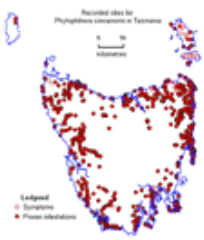

Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia

Part 2 - National Best Practice Guidelines

Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

MURDOCH UNIVERSITY
PERTH, WESTERN AUSTRALIA

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CPSM
Centre for *Phytophthora* Science and Management

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ABBREVIATIONS

ACT	Australian Capital Territory
Alcoa	Alcoa World Alumina
ARC	Australian Research Council
CALM	The Department of Conservation and Land Management, Western Australia
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
DCC	Dieback Consultative Council of Western Australia
DEH	Australian Government Department of the Environment & Heritage
DPIWE	Tasmanian Department of Primary Industries, Water 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
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
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
SA	South Australia
SA DEH	South Australian Government Department for Environment & Heritage
SCRIPT	South Coast Regional Initiative Planning Team
TPWS	Tasmanian Government Parks and Wildlife Service
WA	Western Australia
WWF	World Wildlife Fund

GLOSSARY

accredited

Official recognition by an authorised body that a person or organisation is capable of undertaking a task, or producing a product according to specific criteria and standards.

best practice

A superior method or innovative practice that contributes to the improved performance of an organisation, usually recognised as "best" by other peer organisations.

biodiversity

The variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part) and includes: (a) diversity within species and between species; and (b) diversity of ecosystems (from EPBC Act, 1999). A contraction of, and synonymous with, the term 'biological diversity'.

consequence

The outcome of an event expressed qualitatively or quantitatively, being loss or injury, disadvantage or gain (from Standards Australia: AS/NZS 4360: 1999).

critically endangered species

Species that have been recognised as critically threatened. The categories of species listed as threatened under the EPBC Act are as follows: a) extinct; b) extinct in the wild; c) critically endangered; d) endangered; e) vulnerable and; f) conservation dependent (from EPBC Act, 1999).

dieback

A symptom of plant disease in which there is a progressive death of shoots, leaves and roots beginning at the tips (American Phytopathological Society online glossary). Commonly used in Australia to describe the symptoms of individual plants, or a general decline in the health and numbers of plants in the landscape as a result of disease caused by pathogens of the genus *Phytophthora*.

ecosystem

A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit (from EPBC Act, 1999).

endangered species

Species that have been recognised as threatened. A category of threatened species under the EPBC Act: a) extinct; b) extinct in the wild; c) critically endangered; d) endangered; e) vulnerable and; f) conservation dependent (from EPBC Act, 1999).

endemic

Plant or animal species that are native to a particular area and nowhere else.

***ex-situ* conservation**

The conservation of components of biological diversity outside their natural habitats (from Convention on Biological Diversity website).

geographic information systems (GIS)

A package of computer programs specifically designed to collect, store, retrieve, manipulate, analyse and display mapped data.

habitat

The biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (from EPBC Act, 1999).

infected

When an organism has entered, invaded or penetrated and established a parasitic relationship with a host plant (American Phytopathological Society online glossary).

infested

Used of fungi in soil or other substrate in the sense of 'contaminated' (Hawksworth *et al.* 1995).

key threatening process

A process is defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. A process can be listed as a key threatening process if it could: cause a native species or ecological community to become eligible for adding to a threatened list (other than conservation dependent), or cause an already listed threatened species or threatened ecological community to become more endangered, or if it adversely affects two or more listed threatened species or threatened ecological communities. The assessment of a threatening process as a key threatening process is the first step to addressing the impact of a particular threat under Commonwealth law. Once a threatening process is listed under the EPBC Act a Threat Abatement Plan can be put into place if it is proven to be 'a feasible, effective and efficient way' to abate the threatening process (from DEH website - KTP). *P. cinnamomi* is listed as threatening process to biodiversity in Australia under the EPBC Act, 1999.

likelihood

A qualitative or quantitative description of probability or frequency (Standards Australia, AS/NZS 4360: 1999).

listed

Refer to 'threatened species and communities'.

management plan

Are documents produced by the National or State Government which detail actions that need to be carried in order to manage the natural and cultural values of specific areas, commonly 'protected areas' (e.g. national parks and reserves).

on-ground management

The deployment of physical measures to mitigate the risk of *P. cinnamomi* at specific sites or in a specific area, e.g. the deployment of vehicle wash-down equipment at an infestation boundary to minimise the risk of *P. cinnamomi* being spread from the infested to the uninfested area.

phosphite

An aqueous solution of mono-potassium phosphite and di-potassium phosphite. Also referred to as phosphonate.

recovery plans

The Australian Government Minister for the Environment and Heritage may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act, 1999. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long term survival in the wild of a threatened species or ecological community (from DEH website – Recovery Plans).

resistant

The power of an organism to overcome, completely or to some degree, the effect of a pathogen or other damaging factor (Hawksworth *et al.* 1995).

risk

The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood (Standards Australia, AS/NZS 4360: 1999).

risk assessment

The overall process of risk analysis and risk evaluation (Standard Australia, AS/NZS 4360: 1999) involving probabilities, frequencies, magnitude, and consequences.

stakeholders

Any individual or groups that are affected by regulations for and approaches to the management of *P. cinnamomi* in the environment.

standard

A published document which sets out specifications and procedures designed to ensure that a material, product, method or service is fit for its purpose and consistently performs the way it was intended. (from Standards Australia website).

susceptible

Lacking the inherent ability to resist disease or attack by *P. cinnamomi.* Species which have high mortality in the field.

threat

An indication that serious or irreversible environmental damage may occur (CALM 2004b).

threatened species or communities *(sometimes referred to as 'listed')*

Flora or fauna species or ecological communities that have been recognised as threatened through a legislative process by Commonwealth or State/Territory Governments, in which species are divided into categories according to the level of the threat. The categories of threat vary slightly between States. The categories of species listed as threatened under the EPBC Act are as follows: a) extinct; b) extinct in the wild; c) critically endangered; d) endangered; e) vulnerable and; f) conservation dependent (from EPBC Act, 1999). Listing helps to select and rank the species most in need of practical conservation, which should set in train the processes needed to facilitate de-listing, as the ultimate goal of practical conservation.

uninfested

Areas that are deemed to be free of *P. cinnamomi* by a qualified or suitably experienced person through an assessment of vegetation for indicators of disease (CALM 2004b).

vector

Any biological agent that carries *P. cinnamomi* from one place to another.

vulnerable

Susceptible to physical injury (CALM 2004b)). Also used to formally describe a category of threat to species and ecological communities in Australia (see 'threatened species and communities').

vulnerable zone

Areas where the there is a coincidence of environmental conditions conducive to the establishment and persistence of *P. cinnamomi,* and susceptible native vegetation, so that introduction of the pathogen is likely to result in negative impact due to disease.

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:

- review current management approaches and identify benchmarks for best practice
- develop risk assessment criteria and a system for prioritising management of assets that are or could be threatened by *P. cinnamomi.*

The project outputs are presented in a four-part document entitled **Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia:**

Part 1 – A Review of Current Management

Part 2 – National Best Practice Guidelines (THIS DOCUMENT)

Part 3 – Risk Assessment for Threats to Ecosystems, Species and Communities: A Review

Part 4 – Risk Assessment Models for Species, Ecological Communities and Areas

The model for best practice management of *P. cinnamomi* for biodiversity conservation, developed in Part 1 - A Review of Current Management, is repeated in this document and the best current practices and processes identified in the review are presented in the context of the model.

These are the first national best practice management guidelines developed in Australia for management of *P. cinnamomi* in natural ecosystems, and consequently recommendations on their use are provided. The management guidelines are divided into two sections: i) addressing best practice at the strategic/tactical level of management; and ii) addressing the operational and on-ground management of *P. cinnamomi*. Critical success factors for management and discussions on the development of appropriate performance indicators are provided.

2 A MODEL FOR BEST PRACTICE MANAGEMENT

The management of *P. cinnamomi* will commonly be undertaken in 'protected areas'. A protected area is defined as '*An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means'* (DEH website – Parks and Reserves, accessed 13/11/05).

As *P. cinnamomi* cannot be eradicated from infested sites and autonomous spread is extremely difficult to control, the only practical management objectives are to minimise the spread to areas that are uninfested, and mitigate impacts where infestations occur. The model of best practice (Figure 2.1) depicts all the elements necessary for the deployment of on-ground measures to achieve the management objectives in protected areas, taking into account the range of stakeholders and land uses that management affects.

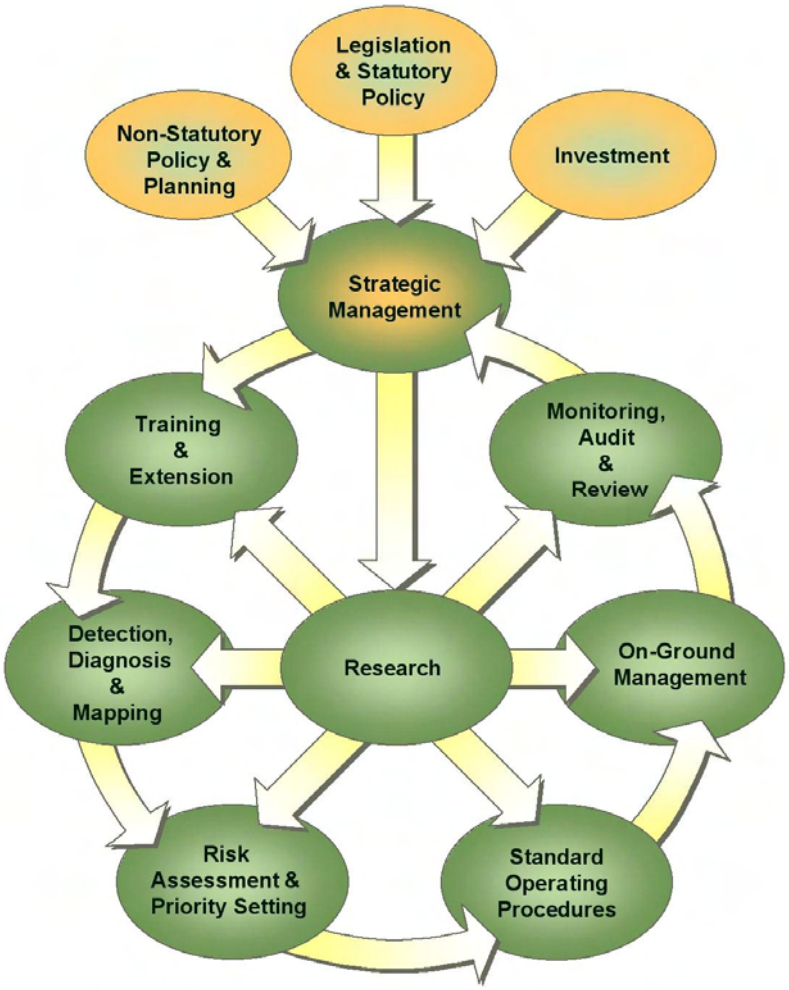


Figure 2.1 A best practice model for the management of *Phytophthora cinnamomi* for biodiversity conservation in natural ecosystems of Australia.

3 RECOMMENDATIONS FOR THE USE OF THE BEST PRACTICE GUIDELINES

Why are these guidelines needed?

National best practice guidelines are needed to facilitate a consistent approach to managing the threat of *P. cinnamomi* across jurisdictions, by providing the current best management procedures, practices and tools in Australia.

Who should use these guidelines?

As *P. cinnamomi* is a management issue primarily in protected areas on public lands it has the potential to affect a wide range of land users and stakeholders. These guidelines are suitable for use by all stakeholders, across all jurisdictions.

However, the primary responsibility for the management of *P. cinnamomi* on public land resides, in the first instance, with government or semi-government land management agencies. Consequently, the guidelines address management of *P. cinnamomi* from the strategic through to the operational and in a level of detail necessary for such agencies.

It is acknowledged that not all stakeholders will want or need this level of detail. Consequently, the information in the guidelines has been presented in discrete sections and appendices to enable stakeholders to readily access the information needed.

How should these guidelines be used?

The potential use of the National Best Practice Guidelines, as indicated by stakeholder consultation, include:

- the NTAP provides a common understanding of the threat *P. cinnamomi* poses in Australia, the National Best Practice Guidelines promotes a common understanding of the best current management of the threat
- review of current management approaches against best practice
- provide new or alternative ideas for management
- development or review of agency, stakeholder or area specific guidelines based on current best practice
- general provision of advice on best practice management
- a resource for training and for raising awareness.

The threat of *P. cinnamomi* varies in scale and magnitude across Australia, and the capacity and resources for management also varies between States and across jurisdictions within affected States. Consequently, appropriate adaptations to the practices and procedures identified will need to be considered.

Review

It is recommended that the National Best Practice Guidelines are reviewed regularly, the mechanisms of review to be considered as part of the 2006 revision of the NTAP.

4 STRATEGIC & TACTICAL BEST PRACTICE MANAGEMENT

In this section the best current practices for management of *P. cinnamomi* in natural ecosystems are presented, in the context of the model for best practice (Figure 1), with examples of best practice from current management of *P. cinnamomi* and other invasive pests in Australia. 'Best practice' was derived subjectively from a review of *P. cinnamomi* management in Australia, where the best current approaches were identified and the gaps in process, practice and knowledge (Part 1 – Review of Current Management). Best practice describes those tools, practices and processes that, when integrated, will lead to more effective and nationally consistent deployment of on-ground *P. cinnamomi* measures.

Where significant gaps were identified in the current management of *P. cinnamomi*, examples of best practices and procedures 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. Not surprisingly, the goals and objectives of the NTAP are not dissimilar to those of the NWS.

4.1 Strategic Management

Legislation and Statutory Policy

Best Practice

1. Use of the EPBC Act to protect biodiversity from the threat of *P. cinnamomi*, with a full understanding of the extent of the threat *P. cinnamomi* poses to biodiversity in Australia.
2. Full implementation of the NTAP.
3. Management of *P. cinnamomi* with a full understanding by land managers of the relevant legislation and the interrelatedness of the various statutory provisions.
4. Legislation that is enacted proactively rather than reactively to *prevent* the introduction of *P. cinnamomi*.

Best Practice Examples

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 potential for the Act to protect

biodiversity from *P. cinnamomi* depends on a good understanding of the extent of the threat, which is currently lacking in many areas of Australia.

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, although implementation as a Threat Abatement Plan Implementation Team was not appointed to coordinate and oversee actions.

The Australian Government Protected Matters Search Tool: DEH provides a tool designed to assist the general public in gathering information about the national environmental significance of specified areas, and numbers of threatened species and ecological communities present in those areas (DEH website – About Protected Matters Search Tool, accessed 24/11/05). The tool is designed to assist in determining whether a proposed development is likely to affect a matter of national environmental significance, and consequently require referral for assessment and approval under the EPBC Act. This is an excellent tool and would be greatly enhanced with overlays of data on the distribution of key threatening processes such as *P. cinnamomi*.

Queensland *Environmental Protection Act 1994* (Queensland EP Act) and improvements to the *WA Environmental Protection Act 1986* (WA EP Act): Under the Queensland EP Act the Queensland Parks and Wildlife Service has a duty of care to prevent *foreseeable* environmental harm including that caused by threatening processes. Recent revisions to the WA EP Act include a new offence for causing unauthorised environmental harm which carries severe penalties. For the purposes of the WA EP Act the definition of environmental harm includes 'potential detriment or degradation' to enable preventative action to be taken (DoE 2004).

Improving the Understanding and Effectiveness of Weeds Legislation: Many 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 World Wildlife Fund (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). The interrelatedness of legislation across jurisdictions is also vexed area in *P. cinnamomi* management, and a study similar to those conducted for weeds is required to unravel some of the complexities of legislation and ensure best use of regulatory provisions.

Non-statutory Policy and Planning

Best Practice

1. A whole-of-government approach to the management of *P. cinnamomi* in relevant States /Territories, consistent with the objectives of the NTAP.

2. An agreed core set of values and principles that drive *P. cinnamomi* management within key conservation land management agencies which are embodied in a policy, position statement or similar.

3. Corporate level planning, strategy and budget setting capability within key conservation land management agencies to ensure *P. cinnamomi* is managed in accordance with the NTAP and State/Territory objectives and priorities.

4. Organisation-wide standard operating procedures for *P. cinnamomi*.

5. Integration of *P. cinnamomi* management with other functional areas to ensure that the issue is included in general management systems and initiatives.

6. Networking opportunities for personnel involved in *P. cinnamomi* management with those in other agencies and States/Territories to facilitate cross-fertilisation and continuous improvement.

Best Practice Examples

Policy and Planning by CALM in Western Australia: The Department of Conservation and Land Management (CALM) has developed the following integrated processes and practices for management of *P. cinnamomi*:

- 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 the West Australian 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*. This includes 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, 2004), 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 conservation 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 Tasmanian Parks and Wildlife Service (TPWS) website (TPWS website – 4WD Recreation, accessed 18/02/05), and also available in pamphlet form.

Investment

The Australian Government has invested in the research and management of *P. cinnamomi* through programs such as the Australian Research Council (ARC), the Natural Heritage Trust and National Action Plan for Salinity and Water Quality (NAPSWQ). However, investment is typically *ad hoc* and only a proportion of it is directed to on-ground management. Investment in the States, with the exception perhaps of WA, is either minimal or non-existent. The current lack of information on the economic impacts of degradation caused by *P. cinnamomi* is a major impediment to attracting the investment necessary for research and management. The overall result is uncoordinated, inconsistent and under-resourced management of *P. cinnamomi* nationally, and at the State level.

Best Practice

1. Core national funding to implement the NTAP.

2. Strategic funding of research according to agreed upon national research priorities, and an understanding of the long-term environmental and economic impacts of *P. cinnamomi* in Australia.

3. Suitably qualified and experienced National Coordinator responsible for coordinating and facilitating implementation of the NTAP.

4. Suitably qualified and experienced position(s) in the key conservation and land management agencies in each State/Territory with dedicated responsibilities for coordinating management of *P. cinnamomi* within the agency, and facilitating a coherent and consistent approach to management by other stakeholders.

5. Core State funding to implement on-ground management based on an agreed process of prioritisation and an understanding of the long-term environmental and economic impacts of *P. cinnamomi*.

6. Inclusion of *P. cinnamomi* in relevant to regional Natural Resource Management (NRM) strategic plans, reflection of that in associated investment plans, and collaboration between regional bodies and State Government agencies in managing priority assets threatened by the pathogen.

Best Practice Examples

Economic Analysis of *P. cinnamomi* Impact in WA: The Centre for *Phytophthora* Science and Management (CPSM) in WA 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 2005). The study clearly indicates in economic terms the significant reduction in the stream of benefits from natural areas over the next 50 years if environmental degradation as a result of *P. cinnamomi* is not reduced immediately.

Economic Analysis of Weed Prevention, Eradication and Containment: 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). As the effectiveness of current on-ground management measures is currently unknown, Economic assessments of this nature are required for the national threat that *P. cinnamomi* poses.

Coordinators Positions in SA and WA: CALM in WA and the SA Department for Environment and Heritage each support a position responsible for the coordination of *P. cinnamomi* management, or management of diseases in native vegetation. The WA Dieback Working Group (DWG), largely as a result of Natural Heritage Trust funding, also has a full-time coordinator. These positions have been central to recent improvements and innovations in *P. cinnamomi* management in their respective States. They provide advice, services and management tools to a wide range of stakeholders.

Cost-Sharing for Weed Management Between the Australian and State/Territory Governments: 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). Similar criteria are needed to ensure funding is available to act quickly and decisively when a *P. cinnamomi* incursion occurs in an area of significant environmental value.

Implementation of the National Weeds Strategy: 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. The position of Project Manager, responsible for the implementation of the weeds strategy, was funded under a cost-sharing arrangement between the Australian and State/Territory Governments. From 2000 to 2002 the project received $169,400 per annum for the implementation of the strategy. The success of the NWS has been largely attributed to the extension and liaison of the Project Managers with all stakeholders. This modest investment enabled the completion of over half the strategies, and significant work to be undertaken on the others, in five years (NWSEC 2002).

4.2 Research

Best Practice

1. A Cooperative Research Centre for research into diseases in native ecosystems caused by *Phytophthora* spp.

Best Practice Examples

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; management; conservation, biodiversity and ecosystem restoration; information dissemination and training; disease diagnostics and extension. Although CPSM is exploring a number of investment options, there is currently no core funding and the Centre's research and management activities depend on competitive grants and other *ad hoc* funding sources.

The Cooperative Research Centre (CRC) Program: 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. Core funding, ranging from $20 to $40 million, is provided to CRCs over seven years (DEST website – CRC, accessed 20/09/05). The CRC for Australian Weed Management (CRC AWM) plays an integral role in the implementation of the NWS (NWSEC 2002) through: conducting research; and providing extension services and technical advice on environmental and agricultural weeds across Australia (Weeds CRC website, accessed 20/09/05).

4.3 Training and Extension

Training

Best Practice

1. Tertiary level (undergraduate and postgraduate) graduates with expertise in the science and management of *Phytophthora* spp. in native ecosystems.
2. Competency-based vocational training appropriate to the duties of all personnel involved in *P. cinnamomi* management within land management agencies.
3. The integration of core *P. cinnamomi* management competencies into organisation-wide training programs within land management agencies.
4. Training to enable effective implementation of codes of practice for high risk activities.

Best Practice Examples

Training by CALM in WA: CALM has developed four competency-based training courses for staff and contractors that are accredited within the organisation and widely recognised in WA: i) management; ii) detection, diagnosis and mapping; iii) field operators course; and iv) phosphite operators course. 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. All training is based on and consistent with the Department's standard operating procedures.

Training by Alcoa World Alumina Australia (Alcoa) 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 the company'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. Re-testing is undertaken every two years. Field-based personnel receive similar training/refreshers in a classroom setting which is triggered at appropriate intervals by the Senior Environmental Officer at the mine.

National Training Competencies in Vertebrate Pest and Weed Management: The National Conservation and Land Management (CLM) Training Package (RTCA website – CLM Training Package RTDO2, accessed 22/11/05) was endorsed in 2002 and provides a formal mechanism to develop practical vocational skills in conservation and land management. It includes sectors on vertebrate pest management and weed management that provide accredited training for a wide range of responsibilities (Hart 2005; NWSEC 2002). Following a review of university weed management courses in Australia, the CRC AWM has developed a range of training resources which meets the objectives of the NWS and which are available free of charge on the CRC AWM website (CRC AWM website – Education and Training Resources, accessed 23/11/05; NWSEC 2002). The training competencies in weed management are predicted to have the greatest single impact of all the NWS action, as 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).

Extension

Best Practice

1. Extension programs and materials with nationally consistent terminology, and advice consistent with the policies and procedures of leading State conservation and land management agencies

Best Practice Examples

Communications Strategy in WA: A comprehensive communications strategy for WA was developed in late 2004, and is in the early stages of implementation. Although the Strategy has been developed under the auspices of the DCC, the WA Dieback Working Group (DWG) is the main driver of the Strategy. The three key goals of the Communications Strategy are: i) increased awareness of *P. cinnamomi* so that it becomes a major environmental priority for the people of WA; ii) identification of key stakeholders groups and ideal behaviours for each group; and iii) simple messages and the identification of appropriate communication methods to evoke the necessary changes in behaviour.

Extension Activities of the WA DWG: The WA 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*. Funding for the activities of the Group has come primarily from the Natural Heritage Trust. Prior to the formation of the WA DWG there was very little information filtering through to Local Government authorities, industry and the community in regards to the *P. cinnamomi* management procedures developed by CALM and mining companies in the State. The WA DWG provides the tools necessary to manage *P. cinnamomi* including: disease occurrence maps and dieback management plans for specific areas; providing training in dieback management procedures; conducting information and field days; developing guidelines for key stakeholders (DWG 2000; DWG 2005; Dunne 2005) and facilitating the uptake of management by Local Government and industry, particularly the extractive industry. Many of these tools have been made available on the WA DWG website (DWG website, accessed 22/11/05).

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 (SA DEH) website (SA DEH website – Biodiversity/Plants & Animals, accessed 22/11/05). The fact sheets target what are considered high-risk activities such as bushwalking (SA DEH 2003b), horse riding (SA DEH 2002) and plant propagation (SA DEH 2003c). The horse riding 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 provides a clear and consistent message about the risks, the potential impacts of the pathogen, and 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 and Mapping

Best Practice

1. Systematic method for determining and mapping the distribution of *P. cinnamomi* in the landscape to facilitate the deployment of on-ground management measures.
2. National standard for the collection and handling of tissue, soil and water samples for *Phytophthora* spp. analysis.
3. Rapid, reliable, inexpensive and nationally standard methods for analysis of tissue, soil and water samples for the presence of *Phytophthora* spp.
4. Single database in each State with information on the distribution of *P. cinnamomi* and other *Phytophthora* spp. on public lands, using nationally agreed standards of recording and storing data.

Best Practice Examples

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 personnel who have undergone internally accredited training. 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 (CALM 2001). Initial interpretation is done wherever possible from aerial colour photographs followed by confirmation by on-ground survey. 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.

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

Diagnostic Protocol for *P. cinnamomi* by the European and Mediterranean Plant Protection Organisation (EPPO): 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 has 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 Protocols in Tasmania, WA and SA: In Tasmania, the Department of Primary Industries, Water and Environment (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 *et al.* 2003; DPIWE website – GTSpot User Guide accessed 03/03/05).

4.5 Risk Assessment and Priority Setting

Although Standards Australia (AS/NZS 4360: 1999) describes risk as being a measure of consequences and likelihood, the term is used variably in *P. cinnamomi* management and often describes only the probability of an event such as pathogen transmission and/or impact. A range of processes is described below that have been developed in Australia, using indicators of consequence and/or likelihood, to assist in planning or in setting priorities for the management of *P. cinnamomi*. The range of methods reflects the variable environmental, political, financial and social contexts in which *P. cinnamomi* must be managed, as well as differences in the amount and quality of data available on the threat. All processes acknowledge to some degree that the scarce resources available for *P. cinnamomi* management must be targeted where the need is greatest and the potential for success is highest.

Best Practice

1. Criteria for determining priorities for *P. cinnamomi* management within each State/Territory.
2. Resources for the management of *P. cinnamomi* directed to environmental assets of the highest priority, and where the potential for successful management is greatest.

Best Practice Examples

Processes to Identify Threatened Species and Ecological Communities for Protection

Risk Assessment Process developed through NTAP for *P. cinnamomi*: In the current project a generic process was developed, suitable for national adoption, for assessing the risk of *P. cinnamomi* to threatened species, ecological communities and areas, and ranking them as the basis for setting management priorities (Part 4 – Risk Assessment Models for Species, Ecological 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. However, where significant knowledge or data gaps exist, expert opinion will be required. The risk assessment process developed is viewed as iterative, and improvements and reviews should be undertaken as new data and knowledge becomes available.

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.

Processes to Identify Significant Disease-Free Areas for Protection

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

These maps are important management tools and may be produced at a strategic or operational scale. The probability of *P. cinnamomi* being introduced and/or becoming established in a defined area is mapped according to environmental parameters and vector activity.

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 geographic information systems (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 outbreaks of disease are associated with particular site characteristics. 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 2005).

Decision Rules

Decision rules have been developed to assist in management planning by identifying vulnerable areas, and applying 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 introduction and establishment. 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 apply to ensure the pathogen is contained (PTG 2003).

4.6 Standard Operating Procedures

Best Practice

1. Clear operational instructions that are consistent with the policies and statutory requirements of the agency, that are readily available to staff and are regularly updated.

Best Practice Examples

A number of guidelines for *P. cinnamomi* management have been developed around Australia for a range of audiences and applications. The application or audience is self-evident from most of the 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):** Parks Victoria has indicated that given the date of this document, some of the guidelines may be out-of-date.
- **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 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 are to provide a framework for the management of *Phytophthora*, by Government and non-government organisations, landholders, community 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)**

4.7 On-Ground Management

Best Practice

1. The strategic deployment of on-ground management that is adequately resourced, underpinned by the latest scientific knowledge, undertaken by appropriately trained and briefed personnel in accordance with the standard operating procedures, with the support of all stakeholders, and monitored for compliance and effectiveness.

Please refer to the following section 'Operational or On-ground Best Practice Management' for comprehensive guidelines on the on-ground management options and their deployment.

4.8 Monitoring, Audit and Review

Monitoring

Monitoring can be undertaken to determine the long-term ecological impacts of disease caused by *P. cinnamomi*, or the rate of pathogen spread in the landscape either in response to environmental variables or management measures. Monitoring pathogen spread to determine the effectiveness of management requires knowledge of compliance to the procedures and prescriptions, and consequently is considered under 'audit and review'.

Best Practice

1. A nationally coordinated and strategic program of monitoring to determine the rate of spread and the long-term ecological impact of *P. cinnamomi* in a range of environments, using standardised techniques, and where possible utilising sites for which data already exists.

Best Practice Examples

Long-term monitoring of impact and spread: A number of monitoring sites have been established in WA, Tasmania and NSW in the 1990s or early 2000s for monitoring the impacts and spread of *P. cinnamomi* and/or the effectiveness of phosphite. Some sites in WA and Tasmania, established by Dr Frank Podger in the 1960/1970s have been re-surveyed. The long-term impact of *P. cinnamomi* in Victoria has been studied by Dr Gretna Weste, who has recently retired from a long and dedicated career in *P. cinnamomi* research. Dr Weste monitored the degradation of infested areas of the Grampians, Brisbane Ranges and Wilsons Promontory from 1970 to 1985, and then the gradual regeneration of those areas to the year 2000 with a corresponding reduction of pathogen levels in the soil (AAS website – Interview with Dr Gretna Weste, accessed 12/12/05). It is critical that monitoring continues at these established sites, and that research on the mechanisms of regeneration.

Audit and Review

Best Practice

1. Mechanisms within key land management agencies to monitor compliance to, and effectiveness of policies and standard operating procedures in a review and adaptive management framework.

Best Practice Examples

Environmental Management System (EMS) of Alcoa in WA: Alcoa undertakes 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 has integrated 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.*). 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.*).

Monitoring of management effectiveness by Alcoa in WA: Other than the studies by Alcoa in bauxite mines of WA (Colquhoun and Hardy 2000), there has been very little done in Australia on the effectiveness of management.

5 OPERATIONAL OR ON-GROUND BEST PRACTICE MANAGEMENT

In this section, options for on-ground management, aimed at limiting the spread and mitigating the impact of *P. cinnamomi* in natural ecosystems, have been compiled from current practices around Australia (Table 5.1 to 5.7). *P. cinnamomi* can be readily moved from one location to another in infested soil, plant material or water. Humans have the potential to spread the pathogen further and faster than any other vector or process. Appendix 1 provides background information on the biology and epidemiology of *P. cinnamomi*.

The main objectives of on-ground management are to:

1. prevent the spread of *P. cinnamomi* to uninfested sites; and
2. mitigate the impact of *P. cinnamomi* at infested sites.

As humans are the most significant vector of *P. cinnamomi*, managing spread commonly involves the modification of human behaviours and activities. The management options are presented in Tables 5.1 to 5.7 according to a range of human activities that vary in the potential for soil disturbance, and thus risk of spreading the pathogen in the landscape. The table format allows only a brief description of each option but further information is available in Appendix 2.

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. apiculture, flower and seed collecting)

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

While an approach in which there is an integration of management options is much more likely to be successful, it will not be practical or possible to deploy all of the management options listed for a particular activity or site. 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 best reduce those risks. Socio/political considerations and available resources are also likely to influence the choice of management options.

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 the disease status of the site.

When the disease status of a site is unknown

The decision flow chart (Figure 5.1) terminates with the determination of disease status of the site, with three possible options: infested, uninfested or disease status unknown. If the disease status of the site is unknown the literature, and other databases should first be consulted. Key literature and/or the custodians of such data are listed below for each State. Please note: this is not an exhaustive list and other sources such as NRM agencies, local scientists or community groups may also possess such information.

Western Australia

- The Department of Conservation and Land Management, Forest Management Branch http://www.calm.wa.gov.au/index.html
- The Dieback Working Group http://www.dwg.org.au/index.cfm

Tasmania

- Department of Primary Industries, Water and Environment - GTSpot Database: http://www.gisparks.tas.gov.au/explorer/GTSpotUserGuide/UserGuide.html

Victoria

- Gibson M, Milne R, Cahill D, Wilson B (2002) Preliminary review of the actual and potential distribution of *Phytophthora cinnamomi* dieback in parks and reserves across Victoria. Report to Parks Victoria. Centre for Environmental Management, University of Ballarat.

South Australia

- Department for Environment and Heritage http://www.environment.sa.gov.au

Far North Queensland

- Gadek PA, Gillieson D, Edwards W, Landsberg J, Pryce J (2001) Rainforest Dieback Mapping and Assessment in the Wet Tropics World Heritage Area. Schools of Tropical Biology, Tropical Environmental Studies, Geography and the Rainforest CRC. James Cook University, Cairns.

If this information is unavailable or is incomplete a survey will need to be undertaken. Current methods of detection, diagnosis and mapping have been reviewed in Part 1 – A Review of Current Management.

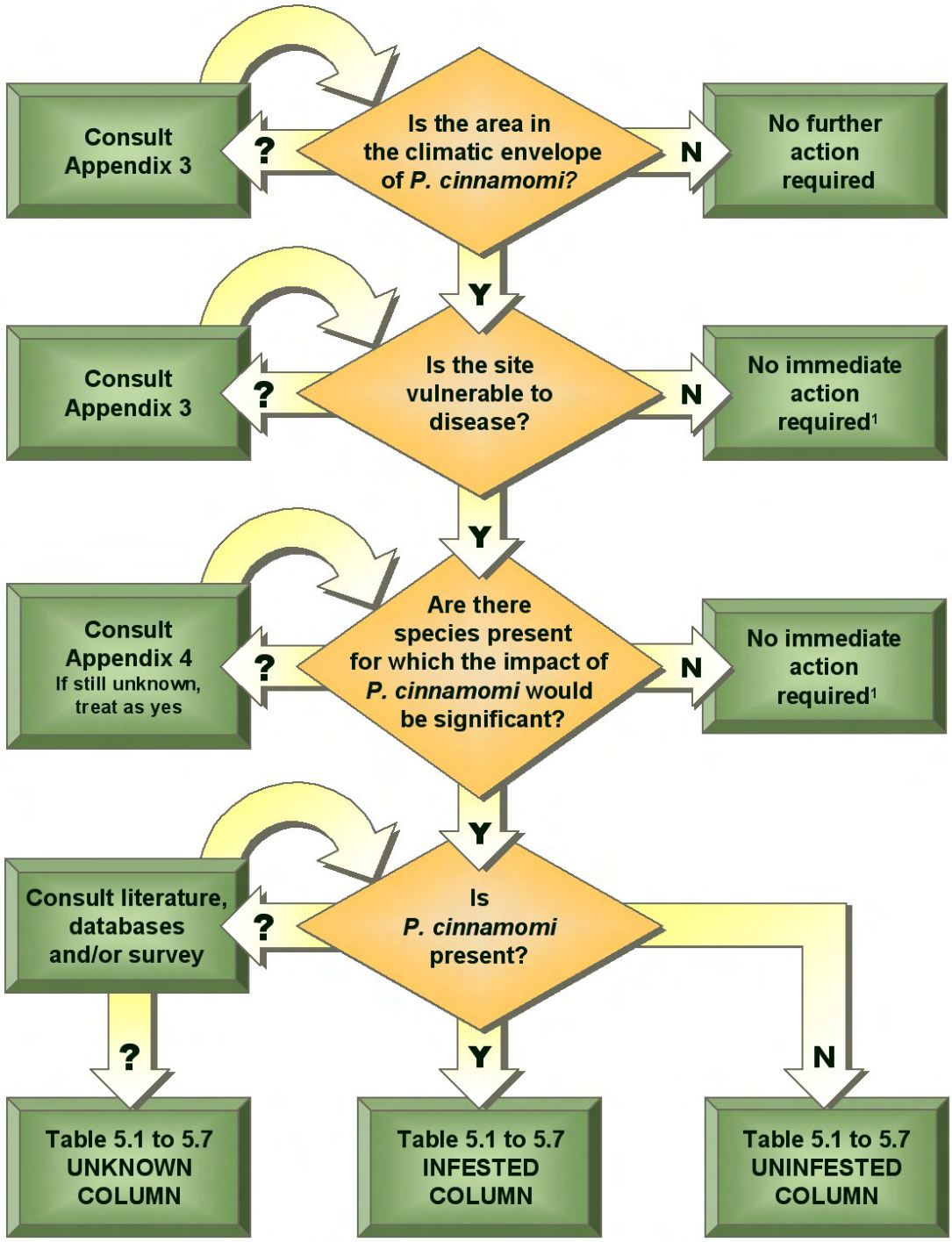
However, surveys may fail to establish the disease status of a site for many reasons including: a failure to detect *P. cinnamomi* from soil and/or tissue samples coupled with cryptic disease expression, poor knowledge of susceptible species in the area, the absence of susceptible species from the site, and/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 of the table should be consulted.

The 'precautionary principle' must be applied where the disease status is unknown, particularly when there are significant values at risk at, or nearby the site. The precautionary principle describes the avoidance of an action that has some potential for major or irreversible negative consequences. Consequently, the management options for

sites where the disease status is unknown includes management options for sites that are infested and uninfested, making management of these sites more onerous.

Management options for infested sites

The difference between the management options for infested and uninfested sites in Tables 5.1 to 5.7, are admittedly subtle. This is the result of management options marked with a '**ǂ**', which denote additional recommendations for management of infested areas in SA, where *P. cinnamomi* has been mapped as discrete areas within largely uninfested areas. In SA, management to contain the pathogen within discrete areas is given a high priority, and this approach would be highly recommended wherever a similar pattern of pathogen distribution occurs.



[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 3 and Appendix 4

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 for Ecosystem and Biodiversity Conservation.

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

Ecosystem and Biodiversity Conservation page 1/2	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
PLANNING			
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	+	+	+
COMMUNICATION			
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	+	+	+
EX-SITU CONSERVATION			
conserve critically endangered species *ex-situ*	+	+	+
PHOSPHITE			
treat threatened plant species or communities with phosphite	+	+	+
ACCESS			
restrict human access permanently	+	‡	+
restrict human access temporarily (e.g. during wet weather)	+	‡	+
restrict access to ranging livestock and other animals	+	‡	+

Ecosystem and Biodiversity Conservation page 2/2	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
WATER, DRAINAGE AND EFFLUENT			
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 constructed to prevent animal and human access to the contents, allow evaporation, and 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 for Research, Survey, Site Restoration and Community Conservation Activities.

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

Research, Survey, Site Restoration and Community Conservation Activities page 1/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
PLANNING			
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	+	‡	+
implement appropriate disease monitoring programs for new outbreaks of disease, spread of existing infestations and effectiveness of disease management procedures and prescriptions	+	+	+
COMMUNICATION			
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	+	+	+

Research, Survey, Site Restoration and Community Conservation Activities page 2/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
ACCESS			
restrict human access permanently	+	‡	+
restrict human access temporarily (e.g. during wet weather)	+	‡	+
restrict access to ranging livestock and other animals	+	‡	+
minimise the number of entry points	+	+	+
control unauthorised access	+	+	+
HYGIENE			
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+
maintain natural barriers to *P. cinnamomi*	+		+
avoid watercourses or sites prone to flooding or ponding	+	‡	+
minimise activities that cause soil disturbance (for example mow, slash or spray weeds rather than plough them under)	+	‡	+
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	+	+	+
avoid the introduction of plants for revegetation. As an alternative, consider direct seeding or regeneration of vegetation by fire	+		+

Research, Survey, Site Restoration and Community Conservation Activities page 3/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
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		+	
WATER, DRAINAGE AND EFFLUENT			
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 constructed to prevent animal and human access to the contents, allow evaporation, and 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 5.3 Management Options for Recreational Land Use.

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

Recreational Land Use page 1/1	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
COMMUNICATION			
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	+	+	+
ACCESS			
permanently restrict public access where threatened or potentially threatened species or communities have been identified	+	+	+
restrict movement of traffic from infested to uninfested areas	+	‡	+
restrict human access temporarily (e.g. during wet weather)	+	‡	+
HYGIENE			
promote hygiene on entry	+		+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	‡	+
promote minimal soil disturbance	+	‡	+
promote the avoidance of watercourses or sites prone to flooding or ponding	+	‡	+
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 for Construction and Maintenance of Roads/Tracks and other Infrastructure.

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

Construction and Maintenance of Roads/Tracks and other Infrastructure page 1/3	**Disease status of land in relation to *Phytophthora cinnamomi***		
	Uninfested	**Infested**	**Unknown**
PLANNING			
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	+	‡	+
plan operation to maintain natural barriers to *P. cinnamomi*	+		+
COMMUNICATION			
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			
ACCESS			
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	+	‡	+
Construction and Maintenance of Roads/Tracks and other Infrastructure page 2/3	**Disease status of land in relation to *Phytophthora cinnamomi***		

	Uninfested	Infested	Unknown
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	+		+
HYGIENE	+	+	+
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+
minimise activities that cause soil disturbance	+	‡	+
grade from upslope to down slope	+		+
do not grade wider than existing road/track or wider than prescribed	+		+
angle grader blade to avoid carrying soil/gravel long distances	+	+	+
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	+	+	+

Construction and Maintenance of Roads/Tracks and other Infrastructure page 3/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
WATER, DRAINAGE AND EFFLUENT			
minimise the amount of water used on the site	+	‡	+
construct wooden walkways over areas prone to ponding or mud	+	‡	+
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 constructed to prevent animal and human access to the contents, allow evaporation, and will contain a 1 in 10 year rainfall event	+	+	+
when cleaning drains direct spoil onto surface such as paved roads where it can be removed and transported to a designated disposal site	+	+	+

Table 5.5 Management Options for Fire Management and Emergency Rescue Operations.

While the priorities of life and property in the management of any emergency situation are recognised, the consideration of P. cinnamomi during *preparations and planning for emergency events has the potential to reduce the risk of pathogen spread and impact.*

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

Fire Management and Emergency Rescue Operations page 1/2	**Disease status of land in relation to *Phytophthora cinnamomi***		
	Uninfested	**Infested**	**Unknown**
PLANNING			
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	+		+
wherever possible schedule emergency preparedness activities for periods with the highest likelihood of dry soil conditions	+	‡	+
COMMUNICATION			
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	+	+	+
ACCESS			
use existing roads and tracks wherever feasible before constructing new ones. If new roads/tracks are necessary refer to Table 5.4 for prescriptions.	+	+	+

Fire Management and Emergency Rescue Operations page 2/2	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
HYGIENE			
wherever possible schedule emergency preparedness activities in uninfested areas before moving to infested	+	‡	+
wherever possible minimise activities that cause soil disturbance	+	‡	+
wherever possible grade from upslope to down slope	+		+
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	+	+	+
WATER, DRAINAGE AND EFFLUENT			
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 Low Risk Commercial Activities (e.g. Apiculture, Flower and Seed Collecting)

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

Low Risk Commercial Activities page 1/2	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
PLANNING			
assess all operations for the likelihood of introducing or spreading *P. cinnamomi*, modify operations & 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	+	‡	+
COMMUNICATION			
educate staff, contractors & volunteers on the threat of *P. cinnamomi*, management objectives, procedures & prescriptions	+	+	+
where appropriate consult with traditional owners prior to implementing management controls	+	+	+
define clear roles & responsibilities for staff & contractors in *P. cinnamomi* management procedures & prescriptions	+	+	+
supervise staff, contractors & volunteers to ensure compliance with *P. cinnamomi* management procedures & prescriptions	+	+	+
write specific *P. cinnamomi* management procedures & prescriptions into contracts & licence agreements, & monitor compliance	+	+	+
HYGIENE			
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	+	‡	+

Low Risk Commercial Activities page 2/2	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
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 High Risk Commercial Activities (e.g. Mining, Extractive Industries, Forestry, Establishment and Maintenance of Utilities)

Note: + in a cell indicates options appropriate for the activity and the disease status of the site. ‡ denotes additional options when the objective of managing the infested site is containment of *P. cinnamomi*.

High Risk Commercial Activities page 1/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
PLANNING			
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	+	‡	+
implement appropriate disease monitoring programs for new outbreaks of disease, spread of existing infestations and effectiveness of disease management procedures and prescriptions	+	‡	+
COMMUNICATION			
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	+	+	+
ACCESS			
use existing roads and tracks wherever feasible before constructing new ones. If new roads/tracks are necessary refer to Table 5.4 for prescriptions.	+	+	+

High Risk Commercial Activities page 2/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
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	+		+
minimise number of entry points	+	+	+
control unauthorised access to site	+	+	+
HYGIENE			
plan for hygienic practices if working across infection boundaries is unavoidable	+	+	+
minimise activities that cause soil disturbance	+	‡	+
grade from upslope to down slope	+		+
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	+		+
restrict movement of vehicles and pedestrians to formed roads and tracks	+	‡	+

High Risk Commercial Activities page 3/3	Disease status of land in relation to *Phytophthora cinnamomi*		
	Uninfested	Infested	Unknown
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	+	+	+
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		+	
WATER, DRAINAGE AND EFFLUENT			
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 constructed to prevent animal and human access to the contents, allow evaporation, and 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	+	+	+

6 CRITICAL SUCCESS FACTORS & PERFORMANCE INDICATORS

P. cinnamomi cannot be eradicated from infested sites and autonomous spread is extremely difficult to control, therefore the only practical management objectives are to minimise the spread to currently uninfested areas and mitigate impacts where infestations occur. As humans are the most significant vectors of *P. cinnamomi*, efforts to minimise further spread focus on modifying human behaviours and activities. Section 5 of this document describes how human activities can be modified to reduce the risk of *P. cinnamomi* transmission.

To prevent the introduction of *P. cinnamomi* to an uninfested area of public land requires the consistent deployment of on-ground management measures by all land-users. Section 4 of this document identifies best practice at the strategic and tactical levels of management in processes, procedures and tools necessary for successful and consistent deployment of on-ground management. Not all the points of best practice identified in section 4 will be applicable in every jurisdiction, as the magnitude and relative importance of the issue varies between States and regions.

For the purposes of this document, therefore, 'critical success factors' have been defined as minimum elements necessary, in all jurisdictions affected by *P. cinnamomi*, for successful deployment of on-ground management:

- a policy framework that recognises the threat of *P. cinnamomi* in decision making
- knowledge of the distribution of *P. cinnamomi* and the extent of the threat it poses to environmental values
- stakeholders, informed of the threat of *P. cinnamomi* and its implications and supportive of active management
- priorities for management of the threat and mechanisms to address those priorities.

Performance indicators

According to the NTAP the objective of *P. cinnamomi* management is to mitigate the impact on biodiversity (Environment Australia, 2001). The effectiveness of current management is unknown, primarily because of inadequate monitoring. However, if long-term progress towards achieving the management objective is to be assessed some indicator(s) of performance is required.

Performance indicators are simple measures that enable trends in the condition of the environment to be tracked over time without having to capture the full complexity of the system (ANZECC-SOERT, 2000). Some attempts have been made to identify performance indicators for the outcomes of *P. cinnamomi* management. The NTAP suggests the following indicators for reporting on the effectiveness of the Plan:

- no new listing or upgrading of threat status for species or ecological communities threatened by *P. cinnamomi*

- majority of high conservation value areas that were free from *P. cinnamomi* at the commencement of the Plan remain free.

A key performance indicator for the success of the WA Forest Management Plan in maintaining ecosystem health and vitality is 'the effectiveness of dieback hygiene' measured as 'the number of sampled areas uninfested with *P. cinnamomi* that remain uninfested following an operation with an approved hygiene management plan' (Conservation Commission WA, 2003).

In Tasmania the 'area adversely impacted by *P. cinnamomi*' is an indicator for the sustainable management of natural resources (Tasmania Together 2002 website - Current Goals and Benchmarks, accessed 16/12/05).

Each of these indicators has distinct weaknesses. The NTAP indicator of '*no new listing or upgrading of threat status for species or ecological communities threatened by* P. cinnamomi', for example, is immediately hampered by inadequate knowledge of the extent of the threat *P. cinnamomi* poses to native taxa generally, and more specifically to currently listed species and communities.

The development of outcome-based performance indicators in biodiversity management is inherently difficult, as acknowledged by ANZECC who developed core indicators for State of the Environment reporting (ANZECC, SOERT, 2000). ANZECC cites incomplete data sets, data inconsistencies across jurisdictions and/or lack of robust measurement techniques as impediments to the development of appropriate and meaningful environmental indicators. While performance indicators on national progress in the protection of biodiversity from *P. cinnamomi* are needed, careful thought and consultation is required on what provides meaningful measures across jurisdictions.

Until such time as sufficient and consistent data becomes available to measure management outcomes, output-based performance indicators, or to use the terminology of State of the Environment Reporting 'response indicators' (ANZECC, SOERT, 2000) could be developed. Performance indicators based on the critical success factors identified above, would at least provide consistent information across jurisdictions on the implementation of the key elements of management, which is information appropriate for State of Environment reporting. Key stakeholders should be consulted as part of the 2006 review of the NTAP on the potential for the development of such indicators.

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TPWS website (Tasmanian Parks and Wildlife Service) –

- 4WD Recreation: http://www.parks.tas.gov.au/recreation/4wd/4wd.html
- Walking Track Management Manual:http://www.parks.tas.gov.au/manage/tracstrat/walking_track_manual.html

Weeds Australia website –

- Newsletter and Papers, Principles of Weed Legislation Discussion Paper http://www.weeds.org.au/docs/weeds_leg_dd.pdf
- National Competencies for Weed Management: http://www.weeds.org.au/ncwc.htm

Weeds CRC Website: http://www.weeds.crc.org.au/index_flash.html

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APPENDIX 1

Phytophthora cinnamomi

What is it?

Phytophthora cinnamomi is a microscopic organism and is often referred to as a fungus. While it shares some characteristics of true fungi it is in fact more closely related to algae.

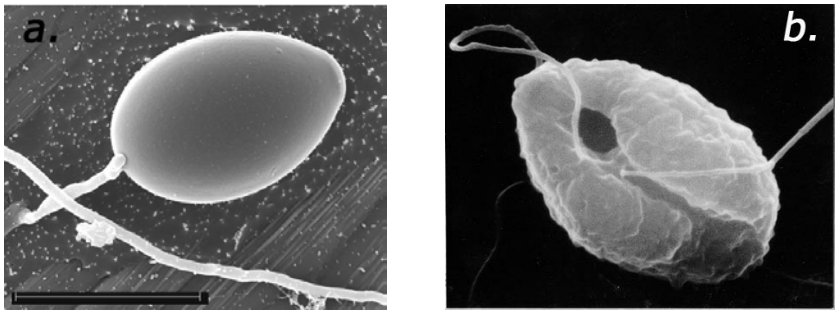
Kingdom:	Chromista
Phylum:	Oomycota
Order:	Personsporales
Family:	Peronosporaceae
Genus:	*Phytophthora*
Species:	*cinnamomi*

What does it look like?

In the vegetative state, *P. cinnamomi* consists of colourless threadlike material called **mycelium**. Three types of spores are produced asexually by the mycelium: **sporangia** (pl.), within which **zoospores** are formed; and **chlamydospores**. A fourth type of spore, called an **oospore**, is produced through sexual recombination of A1 and A2 mating strains of the pathogen.

Sporangia are the largest of all the spores and when mature range from 50 to 70 microns (or 0.05 to 0.07mm) in length (Figure A1.1a), which is invisible to the naked eye. Twenty to thirty zoospores, each less than 10 microns in diametre, are produced within each sporangium. Zoospores are roughly kidney-shaped and have no cell wall with only a membrane to protect them. However, they have two flagella which enables them to swim for short distances (25-35mm) through water (Figure A1.1b).

Chlamydospores are round, average 41 microns in diameter and are commonly thin-walled, although thick walled chlamydospores have been observed (Figure A1.2a). The sexually produced oospores are round and thick-walled, with a diameter in the range 19 to 54 microns and are considered highly resistant to degradation (Figure A1.2b).



Note: Figure A1.1b published in Hardham (1987)

Figure A1.1 A sporangium with mycelium attached, the horizontal bar measures 50 microns (a) and a zoospore showing both flagella (b) of *Phytophthora cinnamomi* (Scanning electron micrographs: Professor A Hardham, The Australian National University, Canberra, A.C.T.).

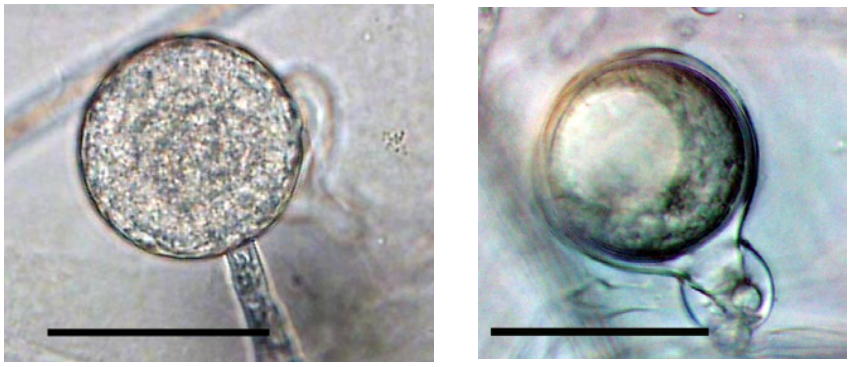


Figure A1.2 A thin-walled chlamydospore (a) and thick–walled oospore (b) of *Phytophthora cinnamomi.* The scale bar in both images represents 40 microns *(*Light microscope images: K McCarren, Murdoch University, Perth, Western Australia.).

What is the life-cycle, and how does it cause disease?

While all spores have the capacity to directly infect plants, zoospores are thought to be the major infection propagule. Figure A1.2 shows the generalised life cycle of *P. cinnamomi*.

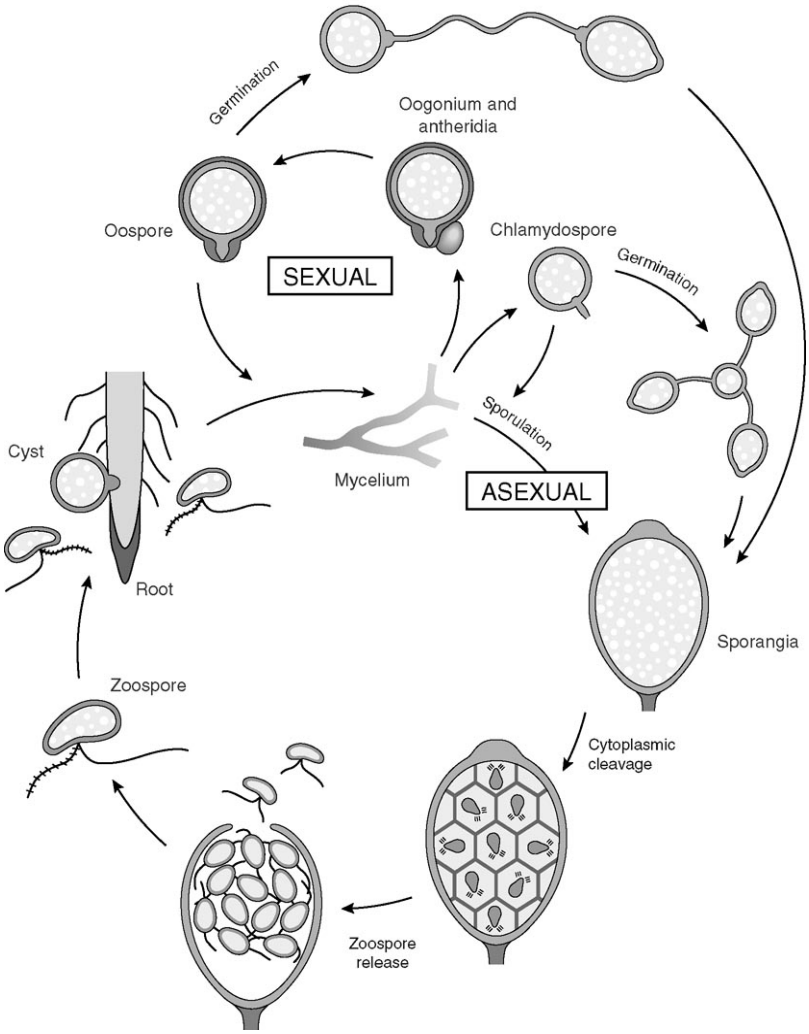


Figure A1.2 Generalised life cycle of *Phytophthora cinnamomi* (Diagram Professor A Hardham, The Australian National University, Canberra, A.C.T.).

Under favourable conditions, *P. cinnamomi* readily produces sporangia. When sporangia reach maturity all the zoospores within it are released. The zoospores can swim short distances in free water and are attracted to the chemical and electrical signals that emanate from actively growing plant root tips.

When a zoospore encounters a root it develops into a cyst which involves: the loss of the flagella; a rounding of the kidney-shape; the release of an adhesive, which firmly fixes the zoospore-cyst to the surface of the root; and the production of a cell wall. The plant becomes infected when the zoospore-cyst produces a germ-tube which chemically and physically breaches the protective surface of the root. Once inside the plant, the germ-tube develops into mycelium and grows between, and into the plant cells gaining nutrients from the contents. The pathogen will travel through the root killing the roots as it goes. The pathogen may exit the infected root at some point starting new infections.

The plant becomes visibly diseased when many infections take place on the one plant (Figure A1.3), resulting in the impairment of the plant's physiological and biochemical functions. Uptake of water is one of the functions affected, and this is why symptoms of *P. cinnamomi* infection have similarities, at least initially, with those of water-stress.

Figure A1.3 Zoospore-cysts of *Phytophthora cinnamomi* amassed on a plant root. (Scanning electron micrograph: Professor A Hardham, The Australian National University, Canberra, A.C.T.).

As the A2 mating strain predominates in the Australian environment, it is unlikely that sexual recombination, and thus oospore production, is happening to any large degree in the natural environment. Of the asexual spores, chlamydospores are considered the most resistant to degradation and have, therefore, been implicated in the ability of *P. cinnamomi* to survive for long periods of time under unfavourable conditions.

Where did it come from?

P. cinnamomi is present in all States and Territories of Australia where it causes disease in an extremely diverse range of native, ornamental, forestry and horticultural plants. Since the mid 1960's/early 1970's *P. cinnamomi* has been recognised as a serious pathogen in native ecosystems of Australia. It is generally accepted that *P. cinnamomi* was introduced to Australia (probably by European settlers on infested horticultural plants), the major evidence being:

1. The A2 strain of *P. cinnamomi* predominates in the Australian environment. However, if Australia was the centre of origin a greater balance between the A1 and A2 strains would be expected.

2. The high level of susceptibility of many Australian native species of plant which suggests that the plants did not evolve with the pathogen.

How does P. cinnamomi spread?

P. cinnamomi can be spread in water, soil or plant material that contains the pathogen and dispersal, whether active or passive, is favoured by moist or wet conditions.

Active Dispersal: Active dispersal occurs as a result of actions by the pathogen and is also referred to as autonomous spread. As mentioned earlier, zoospores can swim short distances in free water. Soil texture determines how easily zoospores can move through the profile, coarse-textured soils with large pores, and water-filled root channels facilitate autonomous spread. As described above, *P. cinnamomi* grows through roots and can spread to the roots of adjacent plants where root-to-root contact occurs. Root-to-root movement of the pathogen is thought to be one of the major ways in which the pathogen moves upslope.

Passive Dispersal: The movement of *P. cinnamomi* with no effort on the part of the pathogen is referred to as passive dispersal. *P. cinnamomi* can be carried in overland and subsurface water flow, which is apparent from the prevalence of infestations in low lying areas. Native and feral animals have been implicated in spreading *P. cinnamomi*, particularly where there are digging behaviours.

By far, the most significant vector of *P. cinnamomi* in the natural environment is, however, the human. Humans have the capacity to disturb and transport more soil than any other vector, and all human activities carry some likelihood of spreading *P. cinnamomi*. Most of the large centres of infestation that exist today in southern temperate Australia occurred as a result of human activity, often as a direct result of the introducing infested soil or road-building materials to vulnerable unifested areas.

Pathogen Survival: There are currently no known methods to completely eradicate *P. cinnamomi* from an infested site, and there is no evidence to suggest that the pathogen will disappear from a site once it has killed all of the most susceptible plant species. *P. cinnamomi* is thought to be able to survive long-periods of unfavourable conditions through the production of chlamydospores. However, there are still significant gaps in our knowledge about the exact mechanisms of long-term pathogen survival.

The rationale for current management approaches

Fact 1: *P. cinnamomi* cannot be eradicated from an infested site.

Fact 2: *P. cinnamomi* can be readily spread in the landscape through the movement of soil, plant material and water that is infested with the invisible pathogen.

Fact 3: Passive spread of *P. cinnamomi* is not easily controlled but is relatively slow.

Fact 4: The potential for active spread of *P. cinnamomi* is variable and so is the ability to control it.

- Active spread by native and feral animals is difficult and prohibitively expensive to control.
- Active spread in subsurface water is difficult to control, however, under certain circumstances and to some degree surface drainage can be controlled.
- **Humans have the potential to spread *P. cinnamomi* faster and further than any other vector. Fortunately however,**

human activities and behaviours can successfully be modified and are thus the primary focus of current management approaches.

Recommended Reading

The information presented above is an extremely brief treatment of international and national research on *P. cinnamomi* spanning over 40 years. Many fundamental questions about the biology and epidemiology of *P. cinnamomi* remain unclear or unanswered. Continued research is essential to unlocking knowledge necessary for improvements in current management approaches. The following books and journal articles provide reviews of the research undertaken to date and are recommended for anyone who would like more information.

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APPENDIX 2

The Rationale of Current Management Options

There are currently no proven methods to eradicate *P. cinnamomi* from a site or to prevent autonomous spread, and transmission by animals is usually very difficult and prohibitively expensive to control. As humans have the potential to spread *P. cinnamomi* further and faster than any other vector, on-ground measures focus on the modification of their activities and behaviours to manage the pathogen and the disease it causes. The management options provided in Table 5.1 to 5.7 (main document) address the two major objectives of *P. cinnamomi* management: i) minimise the spread of *P. cinnamomi* by humans to uninfested sites and ii) mitigate the impact of *P. cinnamomi* at infested sites.

Planning

The efforts and cost of managing *P. cinnamomi* during site restoration or conservation activities, for example, will be quickly laid to waste if the pathogen is not similarly managed during the construction or repair of road and tracks at the same site. Consequently, management of *P. cinnamomi* within an organisation or region should be approached strategically, be included in any existing environmental management framework, and the deployment of options from Tables 5.1 to 5.7 (main document) should form part of a coordinated management plan for a site or area.

While it will not be practical or possible to deploy all the management options for a particular activity, the probability of successful management will be higher if appropriate options are deployed in an integrated fashion. Decisions on the most appropriate combination of options will need to be made on a case-by-case basis in the context of the physical and socio/political environment, the resources available, and the ability to manage the risks associated with *P. cinnamomi*.

Planning will also need to consider management priorities for the implementation of options for which a limited number of species or a limited area will benefit, such as the disease mitigation options of *ex-situ* conservation and phosphite application.

Prior planning is crucial to reducing the likelihood of spreading *P. cinnamomi* during wildfire management or emergency rescue operations. However, it is acknowledged that during such events protection of life and property takes priority.

Communication

The management *P. cinnamomi* on public lands requires cooperation and commitment not only from staff and contractors, but also from the general public. The role of communication in effective deployment of *P. cinnamomi* management measures should not be underestimated. The form and intent of management prescriptions needs to be communicated clearly to all stakeholders. The appropriate communication tools for a particular circumstance will depend on the target stakeholder group but may include: organisational standard operating procedures, codes of practice, conditions of contract, management and work plans for specific sites, training for on-ground workers, signage (Figure A2.1), extension material and programs, and consultation processes.

The form and dissemination of the appropriate information must be considered during the planning phase for management of the site or area. Many of the management options presented in Table 5.1 to 5.7 will require consultation with other stakeholders. Issues of access to public land, for example, will potentially affect wildfire planning and management, commercial activities in the area, and use of the area by the general public.

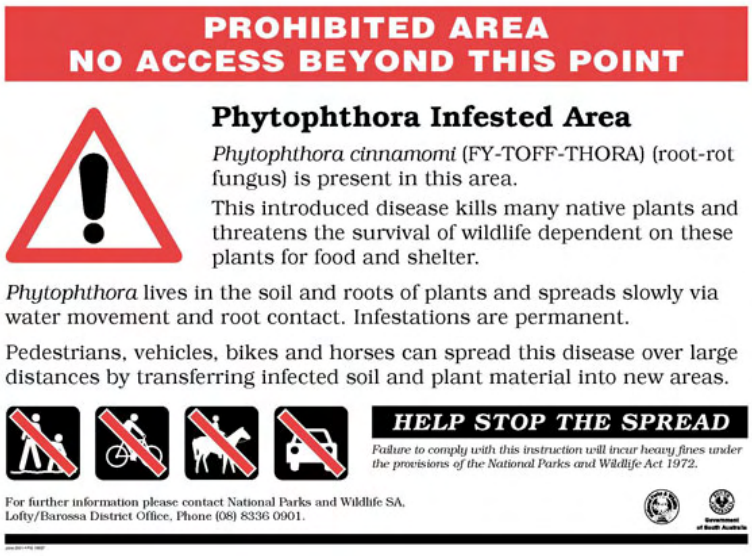

Figure A2.1 A sign used by the Department for Environment and Heritage in South Australia to inform that all access is restricted to a *Phytophthora* infested area, and that non-compliance under State laws that can attract a fine (Image: R Velzeboer, Department for Environment & Heritage in South Australia).

Objective 1: Minimise the Spread of *P. cinnamomi*

Access

Access to a specified area can be managed to minimise the likelihood of human-vectored spread of *P. cinnamomi* through the:

- prohibition of human access (sometimes referred as 'quarantine')
- restriction of access to periods when the likelihood of pathogen transmission is low
- reduction or modification of access points and roads, tracks and trails through an area

Access Prohibition or Restriction

Prohibiting access or quarantining an area is generally used to protect environmental assets of high conservation value from *P. cinnamomi*. Prohibition of access may be enforceable by law, under legislation such as the WA *Conservation and Land Management Act 1984*, the SA *National Parks and Wildlife Act 1972* (Figure A2.1), and the Tasmanian *Plant Quarantine Act 1997*.

As *P. cinnamomi* can be readily spread in infested soil, plant material and water, access to specified areas may be restricted to periods when soils are not likely to adhere to vehicles and pedestrians. Land managers may chose to restrict all access (Figure A2.1) or just vehicular traffic while still permitting activities such as bushwalking, cycling and

horse-riding, which are perceived in some areas and under some circumstances to pose a low risk.

Modification to Access Points, Roads, Trails and Tracks

The distribution pattern of *P. cinnamomi* in many parts of Australia is highly correlated with the occurrence of roads and tracks. Access management should give consideration to the number, position and condition of roads, tracks and trails. The number should be kept to a minimum, where possible they should be positioned down slope of uninfested areas, especially those supporting rare and threatened taxa, and the surface should be hard-packed and free from potholes.

When access to an area is to be permanently prohibited, the methods of road closure must ensure that unauthorised use cannot continue. The methods and standards of permanently closing and rehabilitating roads recommended by CALM in WA include, mechanical ripping of a portion of the road/track surface and/or the use of logs (>400mm diameter) and other debris to block the entrance (Figure A2.2) (CALM, 2003). Other structural barriers such as gates and fencing are used to restrict pedestrian and vehicle access (Figure A2.3).

The following manuals address the construction and maintenance of roads and tracks with specific references to issues of *P. cinnamomi* management:

- Rainforest Dieback: Risks Associated with Roads and Walking Tracks (Worboys and Gadek, 2004), which was developed for the wet tropics of northern Queensland
- Walking Track Management Manual developed by the Tasmanian Parks and Wildlife Service is available from: http://www.parks.tas.gov.au/manage/tracstrat/walking_track_manual.html

Figure A2.2 Permanent closure of a track in Waychinicup National Park in the south-west of Western Australia, by mechanical ripping of a portion of the track, and blocking of the entrance with a log and debris (Photo: E O'Gara).

Figure A2.3 Temporary closure of a road in Fitzgerald River National Park in the south-west of Western Australia (Photo: E O'Gara).

Hygiene

Where access is permitted, hygiene refers to specific procedures designed to prevent the spread of *P. cinnamomi* by ensuring that infested soil, water and/or plant material are removed from machinery, vehicles, equipment and footwear before they enter uninfested areas. The term 'clean on entry' is often used to describe such hygiene procedures. It is generally accepted that 'it is easier to keep clean than to get clean', which leads to the following recommendations: i) postpone activities during wet weather, ii) begin activities with clean vehicles/equipment, and iii) avoid wet or muddy areas during activities.

Machinery and Vehicles

Permanent or semi-permanent wash-down facilities may be constructed where machinery and vehicles require routine cleaning for fixed activities. All vehicles entering the Alcoa Huntly Bauxite Mine in WA, which is situated in an area of jarrah forest that is largely uninfested, must go through an automated wash-down facility (Figure A2.4). The vehicle operator must perform a visual inspection after wash-down, and before proceeding into the mine, to ensure all mud and soil was removed (Alcoa Procedural Control Documents).

Figure A2.4 The automatic wash-down facility at the entrance to Alcoa's Huntly bauxite mine in the south-west of Western Australia, designed to remove soil from trucks and light vehicles entering the mine, thus minimising the probability of introducing *Phytophthora cinnamomi* to the predominantly disease-free site (Photo: E O'Gara).

A hygiene system was developed in Victoria to mitigate the risk of spreading a declared weed by fire-fighting vehicles and personnel during a large bushfire in 2005. A wash-down facility was created on a dry and compacted disused football oval by digging out a wash-bay (20 m long x 7 m wide) and filling it with blue metal. Dozers, dozer transport trucks, fire trucks and command vehicles were driven onto the blue metal, one at a time, for washing with a high pressure water sprayer. Surface run-off was carried away from the wash-bay by drainage channels, although run-off was minimal a result of drainage through the blue metal and the use of high pressure, low volume sprayer. The system was well accepted by the ground-crews and worked in parallel with fire suppression activities, with over 750 vehicles washed in a 35 h period. The system is currently being reviewed for use in the coming year to address the weed risks but also to mitigate the risks of spreading *P. cinnamomi* during fire suppression and prescribed fuel reduction burning operations (J Fleming, *pers. comm.*).

Figure A2.5 Hygiene system developed initially for weed control during fire suppression activities in Victoria, but which is considered suitable also for *P. cinnamomi* management (Photo: J Fleming, Department of Sustainability & Environment, Victoria).

Portable wash-down systems enable machinery and vehicles to be cleaned at the point of risk for activities that do not have a fixed location (Figure A2.6). Hygiene measures commonly call for the minimisation of water during cleaning, as wash-down effluent also poses a risk of spreading the pathogen. To reduce the amount of water required for effective wash-down it is recommended that large clods of dirt are firstly removed with a hard brush or other tool (DWG, 2000; PTG, 2003; Worboys and Gadek, 2004), and high pressure, low-volume water sprayers used to remove remaining material. High pressure hot water systems are recommended for cleaning earth moving equipment in Victoria, as the hot water is believed to assist in killing rather than simply removing the pathogen (Smith, 2002).

Figure A2.6 A portable wash-down unit. This type of system is used widely in South Australia and Western Australia to wash vehicles and equipment during general field and fire-fighting operations (Photo: R. Velzeboer, Department for Environment and Heritage in South Australia).

A group of stakeholders in Tasmania concerned about *Phytophthora* and weed control have developed hygiene procedures for a range of machinery, vehicles and small equipment (Rudman *et al.*, 2004). Dust and grime are not considered a high risk for transmission of the pathogen (DWG, 2000; CALM, 2003; PTG, 2003).

Barrier System for Working Across Infestation Boundaries

A system for working hygienically across infestation boundaries has been developed in WA (CALM, 2003) and Tasmania (Rudman, 2004). In WA, CALM uses a 'barrier system' when forestry operations straddle an infestation boundary, to prevent contamination of the uninfested part of the site. A physical barrier, such as logs, marks the infestation boundary. The operation is split so that certain tasks are restricted to the uninfested part of the site with clean machinery, vehicles and equipment and other tasks to the infested area with separate machinery, vehicles and equipment that are not subject to hygiene (Figure A2.7).

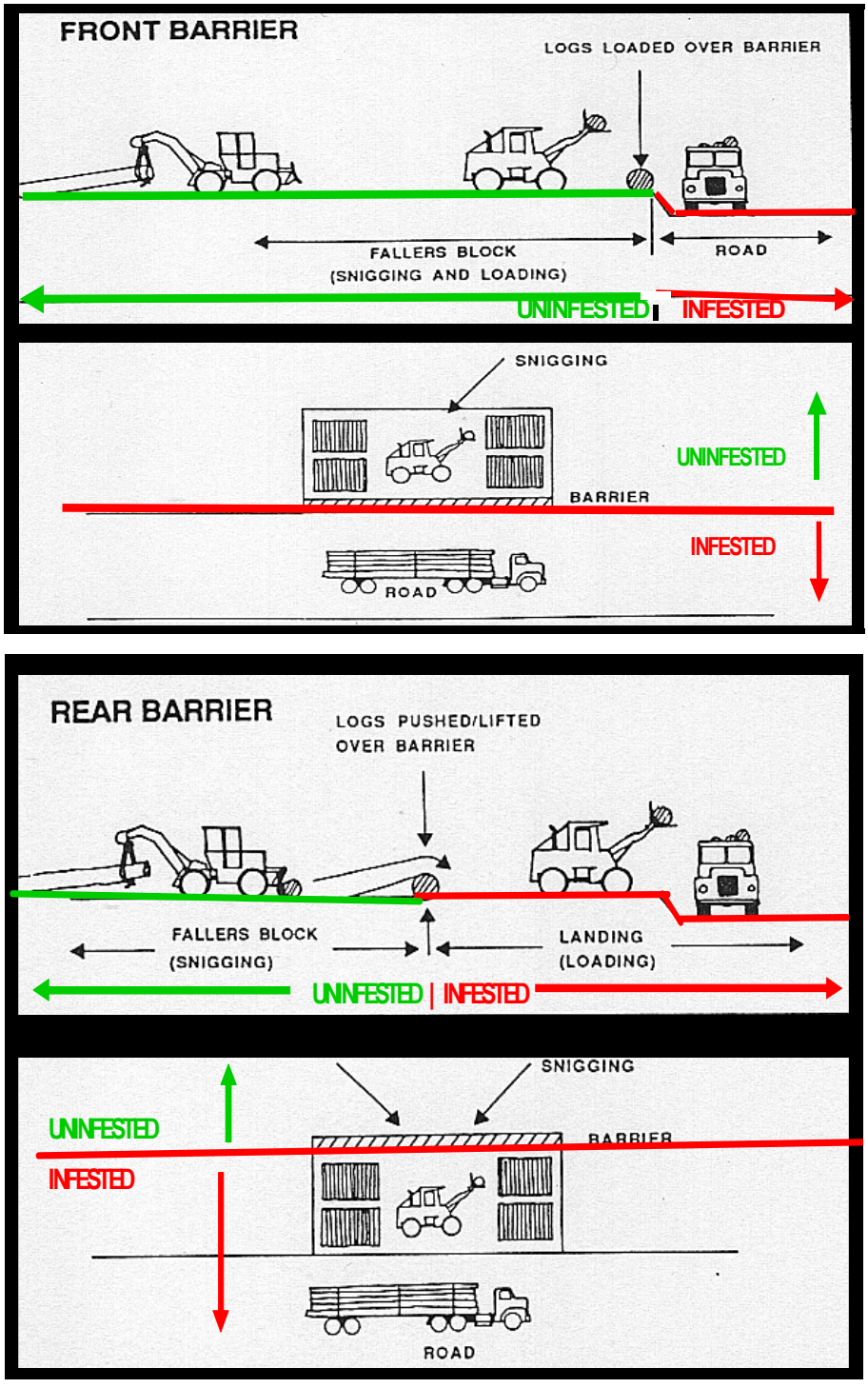

Figure A2.7 Diagrams of the two types of 'barrier system' employed by the Department of Conservation and Land Management in Western Australia to prevent the spread of *Phytophthora cinnamomi* to uninfested sites during operations that traverse infestation boundaries disease (Diagram: K Vear, Department of Conservation and Land Management, Western Australia)

Non-Vehicular Activities

Although activities involving the use of heavy machinery and vehicles present a significant risk of spreading soil infested with *P. cinnamomi*, non-vehicular activities are not without risk. Where high conservation values are at stake, activities such as bushwalking, horse riding and cycling may pose an unacceptable risk of introduction and may also be subject to hygiene. SA DEH developed the idea of a 'hygiene kit' for the cleaning of footwear and small equipment (Figure A2.8), which they encourage bushwalkers to assemble and carry (SA DEH, 2003a), and require all departmental vehicles to carry (SA DEH, 2002a).

Figure A2.8 A 'hygiene kit' containing equipment and information to facilitate the cleaning and disinfection of footwear, small tools and equipment against *Phytophthora*. The Department for Environment and Heritage in South Australia actively promotes the assembly and use of such kits amongst stakeholders (Photo: R Velzeboer, Department for Environment and Heritage in South Australia).

In situ apparatus for footwear hygiene ranges in sophistication from a simple tray and brush system (Figure A2.9) to a system developed by Parks Victoria named the 'Anakie Scrubber' (Figure A2.10). The Anakie Scrubber consists of a disinfectant footwear bath, designed to minimise evaporation and prevent the entry of rainfall and fauna to the reservoir (D Peters, *pers. comm*.).

Figure A2.9 A boot cleaning station in Fitzgerald River National Park in the south-west of Western Australia, consisting of a metal pan into which soil is brushed from footwear with brush provided (Photo: E O'Gara).

Figure A2.10 The 'Anakie Scrubber' footwear cleaning station consists of a metal ramp and disinfectant bath with an immersion plate for the cleaning of footwear prior entering uninfested areas (Photo: D Peters, Parks Victoria).

Introduced Material

Under the Victorian *Flora and Fauna Guarantee Act 1988* the use of gravel infested with *P. cinnamomi* is listed as a key threatening process (DSE, 2004). Current best practice recommends the use of pathogen-free road-building materials in areas that are uninfested or where the disease status is unknown. The difficulty in sourcing pathogen-free material is a significant problem in all parts of Australia, and as there is currently no national certification system, even materials advertised as pathogen-free may not be. In the event that pathogen-free gravels cannot be obtained, the recommendation is that the introduction of suspect material be avoided. A lower risk alternative is freshly crushed rock that has been crushed, transported and stored hygienically.

CALM in WA have an 'in-house' process by which gravel pits on CALM land and for CALM use can be 'certified' *P. cinnamomi*-free by personnel accredited by the Department in the identification and diagnosis of the pathogen (CALM, 2003). There are informal systems in place in Tasmania and Victoria where *P. cinnamomi* experts assess the disease status of quarries through surveys of disease symptoms of vegetation in the pits and drainage lines into and out of the pits, and/or sampling and analysis for the presence of the pathogen (T Rudman and I Smith, *pers. comm*.).

The WA extractive industry has a Code of Practice (DWG, 2004b) and best practice guidelines for management of *P. cinnamomi* (DWG, 2005). A Quarry Code of Practice in Tasmania 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). However, there is currently no national system for the certification of basic raw materials for road building or other bulk soils and sand supplies.

The introduction of planting material to an uninfested site should be avoided wherever possible and revegetation achieved through encouraging natural regrowth or use of seed. However, if the introduction of planting material is necessary, then plants should be obtained from NIASA accredited suppliers (NGIA website – Accreditation, accessed 12/12/05).

Water, Drainage and Effluent

There are currently no accepted methods of controlling the spread of *P. cinnamomi* in subsurface water flows. Under certain circumstances surface drainage can be re-directed away from uninfested areas, and recommendations for the management of drainage is to direct it to infested areas or to the lowest point in the landscape (Rudman, 2004; CALM, 2003; DWG, 2000). Alcoa prevent surface water from freely draining into jarrah forest surrounding bauxite mines in WA through a series of channels and bunds.

The primary recommendations in relation to water management at infested sites, or where disease status is unknown is to minimise use and seriously consider the source of the water wherever possible. If water must be used at a site, suspect supplies should be disinfected using Phytoclean® (http://www.phytoclean.com.au/). All safety precautions should be taken when using disinfectants, and as the environmental effect of broad-scale use is unknown it is recommended that they be used judiciously.

Objective 2: Mitigate the Impact of *P. cinnamomi*

Options for the mitigation of impact to biodiversity at infested sites or areas are currently limited to the use of phosphite and *ex-situ* conservation of susceptible plants. As discussed previously, the cost of these options makes only limited application practical.

Consequently, the use of phosphite and/or *ex-situ* conservation as part of an integrated management plan for a site or area requires a process of prioritisation and forward planning.

Phosphite

The autonomous spread of *P. cinnamomi* is currently very difficult, if not impossible, to control. However, phosphite (also referred to as phosphonate), the anionic form of phosphonic acid (HPO_3^{2-}), has been shown in WA and Victoria to slow the spread and reduce the impact of the *P. cinnamomi* in susceptible vegetation. Phosphite is currently used in WA to protect areas of high conservation value and critically endangered species from the threat of *P. cinnamomi*.

Despite the fact that research on the use of phosphite in natural ecosystems has occurred predominantly in WA and Victoria to date, it is presented in Table 5.1 (in main document) as a management option for ecosystems under threat of *P. cinnamomi* in Australia. Faced with the continued threat that *P. cinnamomi* poses to a significant proportion of Australia's native vegetation, and the limited management options, the most responsible recommendation for other States and Territories is that, after reference to the available research, phosphite be used judiciously in the management of *P. cinnamomi*, results monitored and data collected to increase the national body of knowledge on this important management tool.

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.

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 trees and large shrubs (Hardy *et al.,* 2001)
- the uptake of phosphite through foliage which enables it to be applied as a foliar spray, either manually or by broad scale aerial application (Barrett, 2003)
- it has a simple chemical structure and current data indicates that it has low mammalian toxicity and breaks down rapidly in the soil (Guest and Grant, 1991).

Aerial application (Figure A2.11) is a rapid way to treat entire plant communities especially where rough terrain would make ground application practically impossible or prohibitively expensive (CALM website – Dieback Phosphite, accessed 11/04/05). Foliar application using backpack (Figure A2.12) or trailer-mounted sprayers is usually restricted to small areas such as small reserves, remnant bushland or spot infestations (Hardy *et al.,* 2001). Trunk injection of trees and large shrubs is used in strategic areas where their loss would have a high visible impact, and where foliar application is impractical (Hardy *et al.,* 2001).

Figure A2.11 Aerial application of phosphite in Stirling Ranges National Park in the south-west of Western Australia (Photo: G Freebury, Department of Conservation and Land Management, Western Australia).

Figure A2.12 Foliar application of phosphite by backpack mister (Photo: B Shearer, Department of Conservation and Land Management, Western Australia).

As the need for phosphite treatment in WA regularly exceeds the available resources, a protocol for setting treatment priorities was developed by CALM, and a scoring system developed to rank assets with highest priority. 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.

CALM have also produced detailed Phosphite Operation Guidelines which provides background information on the compound, and covers all methods and aspects of application.

Ex-situ *Conservation*

In WA, *ex-situ* conservation of germplasm in seed banks is a well established technique and with no definitive solution to the threat of *P. cinnamomi*, may be the last hope in conserving some of the States susceptible species (Anon, 2004; Cochrane, 2001; Cochrane, 2004). Compared to other types of germplasm, seed conservation has many benefits including: the simplicity of the technology, low cost and space requirements, the potential for long-term storage with little loss of seed viability, the applicability of the technique to a wide range of species, and greater genetic representation in seed than in vegetative material (Cochrane, 2004).

CALM and the WA Botanic Gardens and Parks Authority are partners in the Millennium Seed Bank Project in which collections of seed in WA are duplicated in the Royal Botanic Gardens Kew, United Kingdom in the Millennium Seed Bank (Cochrane, 2001). The

conserved seed facilitates the implementation of species recovery plans in WA by providing material for translocation of rare and threatened flora (Cochrane, 2004; Royal Botanic Gardens Kew - Millennium Seedbank Project website, accessed 18/04/05). An additional benefit of the WA seed bank has been the provision of material to the Senior *Phytophthora* Research Scientist in CALM for trials to extend knowledge on the range of WA plant species that are susceptible to *P. cinnamomi* (Cochrane, 2004; Shearer *et al.,* 2004).

Translocation as defined by the Australian Network for Plant Conservation is the 'deliberate transfer of plants or regenerative plant material from one place to another' (Australian Network for Plant Conservation website, accessed 18/04/05). Translocation includes the following techniques:

- re-stocking - increasing the size of the existing population
- re-introduction – establish a population where it formerly occurred
- introduction – establish a population where it is not known to have occurred, within the known range and habitat
- conservation introduction – establish a population in an area that is outside the known range, which has appropriate habitat.

Experimental translocation of 10 species in WA was funded in 1998 by the Natural Heritage Trust, and the method is now integrated with a range of other recovery actions to conserve State-listed critically endangered species (Cochrane, 2004; Monks and Coates, 2002; L Monks, *pers. comm.*).

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APPENDIX 3

AREAS VULNERABLE TO DISEASE CAUSED BY *Phytophthora cinnamomi*

This section provides information necessary to navigate the decision flow chart (Figure 5.1) in Guidelines for Best Practice On-Ground Management (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 the establishment and persistence of the pathogen, and in some cases on other criteria such as geology, soil and elevation.

Climatic Envelope of Phytophthora cinnamomi *in Australia*

Figure A3.1 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, but in WA 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 A3.2) that affect its ability to establish and persist. 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.

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 the map in Figure A3.1. 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).

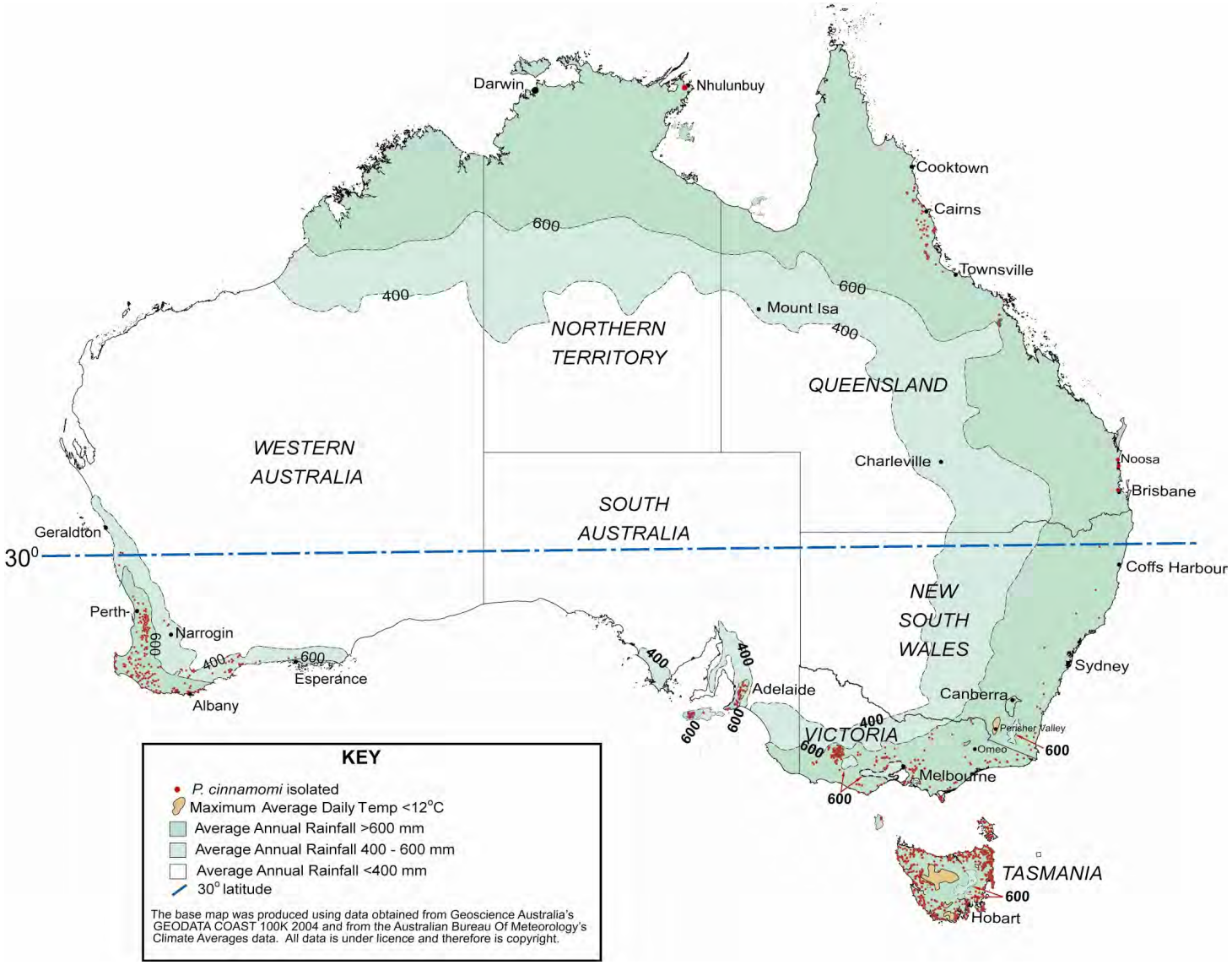

Figure A3.1 Map of Australia indicating the broad climatic envelope of *Phytophthora cinnamomi* in Australia, based on current knowledge of rainfall and temperature requirements. Red spots indicate non-agricultural sites from which *P. cinnamomi* was isolated. Please refer to the main body of text for further explanation of the map.

Source of *P. cinnamomi* isolation data: WA - Podger (1999), WWF, DCC (2004); 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 (2003); 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).

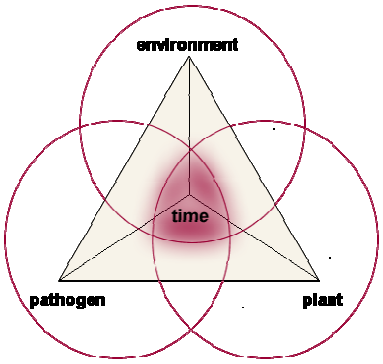

Figure A3.2 Disease pyramid showing disease epidemic (red shading) resulting from the convergence of virulent pathogen, susceptible host, suitable environment and time.

Phytophthora cinnamomi *Isolation Records*

P. cinnamomi isolations records at non-agricultural sites are marked on the map in Figure A3.1. Isolation records do not indicate the extent of the infestation or the impact of disease, merely the presence of the pathogen as indicated by the analysis of soil and/or plant material. Although data was not available, it is thought that *P. cinnamomi* is widespread on the entire coastal strip of NSW.

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 Western Australia, 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 foot 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 in 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 two 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.

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APPENDIX 4

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

A list of Australian plant responses to *Phytophthora cinnamomi* has been compiled[1] (Table A4.1) 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

'Are there species present for which the impact of P. cinnamomi *would be significant?'*

The critera for the level of threat to vegetation at a site, that warrants management of *P. cinnamomi*, is currently impossible to prescribe for nationally. The different States will need to exercise discretion on the criteria, and criteria need to be developed as a first step in planning the management of *P. cinnamomi*.

Table A4.1 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 species present for which the impact of *P. cinnamomi* would be significant', it is suggested that the answer is 'yes' if:

1. there are species present that are listed in the table as moderately (MS) or highly susceptible (HS)
2. there are species and ecological communities present that are threatened and the extent of susceptibility to *P. cinnamomi* is unknown.

Threatened species and ecological 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 A4.1. 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 A4.1; 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:

[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.

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

Important Caveats on the Use of Tables A4.1

Table A4.1 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 A4.1 to indicate the field susceptibility of species to infection and spatial variation in susceptibility where they are known. **The list is indicative and not definitive.** 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 information in Table A4.1 will require some interpretation it is strongly recommended that the following points are noted prior to consulting or using the information:

- the listing of a taxon in Table A4.1 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

- references provided in the list should be sought to clarify issues of variable susceptibility. In addition, the list is 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

Explanatory Notes on Table A4.1

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 A4.1 A list of Australian native plants that are potential hosts of *Phytophthora cinnamomi.* Please consult the accompanying text before using this list.

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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			
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
Allocasuarina paludosa	n,s,t,v	25			S[43]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Elaeocarpus largiflorens subsp. *retinervis*	q				FR[36]
Elaeocarpus sericopetalus	q				S[36]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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		
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	w				HS[41]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Burgman 1377)					
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. comm.*)	n,v	13			HS[13]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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	2,13,17,3 4			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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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			
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		

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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			
Patersonia glabrata	n,q,v				S[42]
Patersonia occidentalis	s,t,v,w	14,24			FR[59],S[24,37,46,53] FR[60]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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					

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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.	n,t,v	25			

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
prostrata					
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Eucalyptus spathulata	w				FR[50]
Eucalyptus staeri	w				LS[40,59]
Eucalyptus talyuberlup	w				FR[59]
Eucalyptus tenuiramis	t	17	3		
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			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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Verticordia carinata **V**	w	58			LS-MS[58]
Verticordia chrysantha	w		3		
Verticordia densiflora	w	14,37, 49,53			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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Tricoryne elatior	n,nt,q,s,t,v,w				FR[21]
PHYLLOCLADACEAE					
Phyllocladus aspleniifolius	t	17,34	3		
PITTOSPORACEAE					
Billardiera drummondiana	w				FR[24]
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		

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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*	
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*	S[46,51],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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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}

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
Grevillea rosieri	w				LS[41]
Grevillea rosmarinifolia s.l.	n,s,v		3		

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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		

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Persoonia gunnii	t	17			
Persoonia hakeiformis	w				LS[41]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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		

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
Crowea saligna	n,q		3		
Flindersia bourjotiana	q				S[36]
Flindersia brayleyana	q			16	
Flindersia pimenteliana	q				FR[36]
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	

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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]
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				

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
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,		21	S[46,48]MS[21]

FAMILY	Distribution	Isolation			Susceptibility Rating
Species		In wild	In cultivation	By experiment	
		48			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]
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	14,24,28, 37,46,48, 53			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, 24,28,37, 46,48,53			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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