Australian Government

Department of the Environment, Water, Heritage and the Arts

THREAT ABATEMENT PLAN

for

DISEASE IN NATURAL ECOSYSTEMS CAUSED BY *PHYTOPHTHORA CINNAMOMI (2009)*

Department of the Environment, Water, Heritage and the Arts

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It is also available by emailing the Department of the Environment, Water, Heritage and the Arts, Community Information Unit at ciu@environment.gov.au or freecall 1800 803 772.

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Front cover illustration:

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1. Introduction

This Threat Abatement Plan (TAP) establishes a national framework to guide and coordinate Australia's response to *Phytophthora cinnamomi*. It identifies the research, management and other actions needed to ensure the long-term survival of native species and ecological communities at risk threatened by *P. cinnamomi* and replaces the threat abatement plan published in 2001 (Environment Australia 2001).

This plan should be read in conjunction with the publication, 'Background document for the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi*' (Commonwealth of Australia 2008). The background document provides information on the scope of the problem; characteristics, biology and distribution of the pathogen; impacts on the environment; and current management practices and measures.

1.1 Threat abatement plans

Under section 270 (A) of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Australian Government develops TAPs and facilitates their implementation. The EPBC Act prescribes the process, content and consultation to be followed when making a TAP. An important part of the TAP is to ensure that knowledge of the threat and its management is disseminated to the community, land managers and land users.

Mitigating the threat of invasive species is not simply a matter of developing and applying better technical solutions. It also involves understanding and addressing social and economic factors, for example, through supporting the efforts of land managers, nurseries and plantation managers to manage and prevent *P. cinnamomi* infestation.

1.2 Threat abatement plan for *Phytophthora cinnamomi*

1.2.1 The threat

Healthy natural environments provide a range of direct and indirect benefits to the community, in addition to the intrinsic value of biodiversity. The disease caused by the introduced plant root pathogen, *P. cinnamomi*, threatens these values and benefits. This disease is often difficult to detect and its impact may be significant before it is detected. Depending upon environmental conditions and plant susceptibility, the pathogen can destroy vegetation communities. *P. cinnamomi* threatens several plant species with extinction.

While the pathogen directly threatens a range of plant species, the broader potential to impact on ecological communities and at a landscape level makes *P. cinnamomi* a very significant threat. This broader threat is not well understood, either in terms of environmental or economic impacts.

Infested areas are increasing in size throughout Australia. *P. cinnamomi* now infests hundreds of thousands of hectares of native vegetation in Western Australia, Victoria and Tasmania, and tens of thousands of hectares in South Australia. In far northern Queensland the extent of the threat is not known. The New South Wales Department of Primary Industry reports that the pathogen has been detected in soil samples from NSW national parks, as well as from nurseries and gardens. Concerns are increasing about the impact of *P. cinnamomi* in environmentally sensitive areas such as rainforests in Barrington Tops, Werrikimbe and Oxley Wild Rivers National Parks.

More information on the pathogen, the disease and its history in Australia can be found in the background document to this TAP (Commonwealth of Australia 2008).

The detrimental impacts of *P. cinnamomi* on biodiversity in Australia led to it being listed as a key threatening process under the EPBC Act. In 2001 the former Australian Government Department of Environment and Heritage published the first threat abatement plan: 'Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi*'.

P. cinnamomi is a threat to many native plant species (see the list at Appendix A). This list is not comprehensive due to the previous high cost of detection of *P. cinnamomi*. Recent improvements in detection techniques (O'Brien, 2008) will enable more accurate and cost-effective detection of *P. cinnamomi* in infected soil and facilitate the further identification of vulnerable plant species. Although there has been a substantial amount of research on the effects of *P. cinnamomi* on vegetation, there has been little work investigating the indirect effects of the pathogen on faunal populations and communities (Cahill *et al.* 2008). Therefore non-plant species, which are affected because their food source or habitat is threatened, are not included in the listing

1.2.2 Managing the threat

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

i) to mitigate the spread of *P. cinnamomi* to uninfested sites, and
ii) to mitigate the impact of *P. cinnamomi* at infested sites.

Humans can spread *P. cinnamomi* further and faster than any other infestation vector. The limited management options currently available focus on modifying human activities by restricting access to certain sites, and, when access is necessary, deploying and enforcing hygiene procedures to minimise the spread of *P. cinnamomi* in the landscape.

Phosphite has been used to mitigate the impacts of *P. cinnamomi* on some vulnerable species at infested sites in Western Australia, but it requires further testing in other states and territories. Current detection and management options are described in the background document to this TAP (Commonwealth of Australia 2008) and in the 'National Best Practice Guidelines' (O'Gara *et al.* 2005).

Priority must be given to protecting and managing areas of high conservation value. These include areas within the climatic zones of *P. cinnamomi* susceptibility that:

- 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 endemicity,
- support high species diversity for a type of vegetation,
- support significant remnant vegetation, or
- are large, ecologically intact and mostly undisturbed.

The TAP acknowledges the major gaps in knowledge that hamper current management. The TAP objectives progressively address priority setting, actions for land owners and managers, building understanding and capacity to perform these actions, and impact assessment. Further research into mechanisms of natural resistance, including the genetic basis of resistance, is targeted. An economic assessment of the scope and significance of the impact of *P. cinnamomi* on natural ecosystems is also a priority.

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

1.2.3 The review process

In accordance with the requirements of the EPBC Act, the original TAP, 'Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi*' (EA 2001), was reviewed in 2006 (CPSM 2006).

The review surveyed a broad range of stakeholders and assessed a range of projects as part of the review. The Department funded seven projects between 2001 and 2005 to implement key actions. These projects included development of a risk assessment process and best practice management guidelines. The review comprehensively documented work that had been done across Australia, and identified projects that had been implemented and commissioned by the states and territories and on Commonwealth land. The review noted, for example, that the Sydney Harbour Federation Trust had adopted the approaches in the threat abatement plan into its management plans.

While the review identified significant activity towards abating *P. cinnamomi*, it recommended stronger coordination of implementation under a revised threat abatement plan. The Australian Government will seek this stronger coordination under the AusBIOSEC national biosecurity institutional arrangements.

This TAP replaces the 2001 document. It incorporates the knowledge gained in the intervening years and has been modified in line with recommendations from the review. 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.

The TAP aims to guide the responsible use of public resources and the best outcomes for native species and ecological communities threatened by *P. cinnamomi*. It seeks to achieve these outcomes by recognising the existing opportunities and limitations, and ensuring that actions are flexible and can align with evolving management options as our understanding of *P. cinnamomi* improves through field experience and research.

1.2.4 Involvement of stakeholders

The success of this TAP will depend on a high level of cooperation between all key stakeholders, including landholders, land users, community groups, local government, state and territory conservation and resource management agencies, and the Australian Government and its agencies. It will be important that managers assess *P. cinnamomi* impacts and allocate adequate resources to achieving effective on-ground prevention and management at critical sites, improving the effectiveness of prevention programs, and measuring and assessing outcomes.

Many stakeholders, however, are unaware of the significance of *P. cinnamomi* and the ways it can be spread. Ongoing delivery of awareness and capacity building programs in natural resource management, at national, state and regional level, can make a significant contribution to national implementation of the TAP.

2. Goals and Actions of the Plan

The TAP has four long-term broad and overlapping goals for the Australia-wide management of *P. cinnamomi*:

- Goal 1: Protection of species and ecological communities which are listed as threatened under the EPBC Act;
- Goal 2: Minimisation of the spread of *P. cinnamomi* infestation so that further species and ecological communities do not become threatened;
- Goal 3: Protection of areas of high conservation value; and
- Goal 4: Mitigation of the impacts of *P. cinnamomi* in currently infested areas of high conservation value.

These goals will be met through a suite of objectives and associated actions:

- Objective 1: To monitor sites 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 and education of land managers in the science and management of *P. cinnamomi*; and
- Objective 4: To assess *P. cinnamomi* impacts in Australia**.**

Each objective is accompanied by a set of actions which form the integrated national response necessary to achieve the objective. Criteria are provided against which achievement may be assessed for these objectives and their associated actions.

Each action has been assigned a priority of 'medium', 'high' or 'very high' and a timeframe for completion. Timeframes are categorised as short term (within three years) and medium term (within three to five years).

Objective 1: To monitor sites of high conservation value under threat from *P. cinnamomi*

Management of the threat to sites of high conservation value will require a nationally consistent system of identifying and monitoring infested areas. This system should map the distribution of *P. cinnamomi*, indicate presence of susceptible species and indicate sites of high conservation value (Actions 1.1 and 1.2).

Standard national methods for testing species susceptibility will allow the modelling of species susceptibility in the absence of confounding environmental or seasonal effects (Action 1.3). Observed variability in disease expression in the field can 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 the Centre for Phytophthora Science and Management (CPSM 2005).

	Action	**Achievement criterion**	**Priority and Timeframe**
Objective 1: To monitor sites of high conservation value under threat from *P. cinnamomi*			
Mapping	1.1 Assess and pursue opportunities for technical improvements in mapping methods	Development of improved methods for the production of accurate operational scale *P. cinnamomi* distribution maps, including potential methods to use remote sensing technology for mapping occurrences with appropriate validation.	*High priority, short term.*

	1.2 Develop and apply a national system of monitoring and surveillance of *P. cinnamomi* infestation, with the capacity to model susceptible species' distribution and environmental parameters	Maps showing the distribution of *P. cinnamomi*; the distribution of susceptible species and ecological communities; and environmental variables such as rainfall, temperature, soil and nutrient types, are prepared, updated when infestations are discovered, and readily available.	*Medium priority, medium term*
Flora susceptibility	1.3 Develop a national model for susceptibility testing and ratings	A standard national method for testing the susceptibility of flora species and ecological communities to *P. cinnamomi* is developed and used nationally.	*Medium priority, medium term*

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

A nationally applicable risk assessment process (Action 2.1) will enable comparative assessments of high-value sites and habitats that are highly susceptible to *P. cinnamomi*. Management priorities will be able to be set with confidence and with lessened reliance on subjective assessments.

Land managers can improve their ability to deal with infestations from a range of management options. The development of management plans and the adoption of the 'National Best Practice Management Guidelines' (Action 2.2) for areas of high conservation value will minimise the risk of spread to uninfested areas. Adoption of these guidelines will also provide a risk-based assessment of the likely need and timing of management actions.

Monitoring and surveillance of infested and at-risk uninfested areas (Action 2.3) will provide information on disease outbreaks as well as the distribution, prevalence, and incidence of *P. cinnamomi*. The 'National Best Practice Management Guidelines' (O'Gara *et al.* 2005) provide decision-support systems to help land managers choose locally appropriate diagnosis and management methods, and to decide when to apply them. Lateral flow devices have been shown to be cost effective in identifying plants infected with *P. cinnamomi* in the United Kingdom. These can be used as an early diagnosis tool by landholders, managers and surveillance officers (Action 2.4).

The Department of Environment and Conservation, Western Australia, has observed a significant difference in the levels of impact upon susceptible species which are unable to recruit back into a site after *P. cinnamomi* infestation. Management methods should take into account the different level of impact when monitoring and managing short and long term impacts.

In the case of species at extreme risk, *ex situ* cultivation is a conservation option (Action 2.5).

Further research into the effectiveness and non-target implications of current management practices, particularly those involving the use of phosphite, would enable these practices to be adopted with greater confidence on a broader scale (Action 2.6).

Some taxa of plants display resistance mechanisms in response to *P. cinnamomi* infection and there is also considerable variation in resistance between species within the same genus or subgenus. Enhancing the process of natural selection for tolerance may be a longer term management option for many taxa. Future research may also allow for the transfer of resistance genes into those taxa that at present appear to have no resistance. An improved understanding of the genetic basis of resistance and genetic diversity of *P. cinnamomi* will be essential. Initially, the availability of samples of *P. cinnamomi* cultures, isolated and collected from a wide range of natural ecosystems, would facilitate any research (Action 2.7).

	Action	Achievement criteria	Priority and Timeframe
Objective 2: To develop and apply management actions that will minimise or mitigate the threat of *P. cinnamomi*			
Prediction	**2.1 Develop a nationally applicable risk assessment process for land owners and managers**	The existing National Risk Assessment Models, developed by the Centre for Phytophthora Science and Management, are validated and modified as necessary.	*High priority, short term*
		The data necessary for effective application of the National Risk Assessment Models are identified and measures undertaken to address any data deficiencies.	*High priority, short term*
Risk Management Models	**2.2 Develop regional management plans, based on the National Risk Assessment Models, which prioritise susceptible species and ecological communities of high conservation value**	Regional management plans are implemented in areas of high conservation value which are vulnerable to *P. cinnamomi* infestation.	*High priority, short term*
		Regional management plans document best practice *P. cinnamomi* management for specific activities.	*High priority, short term*
		Proponents of activities on land of high conservation value threatened by *P. cinnamomi*, or adjacent to such land, implement best practice management.	*High priority, short term*
Monitor outbreaks	**2.3 Improve and maintain current monitoring programs**	New infestations in areas of high conservation value are detected and monitored.	*Very high priority, medium term*
		The long-term direct and indirect impacts of *P. cinnamomi* in natural ecosystems are monitored, enabling the range of ecosystems impacted by *P. cinnamomi* to be monitored.	*Very high priority, medium term*
Diagnosis	**2.4 Develop improved techniques to diagnose *P. cinnamomi* infestation**	Rapid diagnosis systems for *P. cinnamomi* infestation, such as lateral flow devices, are evaluated for ecosystems.	*Medium priority, medium term*
		Disseminate species-specific detection kits to relevant agencies	*Medium priority, medium term*
		Cost effective and accurate methods for the rapid diagnosis of *P. cinnamomi* species are available Australia-wide.	*Medium priority, medium term*
Species at extreme risk	**2.5 Conserve species at extreme risk *ex situ***	Species at extreme risk due to *P. cinnamomi* infestation are identified and priority ranked using national risk assessment. methods.	*Medium priority, short term*
		Ex situ cultivation of species at extreme risk is undertaken at appropriate facilities that are certified as being free of the pathogen; and processes, materials and the facilities are regularly audited to comply with an appropriate standard (eg NIASA Certification).	*Medium priority, short term*
	2.6 Assess current disease management practices and explore scope for improvement	Methods to eradicate from small, infested sites are identified, investigated and their relative efficacy ranked.	*High priority, medium term*
		The efficacy of phosphite in the control of *P. cinnamomi* in susceptible ecological communities is determined.	*High priority, medium term*
		The effects of phosphite on non-target species are identified.	*High priority, medium term*

		Alternatives to phosphite for controlling *P. cinnamomi* are identified and their efficacy ranked (including against *P. cinnamomi*).	*High priority, medium term*
		The effectiveness of current practices to reduce the spread of *P. cinnamomi* is assessed, including control of access to sites of high conservation significance and implementation of hygiene procedures by high risk industry sectors such as nursery, road-building and ecotourism.	*High priority, medium term*
		Further research is conducted into the mechanisms of spread and survival of *P. cinnamomi*, assessing its long term direct and indirect impacts in the range of ecosystems it affects.	*High priority, medium term*
		Success criteria and methods for restoration of sites highly degraded by *P. cinnamomi* are developed into national protocols.	*High priority, medium term*
		The impact of wildfire and fire management practices on disease expression, spread and intensity is investigated.	*High priority, medium term*
		Natural selection for *P. cinnamomi* tolerance in high risk taxa is investigated and evaluated as a conservation method for areas of high conservation value.	*High priority, medium term*
		The possibility of transfer of resistant genes into taxa that at present appear to have no resistance to *P. cinnamomi* is investigated and evaluated as conservation and rehabilitation options.	*High priority, medium term*
Sample availability	**2.7 Establish nationally available standards and repositories for collections**	National standard methods are used by laboratories for the collection and analysis of soil, plant and water samples for the presence of *P. cinnamomi.*	*Medium priority, short term*
		Cultures of P. cinnamomi can be tested against samples available through a complete and accessible national repository for cultures of P. cinnamomi isolated from natural ecosystems.	*Medium priority, short term*

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

Better awareness and surveillance in high-risk regions and high-value sites can lead to early detection of infestations. This, coupled with efficient sampling and diagnostic systems, will be important in minimising the spread within and from infested areas. 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 3.1).

State and territory governments offer training in natural resource, weed and pest management to farm and park managers. The integration of *P. cinnamomi* best practice management into such coursework is desirable (Action 3.2).

Land managers should have an understanding of the basic symptoms and management practices associated with introduction and spread of *P. cinnamomi*, based on up-to-date knowledge and operational experience (Action 3.3). 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. However, existing industry-specific codes of practice for the management of *P. cinnamomi* are often ineffective and need to be targeted towards land managers or developers who supply nursery materials, transport soil, quarry, farm or build roads. Quarry material is not subject to voluntary certification. The Nursery and Garden Industry Association raises awareness of issues associated with plant growth media (including mulch sources) and facilities,

however, availability of non-certified material elevates risk. Leisure activities, such as tourism, hiking and mountain-biking, also pose a threat and appropriate communication strategies need to be implemented. Government agencies will need to identify the gaps in implementing best practice and certification measures to institute safeguards against the inappropriate disposal of *P. cinnamomi* infested material.

	Action	Achievement criteria	Priority and Timeframe
Objective 3: To strengthen training and education of land managers in the science and management of *P. cinnamomi*			
Certified *P. cinnamomi* free product	**3.1 Develop practices to minimise the inadvertent spread of *P. cinnamomi***	Certification schemes are implemented Australia-wide for high risk materials such as nursery materials; soils; quarry products; and road and track building material.	*Medium priority, medium term*
		Pathogen-tested raw materials, compliant with a best practice certification scheme, are used in high-risk infestation pathways such as soil and nursery materials.	*Medium priority, medium term*
	3.2 Integrate management of *P. cinnamomi* with other natural resource management systems	*P. cinnamomi* management is integrated with other compatible land management programs such as invasive weed and pest management programs.	*Medium priority, medium term*
Land manager training	**3.3 Build awareness and develop and provide training for land managers**	Methodologies involved in detection, diagnosis and management of *P. cinnamomi* are integrated into training associated with land planning and management, and biodiversity conservation.	*Medium priority, short term*
		Industry-specific codes of practice for the management of *P. cinnamomi* are accessible and implemented by the proponents of activities in high-risk areas and high-value sites, including: supply of nursery materials; transporting of soil; quarrying; road and track building; tourism; recreational activities such as hiking and mountain-biking; agriculture and horticulture; and the disposal of *P. cinnamomi* infested material.	*Medium priority*
		A national communications strategy is implemented, in which training materials and industry specific codes of practice are promoted.	*Medium priority*
		Land management and land planning agencies are aware of legislation and local government by-laws relating to *P. cinnamomi* management.	*Medium priority*

Objective 4: To assess *P. cinnamomi* impacts in Australia.

The scope and significance of the impact of *P. cinnamomi* on ecological communities and the landscape is poorly understood. An assessment of the environmental impact or the impact on more direct commercial activities is overdue. Quantitative analysis of the effects of *P. cinnamomi* on biodiversity, the environment, economy, and social and cultural values will provide an assessment of the environmental and community costs of the pathogen. This would provide a practical basis upon which to allocate resources to manage the problem.

	Action	Achievement criterion	Priority and Timeframe
Objective 4: To assess *P. cinnamomi* impacts in Australia			
Assess national impact	**4.1 Assess the environmental and economic cost of degradation due to *P. cinnamomi*.**	A quantitative analysis of the environmental and economic costs of *P. cinnamomi* is performed.	*Medium priority, medium term*

3. Duration, implementation and evaluation of the Plan

3.1 Duration of the Plan

The TAP 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.

3.2 Cost of the Plan

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Investment in many of the TAP actions will be determined by the level of resources that stakeholders commit to managing the problem. The total cost of implementation therefore cannot be quantified at the time of writing.

This TAP provides a framework for undertaking targeted priority actions. Budgetary and other constraints may affect the achievement of the objectives of this plan and, as knowledge changes, 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.

3.3 Implementing the Plan

The Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) 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.

DEWHA will facilitate the implementation of this Plan, encouraging involvement of key stakeholders and experts in the research and management of *P. cinnamomi*. DEWHA will seek stronger coordination of national action on *P cinnamomi* under the AusBIOSEC national biosecurity arrangements. The Australian Government will implement the Plan as it applies to Commonwealth land and will act in accordance with the provisions of the Plan. DEWHA will draw on expertise from state and territory agencies, and non-government organisations.

The management of *P. cinnamomi* will be achieved primarily through informing the actions of land owners, leaseholders and parties who access or manage land. Recreational users, tourism, agricultural and horticultural industries will also be engaged. The TAP identifies the importance of collaboration between all 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. Land managers at all levels need to implement prevention and management actions.

Research priorities for *P. cinnamomi* should focus on susceptibility determination and improved management options. Longer-term research options will depend upon the success of other measures, and should include investigating natural selection for tolerance in threatened taxa and the transfer of resistant genes into those taxa that at present appear to have no resistance.

3.4 Evaluating, implementing and reviewing the Plan

Section 279 of the *Environment Protection and Biodiversity Conservation Act 1999* provides for the review of this TAP 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 TAP need to be updated or modified to prevent species or ecological communities becoming threatened, or that the effectiveness of the TAP can be improved, it can be revised within five years of the release of this Plan.

Glossary and abbreviations

Biodiversity	Variability among living organisms from all sources (including terrestrial, marine and other ecosystems and ecological complexes of which they are part), which includes diversity within species and between species and diversity of ecosystems (Beeton *et al.* 2006).
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
Eradication	Application of measures to eliminate an invasive alien species from a defined area.
Invasive species	A species occurring as a result of human activities beyond its accepted normal distribution and which threatens valued environmental, agricultural or personal resources by the damage it causes (Beeton *et al*. 2006).
Key threatening process	As defined in and listed under the EPBC Act a process that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
Performance indicator	A criterion or measure that provides information on the extent to which a policy, program or initiative is achieving its outcomes.
Threat Abatement Plan	Under the EPBC Act, a plan providing for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on a threatened species or ecological community.
Threatened species	A species under the EPBC Act listed as critically endangered; endangered; vulnerable or conservation dependent.

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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*. In the absence of complete research in this area, the list is limited and only indicative of susceptibility in specific areas. A list of over 1000 known native hosts of *P. cinnamomi* in Australia is contained in the National Best Practice Guidelines (O'Gara *et al*. 2005). Further research into susceptibility in different areas is desirable (see Research Actions for Objective 1).

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: NSW/ACT: New South Wales and the Australian Capital Territory, Qld: Queensland, SA: South Australia, Tas: Tasmania, Vic: Victoria, WA: 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 whether

- 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**		
Species			**In wild**	**In cultivation**	**By experiment**
ANTHERICACEAE					
Borya mirabilis	E	Vic	X	X	
CASUARINACEAE					
Allocasuarina fibrosa	V	WA			
EPACRIDACEAE					
Andersonia axilliflora	E	WA	X		
Andersonia pinaster	V	W	X		
Epacris acuminata	E	Tas	X		
Epacris apsleyensis	E	Tas			
Epacris barbata	CE	Tas			
Epacris exserta	E	Tas			X
Epacris glabella	E	Tas			X
Epacris grandis	E	Tas			X
Epacris limbata	CE	Tas			X
Epacris stuartii	CE	Tas			X
Epacris virgata	E	Tas			X

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

FAMILY	**EPBC Act listing status**	**Distribution**	**Isolation**		
Species			**In wild**	**In cultivation**	**By experiment**
Grevillea batrachioides	E	WA			
Grevillea calliantha	E	WA			
Grevillea christinae	E	WA			
Grevillea flexuosa	V	WA			
Grevillea infundibularis	E	WA			
Grevillea involucrata	E	WA			
Grevillea maxwellii	E	WA			
Grevillea murex	E	WA			
Grevillea scapigera	E	WA			
Grevillea williamsonii	E	Vic		X	
Hakea megalosperma	V	WA			
Isopogon uncinatus	E	WA	X		
Lambertia echinata subsp. *echinata*	E	WA			
Lambertia fairallii	E	WA	X		
Lambertia orbifolia	E	WA	X		
Lomatia tasmanica	CE	Tas			X
Persoonia micranthera	E	WA	X		
RUTACEAE					
Asterolasia phebalioides	V	SA,Vic		X	
Leionema ralstonii	V	NSW/ACT		X	
Phabalium daviesii	CE	Tas			X
THYMELAEACEAE					
Pimelea pagophila	V	Vic		X	
TREMANDRACEAE					
Tetratheca gunnii	CE	Tas	X		X
WINTERACEAE					
Tasmannia purpurascens	V	NSW/ACT	X		
XANTHORRHOEACAE					
Xanthorrhoea arenaria	V	Tas			X
Xanthorrhoea bracteata	E	Tas	X		

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