

Draft
Strategic Plan
for the management of
**Phytophthora
cinnamomi**
in Victoria



Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative



Acknowledgments

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Cover: Grass tree death in Anglesea area, photo courtesy M. Aberton

foreword

This Strategic Plan presents a series of actions to improve the management of Victoria's most significant native plant pathogen, *Phytophthora cinnamomi*.

Phytophthora (fy-toff-thor-ah) is latin for 'Plant Destroyer'.

Phytophthora cinnamomi is an introduced microscopic soil-borne organism that attacks the root system of susceptible plants. Depending upon environmental conditions and plant susceptibility, it can destroy vegetation communities leading to the loss of dependent wildlife. Several plant species are also at risk of extinction.

Humans are the main cause of *P.cinnamomi* spread across the landscape. First detected in Australia in 1935, it has since spread across the Australian continent. It has now infested many hundreds of thousands of hectares in Western Australia, Victoria and Tasmania, and tens of thousands of hectares in South Australia, as well as wet coastal forests in Queensland.

P.cinnamomi is still being spread by people today. Once introduced to an area it may spread extensively by itself, and there are no known practical ways to eradicate it.

Its impact on the timber industry has resulted in substantial research and management efforts to mitigate its damage.

P.cinnamomi also poses a significant threat to native and exotic nursery stock and consequently to residential landscapes, as well as revegetation activities.

Efforts to manage the threat, other than in forestry operations, have been disparate to date.

Cooperation is required of people who engage in activities that lead to its spread around susceptible landscapes, and in particular, where it threatens as yet uninfested significant vulnerable areas. Action is also needed to mitigate the impact of *P.cinnamomi* on highly significant remnant patches of vegetation within infested areas, and to secure threatened species.

Influencing individuals and organisations to prevent further spread and reduce the pathogen's impact on significant areas is a key challenge addressed by this Plan. Other challenges include the standardisation of on-ground management, and bringing rigour to the prioritisation of management efforts.

The role of the Department of Sustainability and Environment (DSE) will be to coordinate cross-agency and industry management efforts throughout Victoria.

DSE's vision is of a future where there is a clearer appreciation by stakeholders of the nature of the threat from *P.cinnamomi* and a shared commitment to undertake collaborative best-practice management to minimise its biological, social and economic impacts.

Through this Plan, DSE aims to forge uptake of optimal management of *P.cinnamomi* across susceptible landscapes in Victoria.

This Plan has been prepared as a State management plan under the *National Threat Abatement Plan for Dieback Caused by the Root-rot Fungus Phytophthora cinnamomi* [the National Plan¹].

Several actions in this Plan will be developed and implemented in conjunction with actions contained in the National Plan.

¹ Department of the Environment and Heritage (2001)

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summary

This Plan has been produced with the aim of promoting the uptake of best-practice management across the landscape of *Phytophthora cinnamomi* amongst key stakeholders throughout Victoria. The following provides a brief overview of the Plan layout and management strategy.

This Plan initially provides a brief overview of past and current management efforts of *P.cinnamomi*, followed by the overall aims of the Plan and the regulatory environment.

This Plan then describes the nature of the threat posed by the pathogen, including an overview of the degree of infestation and potential impacts of climate change. The extent of the threat is described from ecological, economic and social perspectives.

A more detailed overview of the current issues for managing spread and safeguarding areas is then provided. Attention is given to three key elements within relevant agencies and industries: culture, governance, and systems and procedures. Relevant research issues are also highlighted.

This Plan presents a program of actions to improve the management of *P.cinnamomi*, which will be implemented in phases.

The first 'Establishment' phase recognises the need to establish an appreciation amongst stakeholders of the threat posed by *P.cinnamomi*. It is essential to gain stakeholder commitment at senior levels to help with the development and implementation of consistent and cooperative best-practice management within various agencies and other bodies across all tenures.

The second 'Systems Formulation' phase provides for the formulation of best-practice management procedures and systems with on-ground and planning staff from relevant agencies and bodies. This phase will integrate with a national initiative aimed at benchmarking such systems around Australia.

The third 'Implementation' phase commences once systems for on-ground management, planning and prioritisation have been finalised. This phase is characterised by coordinated efforts to curb spread and to plan detailed area management.

This Plan provides for an annual appraisal of outcomes, the formulation of which requires stakeholder input. The intent is to provide for adaptation of the approach if necessary and to appraise collaborative efforts.

A final independent review is recommended from which recommendations will come for the process beyond this Plan.



1 introduction

1.1 About this document

This Plan represents a renewed effort to optimise state-wide management of the threat posed to Victoria's ecological, social and economic assets by the introduced pathogen *Phytophthora cinnamomi*.

Past management

Phytophthora cinnamomi was originally isolated from cinnamon trees in Sumatra in 1922.²

The pathogen is believed to have been brought into Australia by early European settlers³.

A state-wide forestry management response in Victoria began following its identification as the cause of an epidemic outbreak in coastal forestry areas in 1969. Recognising that forestry vehicles dispersed infected soil, hygiene procedures were instigated⁴ to prevent the pathogen transferring to more productive forests in the higher country. However the new hygiene procedures ceased after research showed that various environmental factors mitigate the pathogen's impact at higher altitudes.

Management of *P.cinnamomi* elsewhere to prevent spread and protect areas has since been characterised by disparate efforts and approaches by various agencies and other relevant bodies. Past scientific speculation by a small minority that *P.cinnamomi* is 'native' to Australia permeates environmental management circles, despite overwhelming evidence to the contrary. This misconception continues to confound management of natural ecosystems.

Purpose and aim of this Plan

The purpose of this Plan is to outline a broad program of actions for the next three years, aimed at **forging the uptake of optimal management of *Phytophthora cinnamomi* across susceptible landscapes in Victoria**

Optimal *P.cinnamomi* management is seen as the most beneficial use of limited resources to minimise further spread, and to secure significant assets.

A measured precautionary management response is required to help curtail further human spread in susceptible landscapes.

Mitigation of the impact and threat from *P.cinnamomi* requires prioritising management actions for different assets, according to their biodiversity, social amenity or economic value.

DSE considers this Plan to constitute a draft Action Statement under section 19 of the *Flora and Fauna Guarantee Act 1988* and addresses the listed threatening process⁵.

State and Federal Roles

The role of Victoria's Department of Sustainability and Environment (DSE) will be to facilitate a cross-agency and industry approach to managing the threat of *P.cinnamomi* across all land tenures in Victoria.

Some actions in this Plan will align with national initiatives managed by the Australian Government Department of Environment and Heritage (DEH).

In 2001, DEH released the *Threat Abatement Plan for Dieback Caused by the Root-rot Fungus Phytophthora cinnamomi* [the National Plan]⁶.

This National Plan includes objectives and actions that provides for funding States and Territories to develop their own Strategic Plans to reduce and manage the spread and impacts of *P.cinnamomi*. Development of this Plan was subsequently funded under the Australian Government *Endangered Species Program* (ID 30831).

Other actions contained in the National Plan include developing national best-practice standards for the management of sites (and species) that are or could be threatened by *P.cinnamomi*, and criteria for prioritising areas for management.

DSE is actively collaborating in these initiatives.

⁵ (a) Use of *Phytophthora*-infected gravel in construction of roads, bridges and reservoirs (listed in 1991 as a Potentially Threatening Process in Schedule 3 of the FFG Act)

(b) The spread of *Phytophthora cinnamomi* from infected sites into parks or reserves, including roadsides, under the control of a state or local government authority (listed in 2002).

² Weste, G. (1998)

³ Marks, G.C. and Smith, I.W. (1991)

⁴ Via regulation under the *Forest Act 1958*.

⁶ Environment Australia (2001)

1.2 Regulatory environment

The impact of *Phytophthora cinnamomi* has been recognised under both Federal and State legislation with provision being made for its management under fire and forestry Codes of Practice.

National legislation and threat abatement plan

Formal recognition of *P.cinnamomi* as a threat under Federal legislation has led to nationally coordinated efforts to curb its impact. 'Dieback' caused by the root-rot fungus *Phytophthora cinnamomi* was listed on 16 July 2000 as a 'key threatening process' under section 183 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The National Plan provides a framework for implementing actions to reduce the threat of *P.cinnamomi*. The Australian Government is committed to implementing this Plan, and working with key stakeholders to ensure its key objectives and actions are achieved.

Victorian legislation

P.cinnamomi has been listed twice as a threatening process under the *Flora and Fauna Guarantee Act 1988* [FFG Act]. It was initially listed due to the spread of infested gravel for road works and other construction, and subsequently in terms of the pathogen's spread into parks and reserves, including roadside vegetation.

Under the FFG Act, all public authorities have a statutory duty-of-care to manage *P.cinnamomi*, due to their legal requirement to help meet the Act's various flora and fauna conservation and management objectives⁷.

Several other Acts of Parliament⁸ also relate to the management of *P.cinnamomi* or have the potential to be applied to improve management arrangements. These include Codes of Practice⁹, plant pathogen controls¹⁰, planning controls¹¹ and Regional Catchment Strategies¹².

Codes of Practice

Management of *P.cinnamomi* is provided by two Codes of Practice, one for fire management on public land¹³, the other for timber harvesting¹⁴ on both public and private land.

Voluntary best-practise guidelines and a certification program have also been developed by the plant nursery industry to reduce the impact of *P.cinnamomi*.

⁷ Section 4 (2) of the *Flora Fauna Guarantee Act 1988*.

⁸ *Extractive Industries Development Act 1995*

⁹ *Conservation, Forests and Lands Act 1987*

¹⁰ *Plant Health and Plant Products Act 1995*

¹¹ *Planning and Environment (Planning Schemes) Act 1996*

¹² *Catchment and Land Protection Act 1994*

¹³ NRE (1995)

¹⁴ NRE (1996)



2 nature of the threat

2.1 Biology of *Phytophthora cinnamomi*

Phytophthora cinnamomi is an introduced soil-borne plant pathogen that attacks the fine root systems of susceptible plants.

Growth and reproduction

P.cinnamomi is a water mould (*Phylum Oomycota, Kingdom Chromista*) and is related to certain algae¹⁵. Once considered a fungus¹⁶ it is still commonly called 'Cinnamon Fungus'. Its growth and reproduction are favoured by free water in the soil or ponding on the soil surface.

In highly susceptible plant species, *P.cinnamomi* spreads fine filamentous threads (hyphae) throughout the root systems until it girdles the major roots and stems of an infected plant. It kills the plant's vascular tissue¹⁷, impeding their ability to absorb nutrients and water.

As the roots of the infected plant die, *P.cinnamomi* produces non-motile spores (chlamydospores), which can survive dry soil conditions for long periods. This provides a source for re-infection of seedlings or long distance spread via soil movement.

Method of dispersal

vectored spread

Since its introduction, the major vectors of *P.cinnamomi* have included infected nursery stock or infested growing media and other soil.

Other major vectors are vehicles or machinery, particularly those used for earthmoving (*eg.* road construction and fire fighting activities). In these instances long distance dispersal occurs when soil containing chlamydospores adheres to machinery.

The use of infested soil also leads to widespread dispersal.

Minor vectors leading to local spread include pedestrian activities and the movement of native and domestic animals across the landscape. Chlamydospores may be dispersed in minute quantities of soil by animals digging or browsing. There is also some suggestion that *P.cinnamomi* may survive in the gut of some animals if ingested¹⁸.

natural spread

Once introduced to an area *P.cinnamomi* may spread naturally via motile spores (zoospores), a phenomenon greatly aided by surface run-off and sub-surface water movement downhill.

The zoospores infect the roots of susceptible species when the soils are wet.

P.cinnamomi can also move slowly across slopes and uphill via root-to-root contact between infected and uninfected plants.

The time-scale for such natural spread may range from a few years to many decades in some areas, depending upon the topography, vegetation and climate.

¹⁵ Weste, G., Hewett, M. and Reiter, N. (2004)

¹⁶

<http://www.ucmp.berkeley.edu/chromista/oomycota.html>

¹⁷ Laidlaw and Wilson (2003)

¹⁸ Schahinger *et al* (2003)

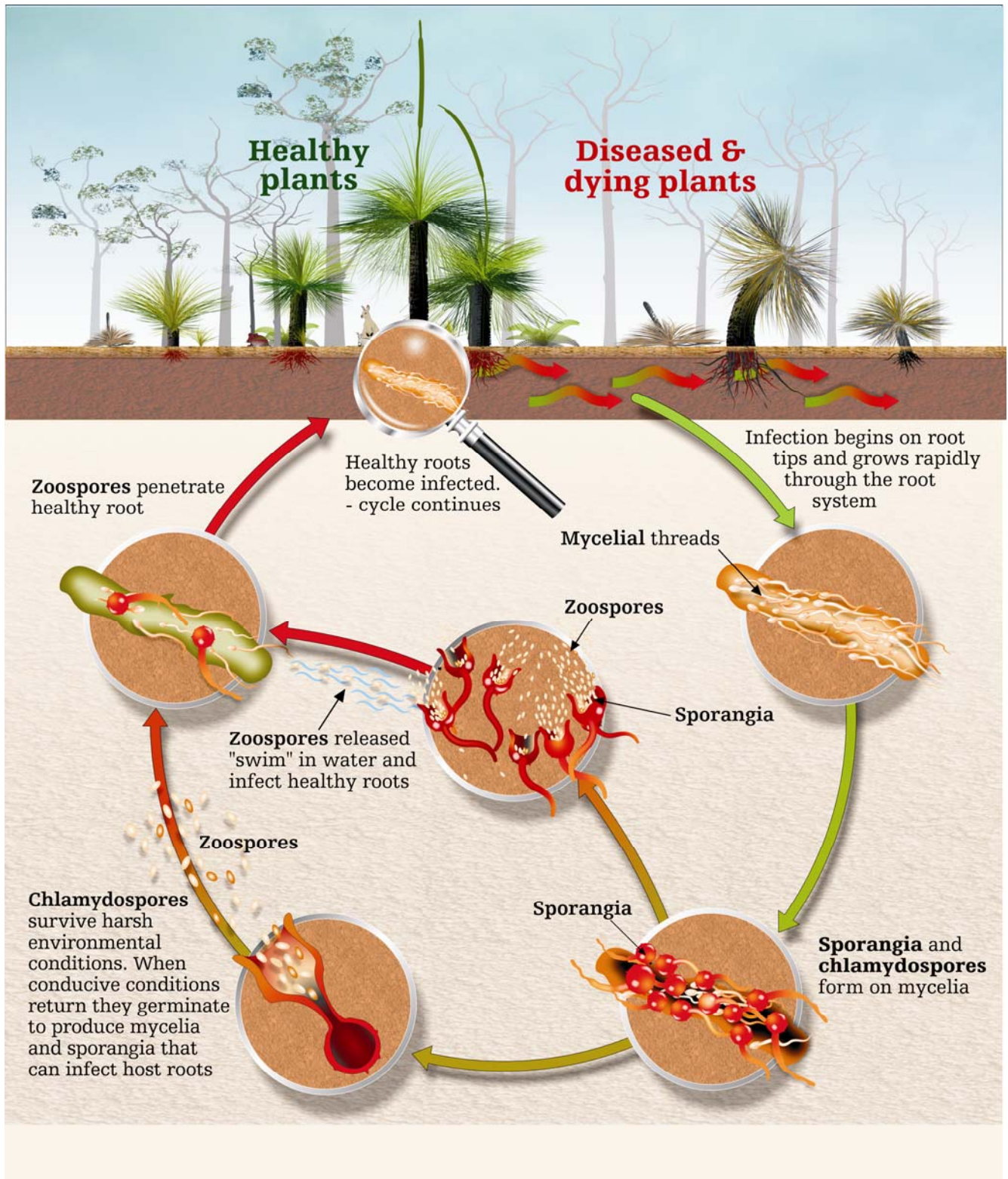


Image courtesy of WWF - Australia and the Western Australian Dieback Working Group

2 nature of the threat

2.2 Distribution

The pathogen was probably introduced to Australia within infected plants. Since its introduction people have inadvertently spread the pathogen far and wide.

The global spread of *P.cinnamomi* has mainly been attributed to the trading of plants infected with the pathogen. It probably arrived in Australia via plants bought by European settlers¹⁹.

P.cinnamomi was first detected in Australia in Willow trees used to make cricket bats in Melbourne in 1935. In 1965, it was recognised as the cause of 'dieback' of Jarrah trees in Western Australia. In 1969, it was identified as the cause of dieback of native forests in East Gippsland²⁰ and of woodlands in the Brisbane Ranges²¹, 75 km west of Melbourne.

The human-assisted transfer of *P.cinnamomi* has led to its spread across the Australian continent. It has now infested hundreds of thousands of hectares in Western Australia, Victoria and Tasmania, and tens of thousands of hectares in South Australia, as well as wet coastal forests in Queensland.

P.cinnamomi causes the most severe damage to native vegetation in areas that receive a mean annual rainfall of over 500 millimetres in three temperate climatic zones across Australia south of latitude 30°. Other than rainfall, temperature and soil characteristics (type and structure) have influenced the geographic distribution of *P.cinnamomi*.

P.cinnamomi continues to be inadvertently spread by cars and other machinery moving along road networks and into parks and reserves.

Gravel, earthmoving equipment and heavy machinery used in road construction and maintenance, and in forestry and fire fighting, have been implicated in the introduction and spread of *P.cinnamomi* to several State forests and national parks in Victoria, including Wilsons Promontory in the 1970's.

Works undertaken by utilities that engage in other earthmoving activities (eg. mining, pipeline and cable laying, building) have also contributed to its spread.

While most infections have started from roadsides, it has also spread down to gullies and in some cases slowly moved back up hills.

Managing incursions of *P.cinnamomi* is easier in areas where road and track density is low and there is little traffic. Track density and frequency of use may be used to assess risk²².

Further information about *P.cinnamomi* is provided in the National Plan and its accompanying technical report.²³

¹⁹ Marks, G.C. and Smith, I.W. (1991)

²⁰ Marks, G.C. Kassaby, F.Y. and Reynolds, S.T. (1972)

²¹ Marks, G.C. and Smith, I.W. (1991)

²² Gibson, M., Milne, R., Cahill, D. and Wilson, B. (2002)

²³ 'A National Overview of *P.cinnamomi* in Australia: supplementary information to accompany the draft national Threat Abatement Plan'.
<http://www.deh.gov.au/biodiversity/threatened/tap/phytophthora/references.html>.

2.3 Current active range in Victoria

Whilst *Phytophthora cinnamomi* is presumed to be widespread in Victoria, its impact is restricted to certain parts of the landscape.

The impact of *P.cinnamomi* within Victoria is limited by a combination of factors including temperature, rainfall and soil types.

Warm wet soils, especially those with impeded drainage, favour sporulation and movement of *P.cinnamomi*, as well as its growth within plant tissue.

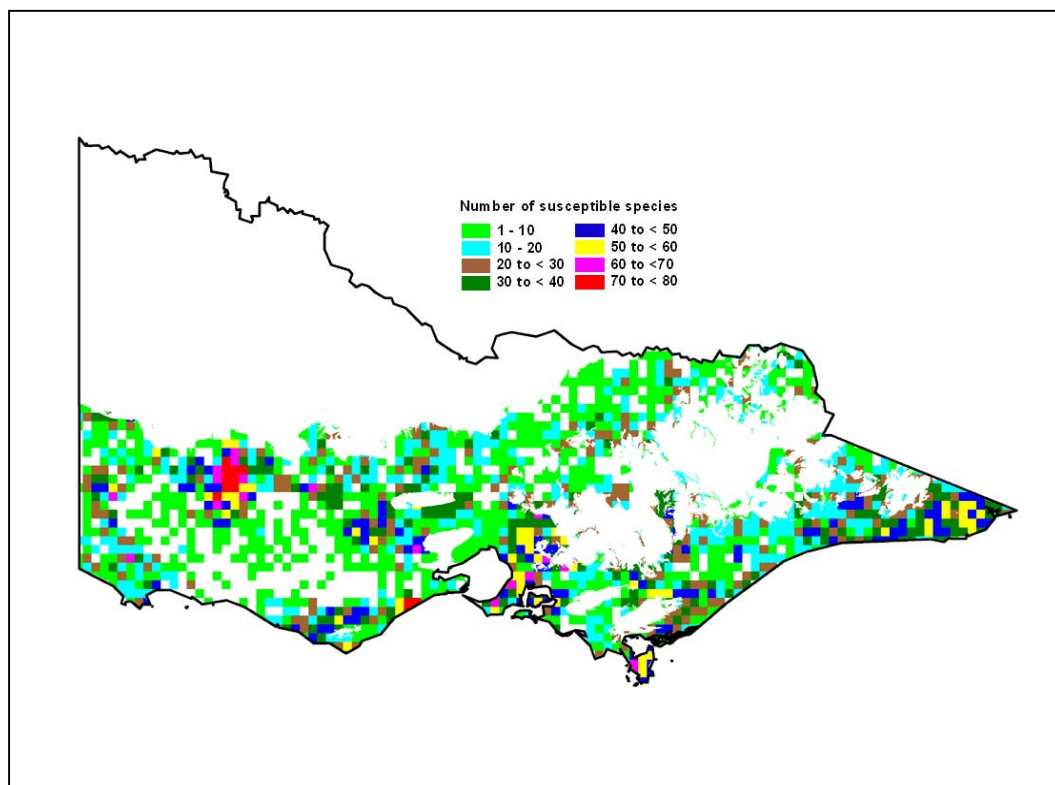
Favourable climatic zones for *P.cinnamomi* in Victoria include:

- All elevations in areas of Mediterranean climate from the west of Victoria across to Wilsons Promontory, where rainfall exceeds 500mm.
- The temperate rainfall regimes at low elevations of the coastal plain.
- Foothills between Wilsons Promontory and south of the border between Victoria and New South Wales.

It is important to note that whilst *P.cinnamomi* has been spread to many areas where it may be active, it has yet to be spread uniformly throughout them. It is typically found along roadlines.

Limiting further spread is a key objective of this Strategic Plan.

Figure 1: Biologically active areas for *Phytophthora cinnamomi* showing locations where the pathogen has been isolated as well as the numbers of susceptible species per 5 minute grid cell. The map is simply indicative of the pathogen's biologically active envelope in Victoria with some indication of its potential impact. Future mapping is intended to clarify the threat to various susceptible taxa and communities as a precursor to identifying areas for further on-ground evaluation of management requirements. From these on-ground appraisals DSE will be in a better position to weigh up the risks and management costs for consideration of the most effective use of resources.



NOTE: This map has been compiled from climate and vegetation analysis undertaken by Ballarat University on behalf of Parks Victoria (Gibson *et al.*, 2002) and modified to reflect areas known to be conducive to the pathogen. It is based upon published research and DSE experience over the last 30 years. It should be noted that this is a generalised map and that some sites within and outside susceptible areas may express or suppress symptoms due to localised topographical features and other soil factors.

2 nature of the threat

2.4 Ramifications of climate change

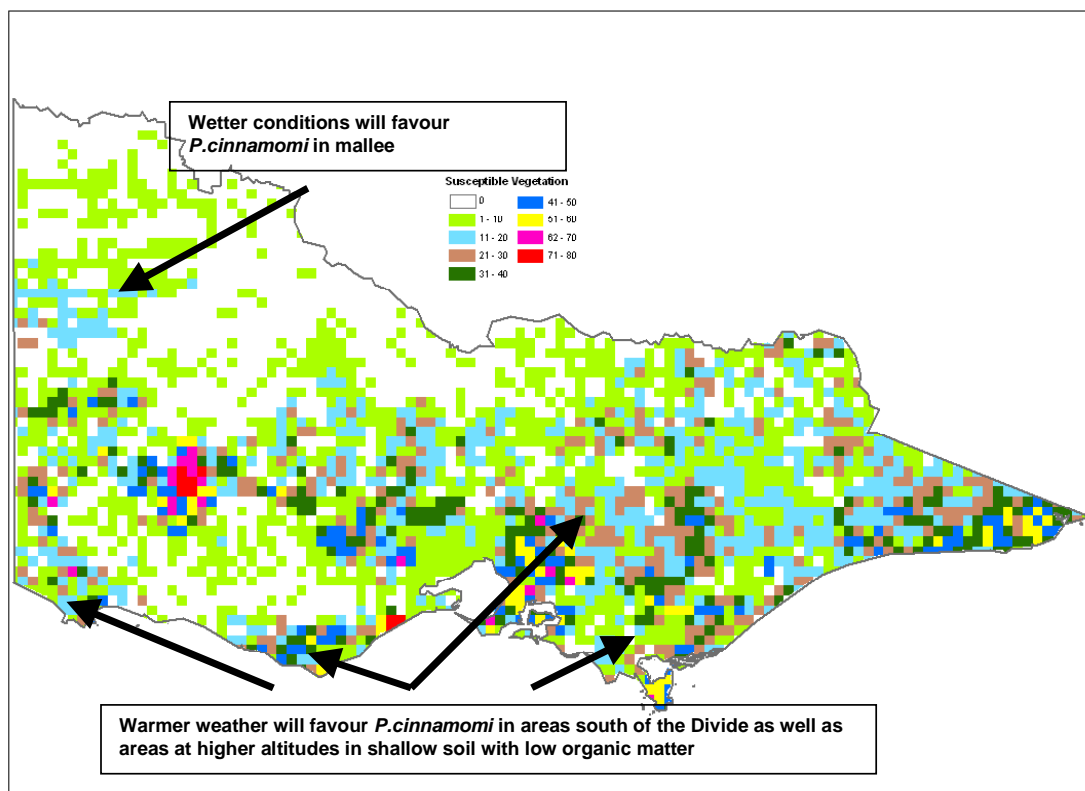
The present biologically active envelopes of *Phytophthora cinnamomi* in Victoria may increase with climate change, which in turn will affect more vegetation.

Climate change leading to wetter summers and warmer winters may result in a greater virulence of *P.cinnamomi* and a potential expansion of its current range.

This may lead to disease outbreaks in more mountainous areas of Victoria that are currently too cool or high in organic matter for *P.cinnamomi* to survive or have a significant impact. For example, in the Central Highlands the impact may be most noticeable for susceptible forestry species growing in flat areas and those with poor drainage, such as Mountain Ash (*Eucalytus regans*) and Shining Gum (*E.ritens*).

Climate change may also lead to greater impact in lower regions where it is currently too dry.

Figure 2: Areas of Victoria highlighting susceptible vegetation.



2.5 Impact on native vegetation – *variation between and within species*

There is considerable variation in the susceptibility of various plants to *Phytophthora cinnamomi*. Plant communities that contain many susceptible species, notably trees, are characterised by symptoms of 'dieback'.

Taxa

In general, herbaceous perennials, annuals and geophytes are more resistant to *P. cinnamomi* than woody perennials. The most susceptible plant families are the Proteaceae, Fabaceae, Dilleniaceae and Epacridaceae²⁴.

However, susceptibility even in these groups may vary significantly. For instance, variation in Proteaceae in Western Australia has been found to be bimodal, featuring both resistant and susceptible groups²⁵.

Variation has also been observed between different populations of the same taxa, as well as within a population, so called intraspecific variation²⁶. Variation in susceptibility between species and genera makes the occurrence of *P. cinnamomi* within family and genus poor predictors of susceptibility.

Vegetation

Woodlands, heathlands and coastal forest communities are particularly susceptible to *P. cinnamomi*²⁷. It can pose a significant threat to ecosystem function in these areas by altering the species composition and structural dominance of vegetation. This ultimately leads to the loss of fauna²⁸.

P. cinnamomi may alter the composition of flora in a landscape from one where plant pollination is dominated by mammals, birds and insects to a landscape that is principally wind pollinated²⁹.

The overall impact on vegetation varies depending on the percentage and dominance of susceptible plants in an infested area.

Symptoms

In vegetation communities where most dominant plants are resistant to *P. cinnamomi*, it is characterised by the attrition of minor floral components. This often makes it difficult to define the boundary between infested and uninfested areas.

In communities like heathlands that feature a high proportion of susceptible plants, the visual impact and boundary definition of *P. cinnamomi* is most stark to a casual observer at the time of an outbreak when susceptible flora dies. After the event, should trees survive, the impact is not often evident to the untrained eye because the susceptible understorey plants are replaced with other plants, most commonly sedges.

Where the roots of larger plants and trees are killed by *P. cinnamomi* they often display symptoms similar to drought stress. The expression of the disease in this instance is commonly referred to as 'dieback'.

Research issue:

Research is needed to identify indicator species and the symptoms indicating the presence of *P. cinnamomi* in different vegetation.



Anglesea Grevillea (*Grevillea infecunda*), a national and state vulnerable species, restricted to Anglesea in an area succumbing to *Phytophthora cinnamomi*.

Photo: Andrew Pritchard

²⁴ Weste, G. and Marks, G.C. (1987)

²⁵ Shearer, B.L., Crane, C.E. and Cochrane, A. (2004)

²⁶ Harris, J. A., Kassaby, F. Y., Smith, I. W. & Marks, G. C. (1983)

²⁷ Laidlaw, W.S. and Wilson, B.A. (2003)

²⁸ Wilson, B., Lewis, A. and Aberton, J. (2003)

²⁹ Kennedy J., and Weste, G. (1986)

2 nature of the threat

2.5 Impact on native vegetation – *dormancy and epidemics*

Apart from varying susceptibility between and within species, local and temporal variations in environmental conditions influence the virulence of *Phytophthora cinnamomi*.

Environmental variation

Apart from inter- and intraspecific differences in susceptibility, the virulence of *P. cinnamomi* also depends on the interplay between it and the local environment, as well as an infected plant and the environment. For instance, if environmental conditions for *P. cinnamomi* are not optimal, despite its presence, it may not be active. The interplay between this triumvirate is often portrayed as the 'disease triangle'³⁰ (see [Figure 3](#)).

Soil conditions that affect *P. cinnamomi* include its moisture, temperature, structure, chemistry and organic matter content. Soil moisture levels and temperatures particularly influence the activity of *P. cinnamomi*. Warm temperatures and high soil moisture levels (*eg.* following rain in spring and summer) favour the production of free swimming spores and increase their potential for infection and spread downhill.

Where environmental conditions for infection are favourable to *P. cinnamomi*, its impact is also a function of host susceptibility and environmental stresses on plants. Plants whose roots are damaged will naturally succumb more rapidly with greater sun exposure³¹.

Warm wet summers that favour *P. cinnamomi*, followed by warm dry autumns that water-stress plants, can lead to epidemic outbreaks. These events tend to be cyclic.

Long-term prognosis

Interpretation of the plant dynamics is difficult given the long time spans associated with regrowth of slow growing species, such as the highly susceptible Austral Grass-tree (*Xanthorrhoea australis*), and the interplay with climatic changes occurring over several decades. This is exacerbated by the difficulty of accurately measuring the activity and amounts of *P. cinnamomi* in the soil.

Ecological studies at Wilsons Promontory and the Brisbane Ranges have noted the return of some susceptible species.

One interpretation is that the regeneration from soil-stored seed has occurred because *P. cinnamomi* has been effectively dormant due to exceptionally dry seasons. This is supported by observations of the subsequent death of seedling and young plants due to a resurgence of activity by *P. cinnamomi* when the weather pattern changes.

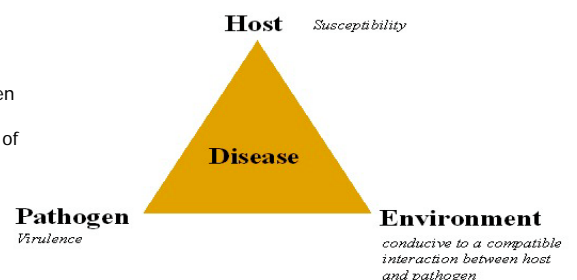
Others have suggested the return of natural vegetation may be due to selection for resistance³².

Long-term forestry research in coastal areas indicates a small percentage of individual trees within susceptible species (genotypes) are tolerant to *P. cinnamomi* infection³².

The percentage of susceptible vegetation observed regenerating in the Brisbane Ranges or Wilsons Promontory that is resistant is unknown. Whilst the potential for selection and restocking with resistant plants is proving effective in forestry, it is not known whether this may provide a long-term basis for managing other infested areas.

In situations where a serious risk of losing significant flora exists, seed collection and/or *ex-situ* cultivation may need to be employed.

Figure 3. The disease triangle describes the relationship between the host, the pathogen and the environment in the development of disease.



³⁰ Brown and Ogle (1997)

³¹ Wilson, B., Lewis, A. and Aberton, J. (2003)

³² Marks, G.C., and Smith, I.W. (1991)

2.6 Impact on fauna

A range of fauna is affected by *P.cinnamomi*, including small mammals, reptiles, birds and invertebrates. Fauna are affected through the subsequent loss of shelter (cover, hollows) and food (nectar, pollen, seed, and prey, particularly invertebrates). The loss of keystone plants such as Grasstrees (*Xanthorrhoea australis*) appears to have a significant impact on some fauna.

The extent of faunal impact depends upon each species' requirements for food and shelter³³. Although faunal research is rather limited, the indications are that the impact is likely to be greatest on those specialist species that require relatively dense species-rich shrublands and have restricted diets.

A preliminary appraisal³⁴ has shown that twenty-two native mammal species, some classified as threatened, have more than 20% of their known distribution in diseased areas in Victoria.

Threatened mammal species likely to be significantly affected in areas heavily impacted by *P.cinnamomi* are the New Holland Mouse (*Pseudomys novaehollandiae*), Smoky Mouse (*Pseudomys fumeus*), Heath Mouse (*Pseudomys shortridgei*), Long-nosed Potoroo (*Potorous tridactylus*), White-footed Dunnart (*Sminthopsis leucopus*) and Southern Brown Bandicoot (*Isodon obesulus*).

Other threatened fauna likely to be affected includes the Ground Parrot (*Pezoporus wallicus*), Rufous Bristlebird (*Dasyornis broadbenti*), King Quail (*Coturnix chinensis*) and Diamond Python (*Morelia spilota spilota*).

Research issue:

Further research is necessary to better understand the threat of *P.cinnamomi* to Victorian fauna. Detailed studies are needed on movement patterns and resource utilisation for the most sensitive species, particularly threatened species. Predictive modelling of likely impacts may be possible based on a knowledge of the habitat requirements of various fauna.



Diamond Python (*Morelia spilota spilota*), a threatened species dependent upon coastal vegetation that is susceptible to *Phytophthora cinnamomi*.

Photo: Ian McCann

³³ Wilson, B.A., Newell, G., Laidlaw, W.S. and Friend, G. (1994)

³⁴ Laidlaw, W.S. (1997)

2 nature of the threat

2.6 Impact on fauna *cont.*



The Ground Parrot (*Pezoporus wallicus*), a threatened species that lives in coastal heathlands across Victoria which include many plant species susceptible to *Phytophthora cinnamomi*.

Photo: © Len Robinson/Viridans Images



Phytophthora cinnamomi threatens the habitat of the Heath Mouse (*Pseudomys shortridgei*), a threatened species that lives in the Grampians and far South West Victoria.

Photo: Ian McCann

2.7 Impact on forestry

While *Phytophthora cinnamomi* is presently only a concern for Victoria's less productive forestry operations at lower elevations, climate change may alter this.

Native forests

In Victoria, *P.cinnamomi* is not presently a major concern for the more productive forestry operations at higher elevations due to it being restricted by environmental and site factors. These areas have predominantly cold winters, dry summers and high soil organic matter.

Mountain Ash (*Eucalyptus regnans*), one of Victoria's more important harvestable trees, is susceptible to *P.cinnamomi*.

The expression of dieback has been limited mostly to Ash (eg. Silvertop *Eucalyptus sieberi*) and Stringybark species of low production coastal forests in east and south Gippsland³⁵.

Even here the impact is variable. The favourable weather conditions that caused an epidemic of dieback in 1971 are cyclic, coming about every 45 years in south Gippsland and about every 15 years to east Gippsland³⁶.

Plantations

The impact of *P.cinnamomi* is being managed in plantation forestry predominantly by growing species that are either not susceptible to the pathogen (eg. Blue Gum, *Eucalyptus globulus*) or only affected on favourable sites in the first two years following establishment (eg. Monterey Pine, *Pinus radiata*).

Plantation trials of Mountain Ash and Shining Gum (*Eucalyptus nitens*) in lower altitudes in Gippsland have been affected by *P.cinnamomi*.

Research findings

The 1969 discovery of *P.cinnamomi* in Victoria's native forests prompted the initiation of government and university research programs to understand its biology and impact, and to determine necessary management actions.

This research has provided a basis for the development of a risk management approach to *P.cinnamomi*. This approach is based on host susceptibility, rainfall, soil type and temperature. It has been incorporated into State Forest Management Plans and a National Parks policy.



Dieback of Yertchuk, (*Eucalyptus consideniana*), Mullundung State Forest.

Photo: I. Smith

³⁵ Marks, G.C., and Smith, I.W. (1991)

³⁶ Tregonning, K. C. and Fagg, P.C. (1985)

2 nature of the threat

2.8 Impact on plant traders and end-users

The garden and nursery industry offers a haven for *Phytophthora* species in the absence of disease management – an issue which has significant implications for end-users.

Nursery and Garden Industry

P.cinnamomi is prevalent in the nursery and garden industry, affecting both nursery operators and growing-media manufacturers³⁷. Although not necessarily present in stock, *P.cinnamomi* may be on the premises, thus posing a constant threat. Hybridisation between 'Phytophthoras' is also a serious threat.

Businesses with stock most likely to be impacted by *P.cinnamomi* take plant hygiene extremely seriously to prevent infestation (eg. raising plants off the ground) and adopting quarantine and other hygiene measures.

In other nurseries, susceptible plants may survive due to favourable conditions such as the provision of adequate shade and water.

The impact may also be lessened through other plant husbandry practices such as the use of fungicides to temporarily inhibit³⁸ or kill the pathogen, or even chemicals to enhance plant resistance.

Horticulture

P.cinnamomi also poses management issues for growers of susceptible native plants (ie. Proteaceae) and where irrigation is used during summer (eg. avocados and chestnuts). Farmers in the cut flower trade must be particularly careful not to introduce it to their land. Such concern translates to the need to employ hygiene procedures by those who supply farms with seedling stock.

Urban consumers

Less professional businesses and community-based nurseries, as well as weekend markets, pose the greatest threat to consumers as these are least likely to be operated with appropriate quarantine and hygiene measures. Such outlets may readily and unknowingly sell either infected stock or pots with infested soil. Tolerant stock may act as host to the pathogen with no apparent signs of ill health. Similarly, susceptible stock may appear healthy simply due to plant husbandry practices. Once infected plants are placed in or on the ground the pathogen may spread.

Although *P.cinnamomi* is widely dispersed in urban environments, there is significant potential for wider dispersal to gardens and other urban landscapes. A significant threat is posed to gardens with established plants such as Rhododendrons, Azaleas and those in the Proteaceae family. The significance of the threat increases in instances where gardens are adjacent to uninfested bushland containing susceptible plants.

London Plain trees (*Platanus X acerifolia*) are also susceptible, posing a management issue for local governments.

Revegetation

The threat of *P.cinnamomi* also extends to revegetation activities. Material sourced from infested nurseries or grown by community groups pose the greatest risk.

Much of this stock is grown directly on the ground, greatly increasing the likelihood of becoming diseased should the premises be infested. Some growers source water from infested dams.

The potential loss or impact due to *P.cinnamomi* is unknown. By way of an example of scale, project proponents funded through the Natural Heritage Trust from 1997 to 2001 reported planting over 23 million seedlings across 32,000 hectares of Victoria.

According to the Australian Bureau of Statistics, there were almost 4 million trees planted (for all purposes excluding timber plantations) in 2001/02 on Victorian farms³⁹. It is unknown to what extent any safeguards have been employed in revegetation efforts.

³⁷ Dr Giles Hardy, Director of the Centre for *Phytophthora* Science and Management, Murdoch University, Western Australia found a range of pathogens in the majority of nurseries in WA in the early 1990's (pers comm.). However that situation is believed to have been mitigated by the larger suppliers with the uptake of hygiene practices (Nursery and Garden Industry, WA, pers. comm.). In NSW the Department of Agriculture found 38 % of nurseries with *Phytophthora* (mostly *P.cinnamomi*) although the percentage was believed to be far higher in view of the latent nature of the pathogen [Nursery Paper (2002)].

³⁸ Many fungicides do not kill the pathogen.

³⁹ Those with annual gross earnings of \$5,000 or more from agriculture.

2.9 Impact on social assets

Significant and iconic natural areas of Victoria have been affected by *Phytophthora cinnamomi*, along with human-made landscapes such as the Botanic Gardens and the Tall Forest Gallery of the Melbourne Museum.

Iconic plant

Victoria's flora emblem, the pink form of Common Heath (*Epacris impressa*), is susceptible to *P. cinnamomi*, although its degree of susceptibility has not been assessed.

Common Heath occurs in coastal regions and adjoining foothills as well as the Grampians and the Little Desert. Much of its heathland habitat is susceptible to *P. cinnamomi*.

Common Heath is depicted in the armorial ensign, granted to Victoria on 28 March 1973.



Iconic natural areas

A number of significant and iconic natural areas in Victoria have been affected by *P. cinnamomi*. Vegetation in parts of Wilsons Promontory National Park and the Grampians have been significantly altered by the pathogen, particularly in areas adjacent to roadsides and tracks. It is believed that infested machinery used to make a fire-break introduced it to Wilsons Promontory, while the use of infested gravel for roads is believed to have caused its spread in the Grampians⁴⁰.

Significant change to vegetation in parts of Wilsons Promontory has subsequently occurred. Pedestrian movement along popular walking trails at the 'Prom' is continuing to spread *P. cinnamomi*, threatening many heathland plants and the loss of their spring floral display⁴¹.

The demise of the striking, long lived Grasstrees is perhaps the most graphic reminder of the damage *P. cinnamomi* can cause, which is highlighted by the yellowing sprays of leaves and the presence of decaying trunks.

Iconic human-made landscapes

Some of the most significant landscapes affected by *P. cinnamomi* include the Royal Botanic Gardens of Melbourne and Cranbourne. High organic matter in the Melbourne gardens limits its impact. The potential risks are greater to Cranbourne's native vegetation, but free draining soil limits its spread and impact. Both gardens also employ hygiene and quarantine procedures to minimise spread within or from susceptible areas.

Melbourne Museum's Forest Gallery is a more recently affected landscape. Infested soil in the rootballs of tall trees transplanted in 1999 is thought to be the source of the *P. cinnamomi*. Intensive ongoing management has limited its impact.



Melbourne Museum, Forest Gallery.
Picture: L. Simpkin

⁴⁰ Weste, G. (1998)

⁴¹ Bluett, V., Weste, G. and Cahill, D. (2003)

3 managing the impacts

3.1 Vectored spread

The threat of continued spread of *Phytophthora cinnamomi* across the landscape from vehicles and other means is complicated by the range of activities and organisations that need to be engaged. Managing the threat will require targeting those engaged in more significant activities.

Culture

A range of earth work activities undertaken across Victorian Government and non-government agencies and businesses may lead to the spread of soil infested with *P.cinnamomi*. It can be transported on earth moving machinery or through the direct cartage of soil from infested gravel pits. The use of infested dam water for fire fighting has also been implicated in the spread of *P.cinnamomi*.

Other activities such as trail-bike riding, four-wheel driving and bushwalking may also lead to the spread of the pathogen. The level of awareness and concern varies amongst these groups.

Dealing with ignorance of the threat and/or lack of appreciation for the outcomes poses a management challenge.

Misconceptions about the manageability of the pathogen also thwart management efforts. These include false notions about the pathogen such as:

- It is native to Australia.
- Management efforts are too late, based on the view that the pathogen has reached all potentially susceptible areas, or that its autonomous spread across the remainder of the landscape is inevitable.

Governance

Management structures

The large scale and number of earth work activities poses a significant challenge for the management of *P.cinnamomi*. A number of key agencies and bodies need to assist with governing management.

Key stakeholders fall into those that may be vectors, and those that manage land that may be affected by vectors.

Such bodies include but are not limited to:

- Municipal Association of Victoria (MAV) and councils
- Melbourne Water
- Country Fire Authority
- VicForests
- VicRoads
- Victorian Association Forestry Industries
- Catchment Management Authorities
- Parks Victoria
- Department of Primary Industries.

Regulatory tools

Two major forest activities, fires and forestry, are governed by two Codes of Practice. Both Codes provide for the management of *P.cinnamomi* (see [Section 1.2](#)).

Systems and procedures

Numerous internal management systems exist within the various agencies, ranging from budget, planning and monitoring.

Strategy for managing vectored spread

Curbing further human spread of *P.cinnamomi* is highly challenging due to its cryptic nature and the difficulties of managing people across different agencies and in different locations.

A measured precautionary management response is required to curtail further human spread.

Efforts will be focussed where outcomes are likely to be most beneficial and where compliance, monitoring and enforcement are practical.

The strategy for managing further spread is:

- Identify particular parts (or zones) of Victoria where management is warranted.
- Work with key stakeholders to identify the best means for ensuring the uptake of best management practices using existing systems and procedures.

3.2 Nursery spread

The threat of continued spread of *Phytophthora cinnamomi* from infected nurseries is potentially significant. Managing the threat will require targeting both producers and consumers of products.

Culture

Nursery and garden industry

A national survey⁴² of attitudes of industry members about plant-diseases indicates a reasonably high level of awareness of the impacts of various diseases and control measures. Most growers in discussion groups around the nation perceived *P.cinnamomi* as a 'secondary issue', reasoning that it was 'ever present', and its expression a function of stress (*eg.* a change in climatic conditions). The inference is that *P.cinnamomi* is manageable through plant husbandry and hygiene practices. This view is at odds with that held by plant pathologists.

Implementation of industry best-practice is generally the *modus operandi* of larger and more professional commercial production nurseries, and of growing media manufacturers, who commonly test twice-yearly for the presence of *P.cinnamomi* and other pathogens. About 3%⁴³ of Victoria's nurseries seek accreditation for operating to industry best-practice standards.

Other nurseries may only adopt those elements of the best practice procedure relevant to *P.cinnamomi* and hence may not seek accreditation. A key factor is often size and the resources necessary to modify practices and operations to improve hygiene. The number that may operate to industry best-practice standards but not seek accreditation is unknown. Others may suppress *P.cinnamomi* through plant-husbandry practices such as fungicide application and/or the provision of additional shading and adequate water.

Consumers

Consumers are invariably ignorant of the threat posed by purchasing plant material from uncertified sources. A preference for acquiring cheap stock is part of the disincentive for the uptake of hygiene measures by the less professional operators within the nursery industry.

Revegetation sector

A key objective for much of the revegetation work is to enhance or restore the landscape. Despite this, there is variable awareness amongst suppliers and purchasers involved with revegetation of the prevalence of *P.cinnamomi*, and hence the potential threat. This includes government agencies contracting large and extensive revegetation programs.

⁴² Nursery Paper (2002)

⁴³ Based on the figures from the peak industry body in Victoria, the Nursery and Garden Industry Victoria (NGIV).

3 managing the impacts

3.2 Nursery spread *cont.*

Governance

Nursery and Garden Industry

Attempting to govern the lack of hygiene in smaller, less professional nurseries through regulation is either impractical or beyond the scope of this Plan. Improving hygiene practices, however, is important for benefits beyond *P.cinnamomi*, that is, for broader biosecurity issues.

A peak national body helping to address biosecurity is Plant Health Australia (PHA)⁴⁴. PHA is the national body coordinating plant health in Australia and is a joint industry-government company whose members include the Australian Government, State and Territory governments, and national plant industry organisations. PHA recognises the need to work with members to reinforce current community perceptions regarding the importance of biosecurity⁴⁵.

The peak industry body in Victoria, the Nursery and Garden Industry Victoria (NGIV) is also well placed to address *P.cinnamomi* spread from nurseries. NGIV is affiliated with the Nursery and Garden Industry Australia (NGIA)⁴⁶, the peak industry body for the Australian nursery and garden industry. NGIA has played a key role in forging better hygiene practices⁴⁷.

The nursery and garden industry has been working with PHA to develop a national Industry Biosecurity Plan through the NGIA, state industry associations and government agencies. This Industry Biosecurity Plan contains a range of risk identification and management measures, including hygiene and recommendations to further manage other biosecurity risks.

Revegetation sector

Several agencies may play a key role in governing the potential threat posed by the spread of *P.cinnamomi* through revegetation activities. These include the Australian Government Department of the Environment and Heritage, the Department of Agriculture, Fisheries and Forestry and, in Victoria, the Department of Sustainability and Environment and the Department of Primary Industries. These agencies collaborate with funding regional revegetation activities through the Natural Heritage Trust (NHT), National Action Plan for Salinity and Water Quality (NAP) and the National Landcare and National Bushcare Programmes (NLC and NBC). Other important bodies that may help govern this threat include Catchment Management Authorities (CMAs), liaison with which may be aided by the Victorian Catchment Management Council (VCMC)⁴⁸.

Groups undertaking revegetation to varying extents include the CMAs, Greening Australia, Trust for Nature, Tree-Project, Land for Wildlife, Greenfleet, Conservation Volunteers Australia, Field Naturalist Club, Birds Observers Club of Australia, Birds Australia, Landcare Groups and Landcare groups (Regional Landcare Coordinators, local level coordinators and facilitators).

Some groups operate independent of industry groups and hence liaising with them poses a challenge.

⁴⁴ PHA was set up in 2000 to protect Australia's plant industries and related resources from the risks posed by organisms. PHA aims to foster greater awareness and preparedness to manage diseases.

⁴⁵ Progressing Plant Biosecurity: Discussion paper on Plant Health Australia's strategic direction
http://www.planthealthaustralia.com.au/corporate_documents/display_document.asp?category=3&ID=232.

⁴⁶ NGIA also has affiliated special interest groups representing the major sectors of the industry.

⁴⁷ NGIV represents the interests of about fifteen per cent of the nursery and garden industry. NGIV membership includes sectors such as growers, wholesalers, retailers, allied traders and consultants. About 20% of the NGIV membership are accredited for employing best practice.

⁴⁸ VCMC is the Victorian Government's peak advisory body on catchment issues from a state-wide perspective.

3.2 Nursery spread *cont.*

Systems and procedures

Nursery and Garden Industry

Australia's nursery industry has a national voluntary accreditation scheme known as the Nursery Industry Accreditation Scheme, Australia (NIASA). The scheme commenced in 1993 following a national meeting of State and Territory Associations.

Revegetation

Funding mechanisms.

Further qualification of the risk *P.cinnamomi* presents to revegetation may highlight the need to take action. Agencies which fund revegetation may subsequently wish to ensure that stock is uninfected and that the activities of those involved with revegetation do not spread the pathogen to clean areas of moderate to high risk of disease expression.

One funding mechanism available is associated with the development and assessment of Regional Catchment Investment Plans (RCIPs)⁴⁹. Management measures for *P.cinnamomi* will require consultation with RCIP managers and stakeholders.

Monitoring

In terms of monitoring the management of *P.cinnamomi*, there is potential to expand the use of the Catchment Activities Management System (CAMS) to improve information sharing across a broader range of revegetation issues. CAMS is a state-wide information system that records on-ground activities that have received financial assistance.

Communication

Communication may be aided through:

- Incorporating awareness of *P.cinnamomi* into other broader training initiatives⁵⁰.
- Providing articles for publications such as Victorian Landcare and Catchment Management Magazine.
- Contributing to the Victorian Landcare website⁵¹.

⁴⁹ Many opportunities exist in the assessment process as outlined in the Regional Catchment Investment Plan Guidance Notes 2005-06 - <http://www.dpi.vic.gov.au/dse/nrenlwm.nsf/childdocs/-E9B6826F3AB828F64A2567D7000B1BA6-49701D1FE760D8C8CA256F7200006AD6?open>

⁵⁰ See recommendation - Greening Australia (2003).

⁵¹ The Victorian Landcare Gateway is a statewide Landcare portal for information on all Landcare regions, groups, networks, news and events. <http://www.landcare.net.au/>.

Strategy for managing nursery threat

Nursery and Garden Industry

- DSE will work with the Nursery and Garden Industry Victoria association to address the issue of the pathogen's spread from nurseries.

Revegetation

Gaining cooperation from funding agencies to manage the threat of *P.cinnamomi* should not be difficult. More work may be needed, however, to raise awareness of its threat to suppliers and community groups, and to motivate them to take precautionary measures to stop its spread.

DSE will work with relevant agencies and key stakeholders to:

- Address the threat of *P.cinnamomi*.
- Consider measured precautionary management to safeguard against the potential for transmission of the disease, using existing systems and procedures. This will include raising awareness amongst end-users and motivating them to take precautionary management actions.

3 managing the impacts

3.3 Safeguarding areas

Capability and motivation for managing *Phytophthora cinnamomi* is currently limited within Victorian organisations. There is limited overall governance and many disparate systems and procedures for site management.

Culture

Natural resource managers have variable levels of knowledge and appreciation of *P.cinnamomi*, and considerable variability in the skills required for detecting and appropriately responding to it.

Identifying the presence of *P.cinnamomi* requires knowledge of its disease symptoms as well as those of other potential plant pathogens in the area. Skill is also needed for taking samples for testing. Also lacking are simple guidelines to alert staff to the probable occurrence of *P.cinnamomi* (eg. symptoms on indicator species).

Management is based upon knowledge of the biology of *P.cinnamomi* and the environmental parameters known to limit its spread and impact. It is based upon the principle of the 'disease triangle'⁵², the elements of which include the host, the pathogen and the environment' (see [Figure 3](#)). Skill is also needed in formulating appropriate area management plans.

This lack of skills and knowledge represents a management gap.

The motivation of staff to act is also an issue. The same misconceptions mentioned in relation to the culture around vectored spread also inhibits area management.

Victoria's capability for managing *P.cinnamomi* is currently limited within its organisations, but this can be improved by employing accredited specialists to guide site appraisals and management planning, such as used in Western Australia. This may be an interim option until local courses are established to train and accredit staff.

Governance

Management structures

Currently, agency and industry governance varies in the adequacy of management programs, the use of licences or permits, as well as monitoring and reporting protocols.

To date, a few researchers⁵³ and the diligence of field staff have been the key drivers in the management of *P.cinnamomi* in Victoria's natural areas. Notable examples are the collaborative efforts by Parks Victoria staff in the Brisbane Ranges National Park with Melbourne and Deakin Universities

Key stakeholders that manage public land susceptible to *P.cinnamomi* include, but are not limited to:

- Melbourne Water
- VicForests
- VicRoads
- Catchment Management Authorities
- Parks Victoria
- Local Government.

Key stakeholders that may influence the management of private land susceptible to *P.cinnamomi* include but are not limited to:

- Catchment Management Authorities
- Australian Government
- Victorian Government.

⁵² Brown, J.F. and Ogle, H.J. (1997)

⁵³ Cahill, D., Harding, C., O' May, J. and Wilson, B. (2002)

3.3 Safeguarding areas *cont.*

Systems and procedures – *Operational and tactical issues*

Prioritisation and planning

A detailed state-wide appraisal of the threat posed by *P.cinnamomi* across all tenures is necessary for prioritising areas. However, there are presently no procedures for prioritising management of the pathogen. DSE has only recently identified areas in Victoria in terms of varying susceptibility to *P.cinnamomi*. This follows Parks Victoria's preliminary review of the actual and potential distribution of *P.cinnamomi* dieback in parks and reserves across the State⁵⁴.

Once DSE has prioritised areas, maps may be produced as a basis to manage further spread of *P.cinnamomi*. Various planning instruments such as the fire management and forestry Codes of Practice may be employed to manage *P.cinnamomi*. It is important to accept that effective control will require integrated and tenure-blind land management across regions and within areas.

Hygiene

Agreement is needed on the most appropriate hygiene procedures to minimise introduction and spread of *P.cinnamomi* by machinery, pedestrians and domestic animals that take into account compliance and resource costs. Once clarified, the appropriate management responses need to be incorporated into state-wide guidelines to guide on-ground hygiene and quarantining of natural and human landscapes.

Ex-situ conservation

There is a need to clarify when and how seed should be saved for *ex-situ* conservation, particularly for rare/threatened keystone taxa.

Clarification of the various systems and procedures will facilitate cost/benefit comparisons between areas (*ie.* assessing the significance of an area against the management costs).

Monitoring and evaluation

Monitoring and evaluation policies and procedures are needed to ensure that *P.cinnamomi* management actions are well coordinated and effectively reported. The development of these policies must be guided by the management principles contained in Victoria's Biodiversity Strategy⁵⁵, and a consideration of resource availability.

Once agreement has been reached between stakeholders regarding the best-practice for on-ground management of *P.cinnamomi*, methods for prioritising sites across the State must be developed. The prioritisation process needs to be consistent across tenures and take into account the cost/benefits within the broader integrated natural resource management context for particular regions.

National co-ordination

The issues presented above have been acknowledged nationally and are being addressed as part of a national project to develop national:

1. Best-practice standards for the management of sites (and species) that are or could be threatened by *P.cinnamomi*.
2. Criteria for prioritising area management. DSE is a partner in this project and will use the outputs as part of implementing this Plan.

⁵⁴ Gibson, M., Milne, R., Cahill, D. and Wilson, B. (2002)

⁵⁵ The second part in the series, Victoria's Biodiversity - Sustaining our Living Wealth (NRE, 1997), describes the legal, economic and social parameters which determine how biodiversity conservation will be implemented.

3 managing the impacts

3.3 Safeguarding areas *cont.*

Systems and procedures – *Research issues.*

Chemical control

Clarification is needed to guide the use of chemicals to control natural spread of *P.cinnamomi*⁵⁶. The use of chemicals may benefit vegetation downhill of infested sites where water movement will lead to inevitable infestation. It may also be possible to create a vegetative barrier to uphill movement of the pathogen that normally occurs via contact with infected roots.

The most promising agent for controlling *P.cinnamomi* is phosphite⁵⁷, a systemic fungicide thought to also trigger and/or enhance intracellular barrier formation to resist the pathogen's passage through a plant. Phosphite is being applied routinely in high value areas in Western Australia both through tree injections and spraying foliage by hand and aircraft. In Victoria, the use of phosphite is being trialled at places such as Wilsons Promontory, Aireys Inlet⁵⁸ and the Brisbane Ranges. At the latter site, phosphite is being trialled for the protection of Scented Bush-pea, *Pultenaea graveolens*, a threatened native plant species.

Management of *P.cinnamomi* by chemical control requires research, particularly on the optimal concentration of phosphite needed to induce resistance while not burning foliage.

Selecting for resistance

A key finding of the long-term forestry research into *P.cinnamomi* offers hope that some plants in a population of an otherwise susceptible species may be more resistant. A small percentage of susceptible trees planted in research trials survived infection, leading to the hope that over time disease resistance may build up in a host population⁵⁹.

An active management approach using fire to create ash-beds for sowing of seed has resulted in the successful regeneration of susceptible eucalypts on sites that were badly affected by dieback 'in the past'⁶⁰.

All susceptible eucalypt species that were affected in the initial dieback events have regenerated.

For other susceptible species, however, research is needed into the best approaches to stimulate production of seed to enhance their potential for survival and/or for *ex-situ* conservation. Such measures should be used in conjunction with chemicals that may temporarily induce resistance to *P.cinnamomi*. To prevent extinction of highly susceptible plants, novel approaches to enhance disease resistance may also need to be considered (*eg.* genetic engineering).

While fire may be used as a regenerative tool for some areas, (*eg.* enhancing seed set) further research is needed to ensure it is appropriate across all highly susceptible vegetation communities. Information is needed on whether prescribed burns have the potential to actually accelerate spread of *P.cinnamomi* through soil movement by fire management vehicles, surface run-off, soil erosion or enhancing its virulence through increased soil temperatures and moisture. Concomitant efforts may also be needed to possibly screen for resistance *ex-situ*.

Modelling distribution

Knowing where *P.cinnamomi* may spread requires knowledge of the variables governing its dispersal and expression. Modelling the distribution of the pathogen also provides the potential to locate highly susceptible uninvaded sites, and this is being considered now for its usefulness⁶¹.

Other methods

Biological control, the use of fire, and alteration of soil drainage are other avenues that have been suggested to protect susceptible areas from the impacts of *P.cinnamomi*. Their efficacy and research needs are discussed by Cahill *et al* (2002).

⁵⁶ Particularly the emphasis on interim protection of significant vegetation patches whilst longer-term solutions are explored.

⁵⁷ Active form of dipotassium phosphonate, also referred to as 'phosphonate'.

⁵⁸ Aerial application has been trialled at Aireys Inlet.

⁵⁹ Harris, J. A., Kassaby, F. Y. & Smith, I. W. (1985)

⁶⁰ Marks, G.C., and Smith, I.W. (1991)

⁶¹ Wilson, B., Lewis, A. and Aberton, J. (2003)

3.3 Safeguarding areas *cont.*

Strategy for safeguarding areas

Efforts must focus initially on keeping highly significant, vulnerable areas free of the pathogen as well as securing unique elements of those already infested.

Areas may be prioritised based on biodiversity, social amenity or economic value.

The foreseeable approach, arising from the prioritisation project under the National Plan, is to assess the significance of susceptible assets, the risks and their management potential, from which an overall cost/benefit analysis may be made.

Keeping highly significant, vulnerable natural areas free of the pathogen will be approached by adoption of 'clean-on-entry' hygiene procedures⁶². It may also entail restricting access or quarantining such areas from all but essential management activities.

'Clean-on-entry' involves testing soil and plant material to be used in vulnerable areas to ensure it is free of *P.cinnamomi*.

It also includes adopting hygiene procedures to avoid inadvertent introduction of infested soil from vectors such as earthmoving equipment and other vehicles, footwear or wild or domestic animals.

Halting the impact of *P.cinnamomi* as an interim measure in infested vegetation may be warranted in certain areas whilst long-term solutions are found. This approach aligns with ecological risk management principles.

Chemical intervention is the only apparent means at present of inducing short-term resistance to *P.cinnamomi*. Preliminary research is needed to ensure correct dosages are applied to different vegetation types.

Securing highly significant unique elements may necessitate salvage for *ex-situ* conservation.



Aerial spraying of Phosphite to control *Phytophthora cinnamomi* in the Anglesea Heathland.
Photo: D. Cahill

⁶² These could be incorporated with weed hygiene procedures.



4 strategic actions

Plan rationale

This Plan outlines a program of interrelated actions to manage *Phytophthora cinnamomi* to be implemented in phases. Each phase contains one or more specific objectives which lay the foundations for subsequent phases.

Setting objectives and phasing implementation

In an attempt to be realistic about outcomes, the objectives in this Plan were developed only after firstly identifying and grouping achievable actions and then considering their timing. The phases of actions are linked with annual budgets although some degree of overlap is expected.

Establishment phase

The Establishment phase includes actions intended to address knowledge gaps of *P.cinnamomi* (cultural issue) and for gaining commitment from various agencies to participate in cooperative efforts to manage the pathogen (governance issue).

It recognises that 'buy-in' at the highest level, essential for effective inter-agency collaboration, is influenced by perceptions and attitudes to *P.cinnamomi* and its management. Site examination with key players to demonstrate its impact on vegetation may be necessary before discussions about collaboration begin.

The cooperative development of a *P.cinnamomi* Strategy Monitoring and Evaluation Plan is critical to enhancing awareness and cementing commitment. There will need to be an understanding of the need, as well as alignment with the purpose and the objectives of the program (see [Section 5](#) for more details). Hence rather than DSE identifying performance indicators in isolation, the intent is to develop these in partnership with participating parties.

The Establishment phase is characterised by:

- Clarification of the threat of *P.cinnamomi* from a state-wide perspective.
- Gaining the genuine commitment of all relevant stakeholders through a Cross Agency Dieback Management Forum.
- Developing a *P.cinnamomi* Monitoring and Evaluation Plan for the program of actions presented in this Plan.

Systems formulation phase

The Systems phase develops and implements actions that relate to system/procedural concerns. It recognises that 'buy-in' at the ground level and within various industries is a perception (cultural) issue that requires engagement to build on system/procedure formulation. It also aims to enhance capabilities.

Actions in this phase will build on or integrate with the implementation of a national project reviewing current best-practice management of sites in Australia. DSE is a key partner in this project which has arisen out of the National Plan.

The Systems phase is characterised by:

- Engagement of the Management Forum across relevant agencies and stakeholders for the standardisation and refinement of best-practice methodologies.
- Production of extension materials.

Staff involvement in the development of systems and/or procedures is recognised as critical to effective uptake. Key middle management and field staff need to play a prominent role in championing current best-practice management initiatives.

Implementation phase

Managing the spread of *P.cinnamomi* will require systematically implementing the systems and procedures that stakeholders agreed on.

The Implementation phase is initially characterised by:

- Preliminary analysis of the threat from a catchment basis.
- Engaging regional management structures for overseeing planning and implementation.
- Subsequent mapping and planning of priority areas, and amending relevant land management planning systems.

As in earlier phases, culture will need to be addressed through extension activities. Area management that aligns with this Plan is anticipated to start by the end of 2007 and continue thereafter. The Management Forum, representing relevant agencies and stakeholders, in consultation with their regional management structures, will be the main facilitators of change.

1st phase: Establishment (2005/06)

Objectives:

- To establish cross-business, cross-agency coordination arrangements for managing *P.cinnamomi*⁶³
- To ensure that major land management agencies and other relevant stakeholders fully appreciate the nature and magnitude of the threat of *P.cinnamomi*, and are committed to participating in this Plan.

Actions

Identify areas at risk across the State and communicate to relevant land managers	Identify significant areas (ecological, social or economic) at risk from <i>P.cinnamomi</i> invasion. Include: <ul style="list-style-type: none"> • Maps of the actual and potential distribution of <i>P.cinnamomi</i> from a state-wide perspective, including climate change. • Overlays of assets ranked by significance and level of risk. • Summary of assets at risk.
Establish coordination arrangements	Form a Cross Agency Dieback Management Forum incorporating agency and industry bodies as appropriate. Clarify role, composition and reporting arrangements in Terms of Reference (see Appendix).
Conduct extension activities	Arrange presentations to relevant stakeholders and site visits to areas identified at risk to demonstrate issue.
Formulate Project Evaluation Plan	Formulate a <i>P.cinnamomi</i> Strategy Monitoring and Evaluation Plan to aid annual evaluation of the success or otherwise of each phase based on key evaluation questions (see <i>Monitoring and Evaluation of program</i> in Section 5). Success must also be measured against the higher order intentions as captured in each phase's objectives. The format and approach for this Plan should be based on most current departmental procedures.

⁶³ Responsibility for overseeing uptake of best-practice lies with senior representatives of key agencies as part of a 'Cross Agency Dieback Management Forum'. The undertaking of many strategic/coordinating actions will fall upon agency representatives within the Management Forum, while planning and implementation will be the responsibility of regional management bodies. The potential tasks of the Management Forum are outlined in the Appendix.

4 strategic actions

2nd phase: Systems formulation (2006/07)

Objectives:

- To ensure all parties are clear on their tasks and effectively discharge their responsibilities.
- To facilitate development of appropriate management systems to manage spread and to protect and prioritise assets from *P.cinnamomi*

Actions

Conduct ongoing extension activities	Arrange presentations and site visits with stakeholders to demonstrate issue (ongoing).
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Managing spread

Formulate operational methods for managing spread	Engage relevant stakeholders in the formulation of measures to address management issues necessary to minimise spread of <i>P.cinnamomi</i> through nursery trade and the transfer of infested soil and water by other means.
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Safeguarding areas

Formulate operational methods for area management	Engage relevant stakeholders in the development and implementation of Operational Procedures for protecting areas from <i>P.cinnamomi</i> .
Formulate tactical criteria to guide planning areas for management	Engage relevant stakeholders in the development and implementation of <i>P.cinnamomi</i> Area Planning and Monitoring Guidelines . These Guidelines are intended to guide planners develop tactical area plans, helping identify where and when to instigate site management activities. Such activities are based on the application of on-ground management tools specified in the Operational Procedures for protecting areas from <i>P.cinnamomi</i> . Plans should also accommodate the aims of relevant area management plans and consider relevant recovery plans or Flora and Fauna Guarantee Action Statements.
Formulate strategic criteria to prioritise areas for management across the landscape	Engage relevant stakeholders in the development of a <i>P.cinnamomi</i> Prioritisation System (including Australian Government) to guide strategic allocation of resources.
Create database capacity for state-wide monitoring of spread	Ensure capacity to monitor spread of <i>P.cinnamomi</i> from a State perspective is created and maintained in a central agency repository.
Facilitate development of systems and processes to accommodate <i>P.cinnamomi</i> management	Set annual targets for <i>P.cinnamomi</i> management that are reviewed by the Management Forum. Facilitate development of consistent planning systems for inclusion of <i>P.cinnamomi</i> management in operations planning and implementation.

3rd phase: Implementation (2007/08)

Objectives:

- To facilitate roll-out of systems devised to manage spread.
- To ensure that management of priority areas is planned in a coordinated regional context involving all relevant parties.
- To maximise the utility of existing landscape planning systems in the planning process.

Actions	
Managing spread	
Conduct extension activities	Work with key bodies to assist with the uptake of hygiene measures to minimise spread of <i>P.cinnamomi</i> through nursery trade and the transfer of infested soil and water by other means.
Safeguarding areas	
Engage or appoint relevant planning bodies	Ensure either existing regional management structures are engaged or appropriate bodies/persons are appointed to oversee planning and management of priority areas.
Conduct extension activities	Arrange regional site visits and presentations for those participants above as required to demonstrate issue.
Prepare area management plans	<p>Undertake detailed area mapping and planning commencing with those of the ⁶⁴highest priority in accord with the <i>P.cinnamomi</i> Area Planning and Monitoring Guidelines. Note: such an appraisal may need to be undertaken by accredited experts.</p> <p>Identify relevant regulatory instruments concerning use and planning suitable for supporting <i>P.cinnamomi</i> management, such as Codes of Practice, planning schemes, Regional Catchment Strategies, other strategies and land management plans.</p> <p>Ensure land managers amend relevant land management planning systems as required, including:</p> <ul style="list-style-type: none"> • Existing local <i>P.cinnamomi</i> management strategies. • Forest management and area prescriptions as required under the <i>Code of Forest Practice for Timber Production</i>. • Fire management plans as required under the <i>Code of Practice for Fire Management</i>. • Park management plans. • Regional Catchment Strategies. • Municipal planning schemes.
Facilitate agency co-ordination and feedback	Develop extension programs and ensure land management agencies adequately inform staff about <i>P.cinnamomi</i> and build capacity for focusing on regional priorities and implementing agreed and consistent management systems (from 2 nd Phase).

⁶⁴ DSE should supply data to assist with determining catchment priorities and subsequent detailed area mapping subject to data supply agreements.

5 monitoring and evaluation

Representatives of the Cross Agency Dieback Management Forum will be responsible for overseeing the monitoring and evaluation of this Plan's strategic program of actions across their respective agencies.

Annual appraisal

The effectiveness of this Plan will be assessed at the end of each financial year, and in addition to outputs, will focus on overall outcomes consistent with the objectives of various phases.

Interim six-monthly appraisals may also be conducted to provide opportunities for modifying the implementation if necessary.

The outcomes of each phase should be communicated via the Management Forum. The appraisals should be based on the *P.cinnamomi* Strategy Monitoring and Evaluation Plan developed in the Establishment phase.

Independent final evaluation

The success of this Plan will ultimately be measured in terms of meeting its aim.

Consistent with the approach in the National Plan, DSE will commission an independent expert before the end of the life of this Plan to appraise its implementation and outcomes.

6 beyond this plan

Once this Plan lays the foundations for *Phytophthora cinnamomi* management it is important it be reviewed and updated.

Plan update

Once the foundations for *P.cinnamomi* management have been laid by this Plan it is important it be reviewed and updated.

Retention of the management arrangements or transfer of responsibilities for monitoring compliance will be necessary beyond the life of this Plan.

Revision of systems and procedures

DSE should oversee updating and uptake by other agencies of revisions to the Operational Procedures and the Area Planning and Monitoring Guidelines.

Such revisions should consider research and management feedback, such as advances in mapping system capability and the refined use of chemicals to stem independent spread.

Recommendations from the independent review will be used to guide decisions on the future strategic management of *P.cinnamomi* throughout Victoria.

appendix

Potential roles and responsibilities

Cross Agency Dieback Management Forum

The Forum will:

- Provide a means of engagement and co-ordination across key agencies and stakeholders involved in practices relevant to the management of *P.cinnamomi*.
- Facilitate alignment of agency work programs to the priorities and actions established by this Plan.
- Consistent with National frameworks and standards, facilitate development and uptake of relevant guidelines, prioritisation systems and operational procedures across agencies.
- Facilitate development of a *P.cinnamomi* Strategy Monitoring and Evaluation Plan to enable annual evaluation of the implementation of this Plan.
- Coordinate an annual discussion and review of the implementation of this Plan, in line with the Monitoring and Evaluation Plan.

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