

# Interim *Phytophthora cinnamomi* Management Guidelines



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Tim Rudman  
Nature Conservation Report  
05/7



Tasmania

DEPARTMENT of  
PRIMARY INDUSTRIES,  
WATER and ENVIRONMENT

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Interim  
***Phytophthora cinnamomi***  
Management Guidelines

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This interim guideline has been developed to provide written advice on the management of *Phytophthora cinnamomi* in Tasmania. The guidelines are not policy and each land manager will have to determine the relevance to their operations. It is provided as an interim document while a national review of *P. cinnamomi* management practice is conducted. The advice provided is broad, generic and may not necessarily apply in any given circumstance. For further assistance contact:

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## Glossary

### **Disease**

The development of symptoms of ill health or malfunctioning in a plant. May be caused by a pathogen and/ or environmental stress. For *P. cinnamomi* to cause disease the plant must be susceptible and the environmental suitable for *P. cinnamomi* to grow.

### **DIER**

Department of Infrastructure, Energy and Resources.

### **DPIWE**

Department of Primary Industries, Water and Environment

### **FT**

Forestry Tasmania

### **High risk activity**

An activity that involves contact with a large amount of soil or the risk of moving large quantities of soil such as the use of heavy machinery (bulldozers etc.), sheeting roads and planting seedlings.

### **Highly susceptible plant communities**

A plant community occurring in a conducive environment and contains a high proportion of susceptible plant.

### **Host**

A plant that may harbour a pathogen on or within its tissues. However it may or may not develop disease symptoms.

### ***P. cinnamomi* Management areas**

Delineated areas that have been identified as having a high priority for management to protect against adverse effects of *P. cinnamomi*.

### **Pathogen**

An organism that can cause disease within a host. *P. cinnamomi* is a pathogen.

### **Spores**

The microscopic reproductive units of *P. cinnamomi* (like seeds) that are released into the soil.

### **Susceptible host**

A plant that will host a pathogen and may develop symptoms provided that environmental conditions are suitable for the pathogen.

### **Susceptible species**

A species of plant that will host a pathogen and in which disease develops in at least a proportion of individuals provided that environmental conditions are suitable for the pathogen. Highly susceptible species will have the majority of individuals killed as a result of disease.

# BACKGROUND

## Introduction

The conservation of a number of plant species and communities within Tasmania is at risk from the impact of an introduced plant pathogen called *Phytophthora cinnamomi* (Phytophthora root-rot). A standard approach to management of *P. cinnamomi* across the different sectors of the community and tenures is required to address the threat from *P. cinnamomi* in Tasmania. This management guide provides the planning framework, assessment tools and recommended prescriptions for planners, land managers and contractors.

*P. cinnamomi* is a soil borne pathogen that causes death in a wide range of native plant species causing floristic and structural changes in susceptible plant communities. In addition it is a significant pathogen affecting some forest, agricultural and horticultural industries. For example, in Western Australia jarrah forests on poorly drained soils are killed, avocado plantations are affected and cut flower industries growing proteas are at risk. Wild plant harvesting industries may also be affected. Some garden plants such as rhododendrons and azaleas are readily killed by *P. cinnamomi* which can cause losses in the nursery industry and damage to city parks and gardens.

*P. cinnamomi* belongs to a primitive group of fungi-like organisms sometimes called water moulds. Water moulds were only recently taxonomically separated from the fungal kingdom when they were placed in the new kingdom of Chromista. However for simplicity *P. cinnamomi* has continued to be referred to as a fungus in many publications. It is not visible in the field as it grows within the roots of host plants as a very fine mycelium and the spores it releases into the soil are microscopic in size.

There are records in Australia of disease similar to that caused by *P. cinnamomi* dating back to 1882 in Queensland (Weste 1994) and 1922 in native vegetation in Western Australia (Shearer and Tippett 1989). However it wasn't until 1922 that *P. cinnamomi* was discovered and named by Rands and it became recognised as a plant pathogen. While the first record of *P. cinnamomi* in Tasmania was from a Hobart garden in 1956, surveys in the 1970's revealed it was widespread in Tasmania suggesting a much earlier introduction to the State. Quite possibly it was introduced in the early years of colonisation by Europeans with the importation of potted plants.

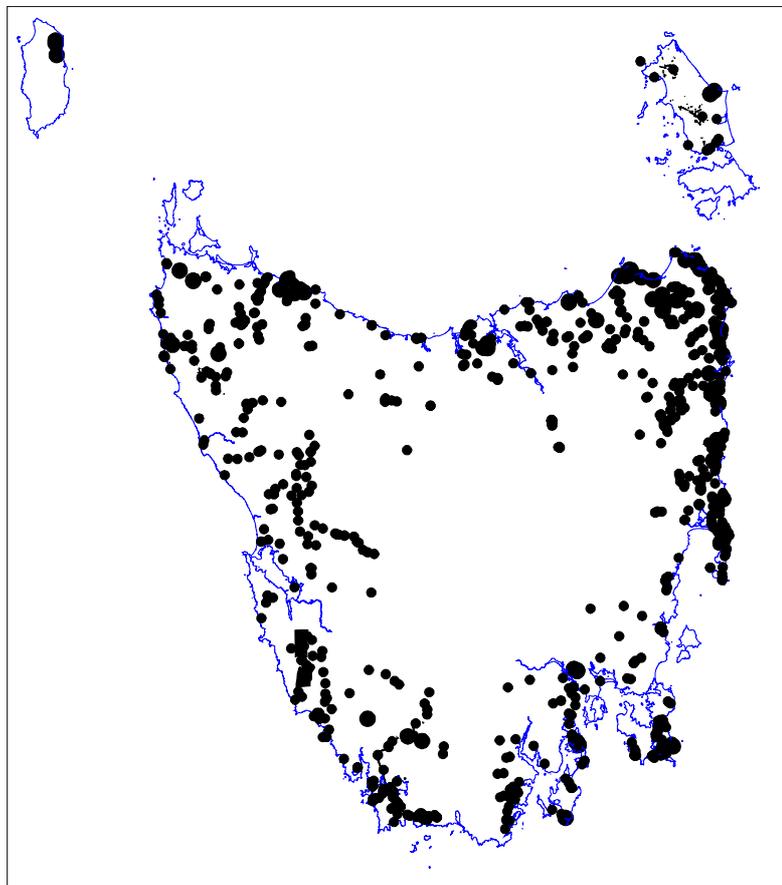
Movement of water, soil or plant roots that are infected with the pathogen can start new infestations. Once *P. cinnamomi* is introduced to a site incremental spread will occur for as long as the conditions are suitable. It may spread locally by its own autonomous means of movement (motile zoospores), with the flow of water downslope or carried by animals. However, it is thought that people moving soil is the primary vector for introducing the pathogen into new areas that are distant from the source of an infection.

*P. cinnamomi* is widely distributed throughout most areas of Tasmania that provide conditions suitable for disease (Figure 2). The only large areas of susceptible native vegetation believed to be free of *P. cinnamomi* remaining are Maria Island and the remote moorlands in SW Tasmania.

Autonomous spread of *P. cinnamomi* along with movement by water, wildlife and man all contribute to a continually increasing impact on biodiversity in Tasmania. Unfortunately few management options are available to control this spiralling disease problem. It is not currently feasible to eradicate *P. cinnamomi* from native vegetation or to locate and contain all infestations. While there is a limited capacity to reduce the impact of disease by manipulating fire and applying phosphite, these management methods are not practical to apply except on a small scale where high value assets are at risk. Reliance on Phosphite may also have unforeseen long-term consequences (e.g. it can depress pollen fertility in a number of native species (Fairbanks et al 2002)). The most practical solution to managing the impact of *P. cinnamomi* is to be found through addressing the protection of the values at risk rather than managing *P. cinnamomi* per se.

Species and communities that are highly susceptible to *P. cinnamomi* have been identified as having a high priority for protection (Barker and Wardlaw 1995, Schahinger et al (2003). Barker *et al.* (1996) developed a method for ranking the priority for protection of areas containing populations of susceptible threatened species. Using this method, Barker (1994) identified 60 areas containing populations of susceptible threatened species as having high priority for management. Schahinger et al (2003) reviewed and extended this approach to identify additional areas containing highly susceptible plant communities that have a high priority for management. In effect defining the critical habitat for species and communities with respect to the *P.*

*cinnamomi* threat. The identification of these high priority management areas does not capture all areas where *P. cinnamomi* management would be beneficial. A *P. cinnamomi* assessment process within industry operating procedures and codes of practice can provide a mechanism for capturing other areas where protection from *P. cinnamomi* would be warranted and beneficial.



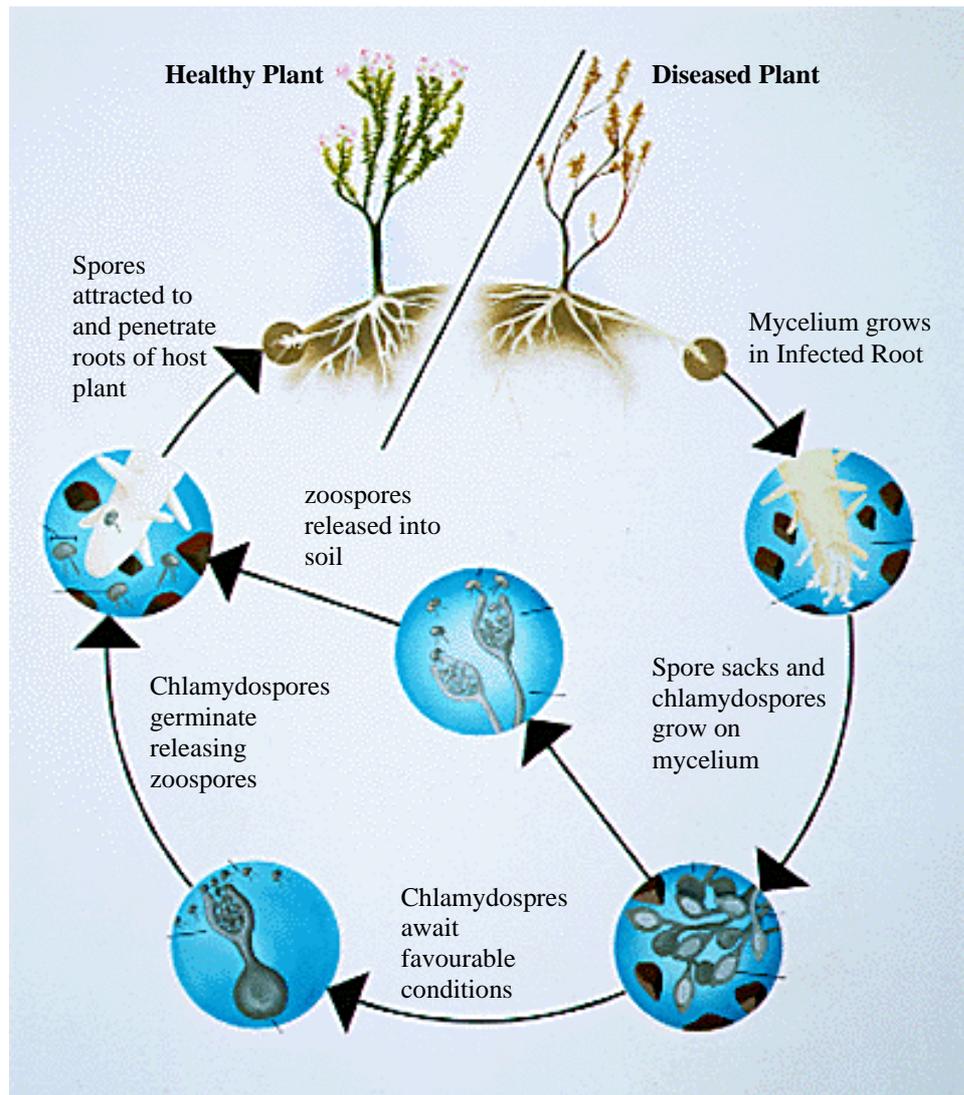
**Figure 1.** Distribution of *Phytophthora cinnamomi* in Tasmania. Note Clarke, Hunter and Cape Barren Islands are also known to be infected.

## Biology of *P. cinnamomi*

A basic understanding of the biology of *P. cinnamomi* is important in the design of an effective management strategy. Motile spores, called zoospores, are produced in flask-shaped organs called sporangia. They are the primary means by which *P. cinnamomi* infects host plants. Zoospores require free water, either in a film surrounding soil particles or in water bodies, to allow them to swim towards roots of host plants. The water requirement for the production of sporangia and the release and dissemination of zoospores is the reason why disease due to *P. cinnamomi* is confined to moist situations.

Once zoospores attach to the host tissue they encyst, produce germ tubes to penetrate the cell walls of the host to finally produce mycelium (fungal threads), which spread through the host roots. Infection seldom spreads beyond the root system only occasionally reaching a few centimetres up plant stems. It is the enzymes produced by the mycelium that are responsible for the destruction of host cells that causes disease. While *P. cinnamomi* is well adapted to parasitise living host tissue it is poorly adapted to survive saprophytically in dead plant tissue.

During unfavourable conditions (absence of suitable hosts to infect or unsuitable soil conditions to allow dispersal) *P. cinnamomi* can produce two types of resting spore. These are thick walled spores capable of persisting for extended periods (usually <1 year but sometimes as long as 6 years) until conditions are favourable for the fungus. Chlamydospores are produced asexually, directly by the mycelium. Oospores are produced sexually from the union of the hyphae of the two mating types (A1 and A2) of the fungus. In southern Australia, the A1 mating type is rarely encountered and consequently oospores are unlikely to be produced in the field. Chlamydospores provide the only means by which the pathogen can persist during unfavourable conditions.



**Figure 2** Generalised life cycle for *Phytophthora cinnamomi*.

## Ecology of *P. cinnamomi*

*P. cinnamomi* evolved in tropical areas and requires warm, as well as moist, soils for at least some of the year to produce sporangia and release zoospores. Only those areas of the State that are below an altitude of about 700m above sea level have soils sufficiently warm for this to occur (Podger *et al* 1990a). There is some variation in the altitude at which disease may be caused due to a general trend in increasing temperatures from west to east at a given altitude and local site factors affecting soil temperatures. Below 700 metres, vegetation types that form closed canopies (e.g. wet sclerophyll forests and rainforests) also depress soil temperatures sufficiently to prevent the production of sporangia and zoospores. The requirement for moisture also limits the distribution of *P. cinnamomi* in Tasmania to areas with a mean annual rainfall of at least 600mm (Podger *et al* 1990a).

In Tasmania over 170 species have been recorded as hosts for *P. cinnamomi*. This includes some host species that remain free of disease such as blue gums, buttongrass or manuka (see appendix 6). Currently 27 threatened species are known to be susceptible to disease and at risk from *P. cinnamomi* infection (Schahinger *et al*. 2003). Vegetation types in which *P. cinnamomi* can cause significant disease include heathlands, buttongrass moorlands, and heathy dry sclerophyll woodlands.



**Figure 3.** Disease front in heathy dry sclerophyll forest, bracken is exposed as the dense layer of susceptible shrubs (*Pultenaea gunnii*) is killed.

## PLANNING FRAMEWORK

### Legislation and Related Plans

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, *Phytophthora cinnamomi* is listed as a key threatening process. A process is defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community. A Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi* (Environment Australia 2002) has been prepared to co-ordinate national action to limit the impact of *P. cinnamomi*. Under the Tasmanian Regional Forest Agreement (1997) the state agreed to participate in the production of the Threat Abatement Plan – implicit in this is an agreement to abide by the plan.

Within Tasmania, the Threatened Species Strategy for Tasmania (2000) identifies *P. cinnamomi* as a threat to species and community conservation in the State. Furthermore the implementation of the national threat abatement plan is identified as an action under the Threatened Species Strategy for Tasmania. As a signatory to the Tasmanian Regional Forest Agreement (1997), the State agrees to improve the management of species listed on the *Environment Protection and Biodiversity Conservation Act 1999*, a number of which are at risk from *P. cinnamomi*.

Additionally *P. cinnamomi* management prescriptions have been incorporated into various industry codes of practice or standard operating procedures such as within the Forest Practices Code, Quarry Code of Practice, Mineral Exploration Code of Practice, Draft Reserve Management Code of Practice, Forestry Tasmania Management Decision Classification System. State environmental impact assessment processes take into account *P. cinnamomi* issues where relevant.

Where necessary provisions of the *Plant Quarantine Act 1997* allow for the establishment of Protected Areas to direct measures for the protection of that area from a plant pathogen. This has been applied in one instance at the George III Monument Historical site for the protection of a threatened species.

## Aim

The aim of *P. cinnamomi* management is to control the human induced spread of the pathogen to minimise the extent of infection in species and communities at risk.

## Priorities

Priorities for *P. cinnamomi* management have been established under the national threat abatement plan (Environment Australia 2002), these are:

- To protect nationally listed threatened species and ecological communities from *Phytophthora cinnamomi*.
- To prevent further species and ecological communities from becoming threatened by reducing the chance of exposure to the pathogen.

Additional State priorities are:

- To protect large areas containing susceptible species or communities that are free of *P. cinnamomi*.

Though further spread of the pathogen is inevitable, taking action to reduce spread with human activity will significantly affect the rate of spread of the pathogen into uninfected areas. Reducing the rate of spread will buy time for development of better techniques to reduce the impact of *P. cinnamomi*. A reduced rate of spread through a population of a susceptible species may also improve the opportunity it has to successfully adapt to this new disease pressure.

## Recommended zoning

Rather than attempting to manage the pathogen, an approach focusing on protection of the biodiversity values at risk provides the most practical and effective means of management. This is further prioritised based on the significance of the value at risk and the practicality of applying management under the prevailing land use.

Three zones are recommended for management of *P. cinnamomi*:

### 1. *P. cinnamomi* infected areas

These areas are important to be identified to ensure that activities that span into uninfected areas do not result in transfer of the pathogen into these areas. Where activities occur in *P. cinnamomi* infected areas people need to be cognisant of when they may need to washdown such as when using heavy machinery. Indeed people have infected their front gardens killing azaleas and rhododendrons after infected mud has been dropped from cars in driveways.

### 2. *Phytophthora* Management Areas

Phytophthora Management Areas have been identified to capture representative areas that contain populations of susceptible threatened species or highly susceptible communities that are at risk from *P. cinnamomi*. This provides the core areas for conservation of biodiversity under threat from *P. cinnamomi*. The management areas are designed to encompass those areas least at risk of introduction of *P. cinnamomi* that contain:

- a population of one or more susceptible threatened species (up to three populations per species);
- and / or a highly susceptible plant community.

In those management areas free of *P. cinnamomi* strict management prescriptions to control high risk activities apply. However for some susceptible threatened species no disease free areas were found. In these situations the management objective is to minimise the spread and impact of *P. cinnamomi* within the areas.

*Phytophthora cinnamomi* management areas are identified on GTSpot (DPIWE), Maplink (PWS), MDC (Forestry Tasmania), Copies of the coverage are available from Nature Conservation Branch, DPIWE.

### 3. Uninfected areas

The second level of protection applies more broadly across the landscape to areas not known to have *P. cinnamomi*. These areas are defined by an absence of *P. cinnamomi* records, a suitable climate (below 700m elevation and > 600 mm annual rainfall) and presence of susceptible vegetation (susceptible species in open plant communities).

It is not possible to map all areas of susceptible *P. cinnamomi* free vegetation. Areas not known to have *P. cinnamomi* are to be considered to be *P. cinnamomi* free vegetation until a survey indicates otherwise. Development proposals will be required to test the presence or absence of *P. cinnamomi* in order to determine appropriate actions on a case by case basis. The practical application of this demands a decision on the scale at which conservation of areas under threat from *P. cinnamomi* will be sustainable.

Some of the factors that affect the longer term viability of protecting an area from *P. cinnamomi* include, the area, land use, natural buffers to spread and distance from existing infections. The assessment of the value and return on protecting an area requires assessment of these factors in both space and time. Additionally where an area has low scope for protection due to proximity to infestations, it may warrant protection from further spread due to land use if high value conservation assets are at risk.

An uninfected area will be determined by:

- A. An uninfected area >4 ha in size when surrounded by natural buffers.
- B. An uninfected area with a minimum distance to infection of 1 km if spread from an adjacent infestation can occur naturally (ie. no natural buffers);
- C. Any uninfected or partially infected population of a *P. cinnamomi* susceptible threatened species

Natural buffers include: closed canopy vegetation (continuous canopy > 2m tall and a minimum 100m wide), non-susceptible vegetation types (>100m wide) climatically unsuitable areas, topographic features such as above cliffs, over 200m elevation above infestations and watercourses / waterbodies. Gravel roads with uncontrolled access void natural buffers.

## Assessing *P. cinnamomi* Management Requirements.

There are two stages to prescribing management for *P. cinnamomi*:

1. Identify *P. cinnamomi* management zone and risk level and objectives
2. Review *P. cinnamomi* risks and develop management prescriptions.

The steps in stage 1 are presented in figure 5 and cover the following actions:

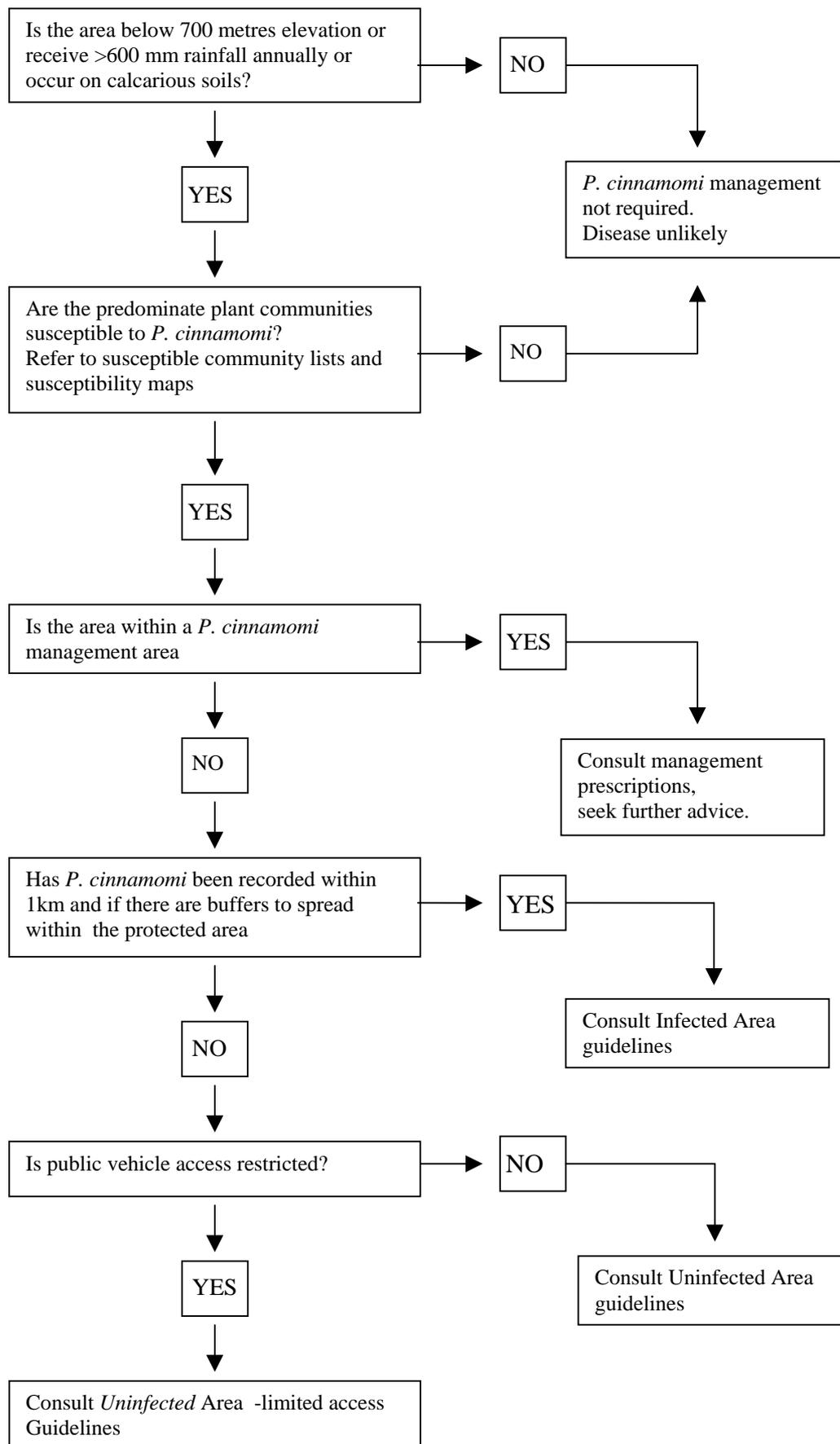
- step 1. determine if the area in question is susceptible to *P. cinnamomi*
- step 2. determine if the plant communities present in the area are susceptible to *P. cinnamomi*
- step 3. check if the area is a prescribed *P. cinnamomi* management area
- step 4. determine if the area is protectable from *P. cinnamomi*
- step 5. determine the level at which may be effectively managed (review access policy if appropriate)

### Defining the level of risk that can be managed

Hygiene can only be effectively implemented to protect an area where *P. cinnamomi* risk can be uniformly managed. For instance, imposing hygiene conditions on vehicle access by an industry but not requiring public compliance in the same area will not result in the outcome sought. Where susceptible *P. cinnamomi* free areas are subject to roading with public access and or other intensive land use only management of high risk activities is advocated given the risk environment. Where susceptible *P. cinnamomi* free areas have restricted access the risk of *P. cinnamomi* introduction and spread can be better managed and hygiene prescriptions covering a broader range of activities are justified. There may also be cause for review of current access policy in the light of potential *P. cinnamomi* impacts and the appropriate level of risk management desired.

Stage 2 can be undertaken by assessing the risks associated with the proposed activity against the management objectives and the potential impact should hygiene be breached. Prescriptions for management appropriate to the risk environment should be developed with reference to the recommended prescriptions for *P. cinnamomi* management.

**Figure 4** Process to determine *P. cinnamomi* management objectives.



## MANAGEMENT GUIDELINES

### Infected Area Guidelines

Infected areas normally consist of a matrix of diseased and disease free areas and varying floristic and site susceptibility to disease. As *P. cinnamomi* may spread naturally with water or animals, actions to restrict the spread caused by human activity is not likely to affect the ultimate expression of disease in the short to medium term. The public and industry also intensively use many infected areas. Therefore the practicality and cost of applying hygiene within these areas is not considered warranted. However activities within these areas will have the potential to *spread P. cinnamomi* to other locations when operations are moved.

**Threat:**

Spread of *P. cinnamomi* to other areas.

**Objective:**

Manage high-risk activities to reduce spread to uninfected areas.

**Management:**

- Ensure managers are aware when they are undertaking high-risk activities in an infected area.
- Manage the risk of *P. cinnamomi* spread with quarry products through industry awareness of infected pits and washdown procedures.

See Prescriptions section for detailed advise relating to different management activities.

### Uninfected Area Guidelines

Unrestricted access areas are those where the public may use vehicles on roads and tracks in an area without any access permits applying, excluding temporary road closure due to management operations.

While hygiene is encouraged, it is realistic to accept a finite level of risk associated with low risk activities such as vehicle use and recreational activities such as walking and horse riding. For example the public road network is open to regular traffic for which hygiene would be impractical to apply. While high risk activities involving movement of soil and use of heavy machinery may be readily managed by land managers or industry.

**Threat:**

The introduction of *P. cinnamomi* with high-risk activities.

**Objective:**

To manage high-risk activities to reduce the risk *P. cinnamomi* infection.

**Management:**

- Apply *P. cinnamomi* hygiene prescription to manage high-risk activities.
- Only introduce products that are screened as free of *P. cinnamomi* contamination into the area.
- Encourage good hygiene practices by users (walkers, farmers, industries)
- Consider managing or limiting public vehicle access where appropriate.
- Prepare for low risk wildfire responses.

See Prescriptions section for detailed advise relating to different management activities.

### Uninfected Area - Limited Access Guidelines.

Limited access areas are those where vehicle access is not possible or where vehicle access is restricted by permanent road closure, a permit system or open to management vehicles only. In this case the risk of human dispersal of *P. cinnamomi* into the area is comparatively low. Developments in these areas have the potential to significantly change the risk profile for the accidental introduction of *P. cinnamomi*

**Threat:**

The introduction of *P. cinnamomi* with all activities.

**Objective:**

To manage all activities to reduce the risk of *P. cinnamomi* infection.

**Management**

- Minimise high-risk activities in area eg use of earth moving machinery.
- Apply *P. cinnamomi* hygiene prescription to manage high-risk activities.
- Avoid as far as possible introduction of high-risk products to the area eg gravel.
- Only introduce products that are screened as free of *P. cinnamomi* contamination into the area.
- Apply *P. cinnamomi* hygiene prescriptions to all vehicle use in the area.
- Encourage good hygiene practices by users (walkers, farmers, industries)
- Manage vehicle access.
- Control risk of *P. cinnamomi* introduction on walking tracks where feasible.
- Prepare for low risk wildfire responses.

See Prescriptions section for detailed advise relating to different management activities.

## **PHYTOPHTHORA CINNAMOMI RESOURCES**

### ***Phytophthora cinnamomi* Distribution Records**

*P. cinnamomi* distribution records consist of *P. cinnamomi* spot isolation records and *P. cinnamomi* symptom polygons. Spot isolation records are extracted from the Forest Health Database (Forestry Tasmania) and represent *P. cinnamomi* isolations obtained from soil baiting or plant root isolation. Spot isolation records provide no information on the area affected. Symptom polygons are based on visual disease symptom mapping by trained observers. Most polygon boundaries are arbitrary as detailed boundary mapping is labour intensive and seldom attempted. Polygon size is generated based on extent of infestation observable on the route taken by the observer.

Maps covering *P. cinnamomi* distribution records, *P. cinnamomi* susceptible areas and *P. cinnamomi* Management areas for Tasmania are available on the web (<http://www.gisparks.tas.gov.au/explorer/html/exLogin.html>) or on internal servers (PWS, MRT, FT) and in paper form. Copies of the layer are available from Nature Conservation Branch, DPIWE.

### ***Phytophthora. cinnamomi* Susceptibility Mapping**

Susceptibility mapping is based on 1:25,000 and 1:100,000 vegetation maps prepared by the Vegetation Management Strategy for the State of Tasmania. Each vegetation type was rated for susceptibility to disease on infection by *P. cinnamomi* based on the known species susceptibility and whether the environment is conducive to disease development (see Appendix 1). Three categories were generated:

**1. Highly susceptible (Red)**

Likely to be severely impacted by *P. cinnamomi* with high levels of mortality across a range of species

**2. Variable or moderate susceptibility (Yellow)**

Variable or moderate susceptibility areas are those where the vegetation type includes a range of plant communities which respond differently to *P. cinnamomi*. Some plant communities may be severely affected while others within this mapping unit are not. In other cases the vegetation mapping unit may be uniformly affected by *P. cinnamomi* but changes to the vegetation are not as severe as for the highly susceptible areas.

**3. Low or no susceptibility (Green)**

Low or no susceptibility areas contain vegetation types where no significant disease problems are expected.

Susceptibility mapping is indicative only as it is based upon vegetation mapping derived from air photo interpretation. Field confirmation of vegetation susceptibility will be required.



- Program earthmoving work for months when the soil should be relatively dry.
- Program works to commence in disease free areas and progress into diseased areas.
- Don't allow machines to cross from *P. cinnamomi* infected areas into disease free areas without a washdown.
- Use in situ gravel wherever possible (e.g. same micro catchment). Don't move gravel or earth from infected quarries etc. into uninfected areas.
- Source water for construction locally and don't import from an infected to an uninfected area. Sterilise with chlorine if there is any uncertainty.
- Construct roads and firebreaks to shed water and dry quickly.
- Construct deep table drains to carry run-off swiftly and directly towards the nearest natural watercourse.
- Don't construct drains that result in ponding.
- Minimise the area of disturbance (e.g. restrict width of road verge).

## Maintenance

*Road and track maintenance has the capacity to move soil and Phytophthora root-rot with it many kilometres across the landscape.*

- Work wherever possible from uninfected areas to infected areas.
- Do as much maintenance as possible in dry weather.
- Identify appropriate spoil dumps that don't expose significant areas to infection.
- Clean out table drains when soil is dry and dump spoil locally. Don't move spoil from infected areas in uninfected catchments.
- Clean machinery before leaving *P. cinnamomi* infected areas.
- Ensure that the operation of machines (angle of blade etc.) and the direction of work will not spread *P. cinnamomi* further.
- Resurfacing with clean gravel over infected road surfaces should be undertaken working from the new surface as it is laid forwards over the road.

## Sourcing road materials

*The introduction of soil and other mineral products is one of the highest risk activities for spreading Phytophthora root-rot.*

- Use in situ gravel where possible or use low risk materials such as fresh crushed rock. Natural gravel is a high-risk material.
- Select gravel pits at least 500m away from and upslope from nearest visible disease symptoms, unless job is entirely in an infected area.
- Wash incoming plant before commencement of resheeting.
- Routes to and from the gravel pit should be on dry, well drained road surfaces.
- Preferentially source materials from quarries with good management practices as in accordance with the Quarry Code of Practice.

## Quarry and borrow pit management.

Movement of infected gravel, sand and soil has been implicated in the spread of *P. cinnamomi* throughout Australia. Maintenance of *P. cinnamomi* free quarries and pits is essential to avoid spreading the fungus. Follow the Quarry Code of Practice (1999) to reduce the likelihood of *P. cinnamomi* infected material being produced. Relevant points are provided below.

- Crushed rock products are considered free of *P. cinnamomi* provided they are not contaminated with topsoil or gravel.
- Quarries will require reassessment (if the last assessment was done more than 12 months ago) for presence of *P. cinnamomi* before supplying material to *P. cinnamomi* sensitive areas (see *P. cinnamomi* survey guidelines).

## Siting quarries and pits.

- Use gravel "in situ" wherever appropriate (e.g. walking tracks).

- Preferably site quarries and borrow pits in non-*P. cinnamomi* susceptible areas. Alternatively if siting in a *P. cinnamomi* free area consider the potential implications if hygiene fails.
- Ensure machinery used in locating quarries is clean.

Select gravel pits in *P. cinnamomi* free areas ie. 500m laterally from nearest infection and free from drainage flowing from infected areas.

### **Maintaining quarries and pits**

- Maintain good drainage to prevent mud building up in working areas.
- Construction of cut-off drains to prevent spores of *Phytophthora cinnamomi* washing into the pit from surrounding areas.
- Wash machinery that is brought onto the site.
- Ensure topsoil stockpiles are located so that drainage does not enter working areas.
- Be aware of the *P. cinnamomi* status of the pit.

### **Managing *P. cinnamomi* infected quarries and pits**

- Consider risk of *Phytophthora* infection in sequential rehabilitation of quarries. For pits open for the short to medium term it is preferable to rehabilitate following completion of quarrying if the risk of contaminating the product stockpiles is high.
- Advise customers if aware that *P. cinnamomi* contamination could be a hazard in the end use.
- Do not distribute non-crushed rock products for use in the nursery industry without advising the potential for *P. cinnamomi* contamination. Sterilisation by steam or other methods is possible.

## **Fire Management**

*Vegetation can recover from fire, it can not recover from infestation by Phytophthora root-rot.*

### **Preparation**

- Plan fuel management and firebreaks to provide fire fighting capacity adjacent to disease free areas to eliminate the risks of fire fighting within these areas.
- Maintain well drained and surfaced firebreaks/tracks.
- Maintain all fire fighting equipment in a clean state ready for deployment in disease free areas if necessary. Wash tools thoroughly after each use.
- Ensure equipment and vehicles are clean before entry into *P. cinnamomi* free areas.
- Consider slashed breaks to minimise soil transfer.
- Provide adequate local water sources.
- Close unnecessary fire tracks.

### **On firelines**

- Check if the area is a phytophthora management area and adjust control strategy as appropriate.
- Don't use machinery to suppress fire within a disease free area there is no alternative response.
- Collect water for fire suppression from local sources; avoid transporting between infected and uninfected areas if possible. When transporting water beyond the local area and there is uncertainty of the disease status, disinfect with chlorine.
- Locate control lines away from susceptible areas if possible.
- Plan control lines to avoid crossing *P. cinnamomi* boundaries where possible. If not, construct firelines from the uninfected zone into infected zones
- Close temporary fire tracks

## **Walking Tracks**

### **Location**

- Tracks should not cross from infected areas into uninfected areas. If this has occurred, encourage walkers to go in one direction, from *P. cinnamomi* free areas into infected areas. Place washdown points beyond

the last site of *P. cinnamomi* infection on the walking track, and use effective topographic controls (e.g. creeks).

- Tracks should not be placed on ridges between catchment areas. Tracks must not be sited on ridges that form boundaries between infected and uninfected areas.
- Tracks should not approach or pass above communities that are highly susceptible to *P. cinnamomi*, or susceptible threatened plants and communities.
- Stream crossings, water logged areas and muddy areas should be avoided or minimised.
- If possible tracks should be located on well drained soil, be mud free and properly drained.
- Avoid developing new tracks in uninfected susceptible areas.

## Walking track washdown points

The designs provided below should be used as a basis for customising a washdown point for a particular location. Dry washdown stations are most suited to sandy soils and low mud environments. Wet washdown stations require a creek flowing back into the infected area or non-susceptible vegetation to prevent further spread of *P. cinnamomi*.

### Wet washdown station

- Platforms at least 2 metres wide that enable a few people to concurrently stand in the water to wash/rinse down at a number of water levels.
- A post to provide support when cleaning undersides of boots.
- Scrubbing brushes secured by cord against floods.
- Information signs.
- Hardened track surface leading well into the *P. cinnamomi* free area.

### Dry washdown

- Requires a raised grid with handrail, the platform should be at least 2 metres wide/long for brushing down on.
- Either a watercourse underneath that will carry the contaminated soil directly back into an infected area or non-susceptible area or a collection tray. If using trays these will require adequate depth and the station should be should be roofed or the tray fitted with lids to prevent flooding with rainwater. Trays will require greater maintenance.
- Information signs.
- Hardened track surface leading well into the *P. cinnamomi* free area.
- Attached boot scrubbers or hand scrubbing brushes.

### Walking track re-routing

Re-routing to avoid *P. cinnamomi* infection is warranted where re-routing will remove the risk of disease spread on the walking track network for at least the medium term. Tracks should be re-routed through non-susceptible vegetation if possible and must not place significant new areas or catchments at risk of disease.

### Walking Track Construction and maintenance

- All equipment used should be clean.
- All construction material entering *P. cinnamomi* free areas should be clean.
- Locally collected material is preferable to imported material when constructing or maintaining tracks.
- If gravel, shale, sand or other fill is required, refer to the gravel section of this manual.
- Ensure that drains do not pond, but carry run-off into the nearest natural watercourse.
- Install information signs for bushwalkers at track registration booths with the *P. cinnamomi* hygiene procedure listed.
- Construct washdown points as specified in the *P. cinnamomi* Management Plan or as required where tracks cross into uninfected areas.
- Write *P. cinnamomi* hygiene specifications into all contracts.

## Cut Lines

*The greatest risk of introducing P. cinnamomi may not be with the use of temporary tracks by managers and industry but with later illegal use by recreational vehicles that don't follow hygiene practices.*

- Where temporary tracks are required the start should be left uncut if possible, only mark discretely such as using offset marking.

## Rehabilitation

### Phytophthora infected areas

- Choose plant species that are not susceptible to *P. cinnamomi*.
- Disposal of weeds that include roots or the first few cm of stems should be disposed of within the infected area.
- Avoid changing drainage patterns where this will divert *P. cinnamomi* to a new area.

### Phytophthora free areas

- Apply hygiene to all rehabilitation activities.
- Allow natural regeneration wherever possible, or employ fire or direct seeding (ensure equipment is clean).
- Propagate on site with natural materials if possible.
- Do not introduce plants unless absolutely necessary. Refer to the Understorey Network propagation guide for hygiene practices if plants are to be introduced to an area.
- Screen plants for disease. If there is any suggestion of ill health in stock to do plant out.
- Use local water from within the *P. cinnamomi* free area.

## Land development

Where developments are adjacent or within highly susceptible vegetation precautions should be taken to prevent *P. cinnamomi* introduction.

- Prevent drainage from entering native vegetation.
- Topsoil removal and importation of topsoil is discouraged.
- Apply hygiene to high-risk activities.
- Use *P. cinnamomi* free materials.

## Aircraft access to remote uninfected areas.

*People in helicopters are just about the only way P. cinnamomi will get into untracked wilderness valleys.*

- Plan the route, to make any stops in uninfected areas prior to stops in the infected areas.
- Observe for evidence of *P. cinnamomi* when landing as there may be unrecorded infestations. Choose well drained or rocky landing sites preferably on top of local rises where risk of infection is lower.
- If you must land in an infected area prior to landing in an uninfected area, avoid wet muddy areas and look for disease free patches on rises to land on.
- Carry a portable washbath and for disinfection of boots, equipment etc. prior to departure.
- Time operation for dry periods where possible.
- If flying into a *Phytophthora* Management Area (Schahinger et al 2003), the aircraft must depart clean from an uninfected area e.g. Cambridge Airport. No landings are permitted in infected areas before any landing in the *Phytophthora* Management Area.

## Working across zone boundaries.

Operations occurring across both zones will require control over the spread of *P. cinnamomi* from infected to uninfected areas. In some circumstances operations may also require *P. cinnamomi* control across a particular disease boundary.

- Clearly mark the zone boundaries on the ground at a point where operations in each zone can be practically segregated.
- Establish washdown points at the zone boundary.
- Complete operations in the uninfected area first if possible.
- Do not cross or minimise crossing of the boundary.
- Segregate machinery and tools as far as possible to minimise washdown requirements.
- Manage drainage across the boundary.
- Time operations for when soils are dry and risk of transfer of soil lowest.
- Plan the access route to minimise the impact if hygiene fails.

## Signs

Recommended sign usage:

- Phytophthora Management Areas must be identified by signs on all roads and tracks entering the area.
- Closed roads in *P. cinnamomi* management areas require a regulation road closed sign to be erected.
- Washdown stations on walking tracks require instruction signage.
- *P. cinnamomi* free areas should be signposted at trackheads.

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## Appendix 1 Project Planning Checklist

### 1. Location

- Identify *P. cinnamomi* zone
- Determine level of hygiene to be applied.
- If possible site where in the event of *P. cinnamomi* introduction least impact will occur e.g. low in landscape.

### 2. Timing of operation

- Determine any restrictions based on time of year or soil moisture e.g. only when soil surface is dry.

### 3. Access.

- Choose route and method that minimise the area at risk from *P. cinnamomi* and or the chance the of *P. cinnamomi* transfer.
- Identify where segregation of infected and uninfected operations are required, or other washdown points.
- Vehicle/Equipment hygiene requirements.
- Write hygiene prescriptions into cartage and construction contracts.

### 4. Source of materials

- Identify local materials where possible, survey suppliers and approve imported materials.

### 5. Implementation

- Contractors are briefed, sites marked
- Supervision of operations or compliance checks.

### 6. Monitor *P. cinnamomi*

- Monitor for *P. cinnamomi* incursion 1-2 years after operation.
- Review of implementation of recommendations.

## Appendix 2 Survey Procedures

### Field Survey

*P. cinnamomi* can not be directly observed in the field. Field identification is therefore based on identifying the characteristic disease symptoms it causes in plant communities. This includes differential mortality in susceptible and non-susceptible species, distribution of disease and evidence of disease progression over time. This will assist in differentiating *P. cinnamomi* from other possible causes of disease such as drought, waterlogging or *Armillaria* fungi. Where two or more stresses are acting upon a plant community it may be difficult to identify an underlying disease caused by *P. cinnamomi*.

Surveys should target areas where disease expression is most likely and where risks of introduction are highest. Drainage lines and other poorly drained areas, tracks and roadsides are all common places to pick up disease symptoms. Where there is an existing *P. cinnamomi* isolation in the vicinity, symptom mapping alone may be adequate if symptoms are clearly expressed. If there is any uncertainty or disease is found in a catchment not known to be infected then a sample should be taken for isolation to confirm the symptom mapping.

The following guide to surveying for *P. cinnamomi* is adapted from Wardlaw (1990) and Podger *et al* (1990b).

1. *Target susceptible communities.*

Symptoms of *P. cinnamomi* infection will be most severe in susceptible sedgeland, heathland and heathy dry sclerophyll communities, see Appendix X. Rainforest and wet sclerophyll forests, if burnt or disturbed mechanically, may also show symptoms (particularly road-side verges where vegetation cover is slow to recover).

2. *Target susceptible sites*

Look where soils are poorly drained and where soils have been disturbed e.g. creeklines, roadside drains, down hill from areas disturbed by machinery and along walking tracks.

3. *Examine disease pattern in the species present.*

Plant species have different levels of susceptibility to *P. cinnamomi*, so infected areas usually contain a mixture of diseased, susceptible plants and healthy more resistant plants. Highly susceptible species in various plant groups that are reliable indicators are listed in Table 1. If diseased examples of these susceptible species are found among a healthy population of resistant indicator species as listed in Table 2, *P. cinnamomi* is a likely cause of the disease. If both resistant and susceptible species display similar symptoms and appear to be in the same state of health, it is likely there is another cause for the deaths such as waterlogging or drought.

Do not expect all susceptible plants to die at once. There is variation in the timing of infection of individuals and in the time it takes for different plants or species to die

4. *Look for progression of disease in space and time.*

*P. cinnamomi* rarely attacks all plants in a patch simultaneously and takes some time to produce strong symptoms. Look for evidence of increasingly more recent mortality when moving outwards from the centre of the dieback patch. A single uniform age of death over a large area may indicate another cause.

Water will spread *P. cinnamomi* more rapidly downhill, so spot infection boundaries are likely to be elongated up and down a slope. Uphill spread rates may be 1 metre a year or less and down hill spread can be 10s of metres to possibly 100s of metres per annum.

5. *Check for lesions.*

Necrosis of root and lower stem tissue will be evident in dying and recently dead susceptible plants. This may be observed by uprooting the plant and searching for blackened or darkly stained lesions on lateral roots, or the root collar and lower stem of particularly susceptible species.

Be aware that symptom expression will vary across geologies and changing environments. Susceptible species will also show variations in mortality within or between populations. In some environments disease may only express itself periodically when conditions favour *P. cinnamomi*.

**Table 1:** Susceptible species which are reliable indicator species for the five broad vegetation classes: S-sedgeland, H-heathland, O-open forest and scrub, T-tall open forest, R-disturbed rainforest. Based on Podger *et al* (1990b). Shaded boxes indicate the species is present in vegetation type.

Susceptible Species	Common Name	Community type				
		Sedgeland	Heath	Open dry sclerophyll forest	Rainforest / Wet sclerophyll forest	Disturbed rainforest
<i>Agastachys odorata</i>	White Waratah					
<i>Allocasuarina monilifera</i>	Scrub She-oak					
<i>Amperea xiphoclada</i>	Broom Spurge					
<i>Anopterus glandulosus</i>	Native Laurel					
<i>Aotus ericoides</i>	Golden Pea					
<i>Astroloma humifusum</i>	Native Cranberry					
<i>Baeckea leptocaulis</i>	Heath Myrtle					
<i>Banksia marginata</i>	Honeysuckle, Banksia					
<i>Bauera rubioides</i>	Bauera					
<i>Blandfordia punicea</i>	Christmas Bells					
<i>Boronia spa.</i>	Boronia					
<i>Cenarrhenes nitida</i>	Native Plum					
<i>Cyathodes glauca</i>	Cheese Berry					
<i>Cyathodes juniperina</i>	Pink Berry					
<i>Dillwynia glaberrima</i>	Smooth Parrot Pea					
<i>Dillwynia sericea</i>	Showy Parrot Pea					
<i>Epacris barbata</i>						
<i>Epacris corymbiflora</i>	Stragging Heath					
<i>Epacris curtisiae</i>	Curtis's Heath					
<i>Epacris lanuginosa</i>	Swamp Heath					
<i>Gaultheria hispida</i>	Snow Berry					
<i>Hibbertia spa.</i>	Guinea Flower					
<i>Gompholobium huegelii</i>	Bladder Pea					
<i>Leucopogon collinus</i>	White Bearded Heath					
<i>Leucopogon ericoides</i>	Pink Bearded Heath					
<i>Melaleuca squamea</i>	Swamp Melaleuca					
<i>Monotoca glauca</i>	Goldywood					
<i>Monotoca submutica</i>	Broom Heath					
<i>Oxylobium spa.</i>	Oxylobium					
<i>Nematolepis squamea</i>	Lancewood, Satinwood					
<i>Phyllocladus aspleniifolius</i>	Celery-top pine					
<i>Platylobium triangular</i>	Ivy flat Pea					
<i>Pultenaea spp. (most).</i>	Bush pea					
<i>Richea pandanifolia</i>	Pandani					
<i>Sprengelia incarnata</i>	Pink Swamp Heath					
<i>Stylidium graminifolium</i>	Trigger Plant					
<i>Tasmania lanceolata</i>	Native Pepper					
<i>Thryptomene micrantha</i>	Heather Bush					
<i>Tetrateca spp.</i>	Lilac Bells, Milkmaids					
<i>Xanthorrhoea spp.</i>	Grass Tree					

**Table 2:** Resistant species that are reliable indicator species for the five broad vegetation classes. Modified from Podger *et al* (1990b)

Resistant Species	Common Name	Community type				
		Sedgeland	Heath	Open dry sclerophyll forest	Rainforest / Wet sclerophyll forest	Disturbed Forest
<i>Acacia</i> spp.	Wattles					
<i>Allocasuarina littoralis</i>	Bull-Oak					
<i>Allocasuarina stricta</i>	She-Oak					
<i>Baumea</i> spp.	Sedge					
<i>Baloskion</i> spp.	Cord Rush					
<i>Bedfordia</i> spp.	Blanket bush					
<i>Calorophus elongatus</i>	Sedge					
<i>Cassinia aculeata</i>	Dolly Bush					
<i>Chordifex</i> spp.	cord rush					
<i>Comesperma</i> spp.	Milkwort					
<i>Coprosma</i> spp.	Current bush					
<i>Empodisma minus</i>	Sedge					
<i>Exocarpos cupressiformis</i>	Native Cherry					
<i>Gahnia grandis</i>	Cutting Grass					
<i>Gymnoschoenus sphaerocephalus</i>	Button Grass					
<i>Hypolaena fastigiata</i>	Tassel Rope Rush					
<i>Kunzea ambigua</i>	White Kunzea					
<i>Lepidosperma</i> spp.	Sword Sedge					
<i>Leptocarpus tenax</i>	Slender Twine Rush					
<i>Leptospermum scoparium</i>	Manuka, Tea-tree					
<i>Lomandra longifolia</i> .	Sagg					
<i>Melaleuca squarrosa</i>	Scented Paperbark					
<i>Olearia</i> spp.	Daisy bush					
<i>Pimelea</i> spp.	Rice Flower					
<i>Pomaderris apetala</i>	Dogwood					
<i>Spyridium</i> spp.	Dusty Miller					
<i>Zieria arborescens</i>	Stinkwood					

### Detection of old infected areas.

If *P. cinnamomi* has been established for a long period, it is unlikely that obvious symptoms will be apparent. The majority of highly susceptible plants will have been killed. Diagnosis will be especially difficult if dead plants have been removed by fire. In this situation a good knowledge of the indicator species and the expected community composition is important. Diagnosis will also be aided by searching for a boundary of active infection, where disease symptoms are more evident.

A couple of species can be good indicators. In moorlands *Sprengelia incarnata* continuously regenerates and a low density of individuals showing scattered mortality may suggest infection. If the *S. incarnata* plants are very large and old, *P. cinnamomi* is less likely to be present than if the plants are all small and young. Also look for an absence of *Banksia marginata* and *Agastachys odorata* (white waratah) in areas where they would be expected (eg on slopes) or depressed populations of *Epacris* species. A marked absence or severe depression in flowering in the spring and summer months will often indicate a *P. cinnamomi* infection from afar. However check that it is not a case of fire, asynchronous patch flowering that occurs in *Sprengelia incarnata* or because of a change in soil conditions that has reduced shrub cover. *P. cinnamomi* can still be reliably isolated from old diseased moorland if *Sprengelia incarnata* is targeted.

In heathlands the resinous bases of *Xanthorrhoea* spp. can survive for some time on the soil surface providing evidence of their previous occupation of the site. Typically there is pronounced depression in populations of

species in the Epacridaceae and Fabaceae with common plants like *Leucopogon collinus* often still present but in unusually low numbers and with scattered deaths. *Lepidosperma concavum* and shrubs like *Leptospermum glaucescens* may visually dominate these old diseased areas. Though *L. glaucescens* may also dominate in some long unburnt heaths.

### Post fire effects on disease expression

Following wildfires diseased areas may regenerate as an apparently healthy community as the seed banks of susceptible species restore the original community composition. Identification of the diseased state may be difficult in the first few years following fire. When suitable warm and wet soil conditions return, *P. cinnamomi* may rapidly increase in population and initiate an epidemic of disease some what like the initial infection phase of a site with clearly evident symptoms. Should a clearly depauperate heathland regenerate following a fire it is a good indicator of the likely presence of *P. cinnamomi* on the site for a long time. There will be few susceptible species present and little evidence of disease on the site making sampling for *P. cinnamomi* difficult. Searching for more recently infected areas in the vicinity will be the best clue to its presence.

### Disease Symptoms in Buttongrass Moorlands.



Dying *Sprengelia incarnata*, *Dillwynia glaberrima* and *Baeckea leptocaulis* in buttongrass moorland .



*Agastachys odorata* (white waratah) is generally the first species to die on infected sites.



A disease front passes vertically down the centre of the photograph. Note lack of flowering in the diseased area on the right.



Diseased moorland at Schooner Cove research site. Note missing emergent banksia and white waratah.

### Disease Symptoms in Heathlands.



Diseased heathland in spring, Coles Bay area. Note few shrubs present exposing the sedgy ground layer.



Healthy heathland in spring, Coles Bay area. Note shrub layer including many susceptible species.



Disease boundary in grasstrees at Cape Portland.



Dying patches of grasstrees are a clear indicator of *P. cinnamomi*.



Disease front in heathy forest on Schouten Island.



Diseased *Epacris barbata* on rockplates can be mistaken for drought death.



A lesion (rot) caused by *P. cinnamomi* in a plant root.

## Appendix 3 Collecting *P. cinnamomi* Soil and Root Samples

If results are required quickly, notify the person you are sending them to ahead of time so that preparations for early analysis can be made. It takes a minimum of 10 days to get a result from time the sample is baited. Samples may incur a processing charge around \$60-70.

1. Aim to survey during the warmer months when soils are still moist *P. cinnamomi* is most easily isolated when spores are being produced in warm (>15° C), moist soil.
2. Ensure that all digging equipment is free of soil and has been sterilised. Use 60% alcohol, methylated spirits or Phytoclean™).
3. Select plants with well developed disease symptoms that are still alive (ie. stem scraping shows tissue is not totally dried out) from areas where there are large numbers of dying plants or infection fronts. Inoculum levels will be higher in the soil in these areas increasing chance of successful isolation of *P. cinnamomi*.
4. Collect 1-2 cupfuls of soil from the top 10-15cm of soil around the selected plant. Small plants like *Sprengelia incarnata* can be pulled out and the roots included as well. If you have more than 2 cupfuls of soil mix well and subsample as large samples cannot be processed. Place in a new plastic bag and seal. Don't add water as it may be carrying *P. cinnamomi* spores. It is often better to subsample around a few different plants and place these together in one bag to reduce laboratory costs doing separate samples.
5. Ensure the sample is appropriately labelled with a sample number, Name and date. Complete a dieback assessment sheet including full AMG co-ordinates, datum used, plant species sampled and dieback symptoms.
6. **After collecting the sample, clean and sterilise digging equipment (and your footwear or vehicle if required) before moving on to another area.**
7. Samples should be kept in sealed containers (zip lock plastic bags) so that don't dry out, refrigerated if possible to ensure they are maintained in good condition. Samples will keep many weeks once refrigerated.
8. Samples should be quickly despatched for analysis to either :

Tim Wardlaw,  
Forestry Tasmania  
79 Melville St  
Hobart TAS 7000  
Phone: (03) 6233 8205  
e-mail: [Tim.Wardlaw@forestrytas.com.au](mailto:Tim.Wardlaw@forestrytas.com.au)

Tim Rudman  
Department of Primary Industries, Water & Environment  
PO Box 44  
Hobart TAS 7001  
Ph; 6233 3912  
Email: [tim.rudman@dpiwe.tas.gov.au](mailto:tim.rudman@dpiwe.tas.gov.au)

## Appendix 4 Vegetation Susceptibility Categorisation

### 1. Tasveg

*Phytophthora cinnamomi* susceptibility of TASVEG mapping units. Updated from Schahinger et al (2003).

The TASVEG vegetation mapping units have been categorised on the basis of their perceived susceptibility to *P. cinnamomi*. Two clear categories are identified, those mapped vegetation types that are reliably **highly susceptible**, and those that are reliably **not susceptible** or have **low** vulnerability. Between these extremes a third category of **variable susceptibility** is identified. This category indicates the need for site assessment to consider *P. cinnamomi* impacts.

Susceptibility indicates the level of susceptible species in the mapping unit and the level of change occurring on infection by *P. cinnamomi*. The assessment of vulnerability was based upon the documented composition of the units or their components (e.g., Duncan and Brown, 1985; Kirkpatrick, 1977; Kirkpatrick and Harris, 1999; TASVEG website), and past *P. cinnamomi* studies in Tasmania (e.g., Podger et al, 1990a and b). There will be considerable variability within a mapping unit, given that each may include a number of described plant communities (e.g., 10-12 communities within the ‘shrubby coastal heath’ unit). Note also that the impact within the eucalypt-dominated units in the ‘variable susceptibility category’ may be quite localised. For these units the presence of reliable indicator species like *Xanthorrhoea australis* (Grass Tree) will help to determine an area’s susceptibility. Geology may also provide a general indicator of susceptibility with those variable susceptibility communities occurring on fertile (eg dolerite derived soils) displaying generally low susceptibility in this situation.

Altitude and rainfall limits also restrict the susceptibility of these communities.

#### 1. Highly susceptible to *Phytophthora cinnamomi*

Hc	shrubby coastal heath
Hh	lowland and intermediate heath
Hr	heath on granite
Hw	wet heath
Hsw	Wingaroo complex (Flinders Island)
HSc	Coastal heath/scrub over-category
HSf	Flinders Island heath-scrub complex
HSk	King Island sedgeland-heath-scrub mosaic
Bb	buttongrass moorland
Bm	<i>Melaleuca squamea</i> with/without Bb on slopes
AC	Coastal <i>Eucalyptus amygdalina</i> forest
Eac	<i>Eucalyptus amygdalina</i> woodland (AC)
BS	<i>Banksia serrata</i> woodland
N	<i>Eucalyptus nitida</i> dry forest
NF	Furneaux <i>Eucalyptus nitida</i> forest

#### 2. Variable or moderate susceptibility (site assessment required)

AD	<i>Eucalyptus amygdalina</i> forest on dolerite
AS	<i>Eucalyptus amygdalina</i> forest on sandstone
G	<i>Eucalyptus viminalis</i> and/or <i>E. globulus</i> coastal shrubby forest
O	<i>Eucalyptus obliqua</i> dry forest
P	<i>Eucalyptus pulchella</i> - <i>E. globulus</i> - <i>E. viminalis</i> grassy shrubby dry forest
RO	<i>Eucalyptus rodwayi</i> forest
SG	<i>Eucalyptus sieberi</i> forest on granite
SO	<i>Eucalyptus sieberi</i> forest on other substrates
TG	<i>Eucalyptus tenuiramis</i> on granite
TD	<i>Eucalyptus tenuiramis</i> forest on dolerite
TI	Inland <i>Eucalyptus tenuiramis</i> forest
Ea	<i>E. amygdalina</i> woodland
Ead	<i>E. amygdalina</i> woodland (AD)

Eas	<i>E. amygdalina</i> woodland (AS)
Ee	<i>E. barberi</i> woodland
Eh	<i>E. ovata</i> heathy woodland (OV)
El	<i>E. obliqua</i> woodland (O)
Em	<i>E. pulchella</i> woodland (P)
Eq	<i>E. perriniana</i> woodland
Er	<i>E. rodwayi</i> woodland (RO)
Esg	<i>E. sieberi</i> woodland (SG)
Eso	<i>E. sieberi</i> woodland (SO)
Etd	<i>E. tenuiramis</i> woodland (TD)
Etg	<i>E. tenuiramis</i> woodland (TG)
Eti	<i>E. tenuiramis</i> woodland (TI)
Ev	<i>E. viminalis</i> heathy woodland (G)
Ro	Boulder fields (viz., The Hazards at Freycinet)
Hg	Lowland/coastal sedgey heath
Sc	Coastal scrub
Sf	Flinders Island scrub
Sn	Western wet scrub with <i>E. nitida</i>

### 3. Low or not susceptible

Includes wet forests, rainforests, high-altitude vegetation, grasslands, wetlands, saltmarshes and sphagnum bogs. Also miscellaneous units that correspond to improved pasture, areas of bracken, exotic plants, sand & water, and developed areas (urban and rural).

## 2. WHA Simplified Vegetation Map

The synusia based vegetation mapping of the WHA has been simplified for general management purposes on the Parks and Wildlife Service maplink site. The *P. cinnamomi* susceptibility classes recorded below apply to these maps.

### 1. High susceptibility

BAM	Banksia moorland
BF	Sparse buttongrass on slopes
BR	Rowitta Sedgy buttongrass moorland
BSW	Southwest buttongrass
MB	Melaleuca on buttongrass
WCH	coastal heath
SLE	Sedgy moorland

### 2. Variable or moderate susceptibility (site assessment required)

BPB	pure buttongrass
BML	Buttongrass teatree sequence

### 3. Low or not susceptible

Includes wet forests, rainforests, high-altitude vegetation, grasslands, wetlands, saltmarshes and sphagnum bogs. Also miscellaneous units that correspond to improved pasture, areas of bracken, exotic plants, sand & water etc.

Note Eastern buttongrass moorland (BEA) only occurs at altitude in the WHA and is therefor not classified as susceptible to *P. cinnamomi* unlike where it occurs in the east of the State.

## Appendix 5 Washing down

The following guidelines are drawn from the Tasmanian Washdown Guidelines For Weed & Disease Control, Edition 1 April 2004. Refer to this guideline for full instruction.

### Equipment

#### Portable vehicle wash equipment

Where field wash down is a regular practice facilities should be obtained and carried for the purpose. Large commercial wash units are available, though firefighting slip-on units are suitable and allowing a flexible choice of washdown sites. A shovel, crow bar and stiff brush are also required. Where a blowdown only is required, compressors or portable blower vacs may be used along with a small brush.

#### Personal and small tool wash equipment

Portable wash baths are recommended for use when travelling in vehicles and helicopters for washing footwear and small tools. Washbaths can be made from a fish box (or other suitably sized plastic box) fitted with an open weave plastic doormat, a scrubbing brush, a pair of safety gloves, glasses, detergent or fungicide, and a container of clean water. For backpacking, a 2 litre bottle, scrubbing brush, safety gloves and glasses can be used for small tools and boot washing.

The fungicide Phytoclean™ should be added to washbaths to control the spread of *Phytophthora cinnamomi* if:

1. sterilising tools used for *P. cinnamomi* sampling
2. entering a population of threatened species that is susceptible to *P. cinnamomi*
3. wash effluent can not be disposed of at the point of washing without further spreading *P. cinnamomi*.

### Standards

For general cleaning procedures the following standard applies:

- remove only those cover plates etc that can be quickly and easily removed and replaced
- no clods of dirt or loose soil should be present after washdown. Smear soil stains and soil firmly lodged in difficult to access areas are acceptable
- radiator, grills and the interior of vehicles should be free of accumulations of seed and other plant material

Always consult and comply with the manufacturers recommended cleaning method.

Cleaning and inspection should be undertaken in accordance with the general washdown procedures

Customised washdown standards may be applied for a higher degree of protection if undertaking activities in a *Phytophthora* Management Area and around *P. cinnamomi* susceptible threatened species. For instance, Phytoclean™ may need to be applied and greater attention to soil accumulations behind protective plates and covers may need to be specified.

## Procedures

### Selecting a field washdown site.

Field washdown of may be required to contain weeds or plant pathogens to a particular area or where machinery is moved directly between field sites. Always consult the landholder. In selecting a washdown site, consideration should be given to:

- siting the washdown at the edge, or nearby, any areas where weeds or pathogens need to be contained, choose sites where the land slopes back into an infested area or an adjacent area not susceptible to the problem
- ensuring run-off will not enter any watercourse or waterbody, a buffer of at least 30m is desirable
- avoiding sensitive vegetation or wildlife habitat eg remnant native vegetation and threatened species sites
- selecting mud-free sites (e.g. well grassed, gravel, bark or timber corded) which are gently sloped to drain effluent away from the washdown area
- allow adequate space to move tracked vehicles
- potential hazards, e.g. powerlines

Note that low loaders are not a suitable platform for washing machinery.

Where there will be large quantities of effluent or there is a risk of extensive run-off, the washdown area should be bunded and a sump constructed to safely dispose of the effluent. Take particular care where the effluent is likely to be contaminated with oils.

### Small tools & portable washbaths

These are used in the management of *Phytophthora* root-rot in native vegetation or can be established as temporary washdown points to contain the spread of soil by foot traffic in other diseased areas.

1. Site the washbath just outside the infected area or at the departure point for the vehicle or aircraft.
2. Remove all loose mud and dirt from the object to be cleaned.
3. Use the recommended safety equipment if washing with a fungicide (safety gloves and glasses).
4. Part fill the washbath with clean water, a depth of about 4 cm is adequate for boot washing. Mix a solution of detergent or fungicide as required (see page 3).
5. Clean boots, gaiters and equipment with the scrubbing brush.
6. Effluent containing registered products such as fungicides must be disposed of in accordance with label recommendations.
7. A final rinse or wipe with fungicide or methylated spirits can be used for sterilisation of scientific equipment.

### General washdown procedure

1. Locate washdown site and prepare the surface or construct bunding as required.
2. Safely park the vehicle free of any hazards (e.g. electrical), ensure the engine is off and the vehicle is immobilised.

3. Look over the vehicle, inside and out, for where dirt, plant material including seeds are lodged. Pay attention to the underside, radiators, spare tyres, foot wells and bumper bars.
4. Remove any guards, covers or plates if required being careful of any parts that may cause injury.
5. Knock off large clods of mud, use a crow bar if required and sweep out the cabin.
6. Use a vacuum or compressed air where available for removing dried plant material like weed seeds and chaff in radiators and other small spaces where this material lodges. Brush off dry material if no other facilities are available.
7. Clean down with a high pressure hose and stiff brush/crowbar. Use only freshwater if washing down in the field.
8. Start with the underside of the vehicle, wheel arches, wheels (including spare). Next do the sides, radiator, tray, bumper bars etc and finally upper body. Some vehicles may need to be moved during washdown eg tracked machinery.
9. Clean any associated implements, eg buckets.
10. Check there is no loose soil or plant material that could be readily dislodged or removed.
11. In wash bays, steam treat or rinse off vehicle with clean water.
12. Wash effluent away from vehicle, do not drive through wash effluent.

### Trucks and vehicles

For small vehicles in the field where washdown facilities can not be provided the minimum requirement is:

- all loose and large clods of dirt should be physically knocked off the vehicle at the desired washdown point before driving back to a suitable wash facility.

Systematically inspect and clean, including:

Cabin	floor, mats and under seats
Engine	radiators
	engine bay and grill
Body	hollow channels
	inside bumper bars
	crevices and ledges
	underside
Wheels	inside and outside
	between dual wheels if fitted
	spare wheel
Tray	hollow channels
	chassis

### Specific cleaning agents for *Phytophthora* root rot.

#### PhytoClean™

PhytoClean™ is registered for the sterilisation of equipment and machinery in Tasmania for the control of *Phytophthora cinnamomi*. It is used at a rate of 200ml per 10L of water for washing surfaces cleaned of mud, and at a rate of 1000ml per 10L water in washbaths. Solution should remain in contact with surfaces for at least 30 seconds before rinsing. It is available in 20L or 200L drums and is manufactured by Avis Chemicals, Dandenong (Ph: 03

9794 5585, fax 03 9706 9206). Use only in accordance with the label directions and when prescribed in the job specifications for the control of *Phytophthora* root rot.

### **Sodium Hypochlorite**

Sodium hypochlorite is recommended for sterilising water in fire-fighting units. However it needs to be used carefully. Once mixed the compound is not stable and quickly degrades, particularly in water with a high organic content. It also corrodes metal. 2 mg/l chlorine is required to kill zoospores in water with a 1 minute exposure time.

### **Pure alcohol and methylated spirits**

These may be used for surface sterilisation of equipment once dirt has been washed off. Its application is limited to small implements and items used in disease survey work such as sampling for *Phytophthora* root-rot.