43]
Tetratheca gunnii **CE**	t	34			MS[60]
Tetratheca hirsuta	w	15		21	HS[21]
Tetratheca labillardierei	n,t,v	17			
Tetratheca pilosa s.l.	n,s,t,v	17,18,25			S[18,43]
Tetratheca procumbens	t	17,34			
Tetratheca setigera	w				HS[40,59]
Tetratheca subaphylla	n,v	13			HS[22]
Tremandra stelligera	w				S[46]
VIOLACEAE					
Hybanthus floribundus	w			21	Q[21]
WINTERACEAE					
Bubbia semecarpoides	q				FR[36]
Tasmannia lanceolata	n,t,v	8,17,34			
Tasmannia purpurascens **V**	n	35			HS[35]
XANTHOPHYLLACEAE					
Xanthophyllum octandrum	q				S[36]
XANTHORRHOEACAE					
Lomandra caespitosa	w			21	
Lomandra confertifolia s.l.	n,q,v				FR[42]
Lomandra filiformis	n,q,v	29			
Lomandra hermaphrodita	w				FR[21]
Lomandra integra	w			21	
Lomandra longifolia	n,q,s,v	29			FR[60]
Lomandra nigricans	w				FR[59]
Lomandra obliqua	n,q				FR[42]
Lomandra odora	w	14			S[46]
Lomandra pauciflora	w				FR[40,59]
Lomandra preisii	w				FR[40]
Lomandra sonderi	w	14,28,46**,** 48		21	S[46,48],MS[21],HS[14]
Lomandra spartea	w				FR[21]
Xanthorrhoea arenaria **V**	t			9	HS[9,60]
Xanthorrhoea australis	n,s,t,v	2,4,13,17,22,29,34	44		S[43],HS[22,61]

FAMILY	Distribution	Isolation			Susceptibility
Species		In wild	In cultivation	By experiment	Rating
Xanthorrhoea bracteata	t	34			
Xanthorrhoea brevistyla	w				HS[40,41]
Xanthorrhoea drummondii	w				S[46]
Xanthorrhoea glauca subsp. *glauca*	n,q	13			HS[13]
Xanthorrhoea gracilis	w	14,28**,** 46**,** 48**,** 37**,**53**,** 24			SP[21],S[24,37,46,48,53],HS[14,40]
Xanthorrhoea latifolia	w	38			
Xanthorrhoea nana	w				S[46]
Xanthorrhoea platyphylla	w	58			HS[40,58,59]
Xanthorrhoea preissii	w	2,14,22, 24,28,46**,** 48**,**37**,**53			SP[21],S[37,46,48,53], HS[14,40,59]
Xanthorrhoea quadrangulata	s	?			
Xanthorrhoea resinifera	n,q,v	13			
Xanthorrhoea semiplana var. *semiplana*	s	18			
Xanthorrhoea semiplana var. *tateana*	s	18			
XYRIDACEAE					
Xyris exilis **V**	w				FR[58,59]
ZAMIACEAE					
Macrozamia communis	n	2			S[22]
Macrozamia riedlei	w	2,14,15, 24			SP[21],S[46,53],HS[40]

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Questionnaire 1

Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia: **Part 1** – A Review of Current Management and the Identification of Best Practice Benchmarks

This document reviews current *P. cinnamomi* management in Australia and identifies benchmark for practices and procedures according to a generic model of best practice which includes the following components:

Strategic Management	**Tactical Management**	**Operational Management**
Legislation and Statutory Policy	Research	On-Ground Management
Non-statutory Policy and Planning	Training and Extension	
Investment	Detection and Diagnosis	
	Risk Assessment and Priority Setting	
	Standard Operating Procedures	
	Monitoring, Audit and Review	

Benchmarks provide a criterion by which to measure something. In the context of this project, the benchmarks are the best processes, practices and/or procedures currently employed in the management of *P. cinnamomi* in Australia. These benchmarks will enable the performance of an organisation in managing *P. cinnamomi* to be measured against what is considered best practice, and provide targets for improved performance. Metric benchmarking was not possible due to a lack of data on the effectiveness of current management approaches, and the subjectivity of the benchmarks identified is acknowledged.

We are seeking feedback and 'in principle' endorsement of the benchmarks we have identified as a framework for improving the management of *P. cinnamomi* in natural ecosystems of Australia. A questionnaire has been formulated which addresses the Strategic/Tactical Management Benchmarks and On-Ground Management Benchmarks separately. We would greatly appreciate your help in completing the questionnaire.

How to submit comments?

Please complete the following questionnaire either in hardcopy or electronically (electronic version available on the CD) and return to CPSM **BY THE CLOSE OF BUSINESS 28TH OCTOBER 2005** as per the instructions below.

Submission Options	*Submission Details*
1. Mail	Dr Emer O'Gara Centre for *Phytophthora* Science and Management School of Biological Sciences and Biotechnology Murdoch University MURDOCH WA 6151
2. Facsimile	08 9360 6303
3. E-Mail	e.ogara@murdoch.edu.au ***Note: please write 'Best Practice Submission' in the 'Subject' line***

Name of Respondent (optional)	
Organisation Name and State	

Benchmarks for Strategic/Tactical Management

Q1. In your opinion, do the strategic/tactical benchmarks identified have the potential to improve the national and state level management of *P. cinnamomi* in Australia?

Yes	
No	
If the answer is no, please specify why	

Q2. It is acknowledged that many of the strategic/tactical benchmarks have been identified from current management of *P. cinnamomi* in WA. In your opinion are the benchmarks identified transferable either directly or with adaptations to the management of *P. cinnamomi* in other States/Territories?

Yes	
No	
If the answer is no, please specify why	

Q3. What, if any, application do you see in your organisation for the strategic/tactical benchmarks identified in the document?

Multiple responses may apply

set or review *P. cinnamomi* management goals and targets	
evaluate current *P. cinnamomi* management performance	
provide new ideas for management approaches	
no application envisaged	
Other, please specify	

Q3. What impediments, if any, do you envisage to the adoption of the strategic/tactical benchmarks by your organisation?

Multiple responses may apply

poor understanding of the impact of *P. cinnamomi* in the region	
lack of support for *P. cinnamomi* management either from within the organisation, or from other stakeholders	
lack of resources	
Please specify if other impediments exist	

Benchmarks for Operational Management

Note: these questions refer directly to the information presented in section 5 On-Ground Management Options and associated Appendices in the document

Q1. Would your organisation have use for the on-ground management options provided in Table 5.1 to 5.7?

Yes	
No	
If the answer is no, please specify why	

Q2. How would you describe the on-ground management options presented in Tables 5.1 to 5.7?

	YES	NO
sufficiently explicit		
in an easily usable format		
logical		
supported with sufficient background information		
If the answer to some/all of these questions is 'no', could you please specify how the tables could be improved		

Q4. What impediments, if any, do you envisage in your organisation to the adoption of the on-ground management options presented in Tables 5.1 to 5.7?

Multiple responses may apply

lack of knowledge on the distribution of *P. cinnamomi* in the region	
lack of support for *P. cinnamomi* management either from within the organisation, or from other stakeholders	
lack of resources	
Please specify if other impediments exist	

Q3. Would your organisation be willing to provide 'in principle' endorsement of the on-ground management options in Table 5.1 to 5.7, as national current best practice in on-ground management?

Yes	
No	
If the answer is no, please specify why and what changes would be necessary to gain such endorsement	

Questionnaire 2

The National Threat Abatement Plan for Dieback Caused by the Root-Rot Fungus *Phytophthora cinnamomi*

P. cinnamomi is listed as a national 'key threatening process' under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). As a requirement of the Act, a National Threat Abatement Plan for *P. cinnamomi* (NTAP) was developed in 2001 and describes goals, objectives and actions for coordinated action to abate the threat of *P. cinnamomi* to biodiversity in Australia (Environment Australia 2001).

Murdoch University's Centre for *Phytophthora* Science and Management has been commissioned to undertake a five-year review and revision of the NTAP. We would greatly appreciate your assistance in completing the following brief questionnaire which will support us in evaluating:

- the progress made in implementing the NTAP
- the effectiveness of the NTAP
- assess the extent to which the NTAP is reflected and influences State and Territory management of *P. cinnamomi*
- how the NTAP could be made more useful and implementation improved.

How to submit comments?

Please complete this form either in hardcopy or electronically (electronic version available on the CD) and return to CPSM **BY THE CLOSE OF BUSINESS 28TH OCTOBER 2005** as per the instructions below.

Submission Options	*Submission Details*
1. Mail	Dr Emer O'Gara Centre for *Phytophthora* Science and Management School of Biological Sciences and Biotechnology Murdoch University MURDOCH WA 6151
2. Facsimile	08 9360 6303
3. E-Mail	e.ogara@murdoch.edu.au ***Note: please write 'Best Practice Submission' in the 'Subject' line***

Name of Respondent (optional)	
Organisation Name and State	

Q1. Prior to 2001 and the release of the NTAP, did you/your organisation actively manage *P. cinnamomi*?

YES	
NO	

Q2. What is your organisations level of awareness of the NTAP?

very familiar with the intent and content of the NTAP	
broad understanding of the NTAP	
aware of the existence of the NTAP, but not familiar with the intent or content	
not aware of the existence of the NTAP	

Q3. To what level has your organisation implemented the NTAP?

specific actions from the NTAP have been implemented	
broad objectives of the NTAP are embodied in the organisations environmental management policy	
management of *P. cinnamomi* is undertaken with no reference to the NTAP	
there has been no attempt to implement the NTAP	
Please supply additional comments, particularly if specific actions have been implemented:	

Q4. What impediments, if any, are there to the implementation of the NTAP in your organisation or region?

Multiple responses may apply

poor understanding of the impact of *P. cinnamomi* in the region	
lack of support for *P. cinnamomi* management either from within the organisation, or from other stakeholders	
lack of resources	
Please specify if other impediments exist	

Q5. How has the NTAP influenced *P. cinnamomi* management outcomes in your organisation or region?

outcomes have improved	
no discernible change in outcomes	
Please supply additional comments, particularly if outcomes have improved:	