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THREAT ABATEMENT PLAN

DISEASE IN NATURAL ECOSYSTEMS CAUSED BY *PHYTOPHTHORA CINNAMOMI*

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1. Introduction

Healthy natural environments provide a range of direct and indirect benefits to the community, in addition to the intrinsic value of biodiversity. Disease caused by the introduced plant root pathogen, *Phytophthora cinnamomi*, threatens these values and benefits. Infected areas are increasing in size in Australia with *P cinnamomi* now present in hundreds of thousands of hectares of native vegetation in Western Australia, Victoria and Tasmania and tens of thousands of hectares in South Australia. Depending upon environmental conditions and plant susceptibility, the pathogen can destroy vegetation communities and several plant species are at risk of extinction. The disease is often difficult to detect. In New South Wales and far north Queensland the extent of the threat is not known, but concerns are increasing about the impacts of *P cinnamomi* in environmentally sensitive areas.

The detrimental impacts of *P cinnamomi* on biodiversity in Australia led to the disease it causes being listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Australian Government Department of Environment and Heritage published the “Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi*” (2001). A review of the implementation and effectiveness of the Threat Abatement Plan (TAP) has been undertaken (CPSM 2006), and informs the revised goals, objectives and actions presented in this, the revised TAP.

The primary responsibility for the management of *P cinnamomi* rests with landholders and managers but requires commitment, leadership and coordination from all levels of government, and the support and cooperation of all land users and the general community. The TAP provides a framework for the coordinated and integrated management of *P cinnamomi* and for the strengthening of training, education and communication.

There are currently no proven methods to eradicate *P cinnamomi* from a site or to prevent autonomous spread of the pathogen. As a result, the two major objectives of *P cinnamomi* management are:

- i) to minimise the spread of *P cinnamomi* to uninfested sites; and
- ii) to mitigate the impact of *P cinnamomi* at infested sites

Humans have the potential to spread *P cinnamomi* further and faster than any other vector. The limited management options currently available focus on the modification of human activities through restricting access to certain sites, and deploying and enforcing hygiene procedures to minimise the spread of *P cinnamomi* in the landscape. Priority must be given to those areas of high conservation value.

Phosphite is used to mitigate the impact of *P cinnamomi* at infested sites, but currently is used as a management tool only in Western Australia, and requires further testing in other states and territories. Current management options are described in the Background document to this TAP and in the National Best Practice Guidelines (O’Gara *et al* 2005a).

Areas of high conservation value are those areas within the climatic zones of *P cinnamomi* susceptibility and which:

- contain threatened species or ecological communities susceptible to *P cinnamomi*;
- contain habitat susceptible to *P cinnamomi* and critical to the survival of threatened fauna;
- support high plant species endemism;
- support high species diversity for the type of vegetation;
- support significant remnant vegetation; or
- are large, ecologically intact and mostly undisturbed.

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The TAP highlights the major gaps in knowledge that hamper current management. The first two objectives of the TAP deal with the identification and prioritisation of areas at risk from *P cinnamomi*, and the development and implementation of management plans to mitigate the risk. Further objectives relate to collecting and disseminating information to improve our understanding of control and mitigation methods, and communicating the importance of the disease to land managers and users.

While the management of *P cinnamomi* remains a challenge to landholders, under the provisions of the original TAP, progress has been made in the development of tools that will allow easier prioritisation of areas for management. A Risk Assessment Process that assesses the risk of *P cinnamomi* to threatened species, ecological communities and areas, and ranking them as the basis for setting management priorities is one such tool. While not yet field tested, the process is potentially suitable for national adoption (CPSM 2005).

2. Revised title of the TAP

The title of the TAP has been modified from: ‘Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi*’ to ‘Threat Abatement Plan for Disease in Natural Ecosystems Caused by *Phytophthora cinnamomi*’, to remove the terms ‘dieback’ and ‘root rot fungus’, which are technically incorrect and are used variably throughout Australia.

3. Goals and objectives of the TAP

The TAP has three long-term goals for the national management of *P cinnamomi* in Australia:

- Goal 1:** To protect nationally listed threatened species and ecological communities from *P cinnamomi*;
- Goal 2:** To minimise the spread of *P cinnamomi* so that further species and ecological communities do not become threatened and so that areas of high conservation are protected; and
- Goal 3:** To mitigate the impact of *P cinnamomi* in currently infested areas of high conservation value.

The TAP’s goals are to be pursued through the following objectives:

- Objective 1:** To develop techniques to enable the identification of management areas of high conservation value under threat from *P cinnamomi*;
- Objective 2:** To develop and apply management actions that will minimise or mitigate the threat of *P cinnamomi*;
- Objective 3:** To strengthen training, education and communication in the science and management of *P cinnamomi*; and
- Objective 4:** To address gaps in the scientific knowledge of *P cinnamomi* and management of the disease it causes, which currently hamper progress towards achieving management goals.

4. Actions to achieve the goals and objectives of the TAP

Specific actions outlined below establish the framework for an integrated national response necessary to achieve the objectives of the Plan.

Objective 1: To develop techniques to enable the identification of management areas of high conservation value under threat from *P cinnamomi*.

Actions 1.1 – 1.3 are directed towards improving our ability to identify and manage infested areas in a nationally consistent manner. The methodology should include an understanding of the biogeography

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of susceptible species, ecological communities, critical and high-risk habitats and the disease caused by *P cinnamomi* to these species and ecological communities.

A nationally applicable risk assessment process would enable comparative assessments of high-value sites and habitats that are highly susceptible to *P cinnamomi*. Management priorities would be able to be set with confidence and with lessened reliance on subjective assessments.

National standard methods for testing species susceptibility would allow the assessment of species susceptibility to be made in the absence of confounding environmental or temporal effects. Observed variability in disease expression in the field could then be attributed to effects of the particular environment at the time of observation. A standard method of determining susceptibility would also improve the usefulness of the National Risk Assessment Models developed by CPSM.

Action No.	Action Description
1.1 Increase predictive capabilities and risk assessment by land managers. (High priority, short term)	1.1.1 Undertake a gap analysis of the data necessary for risk assessment, and then develop programs to address the data deficiencies. Conduct further testing and refining of the National Risk Assessment Models.
	1.1.2 Conduct strategic risk assessments using the National Risk Assessment Models to identify and set management priorities for species, ecological communities and areas of high conservation value that are in need of protection from <i>P cinnamomi</i> .
1.2 Improve monitoring and surveillance. (High priority, medium term)	1.2.1 Develop and regularly update maps of high conservation value areas at risk from <i>P cinnamomi</i> and make these readily available to the public.
	Research Actions for Objective 1
1.3 Standardise susceptibility testing and ratings. (Medium priority, medium term)	1.3.1 Develop national standard methods for testing the susceptibility of flora species to <i>P cinnamomi</i> .
	1.3.2 Using national standard methods, further determine the susceptibility of listed threatened flora species, and the susceptibility of the habitats of listed threatened fauna species.

Performance Indicators

- Risk Assessments are used to identify management priorities.
- Maps (readily accessible to stakeholders, clearly dated and frequently updated) of the distribution of *P cinnamomi*, and threatened species, ecological communities and areas at risk from *P cinnamomi* are available.
- A national standard for testing the susceptibility of flora to *P cinnamomi* has been developed and is being used.

Objective 2: To develop and apply management actions that will minimise or mitigate the threat of *P cinnamomi*

The development of management plans and the adoption of the National Best Practice Management Guidelines (Action 2.1) for areas of high conservation will minimise the risk of spread to uninfested areas and provide an indication of the likely need and time to apply phosphite. Management responses can be enhanced through awareness and the availability of a range of management options available to the land manager.

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Monitoring and surveillance (Action 2.2) of infested areas provide information on disease outbreaks as well as disease distribution, prevalence, and incidence of *P cinnamomi*. The National Best Practice Management Guidelines provide decision-support systems to help land managers decide on locally appropriate management methods, and when to apply them to manage *P cinnamomi*.

The use of infested material for road works has historically been one of the primary mechanisms of spread of the disease. The use of pathogen-free material would reduce this mechanism of spread (Action 2.4).

Further research into the effectiveness of current management practices, particularly those involving the use of phosphite, would enable these practices to be adopted with confidence on a broader scale.

Action No.	Action Description
2.1 Develop generic, specific and context-dependent management plans. (High priority, short term)	2.1.1 For areas of high conservation value that are in need of protection from <i>P cinnamomi</i> , develop and implement <i>P cinnamomi</i> management plans consistent with the National Best Practice Guidelines.
	2.1.2 Promote Best Practice Management and the development of management plans on private and leasehold lands that are adjacent to areas of high conservation value threatened by <i>P cinnamomi</i> .
2.2 Improve and maintain current monitoring programs. (Very high priority, medium term)	2.2.1 Develop and implement monitoring to ensure early detection of new incursions in areas of high conservation value.
	2.2.2 Maintain monitoring programs that study the long-term direct and indirect impacts of <i>P cinnamomi</i> in natural ecosystems. Develop and implement additional monitoring programs to capture the range of ecosystems impacted by <i>P cinnamomi</i> .
2.3 Conserve species at risk. (Very high priority, short term)	2.3.1 Develop and implement a program using risk assessment to identify and conserve species in need of <i>ex situ</i> conservation.
2.4 Develop mechanisms to minimise inadvertent spread. (Medium priority, medium term)	2.4.1 Develop and implement national certification for pathogen-free raw materials, such as those used in nursery materials and practices, and in road and track building.
Research Actions for Objective 2	
2.5 Examine current management practices and explore the potential for improved practices. (2.5.1-2.5.5 High priority, medium term; 2.5.6- 2.5.7 Medium priority, medium term)	2.5.1 Investigate methods to eradicate <i>P cinnamomi</i> from small, infested sites and investigate alternatives to phosphite.
	2.5.2 Determine the effectiveness of current management procedures including phosphite application, access management and hygiene procedures.
	2.5.3 Investigate the epidemiology and mechanisms of spread and survival by <i>P cinnamomi</i> in the range of ecosystems it affects.
	2.5.4 Investigate the use of phosphite for the management of <i>P cinnamomi</i> in susceptible ecological communities of Victoria, South Australia, Tasmania, New South Wales and Queensland, and review the use of phosphite and its effectiveness as used in Western Australia.
	2.5.5 Investigate the target and non-target effects of phosphite.

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	2.5.6 Develop methods for restoration of sites highly degraded by <i>P cinnamomi</i> .
	2.5.7 Investigate the impact of wildfire and fire management practices on disease expression, spread and intensity.
2.6 Improve diagnostic capacity. (Medium priority, short term)	2.6.1 Develop cost effective and accurate methods for the rapid diagnosis of <i>Phytophthora</i> species Australia wide.
2.7 Explore opportunities for technological improvements in mapping. (Medium priority, medium term)	2.6.2 Explore alternative methods for the production of accurate operational scale <i>P cinnamomi</i> distribution maps including remote sensing technology for mapping occurrence without field interpretation.

Performance Indicators

- Management plans developed, and management and monitoring (for early detection and management efficacy) programs deployed in areas identified in the risk assessment process with the highest risk from *P cinnamomi*.
- *Ex-situ* conservation programs developed and implemented for those species identified in risk assessment processes as being at extreme risk from *P cinnamomi*.
- Methods for the localised eradication of *P cinnamomi* investigated.
- The effectiveness of phosphite in disease control is more clearly understood and the applicability of phosphite to disease management is established on a national basis.
- Knowledge and understanding of the epidemiology of *P cinnamomi* is increased, including the direct and indirect impacts of controlled burns and wildfires on epidemiology.
- Monitoring programs to study the long-term direct and indirect impacts of *P cinnamomi* in natural ecosystems implemented, including in sites already established and for which historical data exists.
- A remote method for mapping *P cinnamomi* distribution that is reliable, sensitive and affordable is investigated.
- Restoration methods for sites that are highly degraded by *P cinnamomi* are available.
- A national certification system for basic raw materials and road building materials is developed and implemented.

Objective 3: To strengthen training and education in the science and management of *P cinnamomi*.

Enhanced capacity for awareness, prevention of spread, and improved surveillance in high-risk regions and high-value sites can lead to early detection of incipient infestations. Urgent action may then be undertaken to minimise spread from the infested area.

It is recommended that managers be supported in developing better understanding of the basic symptoms and management implications associated with introduction and spread of *P cinnamomi* based on up-to-date knowledge and operational experience. Additionally, support for research and management training to increase technical expertise in Australia will lead to enhanced management of the disease.

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Action No.	Action Description
3.1 Build capacity and training (Medium priority, short term)	3.1.1 Boost training of staff involved in natural resources management in the recognition, detection and diagnosis of disease caused by <i>P cinnamomi</i> .
	3.1.2 Develop training programs and tools, and integrate training on <i>P cinnamomi</i> and its management into other appropriate programs within land planning, land management and biodiversity conservation agencies.
	3.1.3 Identify, liaise and collaborate with the proponents of high risk activities including the tourism, agricultural and horticultural industries to develop industry-specific Codes of Practice for the management of <i>P cinnamomi</i> .
	3.1.4 Develop nationally consistent messages and terminology to be used in communication initiatives.
	3.1.5 Improve the understanding and awareness in land management and land planning agencies, of legislation and local government by-laws that have the potential to impact on <i>P cinnamomi</i> management.

Performance Indicators

- Training courses in the recognition, detection, diagnosis and management of disease caused by *P cinnamomi* are developed and delivered to all staff directly involved in disease survey and management.
- Training programs and tools are integrated into appropriate programs within land planning, land management and biodiversity conservation agencies.
- Codes of Practice for *P cinnamomi* management are developed with the proponents of high risk activities, and are supported by training programs.

Objective 4: Other supportive activities to enhance knowledge of *P cinnamomi* and management of the disease it causes.

The integration of *P cinnamomi* surveillance into other field surveys, such as for weeds, would provide efficiencies in operational procedures as well as increased awareness of the pathogen and its impacts (Action 4.1).

Improving and standardising diagnostic techniques across the country would allow consistent interpretation of disease status (Action 4.2).

Quantitative analysis of the effects of *P cinnamomi* on biodiversity, the environment, economy, and social and cultural values would provide an assessment of the environmental and economic costs of the pathogen to the community (Action 4.3)..

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Action No.	Action Description
4.1 Integrate management of <i>P cinnamomi</i> with other natural resource management systems. (High priority, medium term)	4.1.1 Integrate <i>P cinnamomi</i> management with other compatible land management programs, including invasive weed and pest management programs.
4.2 Develop national standards and collections. (Medium priority, short term)	4.2.1 Develop national standard methods for the collection and analysis of soil, plant and water samples for the presence of <i>Phytophthora</i> species, and for laboratories involved in the analysis of soil, plant and water samples for the presence of <i>P cinnamomi</i> .
	4.2.2 Establish and maintain a national repository for cultures of <i>Phytophthora</i> species isolated from natural ecosystems.
4.3 Assess <i>P cinnamomi</i> impacts in Australia. (Medium priority, medium term)	4.3.1 Assess the environmental and economic cost of degradation due to <i>P cinnamomi</i> .

Performance Indicators

- *P cinnamomi* management is integrated with other compatible programs such as invasive weeds and pests programs.
- National standard methods have been developed for the collection and analysis of soil, plant and water samples for the presence of *Phytophthora* species.
- A national repository for cultures of *Phytophthora* species. isolated from natural ecosystems established and maintained.
- Land and conservation management agencies in all states and territories have a policy on the management of *P cinnamomi*.

5. Duration, implementation and evaluation of the plan

5.1 Duration and cost of the plan

The plan has been written to reflect the fact that the threat abatement process is likely to be ongoing, as there is no likelihood of nationally eradicating *P cinnamomi* in the foreseeable future.

The costs of many of the actions will be determined by the level of resources that stakeholders commit to management of the problem. Therefore, the total cost of the plan's implementation cannot be quantified at the time of making this plan.

The making of this plan does not necessarily indicate individual stakeholders' commitment to undertaking any specific actions. Achieving the objectives of this plan and provision of funds may be subject to budgetary and other constraints. With changes in knowledge, proposed actions may be modified over the life of the plan.

Australian Government funds may be available to implement key national environmental priorities, such as relevant actions listed in this plan and actions identified in regional natural resource management plans.

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5.2 Implementing the plan

The Australian Government Department of the Environment and Water Resources will continue to convene the *Phytophthora cinnamomi* Threat Abatement Plan Reference Group to facilitate the plan's implementation. The Team will maintain its strong links with state and territory agencies and with local and regional bodies that are responsible for the management of *Phytophthora* incursions.

The Department of the Environment and Water Resources will facilitate the implementation of this plan, encouraging involvement of key stakeholders and experts in the research and management of *P cinnamomi*. The Australian Government will implement the plan as it applies to Commonwealth land and will act in accordance with the provisions of the plan.

The management of *P cinnamomi* is primarily the responsibility of land managers. The TAP identifies the importance of collaboration between the Australian Government and state and territory governments, and other stakeholders, in implementing the TAP. Local governments assist in delivering state and territory priorities at a local and regional level and can create local laws to control certain aspects of land use which also has implications for the management of *P cinnamomi* in the landscape, and the effective implementation of the TAP.

5.3 Reviewing the Plan

Section 279 of the EPBC Act provides for the review of this plan at any time and requires that it be reviewed at intervals of no longer than five years. If evidence is found that the practices recommended in the plan need to be updated or modified to prevent species becoming threatened, the plan can be revised sooner.

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6. Acknowledgements

The Centre for *Phytophthora* Science and Management drafted the revised threat abatement plan. The TAP Reference Group provided guidance and extensive input into this document, and the broader stakeholder group provided feedback on the draft document (TAP Reference Group members and stakeholder lists are contained in CPSM [2006]).

7. References

CPSM (2006) Review and Evaluation of the 2001 National Threat Abatement Plan for Dieback Caused by the Root-Rot Fungus *Phytophthora cinnamomi*.

CPSM (2005) Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia: Part 4 – Risk Assessment Models for Species, Ecological Communities and Areas. A report funded by the Australian Government Department of the Environment and Heritage by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia.

O’Gara E, Howard K, Wilson B, Hardy GESTJ (2005a) Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia: Part 2 – National Best Practice Guidelines. A report funded by the Australian Government Department of the Environment and Heritage by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia.

O’Gara E, Howard K, Wilson B, Hardy GESTJ (2005b) Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia: Part 1 – A Review of Current Management. A report funded by the Australian Government Department of the Environment and Heritage by the Centre for Phytophthora Science and Management, Murdoch University, Western Australia.

APPENDIX A

Threatened flora species known to be susceptible to *Phytophthora cinnamomi*

The following species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* have been identified as being susceptible to *Phytophthora cinnamomi*.

Legend

The EPBC listing codes are CE (critically endangered), E (endangered) and V (vulnerable).

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, Q: Queensland, S: South Australia, T: Tasmania, V: Victoria, W: Western Australia.

The 'isolation' column indicates the circumstances under which susceptibility to *P. cinnamomi* was identified. Species from which *P. cinnamomi* has been isolated have been separated according to

- Identification was made in plants growing in the wild
- Identification was made in plants grown in cultivation (mostly botanic gardens)
- Identification was made from *ex situ* laboratory tests, in a glasshouse environment. For species indicated by *, susceptibility was identified by inoculating propagated plants in the field.

FAMILY	EPBC Act listing status	Distribution	Isolation		
			In wild	In cultivation	By experiment
<i>Species</i>					
ANTHERICACEAE					
<i>Borya mirabilis</i>	E	V	X	X	
CASUARINACEAE					
<i>Allocasuarina fibrosa</i>	V	W			
EPACRIDACEAE					
<i>Andersonia axilliflora</i>	E	W	X		
<i>Andersonia pinaster</i>	V	W	X		
<i>Epacris acuminata</i>	E	T	X		
<i>Epacris apsleyensis</i>	E	T			
<i>Epacris barbata</i>	CE	T			
<i>Epacris exserta</i>	E	T			X
<i>Epacris glabella</i>	E	T			X
<i>Epacris grandis</i>	E	T			X
<i>Epacris limbata</i>	CE	T			X
<i>Epacris stuartii</i>	CE	T			X
<i>Leucopogon gnaphaloides</i>	E	W	X		
<i>Leucopogon marginatus</i>	E	W			

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FAMILY	EPBC Act listing status	Distribution	Isolation		
			In wild	In cultivation	By experiment
<i>Species</i>					
<i>Leucopogon obtectus</i>	E	W			
<i>Sphenotoma drummondii</i>	E	W	X		
FABACEAE					
<i>Daviesia bursarioides</i>	E	W			
<i>Daviesia euphorbioides</i>	E	W			
<i>Daviesia megacalyx</i>	E	W			
<i>Daviesia microcarpa</i>	E	W			
<i>Daviesia pseudaphylla</i>	E	W	X		
<i>Daviesia speciosa</i>	E	W			
MIMOSACEAE					
<i>Acacia axillaris</i>	V	T			X
MYRTACEAE					
<i>Darwinia collina</i>	E	W	X		
<i>Darwinia oxylepis</i>	E	W			
<i>Darwinia squarrosa</i>	V	W			
<i>Darwinia wittwerorum</i>	E	W	X		
<i>Darwinia</i> sp. Stirling Range	V	W			
<i>Eucalyptus imlayensis</i>	E	N			
<i>Verticordia carinata</i>	V	W	X		
PROTEACEAE					
<i>Adenanthos cunninghamii</i>	E	W			
<i>Adenanthos dobagii</i>	E	W			
<i>Adenanthos ellipticus</i>	V	W			
<i>Adenanthos eyrei</i>	E	W			
<i>Adenanthos pungens</i> subsp. <i>effusus</i>	E	W			
<i>Adenanthos pungens</i> subsp. <i>pungens</i>	V	W			
<i>Adenanthos velutinus</i>	E	W			
<i>Banksia brownii</i>	E	W	X	X	X*
<i>Banksia cuneata</i>	E	W		X	X
<i>Banksia goodii</i>	V	W			
<i>Banksia oligantha</i>	E	W			
<i>Banksia verticillata</i>	V	W			X
<i>Dryandra anatona</i>	E	W	X		
<i>Dryandra ionthocarpa</i>	E	W			
<i>Dryandra mimica</i>	E	W			
<i>Dryandra montana</i>	E	W	X		
<i>Grevillea batrachioides</i>	E	W			

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			In wild	In cultivation	By experiment
<i>Species</i>					
<i>Grevillea calliantha</i>	E	W			
<i>Grevillea christinae</i>	E	W			
<i>Grevillea flexuosa</i>	V	W			
<i>Grevillea infundibularis</i>	E	W			
<i>Grevillea involucrata</i>	E	W			
<i>Grevillea maxwellii</i>	E	W			
<i>Grevillea murex</i>	E	W			
<i>Grevillea scapigera</i>	E	W			
<i>Grevillea williamsonii</i>	E	V		X	
<i>Hakea megalosperma</i>	V	W			
<i>Isopogon uncinatus</i>	E	W	X		
<i>Lambertia echinata</i> subsp. <i>echinata</i>	E	W			
<i>Lambertia fairallii</i>	E	W	X		
<i>Lambertia orbifolia</i>	E	W	X		
<i>Lomatia tasmanica</i>	CE	T			X
<i>Persoonia micranthera</i>	E	W	X		
RUTACEAE					
<i>Asterolasia phebaloides</i>	V	S,V		X	
<i>Leionema ralstonii</i>	V	N		X	
THYMELAEACEAE					
<i>Pimelea pagophila</i>	V	V		X	
TREMANDRACEAE					
<i>Tetradlea gunnii</i>	CE	T	X		
WINTERACEAE					
<i>Tasmania purpurascens</i>	V	N	X		
XANTHORRHOEACEAE					
<i>Xanthorrhoea arenaria</i>	V	T			X

Source:

O’Gara E, Howard K, Wilson B, Hardy GESTJ (2005a) Management of *Phytophthora cinnamomi* for Biodiversity Conservation in Australia: Part 2 – National Best Practice Guidelines