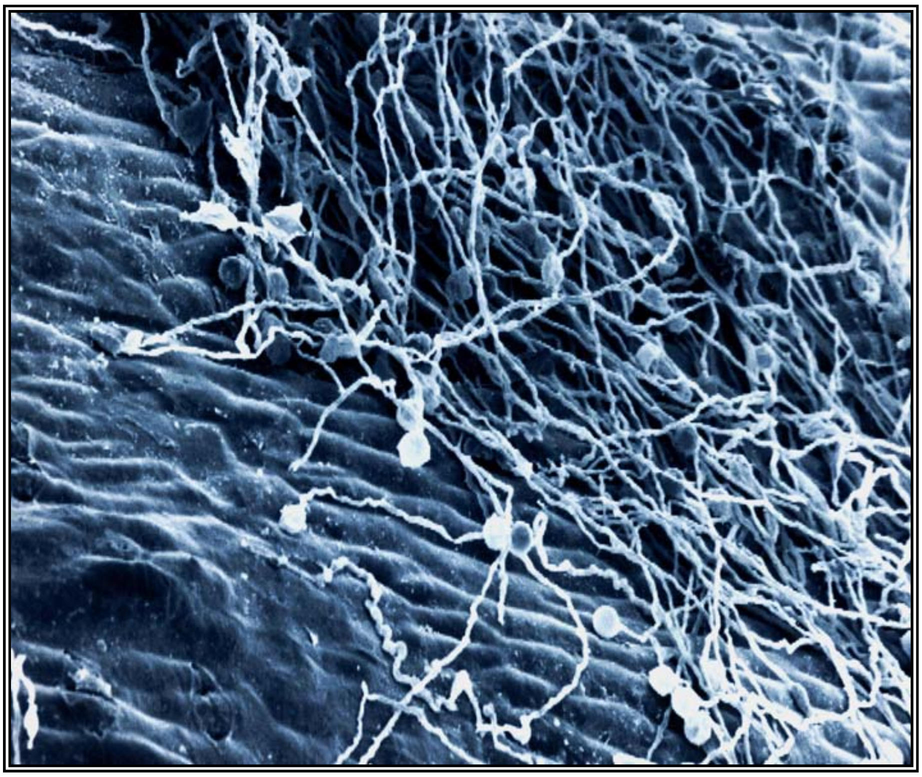
PUBLIC CONSULTATION DRAFT

Best practice guidelines for the management of *Phytophthora cinnamomi*



Guidelines to manage the threat to biodiversity posed by *P. cinnamomi* and the disease caused by it in native vegetation managed by the Department of Conservation and Land Management

2004

PUBLIC CONSULTATION DRAFT

Public Consultation on the Draft Best Practice Guidelines.

What are the Guidelines for?

These draft Guidelines have been prepared for use by staff, contractors and volunteers working to control the threat of *P. cinnamomi* on public lands managed by the Department of Conservation and Land Management (CALM).

What further Guidelines will be prepared in the future?

It is intended that general guidelines to apply to any lands that are susceptible to, or infected with, *P. cinnamomi* will also be produced through the auspices of the Dieback Consultative Council (DCC), following public consultation on CALM's draft.

What are we seeking comments on?

CALM is therefore seeking comments on the draft Guidelines in terms of:

- their accuracy and suitability for application to CALM managed public lands; and,
- amendments that are required to produce management guidelines that can apply to private, leasehold and other Government lands (not managed by CALM) for endorsement by the DCC and the Minister for the Environment.

Your comments are welcome and need to be submitted by 7 May 2004 to be considered in the preparation of the final Guidelines.

How to comment

Please prepare your written comments, referencing specific sections in (or omissions from) the draft Guidelines, and forward them to one of the addresses below by 5 pm Friday 7 May 2004.

(by mail)

Phytophthora Guidelines Comments
Dieback Coordinator
Department of Conservation and Land Management
Locked Bag 104
BENTLEY WA 6983

(by facsimile)

9386 1286

(by e-mail)

biodivconsult@calm.wa.gov.au

TABLE OF CONTENTS

1. OBJECTIVES

The purpose of these guidelines is to provide Departmental staff with a concise, clear and explicit statement of the best practice methods and standards for managing the threat to biodiversity posed by the introduced plant pathogen *Phytophthora cinnamomi* and disease caused by it. The guidelines have a direct relevance to management of native vegetation on conservation lands and other lands managed by the Department within the vulnerable areas of the south western parts of Western Australia that receive more than 400mm of rainfall per annum (Appendix 1).

As there are clearly many similarities with the need to manage *P. cinnamomi* on other lands that are not managed by the Department, these guidelines have also been written to form the basis of guidelines for adaptation and use by other land managers, proponents of activities and others. It is intended that standard guidelines suitable for all lands will be produced by the Dieback Consultative Council after the public comment period on this draft.

2. BACKGROUND

The introduced soil borne water mould *P. cinnamomi* (Figure 1) is known for its capacity to invade and destroy the function of the root systems of many Western Australian native plant species. The slow moving epidemic of destructive root disease *P. cinnamomi* causes in native vegetation in Australia is known as *Phytophthora* dieback, with the term ‘Phytophthora’ being an amalgam of Greek words meaning ‘flora killer’ or ‘plant killer’.

Figure 1. *P. cinnamomi* zoospore germ-tubes penetrating a root.

Figure 2. Impact of *P. cinnamomi* on *E. marginata* (jarrah)

Although *P. cinnamomi* is now widely distributed in the > 400 mm rainfall zone (Appendix 1), its distribution and impacts are greatest in the > 600mm rainfall zone. The impact of *P. cinnamomi* varies greatly across the landscape (Figure 2.) but is characterized by its capacity to infect and ultimately kill approximately 40% of the south-wests native plant species and to prevent them from effectively re-colonizing infested sites. At worst, mass collapse of ecosystems occurs along with significant interference to important ecological processes.

Disease caused by the introduced root-rot pathogen *P. cinnamomi* is listed as a 'key threatening process' under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act]. The Precautionary Principle requires that action be taken where it is considered necessary in order to prevent serious or irreversible environmental damage by possible and known threatening agents. *P. cinnamomi* is considered to be one of the major threatening processes for plant species endemic to Western Australia and declared to be rare flora under the *Wildlife Conservation Act 1950*. CALM uses the internationally recognised term ‘threatened flora’ to apply to flora ranked ‘Critically Endangered’, ‘Endangered’ or ‘Vulnerable’ under IUCN Red List guidelines and specially protected as Declared Rare Flora (DRF). In some cases the few remaining wild populations of susceptible threatened flora and some remnant threatened ecological communities have been invaded by *P. cinnamomi*.

Approximately 40% of the entire known flora of the South West Botanical Province is susceptible to *P. cinnamomi*.

P. cinnamomi will continue its autonomous spread from all its established disease fronts by root to root growth amongst host plants and through the dispersal of zoospores in free-flowing water. Native animals, feral animals and people, including their vehicles and machinery, also transport *P. cinnamomi*.

The most important means of limiting the impact of *P. cinnamomi* is through direct management action to reduce the incidence of people carrying or transporting it into uninfested areas. This can be achieved by closing and rehabilitating unwanted roads within uninfested areas and through the application of rigorous hygiene regimes that minimize the risk that people who enter uninfested areas are not carrying *P. cinnamomi*. Effective management action depends upon knowing whether *P. cinnamomi* is present or absent and accurate demarcation of disease boundaries.

Limited control of disease caused by *P. cinnamomi* is possible over small areas through repeated application of the protective chemical 'phosphite'. This chemical has the effect of temporarily increasing the resistance of flora to the impacts of *P. cinnamomi* and thereby provides protection for threatened flora, threatened ecological communities and the habitat of threatened fauna.

There are limited options for the restoration of areas that have suffered serious environmental damage through the introduction of *P. cinnamomi.* There are also limited options for translocation of threatened flora in the path of a P. cinnamomi disease front.

In the case of susceptible rare flora threatened by *P. cinnamomi,* gene pools may be maintained through the collection and *ex situ* storage of germ-plasm. Investigation of the germination processes, the cultural requirements and the field establishment methods for each of the stored species must accompany the collection and storage process. Site selection protocols to determine the suitability and appropriateness of areas for the reintroduction of species must also be developed and applied.

The degree of precaution used in selecting and applying any preventive measures will depend upon the values identified within uninfested areas, the likely impact the introduction of the *P. cinnamomi* may have on those values, the likely autonomous spread of *P. cinnamomi* into the uninfested areas, and the factors likely to contribute to a breakdown in the effectiveness of the preventive measures selected.

To have regard for the principles of sustainability, the decision-making processes used in the development of plans for the management of *P. cinnamomi* and disease caused by it in native vegetation will need to:

- integrate long-term and short-term economic, environmental, social and equity considerations;
- consider the need for the application of the precautionary principle;
- where possible, ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations; and
- ensure that the conservation of biodiversity and ecological integrity is a fundamental consideration in the decision-making process.

3. BEST PRACTICE MANAGEMENT METHODS

Best practice management includes:

- adaptive management and accredited environmental management systems;
- detection, diagnosis, demarcation and mapping of infested areas and hence the identification of un-infested areas;
- assessment of the threat to the conservation of biodiversity posed by *P. cinnamomi,* including the threat to uninfested areas of high conservation value, to the residual conservation values of infested areas and to the commercial values of uninfested areas;
- analysis and evaluation of the risk of introduction of *P. cinnamomi* into uninfested areas;
- identification, evaluation and application of effective and efficient risk treatment measures to limit the risk of introduction of *P. cinnamomi* into un-infested areas, including systematic planning for, and implementation of, the long term restrictive entry management of uninfested areas;

- planning and implementation of hygiene regimes for all activities within uninfested areas aimed at limiting the human assisted spread of *P. cinnamomi* into un-infested areas;
- application of repeated treatments of the chemical phosphite to, where possible, protect susceptible threatened species, threatened ecological communities and the habitat of threatened native fauna;
- identification of the need for, and where appropriate the planning and implementation of, measures for the restoration of serious environmental damage in infested areas, including recovery or re-introduction of populations of threatened flora and where necessary ex-situ conservation of genetic resources; and
- identification of the need for, and the implementation of, appropriate programs for public consultation and education and for the provision of information related to activities to minimise the spread and impacts of *P. cinnamomi*.

The best practice methods and standards are described in more detail in the following pages.

3.1 ADAPTIVE MANAGEMENT AND ACCREDITED ENVIRONMENTAL MANAGEMENT SYSTEMS

Adaptive management builds on common sense and learning from experience, experimenting, monitoring, and adjusting practices based on what was learned. It includes recognition that there is incomplete knowledge of the effects *P. cinnamomi* has on ecosystems and of the available risk management practices. The capability to undertake adaptive management depends on the accumulation of knowledge through formal research and formal and informal monitoring and compliance checking on management actions. Best practice management therefore includes a formal commitment of resources to coordinated and integrated research, monitoring and audit programs.

In order to provide for effective delivery of on-ground actions land managers and owners should encourage the development and maintenance of environmental management systems (EMS) that are independently accredited as conforming to the Australian/New Zealand Standard *Environmental Management Systems - Specification with guidance for use AS/NZS ISO 14001:1996*.

3.2 DETECTION, DIAGNOSIS, DEMARCATION AND MAPPING OF INFESTED AREAS

Although *P. cinnamomi* is now widely distributed throughout the South West Land Division, many areas remain uninfested. The first step in minimising the human-assisted spread of *P. cinnamomi* into uninfested areas is to use suitably qualified people to detect, diagnose, demarcate and map, using existing information or new surveys, the current location of disease caused by it. Surveys discriminate between areas that exhibit the visible symptoms of plant disease in native vegetation attributable to *P. cinnamomi,* from those areas that appear to be free of visual disease symptoms (Figures 3 & 4). The presence of *P. cinnamomi* at a field location can be confirmed through an accredited laboratory using processes to extract *P. cinnamomi* from root tissue (and surrounding soil) taken from dead and dying plants.

Figure 3. Small ground cover and under-story plants exhibit symptoms of disease caused by *P. cinnamomi*.

3.3 ASSESSMENT OF THREAT

The effect of *P. cinnamomi* on the health of plant communities, and upon the species in them, varies greatly. In many places, root-disease destroys the structure of many native communities, reduces their floristic diversity and primary productivity, and destroys habitat of dependant native fauna, particularly its value as protection against feral predators. In some places *P. cinnamomi* causes little obvious damage at all.

Figure 4. Field demarcation – separating infested areas from uninfested areas

There is no simple or single linkage between the presence of *P. cinnamomi* and the development of disease symptoms because:

- considerable variability exists within and between native plant species in their responses to infection by *P. cinnamomi*; and
- there is differential influence of temporal and spatial variation in environmental factors on *P. cinnamomi*.

However, within the spectrum of variable disease response of numerous hosts to particular environmental circumstances, at least four specific response categories can be recognised. It is now evident that among the overall variety of plant communities that occur within that part of the South West Land Division that receives more than 800mm mean annual rainfall the four sets of distinctive responses are:

1. **No apparent disease at all**: this applies *inter alia* to those areas of karri and wandoo forest without floristic elements of the dry sclerophyll (jarrah) forest type and to plant communities on the calcareous soils of the Quindalup dune systems and of the Swan coastal plain and related landscapes;

2. **An extremely destructive epidemic of root rot**. This applies within the highly susceptible understorey elements of the dry sclerophyll forest in *Banksia* woodland and in heath-land on podsols, podsolic and lateritic landforms. It is characterised by:
   a) devastation soon after the first arrival of the wave front of infestation by *P. cinnamomi*;
   b) steady extension of epidemic disease soon after arrival of *P. cinnamomi*;
   c) complete or near complete elimination of important structural elements of the plant community; and
   d) a relative insensitivity of the degree of damage to variation in soil characteristics;

3. **A variable epidemic occurs within the dominant tree component of the jarrah forest**. This is characterised by:
   a) erratic and often protracted onset of mortality ranging from early localised onset of mass collapse (similar to type above), through delayed and patchy mortality, to no apparent effect at all on health of the jarrah over-storey; and
   b) high sensitivity to subtle differences in soil characteristics particularly those effecting drainage.

   All variants in the response of jarrah coincide with, or are preceded by, mass deaths in susceptible elements of the under-storey. In jarrah the response to infection varies from that characteristic of epidemics of disease due to invasion by an exotic organism to which the vegetation has not been previously exposed to that typical of long established endemic disease; and

4. **Replacement of forest with open woodland**. Where *P. cinnamomi* has been long established (some 50 years or more) in sites formerly dominated by jarrah/banksia forest that have been very heavily impacted, *P. cinnamomi* behaves

in a manner characteristic of an endemic pathogen. The forest is often replaced by open woodland of marri/parrot bush (*Dryandra sessilis*). Periodic outbreaks of mortality in parrot bush follow, with subsequent regeneration by seed. At this late stage, *P. cinnamomi* causes more muted disease than at the initial wave-front.

Despite this complexity it is evident that within the vulnerable areas the management aim should be to minimise the human-assisted arrival of *P. cinnamomi* in any remaining large, uninfested areas.

3.4 ANALYSIS AND EVALUATION OF THE RISK OF INTRODUCTION OF *P. CINNAMOMI*

The objectives of risk analysis are to separate minor acceptable risks from the major risks, and to use data where available to assist in the evaluation of risk against previously established risk criteria. Risk mitigation strategies can then be developed. The process involves consideration of the sources of risk, their consequence and the likelihood that those consequences will occur in the context of existing controls (i.e. existing management, technical systems and procedures and their various strengths and weaknesses).

3.5 LONG TERM PROTECTIVE MANAGEMENT OF UNINFESTED AREAS

Best practice for the long-term management of uninfested areas will involve:

- Permanently closing and rehabilitating non-essential roads and walk/cycle trails;
- The hygienic use of roads and trails retained within the uninfested areas; and
- Directing drainage from infested areas away from the uninfested areas.

METHODS AND STANDARDS

Permanent road and walk trail closure

When permanently closing a road or walk/cycle trail sufficient work must be done to ensure that unauthorised use of the old road or trail does not continue. Ripping of the surface for a minimum of 100 m and covering it with logs, branches and rocks etc. is often necessary (See Figure 5).

Figure 5. An example of effective road closure

Managing the use of roads and walk/cycle trails retained within uninfested areas

Temporary closure and the controlled use of roads and trails are best realised using a system of gates and signs. Gates must be designed to be highly visible to oncoming vehicles and pedestrians. Signs that provide clear information and guidance to potential users should be installed with all gates. The need for "gate ahead" warning signs to be installed must be evaluated. (Figure 6)

Figure 6. Managing the use of roads retained within uninfested areas with gate & warning signs.

Managing drainage from infested areas

Water draining from roads likely to be infested and drainage from infested areas should be directed away from uninfested areas or taken to the lowest possible point in the landscape before being directed into areas of native vegetation (Figure 7).

Water binding during road works should be kept to a level where run-off into adjacent uninfested areas does not occur. The early installation of correctly designed table drains will ensure that un-seasonal rainfall does not flush material from the road building operation across adjoining areas of susceptible native vegetation.

Figure 7. Drainage is captured and prevented from entering uninfested areas

3.6 MANAGEMENT OF ACTIVITIES WITHIN UNINFESTED AREAS

Best practice management of activities within uninfested areas will involve:

- Ensuring, by visual inspection and/or cleaning, that vehicles, plant, equipment, and in some cases foot-ware (and bicycles etc.) are clean when entering uninfested areas;
- Minimising (and clearly signposting) the number of entry points into uninfested areas;
- Preventing cross-contamination into uninfested areas when working at their boundaries;
- Allowing only uninfested basic raw materials to be used for earthworks within uninfested areas.

METHODS AND STANDARDS

Entry Points into Uninfested Areas

Where possible only one entry point should be provided into each uninfested area. Entry points into uninfested areas that are effective in minimising the human assisted spread of *P. cinnamomi* will be characterised by:

- Signage;
- An inspection and/or cleandown point (Figures 8 & 9) and cleaning equipment;
- A gate; and
- A safe place for large vehicles and equipment to turnaround and exit the area if on inspection are found not to be clean or cannot be effectively cleaned in the field.

The timing of the installation of managed entry points is critical in minimising the probability of introducing *P. cinnamomi*. In the case of new roads or trails being built into uninfested areas the entry point should be installed where practicable on the same day as the commencement of the clearing of the road alignment.

Figure 8. Vehicles are cleaned before entering uninfested areas

Figure 9. Simple boot cleaning station

Cleandown Specification

A visual inspection is necessary to determine whether or not boots, vehicles, machinery or equipment is free of a build up of:

- Clods of soil and plant material and/or
- Slurry consisting of a mixture of soil, plant material and water.

Dust and grime adhering to the sides of vehicles need not be removed before entering uninfested areas.

Records of inspections and cleandowns must be maintained.

Construction Standard for Cleandown Points

A cleandown point will meet the following standards:

- Provide a physical separation between the object being cleaned and the effluent being produced;
- Provide a physical separation from the object being cleaned and any infested soil and plants; and
- Provide easy and safe access for both the placement of the object to be cleaned and for the person doing the cleaning.

Field Location Standard for Cleandown Points

Cleandown points will be sited to ensure:

- Effluent will either fall directly onto infested soil or will be contained for later transport and disposal;
- Cleaned objects enter uninfested areas without becoming re-infested; and
- Entry and departure of vehicles and plant and use by operators is conducted safely.

Preventing Cross-contamination during Works in Uninfested Areas

Clean vehicles, machinery, equipment and footwear can enter uninfested areas (e.g. nursery sterile areas, gravel pits, mining pods, logging coupes) and be used to carry out a range of activities over time within that area without the need for further cleaning provided they do not come into contact with infested soil. Cross-contamination can be prevented by:

- Using barrier systems (Figure 10) that ensure that clean equipment within the uninfested area does not come into direct physical contact with infested soil or unclean equipment operating outside the uninfested area;
- Using demarcation and barrier systems to ensure that unclean vehicles and equipment do not cross inadvertently into infested areas; and
- Ensuring that drainage, soil and plant material from the infested areas cannot enter uninfested areas.

Figure 10. A simple log barrier helps prevent cross contamination from the road to the uninfested forest.

Uninfested Basic Raw Materials

Accredited personnel are required in order to assess and certify that basic raw material (rock, stone, gravel, soil and sand) borrow pits are free of *P. cinnamomi*. Borrow pits can only be certified as being free of *P. cinnamomi* under the following circumstances.

- Where a new pit that is to be located in undisturbed areas, where sufficient indicator plants are available for an assessment to be made.
- An existing pit that has records confirming that it was originally free of *P. cinnamomi*, and for which sufficient evidence exists that an effective system of hygiene has been maintained to ensure that the pit has remained free of *P. cinnamomi*.

Existing pits without a known history that can be effectively placed in quarantine and kept free of all living and dead plant material of all species for a period of three years may then have their status reviewed. *P. cinnamomi* requires plant tissue from which to derive its energy (food source) to survive in the long term (i.e. *P. cinnamomi* does not photosynthesise so it cannot survive free in soil in the long term without access to plant tissue). A three year quarantine period, during which no new plant tissue (living or dead), mycelia, chlamydospores or zoospores are introduced into the pit, either by the autonomous movement of *P. cinnamomi* or through human vectoring, in most cases will allow sufficient time for any previously introduced mycelium, chlamydospores and zoospores to desiccate and die.

Where Basic Raw Materials (BRM) are being extracted from deep pits, such as mines and quarries, and where there is no obvious source of inoculum (e.g. mixing of top-soil and plant material, sub-surface water flow from adjacent infested areas likely to be carrying zoospores or unhygienic entry of vehicle, machine or equipment into the area), this material may also be certified as free of *P. cinnamomi* and be suitable for use in uninfested areas.

Uninfested Nursery Stock

When undertaking rehabilitation works in uninfested areas that involve the supplementary planting of seedlings raised in nurseries it is essential that only uninfected planting stock in sterilised soil is utilised and that care is taken during seedling transport to ensure that seedling trays do not come in contact with infested soil or plants.

3.7 PHOSPHITE APPLICATION TO PROTECT SUSCEPTIBLE THREATENED SPECIES, THREATENED ECOLOGICAL COMMUNITIES AND THE HABITAT OF THREATENED NATIVE FAUNA.

Although it can be expensive to apply, the protective chemical phosphite has shown great promise in the battle to conserve rare and endangered Western Australian native plants, threatened ecological communities and the habitat of threatened native fauna under threat from root-rot disease caused by *P. cinnamomi*. Depending on how it is applied phosphite can provide protection for susceptible plant species against *P. cinnamomi* for up to five years. Phosphite is an environmentally safe and relatively easy to use chemical.

Phosphite is an aqueous solution of mono- and dipotassium phosphite made by neutralising phosphonic acid with potassium hydroxide to a pH in the range of 5.7 to 6.0. The active component of the chemical is the phosphite ion (HPO3 -).

The oral median lethal dose (LD50) for 10% phosphonic acid in water is 1.5 g of pure acid per kg body weight. This places the Technical Active Ingredient in Class III of the World Health Organisation classification. Class III is the "slightly hazardous" class and phosphonic acid is at the very low end of the scale within this class. Twenty percent and 40% products have been formulated to eliminate the very slight poisonous and corrosive properties of the Technical Active Ingredient. The formulated products used in protecting native flora are safer than the Technical Active Ingredient because they are neutralised. Phosphite has a pH of 5.7-6.0 that is comparable with the pH of skin and therefore will not cause dermal irritation and is not corrosive to the skin or eyes. Contact with the skin is likely to cause only mild irritation to cuts or mucous membranes. The slightly acid pH lowers the likelihood of phytotoxicity in plants.

The LD50 for commercial phosphite products to be used against *P. cinnamomi* such as

FOS-JECT 200 is of the order of 23.6 g/kg bodyweight and is classified as "not poisonous" by Australia's National Health and Medical Research Council. Estimated LD50 to fish is approximately 1.5 g/l. The chemical is not broken down in animals and is excreted in the normal way. Phosphite is slowly broken down in the soil to phosphate by micro flora. Application of phosphite to native plant species may cause mild chemical leaf-burning of leaf tips or margins when the fungicide is applied at recommended rates. Higher rates or treatments applied under unfavourable environmental conditions may result in chemical burning of foliage or affect the reproductive capabilities of sprayed plants.

The mode of action of phosphite is not fully understood. At high enough concentrations the phosphite will act directly on *P. cinnamomi* as a fungicide or fungistat to either kill it or halt its growth. This direct effect appears to occur within the *Phytophthora* organism, but it also appears that the progress of infection by *P. cinnamomi* is halted when it comes into contact with phosphite in plant tissue. This may be because high phosphite concentrations interfere with the internal phosphorus utilisation cycle essential for survival of *P. cinnamomi* or because the plant self-defence mechanism is triggered to wall-off and isolate the invaded root cells. If treated in time, plants in even poor health have been shown to fully recover and remain healthy for a number of years. However, repeated applications are required over time in order to maintain the active chemical concentrations in the plant at a level that is high enough to sustain protection.

Phosphite is applied via stem injection (Figure 11) or as a spray (Figure 12) by aerial or ground application. There are two main strategies for its application. Either, a 30 to 40 m wide swathe of phosphite can be applied in front of an advancing *P. cinnamomi* infestation to form a protective barrier or phosphite can be applied in an already infested area to protect remaining susceptible plants that have not yet been infected or if infected have not yet succumbed.

The concentration and frequency of the phosphite dose applied, and the choice of surfactant selected in the case of spraying must be determined in consideration with the specific needs of the target plants such as their size, age and leaf characteristics and environmental factors such as time of year, climate, weather, terrain and vegetation structure.

Figure 11. Stem injection of phosphite –*E. marginata* (Jarrah)

Spraying and in particular aerial spraying of phosphite will normally involve two applications some weeks apart with repeat treatments being scheduled at intervals of a year or more depending upon chemical uptake at time of spraying and the subsequent translocation and dilution of the phosphite within the target species.

Figure 12. Aerial application of phosphite – Stirling Range National Park, Western Australia

The Department has in place programs to identify the highest priority threatened flora, threatened ecological communities and habitat of threatened fauna and where appropriate to protect then by applying phosphite.

Managers seeking to protect populations of threatened flora, threatened ecological communities or the habitat of threatened fauna should consider the long-term prognosis for protection of the site using phosphite and design a control program based on the best available knowledge, with regular review of the impacts of management. Where access control is not possible or not likely to be effective in reducing the threat of existing *P. cinnamomi* occurrences spreading, phosphite application should be used to protect priority biodiversity assets.

3.8 RESTORATION OF SERIOUS ENVIRONMENTAL DAMAGE IN INFESTED AREAS AND THE EMERGENCY EX-SITU CONSERVATION OF GENETIC RESOURCES.

Land managers need to consider the merits of undertaking the restoration of areas that have suffered serious environmental damage through the introduction of *P. cinnamomi.* Similarly, in the worst affected areas, ex-situ conservation of key plant species may be more practical than ongoing phosphite applications and access/drainage controls. Factors to be considered include establishing clear and measurable goals for attempting rehabilitation or control, the likelihood of success and the anticipated costs and benefits of the planned management activities.

In the case of the highest priority declared rare flora that is susceptible to, and threatened by, *P. cinnamomi* the Department has in place programs for:

- the collection and cryogenic storage of germ-plasm; and

- investigation of germination processes, propagation requirements and field establishment methods for the species, including site selection protocols to determine the suitability of areas for translocation.

These efforts are particularly appropriate for rare flora ranked as critically endangered, according to IUCN 'Red List' criteria and CALM Policy Statement 50.

It is not practicable to translocate or protect threatened ecological communities 'ex situ' and so efforts should be directed to protecting these 'in situ' following priority rankings.

3.9 PUBLIC CONSULTATION AND EDUCATION AND THE PROVISION OF INFORMATION

In order to most successfully manage to minimise the impacts of *P. cinnamomi* on conservation lands, all people accessing these lands need to have an awareness of the threat it poses to biodiversity and how it can be spread. Managers actively involved in *P. cinnamomi* management, or who are in a situation where they need to be managing for *P. cinnamomi* should also ensure that they or their staff/contractors are suitably accredited and regularly updated on techniques through training programs provided by tertiary institutions and Government agencies, and to ensure that only the most up to date information is promoted.

4. GLOSSARY

"Adaptive management" means:
A process of responding positively to change. The term adaptive management is used to describe an approach to managing complex natural systems that builds on common sense and learning from experience, experimenting, monitoring, and adjusting practices based on what was learned.

"Basic Raw Material" means:
Rock, stone, gravel, soil and sand.

"Consequence" means:
The outcome of the introduction of *Phytophthora cinnamomi* into an uninfested area of native vegetation being a loss, injury, disadvantage or gain.

"Disease" means:
A combination of a pathogen, host and correct environmental conditions, which results in disease symptoms or death of a host.

"Hazard" means:
A source of potential harm or a situation with the potential to cause loss.

"Host" means:
The plant which is invaded by a pathogen and from which the pathogen derives its energy.

"Management Plan" means:
A management plan approved under section 60 of the *Conservation and Land Management Act 1984.*

"Pathogen" means:
Any organism (e.g. *P. cinnamomi)* or factor that causes disease in a host.

"Phosphite" means:
An aqueous solution of mono-potassium phosphite and di-potassium phosphite

"*Precautionary Principle*" has the meaning:
Stated in the *Intergovernmental Agreement on the Environment (1992)*:

" Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:
(i) Careful evaluation to avoid, where-ever practicable, serious or irreversible damage to the environment: and,
(ii) An assessment of the risk-weighted consequences of various options."

"Precaution" means:
An action(s) taken beforehand to avoid environmental degradation or to ensure a desirable environmental outcome.

"Principles of Sustainability" has the same meaning:
As Section 19(2) of the *Conservation and Land Management Act 1984.*

"Risk" means:
The chance of an uninfested area becoming infested through the autonomous actions of the pathogen (*P. cinnamomi)* or the actions of people and animals or a combination of these factors, measured in terms of the magnitude of consequences of that event should it occur and the likelihood of the event and its consequences occurring and assessed in the context of existing controls.

"Risk analysis" means:
The systematic use of available information to determine how often specified events may occur and the magnitude of their consequences.

"Risk control" means:
That part of risk management that involves the implementation of policies, standards, procedures and physical changes to eliminate or minimise adverse risks.

"Risk evaluation" means:
The process used to determine risk management priorities.

"Risk management" means:
The culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects.

"Risk treatment means:
The selection and implementation of appropriate options for dealing with risk.

"Susceptible" means:
Influenced or harmed by *Phytophthora cinnamomi*.

"Threat" means:
An indication that serious or irreversible

environmental damage may occur.

"Uninfested" means:
An area that an accredited person has determined may be free of plant disease symptoms that indicate the presence of *P. cinnamomi.*

"Vulnerable" means:
Susceptible to physical injury.

"Vulnerable zone" means:
That part of the South West Land Division and the areas adjoining it to the north west and the south east that receives mean annual rainfall greater than 400 mm in which susceptible native plants occur in conjunction with the environmental factors required for *P. cinnamomi* to establish and persist.

Appendix 1. - Distribution *P. cinnamomi* and disease caused by it in native vegetation caused by it in Western Australia