Australian Government
Department of the Environment and Energy

Threat abatement plan

for disease in natural ecosystems
caused by *Phytophthora cinnamomi*

2018

This plan should be attributed as '*Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi*, Commonwealth of Australia 2018'.

The Department would like to thank all who contributed to the development of this national plan.

Disclaimer

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for the Environment.

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The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

Image credits

Front cover: Wildflowers on Mondurup Peak, Stirling Range in 1993 © Rob Olver
Back cover: Mondurup Peak, Stirling Range in 2010 © Department of Biodiversity, Conservation and Attractions, Western Australia

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1. Introduction

Thousands of Australian native plant species are susceptible to Phytophthora dieback—a destructive disease caused by the pathogen *Phytophthora cinnamomi* and other *Phytophthora* species. This disease is a major threat to Australia's biodiversity, placing important plant species at risk of death, local extirpation or even extinction. Its dramatic impact on plant communities can also result in major declines in some insect, bird and animal species due to the loss of shelter, nesting sites and food sources. Phytophthora dieback can cause permanent damage to ecosystems. Once an area is infested with the pathogen, eradication is usually impossible. Awareness that human activity can easily spread the pathogen, and adherence to messages such as 'Arrive clean, leave clean' and 'Check, Clean, Disinfect, Dry', will help prevent an increase in the extent of this disease.

This national threat abatement plan (Plan) addresses the key threatening process 'Dieback caused by the root-rot fungus[1] *Phytophthora cinnamomi*', which is listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under New South Wales legislation, infection of native plants by *P. cinnamomi* is listed as a key threatening process, while under Victorian legislation the spread of the pathogen is listed as a potentially threatening process. This Plan establishes a national framework to guide and coordinate Australia's response to Phytophthora dieback. It complies with requirements under the EPBC Act for the development of threat abatement plans, and it identifies the research, management and other actions needed in Australia's response to this pathogen. The involvement of stakeholders from across Australia in the strategic planning of Phytophthora dieback management will help inform and implement effective and meaningful management activities.

Development of this Plan has been possible through the contribution and cooperation of a broad range of stakeholders, but the making or adoption of this Plan does not necessarily indicate the commitment of individual stakeholders to any specific actions. As understanding of the organism responsible for Phytophthora dieback and its impacts develops, it may be necessary to modify proposed actions.

The Australian Government Department of the Environment and Energy (the Department) is responsible for preparing this Plan. Its development has been informed by:

- a review and evaluation of the 2001 Plan (EA, 2001) undertaken by the Australian Government (CPSM, 2006)
- information provided by key stakeholders between 2014 and 2018
- the 2014 Plan, which this Plan replaces.

This Plan should be read in conjunction with its associated *Background document: Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi* (the background document) (DoEE, 2018a). The background document provides information on the scope of the problem; the characteristics, biology and distribution of the pathogen; impacts on the environment; and management practices (as at 2018).

The goal of this Plan is to identify and protect environmental assets (threatened species and ecological communities listed under the EPBC Act and other matters of national environmental significance) from the impacts of Phytophthora dieback. It integrates strategies to prevent Phytophthora from spreading into areas that are free of disease; strategies to reduce the impacts in infested areas; recovery actions for the conservation of biodiversity assets currently being impacted; and research actions towards mitigating the impact of Phytophthora dieback.

The Department recognises that a number of the state and territory governments that own land impacted by Phytophthora have developed management plans and operational guides to abate this threat within their own jurisdictions. This Plan aims to complement state and territory approaches to managing Phytophthora dieback.

1. It is now understood that P. cinnamomi is not a fungus. This was the name of the key threatening process when it was registered under the EPBC Act

Although this Plan applies to *P. cinnamomi*, the Department acknowledges that other species of *Phytophthora* are present in Australia. Some of these species may be widespread and can lead to disease impacts similar to *P.cinnamomi* within native ecosystems. For further information on these species, a reference list is provided at Appendix A in the background document (DoEE, 2018a). The control of pathways for the spread of Phytophthora, especially through good hygiene, and the development of improved control and remediation tools and techniques will also reduce the potential spread and impacts of other *Phytophthora* species.

The Department works with the Department of Agriculture and Water Resources (DAWR) to manage biosecurity risk to Australia's environment. DAWR conducts biosecurity import risk analyses to minimise the risk of harmful plant pathogens being introduced, including additional species of *Phytophthora*. The potential for some *Phytophthora* species to spread their spores aerially presents an additional biosecurity risk, as most control measures used in Australia for *P.cinnamomi* and other soil-borne species are ineffective for airborne species.

1.1 Threat abatement plans and implementation

The EPBC Act prescribes the process, content and consultation to be followed when making a threat abatement plan to address a listed key threatening process. Under section 270A of the EPBC Act, the Australian Government develops threat abatement plans where the Australian Government Minister for the Environment (the Minister) agrees that the making of a threat abatement plan is a feasible, effective and efficient way to abate a key threatening process.

Section 268 of the EPBC Act stipulates that Australian Government agencies must not take any action that contravenes a threat abatement plan.

Under section 269 of the EPBC Act, the Australian Government:

- implements threat abatement plans to the extent they apply in areas under Australian Government control and responsibility
- seeks the cooperation of the affected jurisdictions in situations where a threat abatement plan applies outside Australian Government areas in states or territories, with a view to jointly implementing the threat abatement plan.

The success of this Plan will depend on a high level of cooperation between all key stakeholders, including:

- Australian Government departments and agencies
- state and territory conservation and natural resource management agencies
- local governments
- research institutes
- industry and other businesses, including the forestry, garden and nursery, tourism, mining, and road construction industries
- the general community, including non-government environmental organisations and private conservation land management bodies, private landholders, recreation groups, Indigenous communities, and natural resource management groups.

It will be important that land managers assess the threats and impacts of Phytophthora and allocate adequate resources towards effective on-ground prevention of spread and management of impacts, improving the effectiveness of prevention and management programs, and measuring and assessing outcomes.

It should be acknowledged that a well-informed and engaged community supports efforts to manage Phytophthora dieback and that this understanding encompasses the importance of adhering to conditions that may be placed on access to the conservation estate.

In order to successfully implement this Plan, the Department will:

- coordinate its implementation as it applies to Commonwealth land and act in accordance with the provisions of the Plan as required under the EPBC Act
- seek stronger coordination of national action on Phytophthora dieback
- draw on expertise from state and territory agencies and non-government organisations
- encourage involvement of key stakeholders and experts in Phytophthora research and management.

The Australian Government will monitor the uptake and effectiveness of management actions by all parties as part of a review of the Plan under section 279 of the EPBC Act. Where the Australian Government and state and territory governments have mutual obligations, negotiation of appropriate actions and funding of management actions will be undertaken.

1.2 The pathogen

Phytophthora is a major genus within the diploid, alga-like phylum Oomycota (Cooke et al., 2000). This group is currently referred to as water moulds. Although it was previously referred to as fungi, in taxonomic terms it is more closely related to algae. As *P. cinnamomi* has the ability to cause plant disease and plant death, this document refers to this species of water mould as a pathogen. At least 32 species of *Phytophthora* occur in various parts of Australia. While *P. cinnamomi* is the most destructive, other species—for example *P. arenaria, P. constricta, P. cryptogea, P. elongata, P. gregata, P. megasperma* and *P. multivora*—are also able to cause significant damage in Australian natural ecosystems.

P. cinnamomi occurs in all Australian states and territories except the Northern Territory, where the environmental conditions are not conducive to the pathogen's establishment and persistence.

The development of Phytophthora dieback requires the presence of the pathogen, the presence of susceptible host plant species, and environmental conditions that favour infection and subsequent reproduction and spread of the disease (Garkaklis et al., 2004). The most favourable conditions for spore production are free water and mild temperatures. Soils that have neutral to acidic pH are most favourable for the formation of spores and the survival of *P. cinnamomi* (Zentmyer, 1980).

Plants become visibly diseased when infection results in the impairment of the plant's physiological and biochemical functions. Roots are a primary site of infection; therefore, uptake of water is one of the first functions affected. This is why symptoms of Phytophthora dieback infection have similarities, at least initially, to those of water stress. In susceptible species, apparently healthy plants (in groups or individually) can suddenly die. Less susceptible species can show crown decline symptoms, including leaf yellowing and death of primary leaf-bearing branches. Epicormic[2] branches with smaller leaves can develop and, over time, epicormic branches will decline, with an overall thinning of the crown. Trees with such symptoms can take a number of years to decline and die. The removal of bark at the base of trees just above or below the soil line can reveal areas of necrosis. These necrotic areas effectively girdle the trees and cause death.

It is important to note the intractable nature of Phytophthora dieback, but also that actions which ameliorate its effects—particularly on endangered species and communities—are vital to the conservation of Australia's biodiversity. The background document (DoEE, 2018a) contains further details on the pathogen.

2. Growth from previously dormant buds on the trunk or limb of a tree—very common in *Eucalyptus* species

1.3 Impacts of Phytophthora dieback

Healthy natural environments provide a range of direct and indirect benefits that are threatened by Phytophthora dieback. This disease is often difficult to detect and can cause significant and permanent damage to ecosystems and landscapes before detection.

Potential consequences of infection include:

- inability of infected plants to develop new shoots, flowers, fruit and seed
- extinction of populations of some flora species
- a dramatic modification of the native plant community's structure and composition
- a significant reduction in primary productivity and functionality
- habitat loss and degradation of dependent flora and fauna; to date, these have been irreversible
- local extirpation and a significant loss of genetic diversity
- major declines in some animal species due to the loss of shelter and nesting sites or food

sources. Further details on the impact of Phytophthora dieback are in the background document (DoEE, 2018a).

Wildflowers on Mondurup Peak, Stirling Range WA before the introduction of *Phytophthora cinnamomi* © Rob Olver

Mondurup Peak, Stirling Range WA after the introduction of *Phytophthora cinnamomi* © Department of Biodiversity, Conservation and Attractions, Western Australia

1.3.1 Impacts on matters of national environmental significance

Phytophthora dieback is a key threatening process under the EPBC Act due to its actual and potential impacts on threatened species and ecological communities, which are matters of national environmental significance under the Act. It also has the potential to cause unlisted species or ecological communities to become eligible for listing. An estimated 49 per cent of the rare, poorly known or data-deficient flora of south-west Western Australia are susceptible to *P. cinnamomi* (Shearer et al., 2004), and their conservation status is likely to change significantly overtime.

Appendices A, B and C of this Plan provide details of EPBC-listed threatened species and ecological communities under threat from Phytophthora dieback.

Through destruction of vegetation, Phytophthora dieback can also affect other matters of national environmental significance, including:

- world heritage areas
- national heritage places
- Commonwealth heritage on Commonwealth lands
- Ramsar wetlands.

Phytophthora dieback has an impact on the following world heritage areas:

- Wet Tropics of Queensland World Heritage Area in North Queensland. There are more than 200 patches infected with *P. cinnamomi*, mostly in wet notophyll vine forests above 750 metres on acid volcanic soils. These forests comprise 14 per cent of the area
- Gondwana Rainforests of Australia World Heritage Area of northern New South Wales and southern Queensland. *P. cinnamomi* is widespread across the region
- Greater Blue Mountains World Heritage Area. *P. cinnamomi* has been detected at various sites, including the endangered Wollemi Pine site
- Tasmanian Wilderness World Heritage Area. *P. cinnamomi* is having a widespread and severe impact on Buttongrass moorland vegetation
- Lord Howe Island Group World Heritage Area. *P. cinnamomi* occurs on one lease in the southern part of the island's settlement area and could potentially spread to the Lord Howe Island Permanent Park Preserve on footwear or vehicles (DECCW, 2010).

Phytophthora dieback is a known threat to the following national heritage places:

- Stirling Range National Park, Porongurup National Park and Fitzgerald River National Park in south-west Western Australia, home to diverse plant communities of great richness and endemicity.[3] The Fitzgerald River National Park sits within the Fitzgerald Biosphere Reserve—a site recognised internationally under UNESCO's[4] Man and the Biosphere Program. *P. cinnamomi* is widespread in the Stirling Range and the number of infestations in the Fitzgerald have increased in recent years
- Lesueur National Park on the Coral Coast of Western Australia
- Grampians National Park (Gariwerd) in Victoria, where *P. cinnamomi* has been recorded at many sites and longer term studies have shown wide-scale changes in their floristic composition
- Anglesea Heath, Great Otway National Park in Victoria, in the national heritage listed Great Ocean Road and Scenic Environs, where long-term studies (1988–2015) have shown significant changes in the floristic and structural composition of impacted sites and significant impacts on fauna abundance and habitats
- Recherche Bay (North East Peninsula) Area, Tasmania, where the pathogen has been isolated from eastern Buttongrass moorland
- Lavinia Wetland on the north-east coast of King Island, Tasmania (PWS, 2000); the Lake Warden System at Esperance on the south coast of Western Australia (DEC, 2009); and Forrestdale Lake in Perth, Western Australia (CCWA, 2005), where Ramsar wetlands of international importance are known to be affected by Phytophthora dieback.

All of the areas mentioned above also contain EPBC-listed threatened species and/or ecological communities. For example, the Eastern Stirling Range Montane Heath and Thicket and the Proteaceae Dominated Kwongkan Shrublands of the South-east Coastal Floristic Province of Western Australia, endangered ecological communities endemic to south-west Western Australia, are both threatened by Phytophthora dieback.

Although not listed as matters of national environmental significance under the EPBC Act, a number of Indigenous lands are affected by Phytophthora dieback where culturally important values such as grasstrees (*Xanthorrhoea* spp.) are impacted. In Tasmania this includes lungatalanana Indigenous Protected Area (NVA, 2017).

3. Flora and fauna that are native to a particular area
4. United Nations Educational, Scientific and Cultural Organisation

1.4 Managing the threat

There are various management methods to minimise the spread or mitigate the impact of Phytophthora dieback; the choice of method will depend on environmental conditions and resource capacity. Strategic planning and understanding the extent of Phytophthora in an area is important to determine prioritisation of management funds and the appropriate management method. Humans can spread Phytophthora further and faster than any other infestation vector. Any activity that moves soil, organic material or water into susceptible native vegetation areas has the potential to introduce and spread soil pathogens. The limited management options available focus on modifying human activities through education, restricting access to certain sites and, when access is necessary, deploying and enforcing stringent hygiene protocols[5] before entering or leaving a site to minimise the spread of Phytophthora in the landscape. The promotion of clear messages such as 'Arrive clean, leave clean' and 'Check, Clean, Disinfect, Dry' will raise awareness of the threat of spread and encourage behaviour change.

Containment methods are available to mitigate the spread of the pathogen. In rare cases, eradication of very small infestations is possible (Dunstan et al., 2010). However, further work is required to:

- minimise the spread of Phytophthora to uninfested sites
- mitigate the impact of Phytophthora at infested sites.

A priority is to minimise the spread and mitigate the impact of Phytophthora in areas containing biodiversity assets of high conservation value, including:

- threatened species or ecological communities susceptible to Phytophthora
- habitat susceptible to Phytophthora and critical to the survival of threatened flora and fauna.

Phytophthora dieback may cause native species or ecological communities not yet listed under the EPBC Act to become eligible for listing as threatened. This means that it is also important to address the impacts and spread of Phytophthora in areas that:

- support high plant species endemicity
- support high species diversity for a type of vegetation
- support significant remnant vegetation as per state or territory criteria
- are large, ecologically intact and mostly undisturbed
- support susceptible species listed as threatened at the state or territory level.

The use of the biodegradable, systemic fungicide phosphite to assist existing management strategies has been recommended for protection of susceptible vegetation communities (Aberton et al., 1999, 2003; Barrett & Rathbone, 2018). The strategic application of phosphite has been shown to reduce the rate of autonomous spread of the pathogen, enhance the survival of susceptible species and ameliorate impacts on plant community structure.

The Western Australian Government, in association with Murdoch University, has undertaken major containment and spot eradication projects using phosphite for Phytophthora in both the Fitzgerald River and Cape Arid National Parks in Western Australia.

More information on the use of phosphite, containment activities and other management measures undertaken in Australia can be found in the background document (DoEE, 2018a).

5. A series of steps that people take to ensure that vehicles and equipment are clean of Phytophthora or any other pathogen before moving to an uninfected site

2. Objectives and actions

The goal of this Plan is to minimise the impacts of Phytophthora on matters of national environmental significance under the EPBC Act and priority biodiversity assets identified by the actions of this Plan. To achieve this goal, the Plan has four objectives:

1. Identify and prioritise for protection biodiversity assets that are, or may be, impacted by Phytophthora. Prioritised biodiversity assets may include:
   - listed threatened species and ecological communities
   - areas where there is potential for Phytophthora to cause unlisted native species or ecological communities to become eligible for listing under the EPBC Act (in any category other than conservation dependent).
2. Reduce the spread and mitigate the impacts of Phytophthora to protect:
   - priority biodiversity assets
   - areas where there is potential for Phytophthora to cause native species or ecological communities not yet listed to become eligible for listing under the EPBC Act (in any category other than conservation dependent).
3. Inform and engage the community by promoting information about Phytophthora, its impacts on biodiversity and actions to mitigate these impacts.
4. Encourage research on *Phytophthora* species and options to manage infestations and protect biodiversity assets.

Under each objective is a set of actions to help achieve the goal of the Plan. The priorities for actions are relative over the life of the Plan. Time frames listed for the actions are:

- short term, one to three years
- medium term, three to five years
- long term, more than five years
- ongoing.

Objective 1: Identify and prioritise for protection biodiversity assets that are, or may be, impacted by Phytophthora

There is a need to develop a list of national priority biodiversity assets for protection from Phytophthora. The background document (DoEE, 2018a) includes discussion of state-based approaches to the assessment of risks from Phytophthora.

EPBC Act listed threatened species and ecological communities at risk from Phytophthora appear in appendices A, B and C in this document. Although understanding of plant species susceptibility and impacts on dependent wildlife is still developing, these lists provide a starting point for prioritisation.

Threatened species and communities are also listed under state and territory legislation. Australian Government and state/territory lists do not necessarily align, creating the potential for inconsistency in priorities. Current work to align these lists at state and national levels will lead to greater efficiencies. Under the common assessment method, a species will be assessed by only one jurisdiction: either the Australian Government or a state or territory where the species occurs. The outcome of that assessment can then be adopted by relevant jurisdictions to update their Single Operational List. A current list of threatened species and communities is available on the Species Profile and Threats Database (SPRAT) (DoEE, 2018b).

Risk assessment methodologies should be the basis for governments in setting management priorities and allocating resources. The risk assessment process extends beyond susceptible plant species and ecological communities that are currently listed as threatened under the EPBC Act. It also covers those that are at risk of becoming listed due to factors such as proximity to infested areas, and extends to habitat-dependent wildlife and plant species that may be impacted by Phytophthora dieback.

Project Dieback in Western Australia brought together key partner organisations to develop a State Phytophthora dieback Management and Investment Framework in 2014 (Project Dieback, 2014). As part of the framework an indicative top 100 priority protection areas were identified to assist in prioritising investment and management.

This framework can be applied nationally, with the value of assets at risk determining the number of priority protection areas. Prioritising the most important areas which offer the greatest chance of successful disease control or mitigation will maximise current and future Phytophthora dieback investment.

Table 1: Objective 1 actions

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 1.1 Identify impacts and prioritise flora, fauna and communities at risk to inform Phytophthora dieback management.	Australian Government and state and territory governments	High priority	Medium term	Identification and prioritisation of flora, fauna and ecological communities at risk. Reviews of Commonwealth recovery plans and conservation advices consider the threat of Phytophthora dieback.	$75,000 for a 3–6 month project to review recovery plans and conservation advices to develop a report providing a prioritised list of species and communities in need of protection.
Action 1.2 Identify areas at risk of infection spatially to generate lists of biodiversity assets vulnerable to Phytophthora dieback—develop or use existing prioritisation frameworks.	Australian Government and state and territory governments	Very high priority	Short term	Spatial identification of areas at risk of infection and communication of these areas to the community through preparation of: ' maps of potential national distribution of *Phytophthora* species ' maps of priority biodiversity assets.	$150,000 plus in kind support for provision of data for a 6–12 month project to design a model that can draw on mapping layers to create risk maps for *Phytophthora* species. This may be done best in association with state departments using finer detailed mapping (e.g. soil and vegetation types) to enable maps to be produced that are of a finer resolution than current mapping.
Action 1.3 Identify priority biodiversity assets and areas for protection at a local scale—develop or use existing prioritisation frameworks.	Australian Government and state, territory and local governments	Very high priority	Medium term	Revision and production of local-scale maps of priority biodiversity assets and protection areas. Use of the Department's mapping tools to identify areas that are matters of national environmental significance requiring protection or management.	$30,000 for a 2–3 month project to develop methodology. $300,000 shared between jurisdictions for 3–12 months per jurisdiction, depending on the number of priority areas. Work would be best done in conjunction with the mapping above. Note that this is not the detailed mapping requiring on-ground surveying.

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 1.4 Improve and maintain monitoring programs.	Australian Government and state, territory and local governments; natural resource management (NRM) bodies	Very high priority	Ongoing	Annual monitoring to detect spread or any new infestations in areas of priority biodiversity assets and protection areas.	$10,000–$20,000 per site for monitoring involving on-ground survey and polymerase chain reaction (PCR)[6] analysis of samples.
Action 1.5 Develop a national framework for strategic investment in the management of Phytophthora dieback to ensure a uniform approach to management across industries and tenures.	Australian Government and state, territory and local governments; NRM bodies	High priority	Short term	National framework based on the WA State Phytophthora dieback Management and Investment Framework, informed by state and local expertise and priorities.	$200,000 for facilitation of a workshop to initiate development of a national framework and a consultancy to complete, test and roll out the framework to stakeholders.

Objective 2: Reduce the spread and mitigate the impacts of Phytophthora to protect priority biodiversity assets and susceptible landscapes

To direct the limited resources available for implementing threat abatement activities to the greatest benefit, this Plan directs action to safeguard priority biodiversity assets from the spread of Phytophthora dieback through adherence to hygiene measures. It also directs action to mitigate the impacts of Phytophthora dieback on priority biodiversity assets. It is the responsibility of states, territories and relevant agencies to determine priority biodiversity assets.

Table 2: Objective 2 actions

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 2.1 Assess the feasibility of registering phosphite for management of Phytophthora dieback in natural ecosystems. If feasible, initiate registration by the Australian Pesticides and Veterinary Management Authority.	State and territory governments	High priority	Short term	Decision on whether to pursue registration of phosphite as a control method for Phytophthora dieback in natural ecosystems. Identification and commencement of necessary research. If feasible, commencement of a process for registration of phosphite for national use in natural ecosystems.	In kind: assessment of available data by individual state/territory governments. $300,000 for research projects to gather further necessary data. $80,000 for a registration package.

6. Polymerase chain reaction (PCR) is a technique used in molecular biology to amplify a single copy or a few copies of a segment of DNA across several orders of magnitude, generating thousands to millions of copies of a particular DNA sequence

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 2.2 Implement risk mitigation and management actions to protect priority biodiversity assets (as identified under Objective 1) from the impacts of Phytophthora.	Australian Government and state, territory and local governments	High priority	Ongoing	Implementation of quarantine and hygiene measures for priority biodiversity assets. Implementation of suitable risk mitigation, eradication, containment or control methods where applicable (e.g. eradicate small infestations to protect high-value healthy catchments, apply phosphite to priority protection areas).	$1000–$2000 per sign. $2500–$5000 per footwear hygiene station, including installation and signage (depending on site and disease status). $30,000–$45,000 per vehicle wash-down station including installation and signage.
Action 2.3 Implement risk mitigation and management actions to minimise the extinction risk of threatened flora and ecological communities.	Australian Government and state, territory and local governments	High priority	Ongoing	Apply phosphite to high-priority threatened flora populations and threatened ecological community occurrences. Ex situ conservation of germplasm and species at risk at appropriate facilities/sites/locations using techniques that manage the risk of Phytophthora introduction. Implementation of translocations in accordance with the current translocation guidelines (Vallee et al., 2004, or subsequent edition) involving the establishment of new populations of highly susceptible species in Phytophthora-free sites.	$160 per hectare for aerial phosphite application. $2000–$20,000 per species for germplasm conservation, depending on the population status, the availability of viable tissue, the extent of fieldwork required to secure suitable collections and the varying costs of processing, storage and germination research. For species that present dormancy or long-term storage challenges, complicated and/or protracted research may be required. This can result in significantly higher costs, in excess of $20,000.
Action 2.4 Develop and implement practices to minimise the inadvertent spread of Phytophthora to priority biodiversity assets.	Australian Government and state, territory and local governments (including fire services); relevant industries conducting high-risk activities (e.g. forestry, garden/ nursery, road construction, recreation, mining and tourism)	High priority	Short term and ongoing	Preparation of risk reduction plans (prevention, impact reduction, containment, stakeholder engagement, communication materials including signage, monitoring) for priority protection areas and biodiversity assets and promotion of clear messages such as 'Arrive clean, leave clean' and 'Check, Clean, Disinfect, Dry'. Development of recreation planning and management to integrate appropriate hygiene protocols into recreational activities and facilities and evaluate their effectiveness. Work towards a sampling strategy to determine and monitor the disease status of basic raw material for construction and road building.	In kind or $30,000 for a 2–3 month project for preparation of a risk reduction plan. $1000 for basic flyers, website notices etc. to $15,000 to include people at events for communications and stakeholder engagement. $400 each for cameras to record uptake of hygiene stations. $15,000 for manual monitoring and reporting. In kind for 3–6 months for recreational planning and management policy by a government or recreational organisation. $150,000 for 1 officer + $50,000 for expenses for a 12-month research project on a monitoring strategy for raw material.

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
				Engagement with industry to encourage implementation of a voluntary certification scheme Australia-wide for high-risk materials such as nursery materials, soils, quarry products and road and track building material. Use of raw materials assessed to be pathogen-free in high-risk infestation pathways such as soil and nursery materials.	$1 million for a sampling strategy and rollout with incentives to assist industry participation. $75,000 for 1 officer for 6 months to promote a certification scheme.
Action 2.5 Integrate management of Phytophthora dieback with other natural resource management systems, especially fire management, including emergency suppression protocols, and prescribed fires.	Australian Government and state, territory and local governments; NRM bodies	Medium priority	Medium term	Adoption of integrated hygiene protocols for works in native vegetation to manage pests, weeds and disease risks. Adoption of hygiene protocols during fire suppression activities. Integration of Phytophthora management with other compatible land management programs such as revegetation, fire, weed and pest management and road maintenance programs.	$450,000 per jurisdiction for 1 officer for 3 years (possibly partially in kind if integrated with other policy delivery) for collaboration with agencies delivering NRM programs, fire suppression etc. to integrate and adopt hygiene protocols.
Action 2.6 Promote use of guidelines to minimise risks from Phytophthora arising from environmental restoration activities, including Australian Government funding programs.	Australian Government and state, territory and local governments; NRM bodies; organisations conducting high-risk activities	High priority	Ongoing	Funding recipients are aware of guidelines to minimise risks from Phytophthora—for example 'Arrive clean, leave clean' (DoEE, 2015). Development of guidance documents to encourage incorporation of hygiene protocols into project plans and contracts. Regular reviews of the guidelines to ensure they are up to date. Development of industry-level Phytophthora interpretation and operational guidelines to link to environmental approval requirements.	$5000 for development of guidance documents tailored to various audiences. In kind to $1000 to review documents depending on level of requirement for amendments.
Action 2.7 Encourage implementation of Phytophthora management actions in national recovery plans for EPBC-listed threatened species and ecological communities.	Australian Government and state, territory and local governments	High priority	Ongoing	Increased use of linkages between recovery plans and threat abatement plans to leverage funding for management actions related to Phytophthora.	In kind for communications.

Objective 3: Inform and engage the community by promoting information about Phytophthora, its impacts on biodiversity and actions to mitigate these impacts

There are limited options for managing Phytophthora infestations, so preventing its spread is vital. As the cumulative impacts of Phytophthora dieback cause further permanent damage to Australian landscapes, it is increasingly important to reinvigorate concern and broadly publicise the importance of hygiene and spread minimisation through clear messages such as 'Arrive clean, leave clean' and 'Check, Clean, Disinfect, Dry'. National coordination and sharing of state/regional communications approaches can help raise awareness of this threat to a higher level. Standardised, simple protocols and messages will be more memorable and reach a broader audience. Clear communication should inform industry, land managers and all land users, including the general public, of:

- the approach adopted in this Plan
- the scale of the threat to biodiversity posed by Phytophthora dieback and how to minimise it
- the priority biodiversity assets that need protection
- the tools and practices that will minimise the inadvertent spread of Phytophthora
- the need for industry and land managers in conservation, forestry, horticulture, agriculture, and water resources to receive an appropriate level of training in the science and management of Phytophthora
- the need for recreation and tourism leaders and companies to receive an appropriate level of training in minimising the spread of Phytophthora
- the need for integration of Phytophthora management, education and training with other natural resource management activities.

A number of networks of conservation groups and researchers with an interest in Phytophthora already exist. Networks such as the Dieback Working Group; Project Dieback; the Department of Biodiversity, Conservation and Attractions; and the Dieback Information and Delivery Management System (DIDMS) in Western Australia; threatened flora recovery teams; regional natural resource management (NRM) bodies; Leave No Trace Australia; and the Australian Network for Plant Conservation can assist in communicating developments in the management of Phytophthora, host susceptibility and other issues. The appointment of a dieback coordinator to relevant local government areas may also assist in providing guidance on and coordination of dieback matters at the local and regional scale.

Table 3: Objective 3 actions

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 3.1 Develop and implement a national communications strategy to raise awareness of the threat of Phytophthora dieback and the importance of behaviour change to prevent spread.	Australian Government and state and territory governments	High priority	Medium term and ongoing	Identification of stakeholders, key messages and the most efficient means of communicating on issues related to preventing Phytophthora impacts on priority biodiversity assets. Collaborative work towards a coordinated communications strategy to raise awareness of the threat nationally. Effective progression of communication actions and assessment of their effectiveness. Assessment, documentation and communication of research and other findings to stakeholders.	$40,000 for development of a communications strategy. $5000–$50,000 for implementation, depending on level of engagement.

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
				Integration of Phytophthora messages with those of other biosecurity threats through promotion of clear messages such as 'Arrive clean, leave clean' and 'Check, Clean, Disinfect, Dry'.	
Action 3.2 Develop and implement training and education that is accessible to all stakeholder groups and targets positive behaviour change. Stakeholder groups include but are not limited to community, traditional owners, industry, government and non-government organisations.	Australian Government and state, territory and local governments; non-government organisations; natural resource management (NRM) bodies; industry	High priority	Short term and ongoing	Use of existing programs (e.g. Green Card) to develop and make available training material on the methodologies involved in detection, diagnosis and management of Phytophthora. Integration of this material into training associated with land management and biodiversity conservation. Collaboration with Indigenous Rangers to ensure messages reach areas at risk from Phytophthora. Availability of industry-specific codes of practice for the management of Phytophthora for implementation 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; land restoration; agriculture and horticulture; and the disposal of Phytophthora-infested material. Availability of tailored guidelines for natural area recreation such as motorised recreation, fishing, hunting, bushwalking, orienteering and mountain biking. Engagement of educators and school students, as they will influence future decisions and be responsible for managing this threat. Work towards national accreditation for standardised training for industries/land users in high-risk areas.	$10,000 for reinterpretation of existing programs by other jurisdictions or organisations for training. In kind for collaboration with Indigenous Rangers in association with liaison about other matters. $75,000 for a 3–6 month project for each industry. $750,000 + for development of industry-specific codes ofpractice. $150,000 + $50,000 expenses per year for engagement of a communications officer to work with industry, schools, Indigenous groups etc.
Action 3.3 Ensure that mapping and guidelines (including codes of practice and standard operating procedures) for managing Phytophthora are available to key stakeholders and are implemented, reviewed and updated.	Australian Government and state, territory and local governments	High priority	Ongoing	Availability of up-to-date mapping and guidelines (including codes of practice and standard operating procedures) to key stakeholders. Regular review of the effectiveness of these guidelines.	In kindcontributions by jurisdictions once materials are developed.

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 3.4 Develop or adopt a national system of signage and alerts to guide park visitors and land managers in affected priority protection areas.	Australian Government and state, territory and local governments	Medium priority	Medium term	Consultation with all stakeholders, including traditional owners and recreation groups to ensure messages are clear and consistent. Consideration of varying levels of English literacy during development of signage. Development of information resources in language in Indigenous Protected Areas. A national system of signage and alerts for use in priority protection areas using Australian Standard placement requirements and terminology. Monitoring to evaluate its effectiveness.	$50,000 for a communications expert to develop and test effective messages and symbols for signage, in consultation with all interested groups.
Action 3.5 Acquire and maintain up-to-date information on Phytophthora and the progress of the Plan.	Australian Government with assistance from state, territory and local governments, NRM bodies and research organisations	Medium priority	Ongoing	The Department seeks input from states and territories to develop a list of stakeholders. The Department hosts a regular forum with key stakeholders to coordinate implementation of the Plan, review actions, and document achievements or lessons learned. The Department's website maintains up-to-date information reflecting achievements against the Plan's actions and promotes the uptake of research findings.	In kind.
Action 3.6 Integrate messages about Phytophthora hygiene measures into materials addressing multiple pest and pathogen threats.	Australian Government and state, territory and local governments; NRM bodies; industry	High priority	Ongoing	Collaboration between stakeholders to develop efficient messages that apply to multiple threats. Promotion of clear messages such as 'Arrive clean, leave clean' and 'Check, Clean, Disinfect, Dry'.	In kind.

Objective 4: Encourage research on *Phytophthora* species and options to manage infestations and protect biodiversity assets

Research will improve our understanding of the pathogen and help develop new control and restoration techniques.

There is a lack of an effective long-term control for Phytophthora dieback. A major research initiative is needed to address this problem and prevent further irreversible assemblage changes to ecological communities from the loss of vulnerable species. Major research projects are expensive to fund, so a cooperative approach that includes government, philanthropic and corporate funding is necessary.

In addition to the overriding requirement to mitigate the threat and develop a control, there is a need to evaluate the efficacy of existing management measures. As humans are a major vector of the pathogen, social research in this area is also necessary.

Research is needed to:

- better understand the *Phytophthora* genus
- improve the use of phosphite to control Phytophthora dieback
- assist native plant resistance to the pathogen (through selective breeding or gene manipulation)
- develop methodologies for long-term preservation of vulnerable species with a view to possible restoration of those species to ecological communities in the future
- understand how to encourage behaviour change to minimise spread by humans.

Table 4: Objective 4 actions

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 4.1 Undertake a thorough review of the science on Phytophthora biology, epidemiology, prioritisation and its implications for management of Phytophthora dieback. Undertake further or new research on: - developing new and effective treatments for the disease that minimise collateral impacts (including potential off-target impacts of phosphite application)	Australian Government and state and territory governments; research organisations	High priority	Ongoing	An understanding of the existing science identifies gaps in knowledge and informs decisions on research priorities. Collaborative applied research projects to test and improve plant species resistance in the field and management of the pathogen, including eradication methods and biocontrol options.	$100,000 for a review to identify gaps. $250,000–$500,000 per research project.

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
' eradication methods for a variety of soil types ' techniques to develop resistance and resilience in vulnerable species and communities.					
Action 4.2 Encourage new partnerships (e.g. through the Australian Research Council, forestry, mining and nursery industries, philanthropists) to support the funding of research relating to the management of Phytophthora dieback.	Australian Government and state and territory governments; research organisations; industry; philanthropists; community	High priority	Short term; ongoing	Exploration of options to form funding partnerships. Approaches to seek corporate funding for research into the development of an alternative treatment to phosphite. Initiation of new partnerships.	$150,000 for a 6–12 month project to investigate new opportunities and initiate partnerships.
Action 4.3 Increase understanding of pathogen distribution and expression, and factors affecting this (including climate change, microclimate, fire, feral animals, herbivory and other threats).	Australian Government and state and territory governments; research organisations; industry	Medium priority	Medium term	Development of improved management techniques following publication of material on factors affecting pathogen distribution and expression. Further research on the mechanisms of spread and survival of Phytophthora, assessing its long-term direct and indirect impacts on the range of priority ecosystems it affects. Use of non-invasive technology such as digital multi-spectral imaging,[7] drones and remote sensing to monitor infestations.	$250,000–$500,000 per research project.
Action 4.4 Undertake susceptibility/natural resistance screening of priority species.	State and territory governments; research organisations; industry	Medium priority	Medium term	Susceptibility screening of priority species is undertaken at appropriate facilities using plant material from ex situ programs (where available). Infested sites are monitored for resistant individuals or populations to enable the sourcing of material for resistance screening.	$250,000 per site or priority species for field work and screening.

7. Multi-spectral imaging captures image data within specific wavelength ranges that are suitable for picking up dying vegetation.

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 4.5 Develop improved techniques for rapid diagnosis of Phytophthora infestation for all stakeholders (e.g. building on existing efforts for detection via water sampling, testing large volumes of soil (or quarried material) or remote methods such as use of digital multi- spectral imagery).	State and territory governments; research organisations; industry	Very high priority	Medium term	Evaluation of rapid diagnosis systems for identifying *Phytophthora* spp. infestations for use in natural ecosystems. Availability of cost-effective and accurate methods for the rapid diagnosis of *Phytophthora* spp.	$500,000 for a research and development project.
Action 4.6 Assess disease management, mitigation and control practices; explore scope for improvement; and develop new control actions as necessary.	Australian Government and state and territory governments; research organisations	High priority	Medium term	Identification and assessment of methods to eradicate Phytophthora from small infested sites. Assessment of the efficacy of phosphite in the control of Phytophthora across a range of susceptible ecological communities. Identification of the effects of phosphite on native species. Identification and assessment of alternatives to phosphite for controlling Phytophthora. This may include, but is not limited to, potential biocontrol options and other chemicals to augment/ supplement phosphite. Assessment of hygiene protocols for controlling disease spread and improvement of implementation (this could include the efficacy of implementation practices).	$250,000–$500,000 per project.
Action 4.7 Develop methods for restoration of priority sites that are degraded by Phytophthora dieback.	Australian Government and state and territory governments; research organisations	Medium priority	Ongoing	Development of restoration and revegetation techniques for priority sites degraded by Phytophthora dieback, using resistant plant species. Development of a best practice guide for restoration. Introduction of resistant species that may provide structure and food sources for priority fauna species into priority protection areas.	$250,000–$500,000 per site for a restoration project (using several sites with varying characteristics).

Action	Responsibility	Priority	Time frame	Outcomes	Estimate of resources required
Action 4.8 Establish repositories for collections of Phytophthora cultures and nationally available standards for collection and analysis of Phytophthora samples, in order to facilitate research on the genetic basis of resistance and genetic diversity of Phytophthora.	Australian Government and state and territory governments; research organisations	Medium priority	Medium term	Cultures of Phytophthora can be tested against samples available through a complete and accessible national repository for cultures of Phytophthora isolated from natural ecosystems. Use of national standard methods by laboratories for the collection and analysis of soil, plant and water samples for the presence of Phytophthora. Communication of data findings to stakeholders.	$80,000 for the development and adoption of a standard protocol.
Action 4.9 Undertake social research to determine the level of public awareness of the threat, uptake of messages and subsequent behaviour change.	Australian Government and state and territory governments; non-government organisations; research organisations	High priority	Ongoing	Use of research findings to inform targeted communication around threat mitigation.	$250,000–$500,000 for a social research project.

3. Duration, review, funding and implementation

3.1 Duration and review of the Plan

Section 279 of the EPBC Act provides for the review of this Plan at any time and requires that it be reviewed by the Minister at intervals of no longer than five years. During the life of the Plan, the Minister's scientific advisory committee (the Threatened Species Scientific Committee) will be provided with updates of actions taken under this Plan to aid them in advising the Minister on the effectiveness of the Plan in abating the key threatening process.

3.2 Funding and implementation

It is important to note that threat abatement plans are not linked directly to a specific funding program. Each financial year, the Australian Government funds threat abatement plan development and implementation as one part of a broader approach to biodiversity conservation (www.environment.gov.au/about/publications/ budget/index.html). The Department allocates its annual budget to a range of competing biodiversity conservation priorities. The budget applied to the implementation of individual threat abatement plans may vary from year to year according to priorities.

The total cost of implementing this Plan cannot be quantified at the time of writing. Projects that are to be undertaken by the Australian Government will need to be procured in accordance with the Commonwealth Procurement Rules. The cost of individual projects will not be accurately known until a process to test the market (for example, to obtain quotes or tenders for those projects) has been undertaken. However, the tables in section 2 above include an estimated cost for selected actions.

The Australian Government recognises that the capacity of each state or territory government to implement this Plan will be dependent on the resources and priorities of that state or territory and the methods of implementation they choose to adopt.

The mining, tourism, horticulture and forestry industries have an interest in protecting biodiversity from the impacts of Phytophthora dieback. Joint delivery of projects and/or corporate sponsorship from such groups for research and management should be encouraged.

Leveraging existing collaborations and partnerships at the regional and national levels should be considered for implementation activities. Building on existing networks to deliver research and management actions is likely to be more cost-effective than establishing new capabilities.

Phytophthora dieback occurs in dynamic and evolving cultural landscapes where customary rights and legal and land management changes acknowledge and enable customary activities to take place. Significant opportunities exist to engage and work with Indigenous organisations and custodians of country to achieve the objectives of this Plan.

3.3 Links to legislation and to Australian and state government plans and programs

As a legislative instrument under the EPBC Act, this Plan sits within the context of national legislation, policy and programs directed to the long-term preservation of Australia's biodiversity.

Flora and fauna listed as threatened under the EPBC Act and documented as impacted by Phytophthora dieback are shown at appendices A and B. Listed threatened ecological communities identified as impacted by Phytophthora dieback are shown at Appendix C. Recovery plans and approved conservation advice documents for these species and communities may be available through the Species Profile and Threats Database (SPRAT) (DoEE, 2018b).

Australian Government funding for scientific research or management actions in line with the objectives and actions of this Plan may be possible. The National Environmental Science Program provides a long-term commitment to environment and climate research through six research hubs (including the Threatened Species Recovery Hub).

Additionally, the Australian Government's Threatened Species Strategy provides a broad framework for science, action and partnership to achieve Australia's long-term goal of reversing species declines and supporting species recovery.

State government agencies have policies in place to manage Phytophthora infected sites and the spread of plant pathogens generally. For example, Western Australia's Forest Management Plan 2014–2023 (CCWA, 2013) details proposed operations and provides key performance indicators to track implementation of the Plan.

4. 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).
Biodiversity asset	A species, ecological community or vegetation landscape under threat from Phytophthora dieback.
Conservation dependent	A native species is eligible to be included in the conservation dependent category of the EPBC Act at a particular time if at that time the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered.
Ecological community	A group of native plants, animals and other organisms that naturally occur together and interact in a unique habitat.
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.
Hazard	A pathway or activity that links Phytophthora dieback locations to an uninfested susceptible area (including environmental hazards such as wet soil, soil type, slope, landform, climate).
Impact	The effect of Phytophthora on a plant, community, ecosystem, landscape, species composition or structure and function.
Key threatening process	A threatening process listed under the EPBC Act which: ' could cause a native species or an ecological community to become eligible for listing in any category, other than conservation dependent; or ' could cause a listed threatened species or a listed threatened ecological community to become eligible to be listed in another category representing a higher degree of endangerment; or ' adversely affects two or more listed threatened species (other than conservation dependent species) or two or more listed threatened ecological communities.
Matters of national environmental significance	The nine matters of national environmental significance protected under the EPBC Act are: ' world heritage properties ' national heritage places ' wetlands of international importance (listed under the Ramsar Convention) ' listed threatened species and ecological communities ' migratory species protected under international agreements ' Commonwealth marine areas ' the Great Barrier Reef Marine Park ' nuclear actions (including uranium mines) ' a water resource, in relation to coal seam gas development and large coal mining development (DEWHA, 2013).
Phytophthora dieback	Plant disease caused by *Phytophthora* species.

Priority biodiversity assets	Matters of national environmental significance listed under the EPBC Act, such as threatened species and ecological communities; and other plants, animals, communities and vegetation landscapes prioritised under Objective 1 of this Plan for protection or remediation.
Risk	The chance that Phytophthora will result in adverse impacts on vulnerable values or assets.
Susceptibility	The level of resilience of a species, community, ecosystem or landscape to impact from Phytophthora.
Threat	The known location or source, extent and severity of Phytophthora dieback in an area and its proximity to uninfested susceptible areas.
Threat abatement plan	Under the EPBC Act (section 270A), a plan providing for 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 ecological community	An ecological community listed under the EPBC Act as critically endangered, endangered or vulnerable.
Threatened species	A species listed under the EPBC Act as critically endangered, endangered, vulnerable or conservation dependent.
Threatening process	A process that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
Vulnerability	The sum of susceptibility and hazards in an area, which provides a measure of exposure to the likelihood of being harmed.

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Appendix A

Threatened flora species known to be susceptible to Phytophthora dieback

Species in Appendix A are listed as threatened under the EPBC Act at the time of publishing and are known to be susceptible to Phytophthora dieback. Other species may also be susceptible, including species listed afterthis time. A full list of threatened flora under the EPBC Act is available at www.environment.gov.au/threatened-flora. Additional susceptible species may be listed as threatened under state/territory legislation.

Susceptibility information is from a review by O'Gara et al. (2005), which compiles published material, unpublished records and observations of individual researchers on the responses of native plants to *P. cinnamomi*. For further detail relating to native species not listed under the EPBC Act, please refer to the O'Gara review.

Several additional EPBC-listed species were confirmed as susceptible by Barrett et al. (2008), Kueh et al. (2012) and Tim Rudman (pers comm 2012).

Table 5: Threatened flora that may be affected by Phytophthora dieback

Family	Scientific name	Common name	EPBC Act status	State/ territory
Asteraceae	*Olearia pannosa subsp. pannosa*	Silver Daisy-bush, Silver-leaved Daisy, Velvet Daisy-bush	**VU**	**SA**
Araucariaceae	*Wollemia nobilis*	Wollemi Pine	**CR**	**NSW**
Boryaceae	*Borya mirabilis*	Grampians Pincushion-lily	**E**	**Vic**
Casuarinaceae	*Allocasuarina fibrosa*	Woolly Sheoak	**VU**	**WA**
Ericaeae	*Andersonia annelsii*		**CR**	**WA**
Ericaceae	*Andersonia axilliflora*	Giant Andersonia	**E**	**WA**
Ericaceae	*Andersonia gracilis*	Slender Andersonia	**E**	**WA**
Ericaceae	*Andersonia pinaster*	Two Peoples Bay Andersonia	**VU**	**WA**
Ericaceae	*Epacris apsleyensis*	Apsley Heath	**E**	**Tas**
Ericaceae	*Epacris barbata*	Bearded Heath, Freycinet Heath	**E**	**Tas**
Ericaceae	*Epacris exserta*	South Esk Heath	**E**	**Tas**
Ericaceae	*Epacris glabella*	Funnel Heath, Smooth Heath	**E**	**Tas**
Ericaceae	*Epacris grandis*	Grand Heath, Tall Heath	**E**	**Tas**
Ericaceae	*Epacris graniticola*	Mt Cameron Heath, Granite Heath	**CR**	**Tas**
Ericaceae	*Epacris limbata*	Border Heath	**CR**	**Tas**
Ericaceae	*Epacris stuartii*	Stuarts Heath, Southport Heath	**CR**	**Tas**
Ericaceae	*Epacris virgata*	Pretty Heath, Dan Hill Heath	**E**	**Tas**
Ericaceae	*Leucopogon gnaphalioides*	Stirling Range Beard Heath	**E**	**WA**
Ericaceae	*Leucopogon marginatus*	Thick-margined Leucopogon	**E**	**WA**
Ericaceae	*Leucopogon obtectus*	Hidden Beard-heath	**E**	**WA**

EPBC Act status: CR = critically endangered; E = endangered; VU = vulnerable

Family	Scientific name	Common name	EPBC Act status	State/ territory
Ericaceae	*Leucopogon sp. Flynn (F. Hort, J. Hort & A. Lowrie 859)*		**CR**	**WA**
Ericacea	*Styphelia longissima*		**CR**	**WA**
Ericaceae	*Sphenotoma drummondii*	Mountain Paper-heath	**E**	**WA**
Fabaceae	*Acacia pinguifolia*	Fat-leaved Wattle	**E**	**SA**
Fabaceae	*Acacia recurvata*	Recurved Wattle	**E**	**WA**
Fabaceae	*Daviesia bursarioides*	Three Springs Daviesia	**E**	**WA**
Fabaceae	*Daviesia euphorbioides*	Wongan Cactus	**E**	**WA**
Fabaceae	*Daviesia glossosema*	Maroon-flowered Daviesia	**CR**	**WA**
Fabaceae	*Daviesia megacalyx*	Long-sepalled Daviesia	**E**	**WA**
Fabaceae	*Daviesia microcarpa*	Norseman Pea	**E**	**WA**
Fabaceae	*Daviesia obovata*	Paddle-leaf Daviesia	**E**	**WA**
Fabaceae	*Daviesia ovata*	Broad-leaf Daviesia	**CR**	**WA**
Fabaceae	*Daviesia pseudaphylla*	Stirling Range Daviesia	**E**	**WA**
Fabaceae	*Daviesia speciosa*	Beautiful Daviesia	**E**	**WA**
Fabaceae	*Gastrolobium luteifolium*	Yellow-leafed Gastrolobium	**CR**	**WA**
Fabaceae	*Gastrolobium papilio*	Butterfly-leaved Gastrolobium	**E**	**WA**
Fabaceae	*Gastrolobium vestitum*		**CR**	**WA**
Fabaceae	*Glycine latrobeana*	Clover Glycine, Purple Clover	**VU**	**NSW, SA, Tas, Vic**
Fabaceae	*Kennedia glabrata*	Northcliffe Kennedia	**VU**	**WA**
Fabaceae	*Latrobea colophona*		**CR**	**WA**
Lamiaceae	*Prostanthera eurybioides*	Monarto Mintbush	**E**	**SA**
Lamiaceae	*Prostanthera marifolia*	Seaforth Mintbush	**CR**	**NSW**
Myrtaceae	*Chamelaucium sp. S coastal plain (R.D. Royce 4872)*	Royce's Waxflower	**VU**	**WA**
Myrtaceae	*Darwinia acerosa*	Fine-leaved Darwinia	**E**	**WA**
Myrtaceae	*Darwinia collina*	Yellow Mountain Bell	**E**	**WA**
Myrtaceae	*Darwinia ferricola*	Scott River Darwinia	**E**	**WA**
Myrtaceae	*Darwinia meeboldii*	Cranbrook Bell	**VU**	**WA**
Myrtaceae	*Darwinia nubigena*	Success Bell, Red Mountain Bell	**VU**	**WA**
Myrtaceae	*Darwinia oxylepis*	Gillam's Bell	**E**	**WA**
Myrtaceae	*Darwinia squarrosa*	Fringed Mountain Bell, Pink Mountain Bell	**VU**	**WA**
Myrtaceae	*Darwinia wittwerorum*	Wittwer's Mountain Bell	**E**	**WA**
Myrtaceae	*Eucalyptus imlayensis*	Imlay Mallee, Mount Imlay Mallee	**E**	**NSW**
Myrtaceae	*Eucalyptus recurva*	Mongarlowe Mallee	**CR**	**NSW**
Myrtaceae	*Kunzea ericifolia subsp. subulata*		**VU**	**WA**
Myrtaceae	*Kunzea similis subsp. similis*		**CR**	**WA**

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Family	Scientific name	Common name	EPBC Act status	State/ territory
Myrtaceae	*Verticordia apecta*	Hay River Featherflower, Scruffy Verticordia	**CR**	**WA**
Myrtaceae	*Verticordia carinata*	Stirling Range Featherflower	**VU**	**WA**
Myrtaceae	*Verticordia densiflora var. pedunculata*	Long-stalked Featherflower	**E**	**WA**
Myrtaceae	*Verticordia plumosa var. ananeotes*	Tufted Plumed Featherflower	**E**	**WA**
Myrtaceae	*Verticordia plumosa var. vassensis*	Vasse Featherflower	**E**	**WA**
Proteaceae	*Adenanthos dobagii*	Fitzgerald Woollybush	**E**	**WA**
Proteaceae	*Adenanthos ellipticus*	Oval-leaf Adenanthos	**VU**	**WA**
Proteaceae	*Adenanthos eyrei*	Toolinna Adenanthos	**E**	**WA**
Proteaceae	*Adenanthos pungens subsp. effusus*	Sprawling Spiky Adenanthos	**E**	**WA**
Proteaceae	*Adenanthos pungens subsp. pungens*	Spiky Adenanthos	**VU**	**WA**
Proteaceae	*Adenanthos velutinus*	Velvet Woollybush	**E**	**WA**
Proteaceae	*Banksia anatona*	Cactus Dryandra	**CR**	**WA**
Proteaceae	*Banksia aurantia*	Orange Dryandra	**CR**	**WA**
Proteaceae	*Banksia brownii*	Brown's Banksia, Feather-leaved Banksia	**E**	**WA**
Proteaceae	*Banksia cuneata*	Matchstick Banksia, Quairading Banksia	**E**	**WA**
Proteaceae	*Banksia goodii*	Goods Banksia	**VU**	**WA**
Proteaceae	*Banksia ionthocarpa*	Kamballup Dryandra	**E**	**WA**
Proteaceae	*Banksia mimica*	Summer Honeypot	**E**	**WA**
Proteaceae	*Banksia montana*	Stirling Range Dryandra	**E**	**WA**
Proteaceae	*Banksia nivea subsp. uliginosa*	Swamp Honeypot	**E**	**WA**
Proteaceae	*Banksia oligantha*	Wagin Banksia	**E**	**WA**
Proteaceae	*Banksia pseudoplumosa*	False Plumed-Banksia	**E**	**WA**
Proteaceae	*Banksia rufa subsp. pumila*		**E**	**WA**
Proteaceae	*Banksia serratuloides subsp. perissa*	Northern Serrate Dryandra	**CR**	**WA**
Proteaceae	*Banksia serratuloides subsp. serratuloides*	Southern Serrate Dryandra	**VU**	**WA**
Proteaceae	*Banksia squarrosa subsp. argillacea*	Whicher Range Dryandra	**VU**	**WA**
Proteaceae	*Banksia verticillata*	Granite Banksia, Albany Banksia, River Banksia	**VU**	**WA**
Proteaceae	*Banksia vincentia*		**CR**	**NSW**
Proteaceae	*Conospermum hookeri*	Variable Smokebush	**VU**	**Tas**
Proteaceae	*Conospermum undulatum*	Wavy-leaved Smokebush	**VU**	**WA**
Proteaceae	*Grevillea batrachioides*	Mt Lesueur Grevillea	**E**	**WA**
Proteaceae	*Grevillea caleyi*	Caley's Grevillea	**CR**	**NSW**
Proteaceae	*Grevillea calliantha*	Foote's Grevillea, Cataby Grevillea, Black Magic Grevillea	**E**	**WA**

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Family	Scientific name	Common name	EPBC Act status	State/ territory
Proteaceae	*Grevillea christinae*	Christine's Grevillea	**E**	**WA**
Proteaceae	*Grevillea elongata*	Ironstone Grevillea	**VU**	**WA**
Proteaceae	*Grevillea flexuosa*	Zig Zag Grevillea	**VU**	**WA**
Proteaceae	*Grevillea infundibularis*	Fan-leaf Grevillea	**E**	**WA**
Proteaceae	*Grevillea involucrata*	Lake Varley Grevillea	**E**	**WA**
Proteaceae	*Grevillea maccutcheonii*	McCutcheon's Grevillea	**E**	**WA**
Proteaceae	*Grevillea maxwellii*	Maxwell's Grevillea	**E**	**WA**
Proteaceae	*Grevillea murex*		**E**	**WA**
Proteaceae	*Grevillea scapigera*	Corrigin Grevillea	**E**	**WA**
Proteaceae	*Hakea megalosperma*	Lesueur Hakea	**VU**	**WA**
Proteaceae	*Isopogon fletcheri*	Fletcher's Drumsticks	**VU**	**NSW**
Proteaceae	*Isopogon uncinatus*	Albany Cone Bush, Hook-leaf Isopogon	**E**	**WA**
Proteaceae	*Lambertia echinata subsp. echinata*	Prickly Honeysuckle	**E**	**WA**
Proteaceae	*Lambertia echinata subsp. occidentalis*	Western Prickly Honeysuckle	**E**	**WA**
Proteaceae	*Lambertia fairallii*	Fairall's Honeysuckle	**E**	**WA**
Proteaceae	*Lambertia orbifolia*	Roundleaf Honeysuckle	**E**	**WA**
Proteaceae	*Lomatia tasmanica*	King's Lomatia	**CR**	**Tas**
Proteaceae	*Persoonia acerosa*	Needle Geebung	**VU**	**NSW**
Proteaceae	*Persoonia micranthera*	Small-flowered Snottygobble	**E**	**WA**
Proteaceae	*Petrophile latericola*	Laterite Petrophile	**E**	**WA**
Restionaceae	*Chordifex abortivus*	Manypeaks Rush	**E**	**WA**
Rhamnaceae	*Pomaderris halmaturina subsp. halmaturina*	Kangaroo Island Pomaderris	**VU**	**SA**
Rutaceae	*Asterolasia phebalioides*	Downy Star-bush	**VU**	**SA, Vic**
Rutaceae	*Boronia revoluta*	Ironcap Boronia	**E**	**WA**
Rutaceae	*Correa calycina*	Hindmarsh Correa	**VU**	**SA**
Rutaceae	*Leionema ralstonii*	Ralston's Leionema	**VU**	**NSW**
Rutaceae	*Phebalium daviesii*	Davies Waxflower, St Helens Waxflower	**CR**	**Tas**
Thymelaeaceae	*Pimelea pagophila*	Grampians Rice-flower	**VU**	**Vic**
Tremandraceae	*Tetratheca gunnii*	Shy Pinkbells, Shy Susan	**CR**	**Tas**
Tremandraceae	*Tetratheca juncea*	Black-eyed Susan	**VU**	**NSW**
Winteraceae	*Tasmannia glaucifolia*	Fragrant Pepperbush	**VU**	**NSW**
Xanthorrhoeacae	*Xanthorrhoea arenaria*	Sand Grasstree	**VU**	**Tas**
Xanthorrhoeacae	*Xanthorrhoea bracteata*	Shiny Grasstree	**E**	**Tas**

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Appendix B

Threatened fauna listed under the EPBC Act that may be impacted by Phytophthora dieback

The species in Appendix B are listed as threatened under the EPBC Act at the time of publishing. The habitat of these species is susceptible to Phytophthora dieback. Other fauna may also be affected, including species listed after this time. A full list of threatened fauna under the EPBC Act is available at www.environment.gov.au/threatened-fauna. Additional affected species may be listed as threatened under state/territory legislation.

Table 6: Threatened fauna that may be affected by Phytophthora dieback

Class	Scientific name	Common name	EPBC Act status	State/ territory
Amphibia	*Geocrinia alba*	White-bellied Frog, Creek Frog	**E**	**WA**
Amphibia	*Spicospina flammocaerulea*	Sunset Frog	**E**	**WA**
Aves	*Atrichornis clamosus*	Noisy Scrub-bird, Tjimiluk	**E**	**WA**
Aves	*Dasyornis longirostris*	Western Bristlebird	**E**	**WA**
Aves	*Pezoporus flaviventris*	Western Ground Parrot, Kyloring	**CR**	**WA**
Aves	*Stipiturus malachurus parimeda*	Southern Emu-wren (Eyre Peninsula)	**VU**	**SA**
Mammalia	*Bettongia penicillata ogilbyi*	Woylie	**E**	**SA, WA**
Mammalia	*Isoodon obesulus nauticus*	Southern Brown Bandicoot (Nuyts Archipelago)	**VU**	**SA**
Mammalia	*Parantechinus apicalis*	Dibbler	**E**	**WA**
Mammalia	*Potorous gilbertii*	Gilbert's Potoroo, Ngilkat	**CR**	**WA**
Mammalia	*Pseudomys fumeus*	Smoky Mouse, Konoom	**E**	**ACT, NSW, Vic**
Mammalia	*Pseudomys novaehollandiae*	New Holland Mouse, Pookila	**VU**	**NSW, Qld, Tas, Vic**
Migidae	*Bertmainius colonus*	Eastern Stirling Range Pygmy Trapdoor Spider	**VU**	**WA**
Pseudococcidae	*Pseudococcus markharveyi*	Banksia Montana Mealybug	**CR**	**WA**

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Appendix C

Threatened ecological communities listed under the EPBC Act that may be impacted by Phytophthora dieback

Appendix C records threatened ecological communities occurring within the climatic zone favourable to Phytophthora. The list was developed in September 2017 in consultation with state agencies. Other ecological communities may also be susceptible, including those listed after this time. Conservation advices indicate whether Phytophthora dieback is a threat. A full list of threatened ecological communities is available at www.environment.gov.au/threatened-communities. Additional susceptible ecological communities may be listed as threatened under state/territory legislation.

Table 7: Threatened ecological communities that may be affected by Phytophthora dieback

Ecological communities listed under the EPBC Act	EPBC Act status	State/territory
Banksia Woodlands of the Swan Coastal Plain Ecological Community	**E**	**WA**
Blue Gum High Forest of the Sydney Basin Bioregion	**CR**	**NSW**
Broad Leaf Tea-tree (*Melaleuca viridiflora*) Woodlands in High Rainfall Coastal North Queensland	**E**	**Qld**
Claypans of the Swan Coastal Plain	**CR**	**WA**
Coastal Upland Swamps in the Sydney Basin Bioregion	**E**	**NSW**
Corymbia calophylla—Kingia australis Woodlands on Heavy Soils of the Swan Coastal Plain	**E**	**WA**
Corymbia calophylla—Xanthorrhoea preissii Woodlands and Shrublands of the Swan Coastal Plain	**E**	**WA**
Cumberland Plain Shale Woodlands and Shale-gravel Transition Forest	**CR**	**NSW**
Eastern Stirling Range Montane Heath and Thicket	**E**	**WA**
Eastern Suburbs Banksia Scrub of the Sydney Region	**E**	**NSW**
Eucalypt Woodlands of the Western Australian Wheatbelt	**CR**	**WA**
Gippsland Red Gum (*Eucalyptus tereticornis* subsp. *mediana*) Grassy Woodland and Associated Native Grassland	**CR**	**Vic**
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	**CR**	**Vic**
Lowland Grassy Woodland in the South-east Corner Bioregion	**CR**	**NSW, Vic**
Lowland Rainforest of Subtropical Australia	**CR**	**NSW, Qld**
Monsoon Vine Thickets on the Coastal Sand Dunes of Dampier Peninsula	**E**	**WA**
New England Peppermint (*Eucalyptus nova-anglica*) Grassy Woodlands	**CR**	**NSW, Qld**
Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia	**CR**	**SA**
Proteaceae Dominated Kwongkan Shrublands of the South-east Coastal Floristic Province of Western Australia	**E**	**WA**
Scott River Ironstone Association	**E**	**WA**
Sedgelands in Holocene Dune Swales of the Southern Swan Coastal Plain	**E**	**WA**
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	**CR**	**NSW**

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Ecological communities listed under the EPBC Act	EPBC Act status	State/territory
Shrublands and Woodlands of the Eastern Swan Coastal Plain	**E**	**WA**
Shrublands on Southern Swan Coastal Plain Ironstones	**E**	**WA**
Silurian Limestone Pomaderris Shrubland of the South-east Corner and Australian Alps Bioregions	**E**	**Vic**
Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland	**CR**	**Qld**
Swamps of the Fleurieu Peninsula	**CR**	**SA**
Temperate Highland Peat Swamps on Sandstone	**E**	**NSW, Vic**
Turpentine–Ironbark Forest of the Sydney Basin Bioregion	**CR**	**NSW**
Hunter Valley Weeping Myall (*Acacia pendula*) Woodland	**CR**	**NSW**
Western Sydney Dry Rainforest and Moist Woodland on Shale	**CR**	**NSW**
White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland	**CR**	**ACT, NSW, Qld, Vic**

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