

PHYTOPHTHORA CINNAMOMI

AND DISEASE CAUSED BY IT

Volume I – Management Guidelines



2002



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SECTION 1 - INTRODUCTION

1.1 BACKGROUND - *PHYTOPHTHORA CINNAMOMI* AND PLANT DISEASE CAUSED BY IT

The colourless microbe known to science as *Phytophthora cinnamomi* is infamous world wide for its capacity to invade and destroy the function of the root systems of an extraordinary range of plants. The slow moving epidemic of destructive root disease the pathogen causes in native vegetation in Australia is known as *Phytophthora* dieback. The impact of this now widespread pathogen, believed by many to have been first introduced to Western Australia at or soon after European settlement in 1828, varies greatly across the landscape. (Figure 1.1)

In Western Australia *Phytophthora cinnamomi* will continue its autonomous spread from all its established disease fronts. The rate of uphill spread via root to root contact amongst host plants has been reported as approximately one meter per annum under idea environmental conditions. The cross slope and down-slope rate of spread occurs at a faster rate due to the influence of surface and sub-surface water-flows on the dispersal of zoospores. Native animals, feral animals and people act as vectors aiding the wide and rapid spread of *Phytophthora cinnamomi*, thereby enabling it to establish new centres of infestation in previously uninfested areas.

Limited control of *Phytophthora cinnamomi* and disease it causes is possible over small areas through repeat application of phosphite. Phosphite can be used to increase the resistance of threatened flora, threatened ecological communities and the habitat of threatened native fauna.

The only other direct management action that the Department and other land managers can take at present is to control human vectoring of the pathogen. This can be achieved through the application of rigorous hygiene to ensure that all who have a valid reason to enter uninfested areas are clean upon entry. (i.e. do not carry the pathogen with them into uninfested areas).

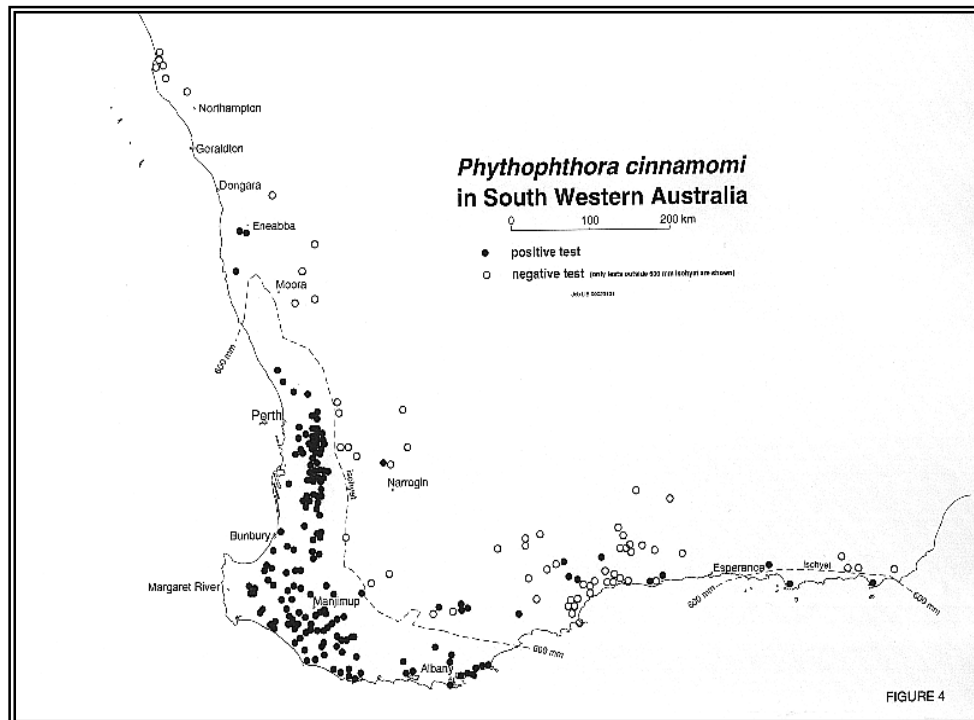


Figure 1.1 Distribution of disease in native vegetation caused by *Phytophthora cinnamomi* in Western Australia

1.2 PURPOSE OF THIS MANUAL AND EACH OF ITS VOLUMES

This manual :-

- Provides the Department with a single source document on :-
 - a) Information about the pathogen *Phytophthora cinnamomi* and diseases it causes (*Phytophthora cinnamomi* and disease caused by it. Volume I - Management Guidelines and *Phytophthora cinnamomi* and disease caused by it. Volume II – Guidelines for Detection, Diagnosis and Mapping of Disease caused by *Phytophthora cinnamomi*.),
 - b) Management guidelines (*Phytophthora cinnamomi* and disease caused by it . Volume I- Management Guidelines),
 - c) Disease detection, diagnosis (interpretation), demarcation and mapping guidelines (*Phytophthora cinnamomi* and disease caused by it. Volume II –Guidelines for Detection, Diagnosis and Mapping of Disease.)



- d) Phosphite operational guidelines (*Phytophthora cinnamomi* and disease caused by it .
Volume III - Phosphite Operations Guidelines), and
 - e) Training curriculum and syllabi (*Phytophthora cinnamomi* and disease caused by it .
Volume IV - Training Curriculum and Syllabi)
- ❑ Eliminates the need for detailed information about the pathogen, the diseases it causes hygiene practices and phosphate use being included in the Department’s other manuals.
 - ❑ Replaces Administration Instruction No. 46 “Departmental Procedures for Approval of 7-Way Tests”, the Hygiene Evaluation form and the Hygiene Manual.

1.3 PROCEDURE FOR UPDATING AND MAINTAINING THIS MANUAL

1.3.1 Manual Updates

Each page of this manual is numbered and date stamped. The Department’s *Phytophthora* Management Coordinator is responsible for authorising all updates to the manual.

1.3.2 Maintaining manuals

Manuals are issued to individual managers and their staff who are responsible for ensuring that their copy is up to date through regular liaison with the *Phytophthora* Management Coordinator and by regularly down loading updated versions from the Department ‘s website.

SECTION 2 – TERMINOLOGY, CONCEPTS AND GLOSSARY

2.1 NEED FOR USE OF PRECISE TERMINOLOGY

Understanding the correct meaning of words prevents confusion in the use of terms and their conceptual basis. Correct word use stops the invention of new ambiguous words that in turn encourage tautological and counter intuitive language. Clear, concise and accurate communication leads to major savings and improved conservation outcomes.

2.2 GLOSSARY OF COMMON WORDS

Infested areas

Areas that a accredited Interpreter has determined have plant disease symptoms consistent with the presence of the pathogen *Phytophthora cinnamomi*.

Uninfested areas

Areas that an accredited Interpreter has determined to be free of plant disease symptoms which would indicate the presence of the pathogen *Phytophthora cinnamomi*.

‘Protectable’ areas

Defines areas of land managed by the Department over which the hygiene rule, for the plant pathogen *Phytophthora cinnamomi*, of clean on entry will apply and access will be minimised.

- Can include uninterpretable areas.
- Are situated in areas receiving > 600 mm per annum rainfall or are water gaining sites (eg. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600 per annum rainfall zone.
- Does not have a calcareous soil (e.g. not Spearwood Sand dune)
- Has been determined to be free of the pathogen *Phytophthora cinnamomi* by a qualified Interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *Phytophthora cinnamomi* are evident)

- Are positioned in the landscape and are of sufficient size (eg. > 4 ha with axis > 100m) such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term. (e.g. A few decades)
- Consists of areas where human vectors are controllable (eg. not an open road or private property)
- Includes high value areas (eg. a small uninfested area which contains a species of susceptible threatened flora)

‘Un-protectable’ areas

Consist of all areas not classed as ‘protectable’

Uninterpretable areas

Are situated in areas receiving > 600+ mm per annum rainfall or are water gaining sites (eg. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600mm per annum rainfall zone. Indicator plants are absent or too few to determine the presence or absence of disease caused by *Phytophthora cinnamomi*.

Landscape unit

Used in the analysis of the need for, and the determination of the boundaries of, areas to be mapped for *Phytophthora cinnamomi* Occurrence, for determining ‘protectable’ Areas and their appropriate boundaries, and for preparing *Phytophthora cinnamomi* Hygiene Plans. A landscape unit is an area bounded by features such as creeks, ridges, saddles, open roads and/or freehold land.

***Phytophthora cinnamomi* Occurrence Map**

This is the main map produced by Interpreters. It shows *Phytophthora cinnamomi* occurrence, *Phytophthora cinnamomi* free areas, uninterpretable areas and may show un’protectable’ areas.

***Phytophthora cinnamomi* Management Plan**

Is a document (includes appended maps) that describes and controls how human access to uninfested ‘protectable’ areas is to be managed so that the role of humans as vectors in establishing new centres of infestation will be reduced to the lowest possible level.



***Phytophthora cinnamomi* Management Map**

Prepared as part of 'protectable' areas *Phytophthora cinnamomi* management planning process. It records details of planned management actions and is placed in District and FMB records systems.

Disease

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

Environment

The sum of all the factors which act on an individual organism during its lifetime.

Host

The plant which is invaded by a pathogen and from which the pathogen derives its energy

Pathogen

Any organism or factor causing disease within a host.

Hyphae

A singular tubular filament of a fungus, oomycete, or chytrid; the hyphae together comprise the mycelium.

SECTION 3 - *PHYTOPHTHORA CINNAMOMI* BIOLOGY

3.1 DESCRIPTION OF *PHYTOPHTHORA CINNAMOMI*

Phytophthora cinnamomi and other members of the genus *Phytophthora* are not part of the Fungi kingdom but instead belong to the water moulds or Oomycota (class Oomycetes) which are placed in the Kingdom Chromista (or Stramenopila). Despite this, Taxonomist's advice is that *Phytophthora* species be referred to as fungi.

Phytophthora cinnamomi is an introduced soil-borne pathogen that kills a wide range of plant species in the South West by attacking their root system. *Phytophthora cinnamomi* can also survive and reproduce on a wide range of native plants without killing them. It has a widespread but discontinuous distribution in areas of the South West with an annual rainfall above 400mm.

There are over 50 species of *Phytophthora* which occur around the world and all of them cause plant diseases. *Phytophthora cinnamomi* is the *Phytophthora* species most frequently isolated from areas of dead vegetation in the South West.

Phytophthora cinnamomi has a superficial resemblance to fungi but they are different in that their cell walls are cellulosic rather than chitinous. The fungus grows as microscopic sized filaments (mycelium) on the surface of plant roots (Figure 3.1) and invades the cells of susceptible host plants Figure 3.4). Their food source is the root and basal stem tissue of living plants.

The fungus consumes the host plant causing lesions (areas that appear rotten). This weakens or kills the plants by reducing or stopping the movement of water and nutrients within the plant. Once attacked susceptible hosts rarely recover. Most succumb to a "sudden death" syndrome, rather than a "dying back or dieback" syndrome.

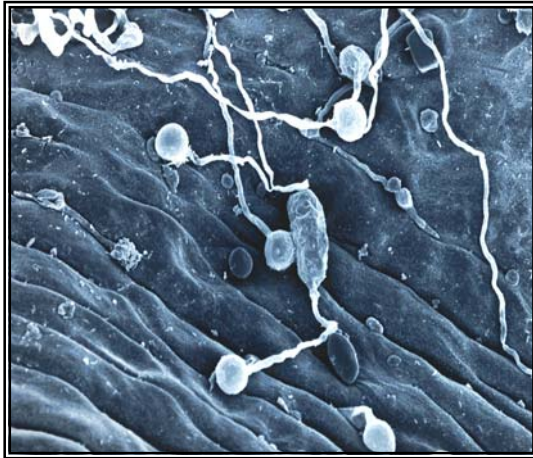


Figure 3.1 Mycelium growing on a the surface of a root

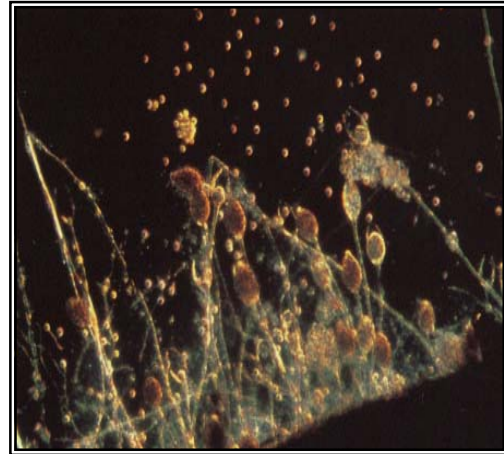


Figure 3.2 Spore sacs of *P. cinnamomi* release zoospores that swim in free water and infect nearby roots



Figure 3.3 Hyphal swellings of *P. cinnamomi*



Figure 3.4 Germ-tubes penetrating a root

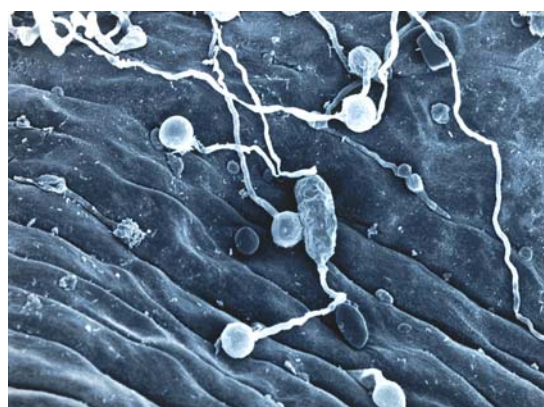


Figure 3.5 Zoospore growing sporangia

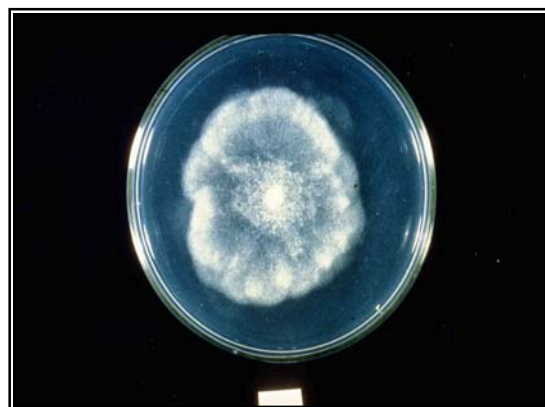


Figure 3.6 *Phytophthora cinnamomi* growing on agar plate

3.2 LIFE CYCLE OF *PHYTOPHTHORA CINNAMOMI*

The life cycle of *Phytophthora cinnamomi* (Fig. 3.7 & 3.8) depends on moist conditions that favour survival, sporulation and dispersal.

The pathogen is not capable of photosynthesis and so it needs to extract food from living plant tissue. It does this via a mass of microscopic threadlike mycelium that form the body of the organism that grows through host tissue. Mycelia continue to grow within the host tissue when it is above 80% moisture ambient. Mycelia may be transported in soil and host tissue and deposited where it may infect new hosts. The mycelium, given warm, moist conditions are capable of producing the millions of tiny spores that reproduce the fungus. Two kinds of spores are likely to be found.

Zoospores

Very small spores that can actively swim very short distances towards new hosts and initiate new infections. They are short-lived and fragile but produced in large numbers, and are the mode for the spread of the disease from one plant to the next. They can also be carried along in moving water over large distances. As they move through the soil zoospores lodge on plant roots, infect them, and in susceptible plants produce mycelia. The mycelium grows, feeding on the host, rotting the roots and cutting off the plant's water supply. The mycelium may grow from plant to plant via root to root contact points and/or root grafts.

Chlamydo-spore

Larger spores that are tough and long-lived (within dead plants and the soil). They are produced under unfavourable conditions and are the resistant resting phase of the fungus. They may be transported in soil or roots and then germinate to cause a new infection when they encounter favourable conditions. The chlamydo-spores produce mycelium and zoospores.

When conditions are warm and moist, microscopic spore sacks called sporangia and thick walled chlamydo-spores are produced vegetatively from mycelia strands that form the body of the fungus in the soil or host tissue. The sporangia release motile zoospores in free water to infect host roots. Mycelia of different mating types may grow together inducing the production of thick walled sexual spores called oospores. The mating types are called A1 or A2.

Only one mating type (A1) occurs in WA. Currently the pathogen cannot reproduce sexually in WA and relies on vegetative reproduction for survival and dispersal.

After infection, the fungus invades root bark and forms lesions that may extend in to the plants stem collar. In susceptible species infection of roots and collar results in death of the host. Once dispersed, the spores of the fungus may infect a wide range of resistant and susceptible hosts.

Figure 3.7

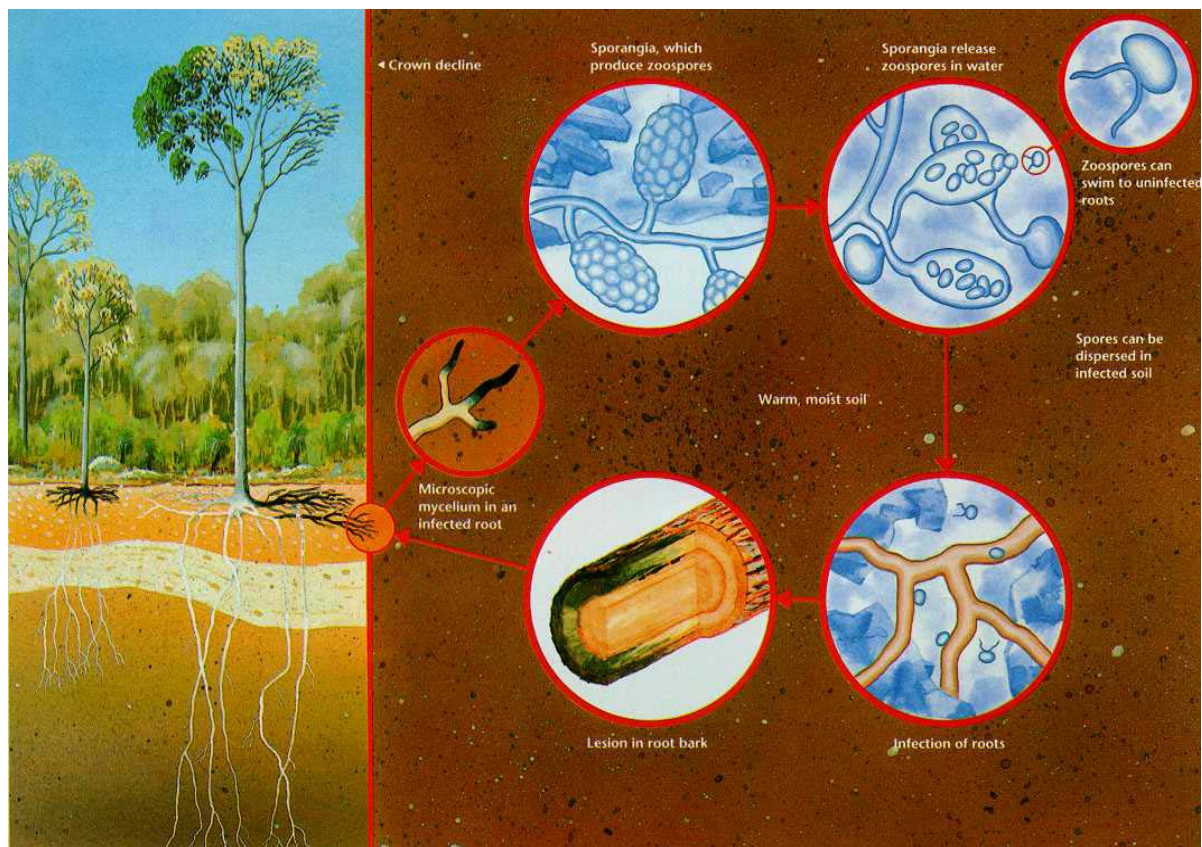
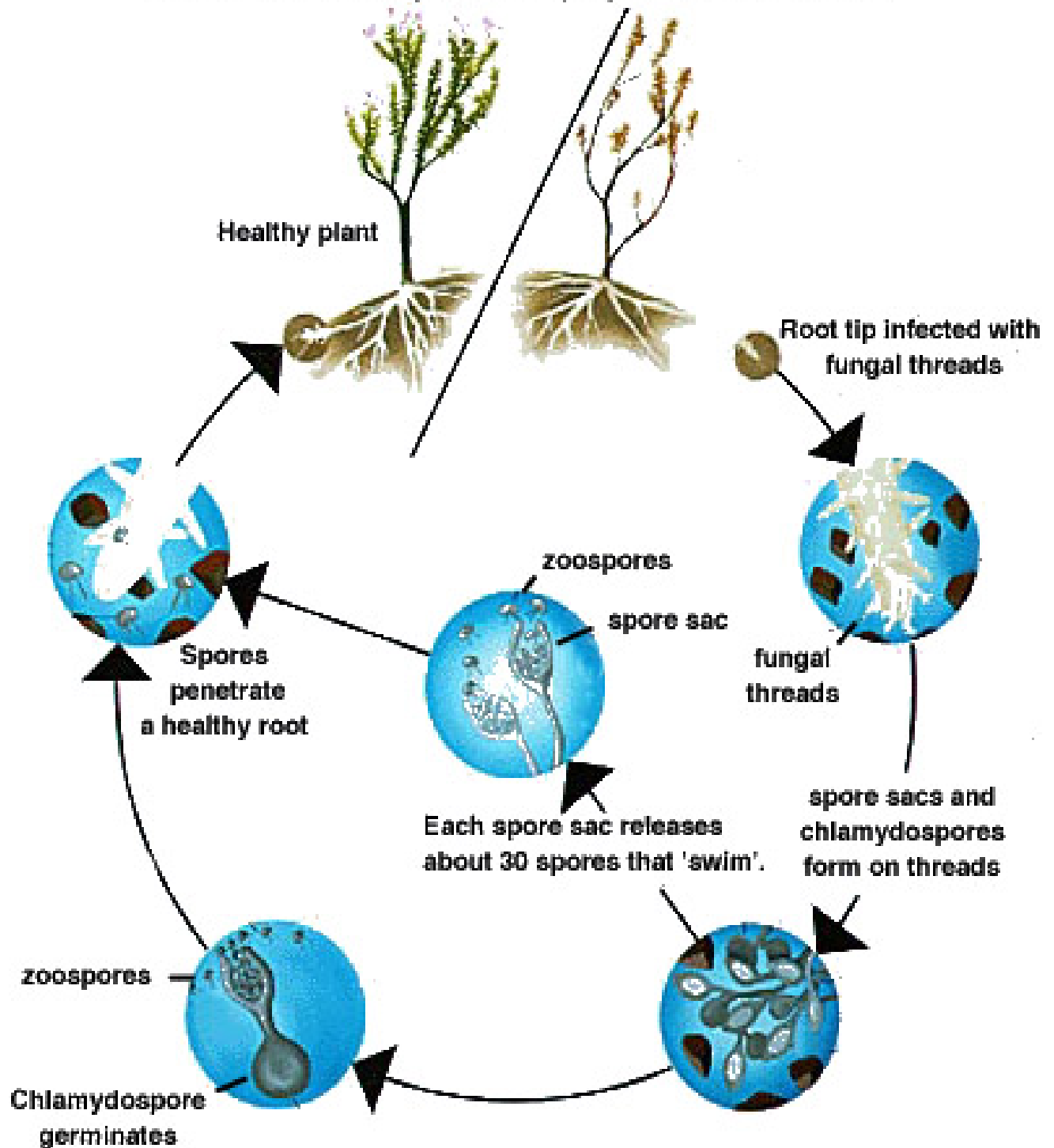


Figure 3.8

Generalised Life Cycle of *Phytophthora cinnamomi*



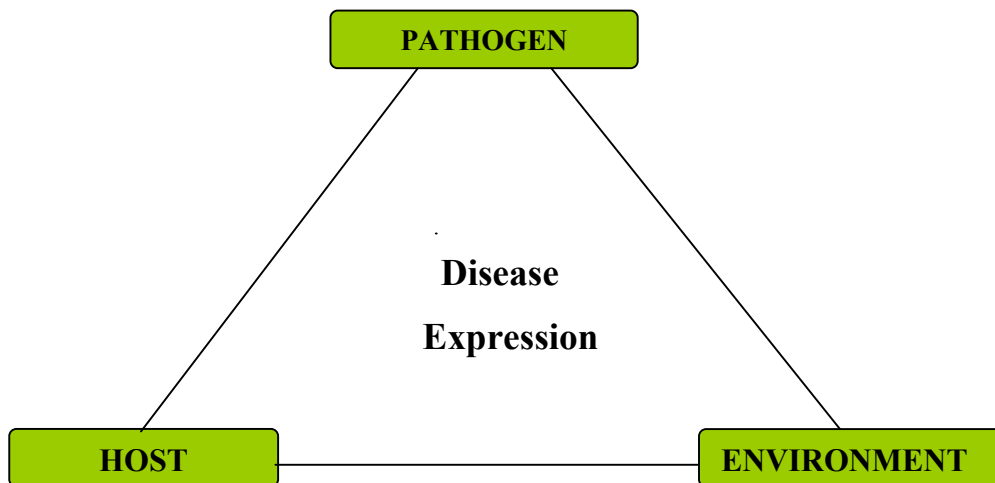
3.3 DISEASE TRIANGLE

DISEASE: A combination of a pathogen, host and correct environmental conditions, which results in the expression of disease symptoms in the host.

ENVIRONMENT: The sum of all the factors that act on an individual organism during its lifetime.

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

PATHOGEN: Any organism or factor that derives its energy or nutrients from a host, often causing disease in the host.



The lack any one at a particular field site means that disease in native plants will not occur.

3.4 INTERACTION WITH THE HOST

Phytophthora cinnamomi has a very wide host range. At least 1000 species from taxonomically diverse families have been reported as hosts for *Phytophthora cinnamomi* of which nearly half have been recorded from research in Australia. Indigenous species most affected belong to four families:-

- Proteaceae
- Epacridaceae
- Papilionaceae/Fabaceae
- Myrtaceae

Not all genera within a family or all species within a genus are necessarily susceptible. E.g. some species of Eucalyptus are highly resistant (including Karri, Marri, Wandoo and Tuart) while some, such as Jarrah, are affected but have the ability to resist the invasion of the fungus under certain conditions (Tissue moisture content < 80%).

Broad estimates are that perhaps 1500 to 2000 species of the estimated 8000 species of vascular plants in the South West of WA may be susceptible to the degree that successful infections result in the death of the host.

The interaction between pathogen and host starts with infection, with zoospores and mycelium growth via root to root contact initiating most infections. Zoospores are attracted to the growing tips of roots chemotactically, they encyst and germinate to produce germ tubes which penetrate roots. Hyphae proliferate within roots, macerating tissues and causing the roots to rot. The mycelium feeds on sugars within the plant's cells

Once the fungus has established within the roots of a prospective host, it establishes within un lignified cortical tissue and the phloem. This blocks the conductive tissue and prevents the uptake of water and nutrients

Host plants can resist the attack with the formation of blocking lesions or resist entry by having tough epidermal cells on root hairs. Those that do not die will, once the destruction of their conductive tissue reaches the point where they are unable to sustain themselves.

Figure 3.9 illustrates the progressive spread of *Phytophthora cinnamomi* and its impact on various elements of the vegetation.

The top section of figure 3.9 shows a horizontal view of a transect in uninfested jarrah forest prior to introduction of *Phytophthora cinnamomi*. The three tiered stand structure of ground cover, dense *Banksia* understorey, and eucalypt overstorey. Three structural arrangements are shown:

1. Selection logged old growth.
2. Seventy year old uniform regrowth arising from clear felling of old growth.

3. Virgin old growth. Note also dead branches protruding above the canopy of a number of the large veteran old-growth trees.

The lower section of Figure 3.10 shows the same transect 3-5 years after introduction of *Phytophthora cinnamomi* at point X, with concurrent death ("mass collapse") of understorey of *Banksia grandis* and mature jarrah of the overstorey on a high impact site. The distribution of *Phytophthora cinnamomi* in soil beneath the forest is indicated by circles, the vertical columns indicate the relative intensity of infestation. Arrows indicate the direction of spread and relative rates of spread downslope left and upslope right.

Figure 3.10 illustrates the movement of a "wave front" of high density *Phytophthora cinnamomi* at the perimeter of a diseased area and the decline in pathogen numbers in the wake of infection.

The top section of figure 3.10 shows the relationship of infestation to disease expression and hygiene zones.

- a) outer limit of pathogen free buffer zone (wider downslope left than upslope right)
- b) outer limit of cryptic infection and disease symptoms.
- c) inner limit of wave of active disease.

The lower section of figure 3.10 shows the variation in disease impact on jarrah trees:

- 1) e-f low impact on jarrah but elimination of *Banksia* .
- 2) f-g "graveyard" site of high impact on both jarrah overstorey and *Banksia* understorey with gradual colonisation by marri in an open woodland.

Figure 3.9

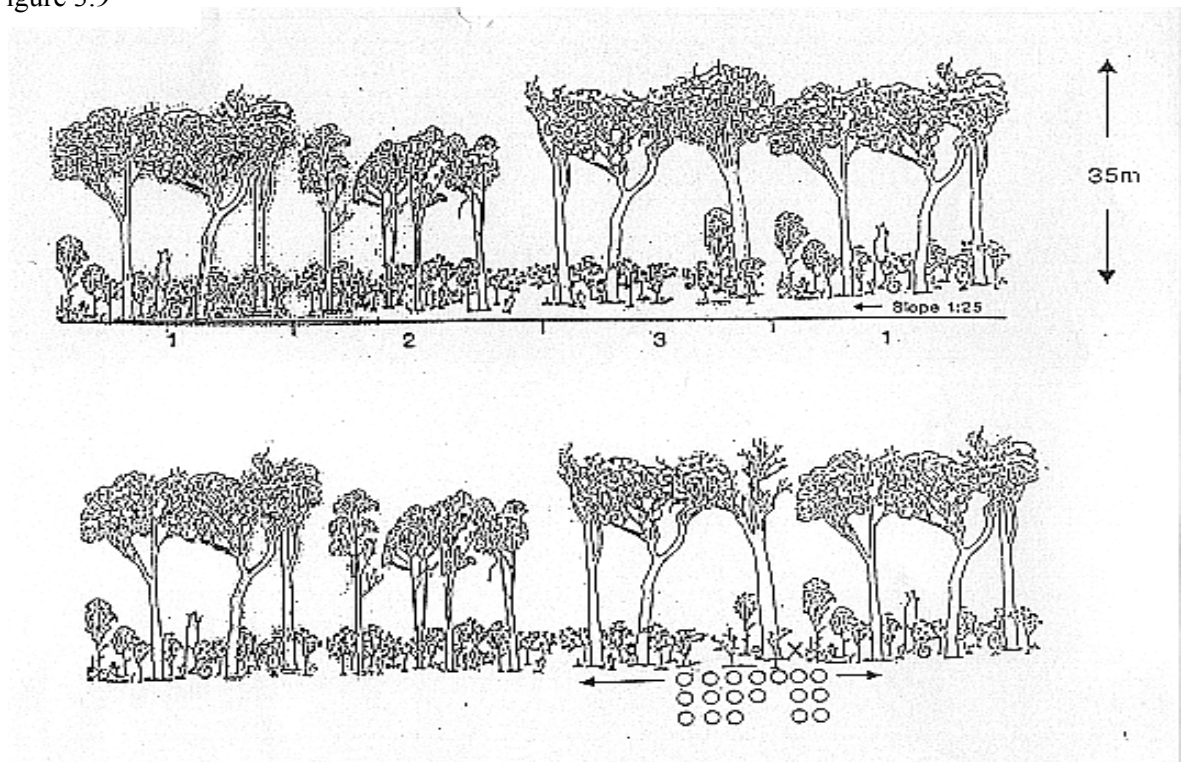
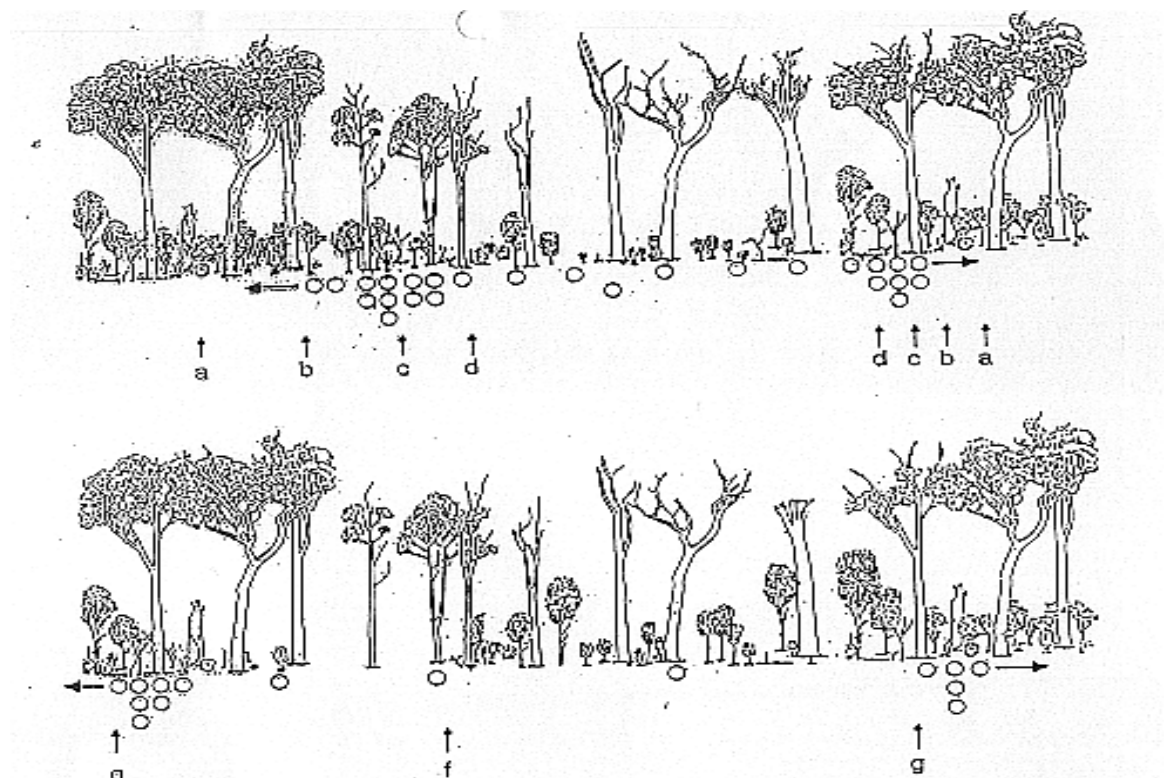


Figure 3.10



3.5 DETECTION, DIAGNOSIS, DEMARCATION AND MAPPING

A detailed field survey by trained observers is necessary in order to discriminate between areas that exhibit the visible symptoms of plant disease in native vegetation attributable to the pathogen *P. cinnamomi*, from those areas that appear to be free of visual disease symptoms (Figure 3.11 & 3.12) Confirmation of the presence of the pathogen may often be made by the laboratory analysis of soil samples and root tissue taken from dead and dying plants

Detection of disease symptoms, sampling of soil and plant tissue for laboratory analysis, diagnosis, field demarcation and mapping for the presence of *Phytophthora cinnamomi* is described in detail in ‘*Phytophthora cinnamomi* and disease caused by it. Volume II –Guidelines for Detection, Diagnosis and Mapping of Disease caused by *Phytophthora cinnamomi*’.

The boundary between infested and uninfested areas is generally demarcated using red flagging tape or yellow painted blazes (Figure 3.13 & 3.14).



Figure 3.11 Small ground cover and understory plants exhibit symptoms of the lethal disease caused by *P. cinnamomi*.



Figure 3.12 Impact of *P. cinnamomi* on *E. marginata* (Jarrah) forest



Figure 3.13 Field demarcation.



Figure 3.14. Field demarcation – separating infested areas from uninfested areas

SECTION 4 - THE NATURE OF THE THREAT POSED BY *PHYTOPHTHORA CINNAMOMI* IN WESTERN AUSTRALIA

4.1 HISTORY OF INTRODUCTION AND SPREAD

Since 1921 it has been evident that an increasing number of patches of formerly healthy jarrah forest have become afflicted with a lethal disease known as “jarrah dieback” (‘JDB’).

Until 1964, the cause of this malady had been the subject of contending speculation. In that year proof of the role of the plant pathogen *Phytophthora cinnamomi* as the cause of ‘JDB’ was established. At the same time, it was recognised that this exotic microbe was also intimately associated with similar damage in other plant communities of sclerophyllous natives, whether jarrah was dominant, a minor component only, or not present at all. The period of intensive research that followed is ongoing and has resulted in revised perceptions of the nature of the pathogen and of the diseases that result from its interactions with the enormously diverse native vegetation of south western Australia.

Phytophthora cinnamomi is a soil-borne micro-organism of foreign origins. It almost certainly entered Western Australia for the first time on soil around the roots of cultivated plants, shortly after European settlement in 1827. Until the effective implementation by Australia of quarantine of import of exotic soil and plant products, there must have been innumerable introductions at many points of entry around the continent and its redistribution within the country over a period of some 150 years.

Phytophthora cinnamomi has now extended its largely unfettered colonisation of the southwest by human and animal (native and feral) movement of infested soils and autonomous spread (the latter largely by growth of the pathogen in the root systems of highly susceptible native plants, but also assisted by sub-surface and over land flow of water carrying zoospores). This epidemic of colonisation, which has produced a complex mosaic of infested and uninfested areas, is now well on its way toward the middle stages of its ultimate potential to occupy all of those sites which are environmentally suited to its establishment, survival and multiplication. Such sites are very widely distributed over some 20% or more of the natural vegetation in areas throughout that part of the South West Land Division that receives mean annual rainfall in excess of 800mm and occur sporadically at lower rainfall.

Within the 600 – 800mm rainfall zone the occurrence of *Phytophthora cinnamomi* is also widespread but much less extensive. In this zone, severe damage to native vegetation is largely confined to water-gaining sites or to years with an abnormally high summer rains. In these circumstances localised patches of the vegetation may periodically suffer severe damage with intervals of recovery during drier periods.

In areas receiving < 600mm rainfall per annum, root rot caused by *Phytophthora cinnamomi* is restricted to circumstances where localised hydrological effects, such as the shed from granite bosses or rising ground water tables associated with up-slope land clearance in the catchment, cause effective rainfall to substantially exceed the regional patterns.

There is no record of *Phytophthora cinnamomi* establishing in natural ecosystems in regions receiving < 400mm rainfall per annum. It may occur in irrigated horticultural activities.

4.2 DISEASE SYNDROMES

The effect of *Phytophthora cinnamomi* upon the health of plant communities, and upon the species in them, varies greatly. In many places, lethal root-disease destroys the structure of many native communities, reduces their floristic diversity, decimates their primary productivity and destroys habitat for much dependant native fauna, particularly its value as protection against feral predators. In some places the pathogen causes little damage at all. Unfortunately the extent of susceptible communities in vulnerable environments is much greater than that of communities which occur in environments which are inherently unfavourable to the pathogen.

No simple or single relationships exist between the presence of *Phytophthora cinnamomi* and the development of disease because of :-

- i) the considerable variability which exists within and between native plant species in their responses to the presence of *Phytophthora cinnamomi*,
- ii) the differential influence of temporal and spatial variation in environmental forces,

However, within the spectrum of variable disease, response of numerous hosts to particular environmental circumstance, at least four specific nodes can be recognised. These are due to either distinct processes or to different stages in the development of disease which occur upon

and after the arrival of the pathogen and its persistence in previously uninfested areas. Each of these circumstances presents a different problem that requires a separate management response. It is now evident that among the variety of plant communities, which occur within that part of the South West Land Division that receives more than 800mm mean annual rainfall the four sets of distinctive consequences are:

I) No apparent disease at all :

This applies *inter alia* to those areas of karri and wandoo forest which contain no floristic elements of the dry sclerophyll (jarrah) forest type and to plant communities on the calcareous soils of the Spearwood and Quindalup Dune Systems and of the Swan Coastal Plain and pedogenically related landscapes.

II) 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 heathland on podsols, podsollic and lateritic landform. It is characterised by:

- a) devastation soon after the first arrival of the wave front of infestation,
- b) steady extension of epidemic disease soon after arrival of the pathogen,
- c) complete or near complete elimination of important structural elements of the plant community.
- d) a relative insensitivity of the degree of damage to variation in soil characteristics.

iii) A variable epidemic within the dominant jarrah tree component of the forest :

This is characterised by :-

- a) a much more 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 overstorey.
- b) high sensitivity to subtle differences in soil characteristics particularly those effecting drainage.

All variants in the response of jarrah are coincident with, or preceded by, mass deaths in susceptible elements of the understorey. In jarrah, their behaviour 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.

iv) An 'endemic' pathogen

Where *Phytophthora cinnamomi* has been long established (some 50 years or more) in sites formerly dominated by jarrah/banksia forest and has been very heavily impacted *Phytophthora cinnamomi* behaves in a manner characteristic of endemic pathogen. The forest is often replaced by an open woodland of marri/parrot bush. Periodic outbreaks of mortality in parrot bush (*Dryandra sessilis*) follow, with subsequent regeneration by seed. At this late stage, *Phytophthora cinnamomi* causes more muted disease than at the wave front.

4.3 PROGNOSIS – SPREAD, ERADICATION AND CONTROL

The Department has accepted that eradication and prevention of the establishment of new centres of infection is not a realisable objective, even were it to involve both a socially acceptable strategy of denial of human access for any purpose and an eradication program of native animals which vector the pathogen. Similarly insurmountable problems of scale and cost would attend efforts to map and treat the thousands of kilometres of invasion front now established within 17 million ha of remnant native vegetation in the Southwest Land Division.

Further, despite intensive research and extensive field tests over three decades (1970 to 2000), the delivery of ameliorative treatments (which might favourably modify those environmental influences responsible for destructive interaction between plant species which are susceptible to the pathogen) though biologically well founded have so far proved to be impracticable.

Ultimately this pathogen will occupy through autonomous and vectored spread all of the sites where the correct combination of host and environment occur (See figure 4.1 and 4.2)

4.4 IMPACTS

Estimates of annual losses caused by *Phytophthora* in WA provided by officers of Agriculture WA for a Rural Resources Development Corporation survey in 1993 total \$1,200,000 for horticulture and \$500,000 for floriculture. Losses due to *P. claudstina* in clover crops have not been estimated but are believed to be substantial.

Plant Crops, even to longer lived perennials such as avocado, are amenable to a variety of techniques of control including drainage, organic amendment, chemical treatment and the use of resistant lines.

The arrival and spread of *Phytophthora cinnamomi* in the native vegetation of WA is now seen to be a biological disaster of global significance for conservation of areas of great bio-diversity and a major problem for wood-based and other extractive industries. A number of plant species face extinction unless the use of programs of phosphite treatments, cryogenic storage of genetic material and the use of appropriate fire regimes to exploit the phenomenon known as “disease escape” are effectively implemented and maintained.

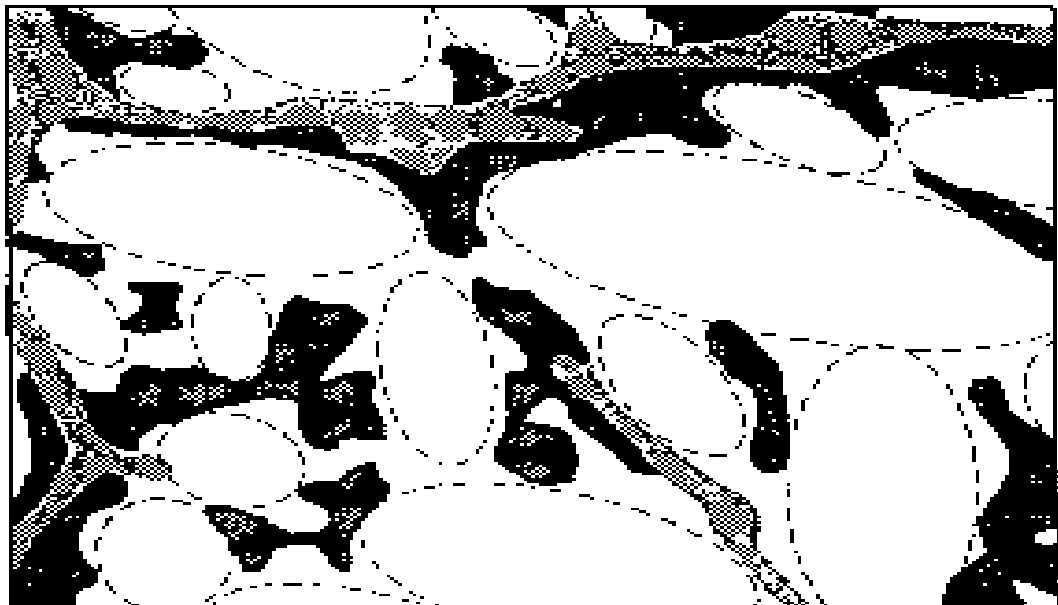


Figure 4.1 Sample area of pre 1976 dieback mapping (after Shea, 1975), with notional compact areas of dieback-free forest (shown as dashed ellipses). Light grey : riparian non-forest communities; Dark grey: *Phytophthora* affected jarrah forest.

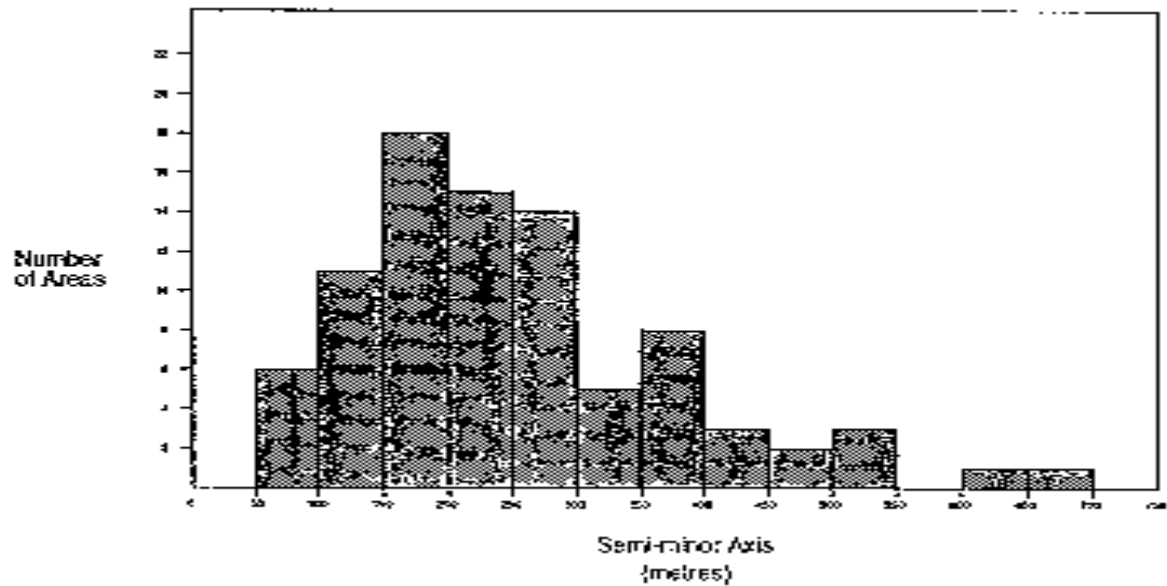


Figure 4.2 Histogram showing the frequency of compact areas (approximated as ellipses) verses the distance of their most remote point from the nearest dieback (semi minor axis of the ellipse). The behaviour at the lower end of the distance axis is strongly influenced by the cut-off in the sampling of small areas.



SECTION 5 - CONSERVATION AND LAND MANAGEMENT ACT 2000, REGULATIONS AND DEPARTMENTAL POLICY

5.1 CONSERVATION AND LAND MANAGEMENT ACT 2000 AND REGULATIONS

The Department is responsible for administering the *Conservation and Land Management Act 1984* and the *Forest Management Regulations 1993*.

The long title of this Act is:

"An Act to make better provisions for the use, protection and management of certain public lands and waters and the flora and fauna thereof, to establish authorities to be responsible therefore, and for incidental purposes".

This *CALM Act 1984* establishes the Department as the agency charged with the responsibility for the management of lands and waters vested in the Conservation Commission of Western Australia and the Marine Parks and Reserves Authority.

The *CALM Act 1984* influences the management of *Phytophthora* and diseases caused by it through the following:

- Part 7 (Sections 79 - 86)
- Section 45
- Section 62
- Section 120
- Section 124-125

Classification of Land (Section 62)

The Minister may classify land on the recommendation of the controlling body as:

- a wilderness
- a prohibited area
- a limited access area
- a temporary control area
- a recreation area



or other classification as the Minister and controlling body see fit.

Control of access under the Section can be applied to any land or waters vested in the Conservation Commission.

A temporary control area classification for land or water shall only be for the purpose of public safety or the protection of flora and/or fauna. Temporary control areas cannot exceed a period of 90 days, however, can be made more than once for the same area and purpose.

For Section 62 to be applied there needs to be a broad provision for it in the management plan applicable to the area. There is also no Regulation to enforce Section 62.

Restriction of access for disease purposes is best carried out under Part 7 of the *CALM Act 2000*.

5.1.1 Control and Eradication of Forest Diseases - Part VII (Sections 79 - 86)

The purposes of Part VII are to identify the areas of public land in which trees may already be, may become, or are infected with any forest disease and to control and eradicate such forest diseases as are detected in such areas.

Public land includes State forest and Timber Reserves, Crown land including pastoral leases and mining tenements and other land dedicated under *the Land Administration Act of 1933*.

Steps to be taken before Minister makes recommendation

(a) Extension, reduction or abolition of risk and disease areas

A risk area or a disease area may be extended, reduced or abolished by order of the Governor made on the recommendation of the Minister.

(b) Mining tenements in risk or disease area

If the holder of the tenement intends to explore or exploit a part of it they have to give three months written notice before the date they intend on doing so to the Minister.

If the holder of the mining tenement is given written authority from the Minister to explore or exploit they may do so only by entering that part by a route described in the written authority or subject to conditions in the written authority.



Disease Risk Areas relate to the control of forest diseases and have only been gazetted over areas of State Forest or former State Forest in the South West of the State.

5.1.2 Permits, licences, contracts, leases etc. - Section 8 (Section 120,124,125)

Sect 120 - Power to enter and inspect land

An authorised officer may enter land held or occupied by virtue of a permit, licence, agreement or forest lease for the purpose of making inspections, carrying out silviculture operations, or other forest work, and preventing or suppressing fires.

Sect 124- Powers of rangers and conservation and land management officers

- (1) A ranger or conservation and land management officer who finds a person committing a relevant offence on or in any land or waters or who on reasonable grounds suspects that such an offence has been committed or is about to be committed, may without warrant -
 - (a) stop, detain and search any vehicle, vessel or conveyance;
 - (b) remove any vehicle, vessel, animal or other thing from the land or waters;
 - (c) require the person to give to him the person's name and address;
 - (d) require the person to leave the land or waters and,
 - (e) in addition, a ranger may enter and search any hut, tent, caravan or other erection which is not a permanent residence.
- (2) A ranger may detain the person until he can be delivered to a police officer if, when required to do so, he does not give to the ranger or officer his name and address, or gives him a false name and address.
- (3) Instead of so detaining the person the ranger may take him into custody himself, to be dealt with according to the law, pursuant to section 50 of the Police Act 1892, as if he had not given his name and address, or had given a false name and address to a police officer
- (4) A person shall not remain on or in any land or waters after being required to leave the same by a ranger or conservation and land management officer.
- (5) A ranger or conservation and land management officer shall not exercise any power specified in subsection (1) (a) or (b) and a ranger shall not exercise the power to enter and search conferred by that subsection unless he has first taken all reasonable steps to communicate to the person who owns or is in charge of the vehicle, animal, vessel, conveyance, hut, tent, caravan or other thing concerned (if the identity of that person can reasonably be ascertained)



his intention to exercise the power and his reasons for believing that he is authorised to exercise the power.

- (6) Nothing in this section derogates from the powers of a ranger who is a police officer

Sect 125 - Powers of wildlife officers

The powers of a wildlife officer under Sections 20 and 20A of *the Wildlife Conservation Act 1950*, and other provisions of those sections, extend to offences against regulations made under Part X.

Enforcement Officers (Section 45)

The Minister can designate any person employed in the Department to be

- a) a wildlife officer;
- b) a forest officer;
- c) a ranger
- d) a conservation and land management officer

Wildlife officers, forest officers, rangers and conservation and land management officers have the functions conferred in theme respectively by or under this Act. In addition, wildlife officers, have the functions conferred on them by the *Wildlife Conservation Act 1950*.

5.1.3 Forest Management Regulations 1993

Part 16 - Control and Eradication of Forest Diseases (see Appendix 12.8)

The following is a summary of the control and eradication of forest disease regulations.

106 States:

1. An authorised person in writing may authorize:
 - the taking of a potential carrier into a risk area
 - the possession, use or movement of a potential carrier in a risk area
2. Written authorisation may be subject to conditions
3. Authorised person may revoke a written authorisation or vary, or remove conditions.



107 Verbal authorisation may be given in an emergency to take into and move around a potential carrier in a risk area.

108 It is an offence to enter, use or move around a potential carrier in a risk area or disease area contrary to instruction or direction.

110 An authorised person may erect signposts or barricades to prohibit or restrict admission or potential carriers into risk or disease areas.

111 Written authorisation must be carried, by a person in charge of a potential carrier in a risk area, at all times. It is an offence not to produce written authorisation when requested by an authorised person.

112 Written authorisation will terminate immediately on breach of any condition.

113 A person shall provide information upon request by an authorised person or any occurrence or suspected occurrence of a Forest Disease. It is an offence not to do so.

114 An authorised person may stop and examine a potential carrier whether or not it is infected and may erect signs or barricades on roads:

- in or leading to a risk area.
- In or leading out of a disease area.

115 An authorised person may direct an infected or potential carrier entering or leaving a risk area to a quarantine station.

116 An authorised person may direct a person in charge of an infected or potential carrier entering a risk area or leaving a disease area to cleanse and disinfect the carrier.

117 The Executive Director may establish or arrange for the establishment and maintenance of a quarantine station for the cleaning of carriers entering a risk area or leaving a disease area.

118 The period for which an infected or potential carrier is kept in quarantine for cleansing is determined by an authorised person.



119 It is an offence if a person does not cleanse or disinfect a carrier as directed by an authorised person.

120 Owner of a potential carrier to inform an authorised person of the identity and address of a person in charge of a potential carrier at the time of the offence.

If the information is not provided within 14 days the owner will be deemed to have committed the offence.

121 An authorised person may detain, control or remove a potential carrier from a risk or disease area if:

- in contravention to any part of these Regulations or conditions of written authorisation
- failed to comply with directions of an authorised person
- Authorised person considers there is a greater risk of the spread of infection

122 Authorised person may remove a person from a risk area if suspected of contravening these Regulations or written conditions.

123 It is an offence for a person to refuse giving their name and address to an authorised person while in a disease risk area.

124 A driver or potential carrier commits an offence if they:

- fail to stop when requested by an authorised person
- ignores or fails to comply with a signpost
- avoids or breaks through a barricade

125 It is an offence for a person to hinder or obstruct, or fail to comply with a direction given by any authorised person.



5.2 GOVERNMENT POSITION – WESTERN AUSTRALIAN DIEBACK REVIEW PANEL

In 1996 an independent review of the matter of dieback in Western Australia was conducted for the Government, a process of public input completed, and an appraisal of the recommendations of the WADRP (Podger *et al*) completed by the Department.

The WADRP report was endorsed by Government in 1998 and the Department is progressively implementing all 33 of the Review Panel Recommendations

5.3 DIEBACK CONSULTATIVE COUNCIL

The Dieback Consultative Council (DCC) is an independent body appointed by the Hon. Minister for the Environment in November 1998 to advise her on the matter of *Phytophthora cinnamomi* (Dieback) and disease it causes in Western Australian native vegetation.

The Minister established the DCC in November 1998 in response to recommendations no. 24 of the Western Australian Dieback Review Panel in its report to government.

The DCC has a current membership of 14 drawn from a wide cross section of interest groups and agencies.

5.4 COPY OF DEPARTMENTAL POLICY STATEMENT NO.3 OF DECEMBER 1998

This section (following pages) is a reprint of the Department's current policy document.



MANAGEMENT OF *PHYTOPHTHORA* AND DISEASE CAUSED BY IT

POLICY STATEMENT No.3 of DECEMBER 1998

BACKGROUND

This document replaces Department of Conservation and Land Management Policy Statement No.3 of January 1991 and should be read in conjunction with other Policy Statements and the background paper (see Appendix 12.6):

“ Management of *Phytophthora* and disease caused by it: A revision of Department of Conservation and Land Management Policy Statement No.3 of January 1991 ” prepared by F.D. Podger & K.R. Vear July 1998

INTRODUCTION

1. The Department has a responsibility to monitor the health of native plants, ecological communities and fauna habitat and to respond according to need on a case by case basis.
2. At least 8 distinct species of *Phytophthora* occur at various places in native plant communities of Western Australia. Whilst the potential importance of several of them still require some further elucidation, *Phytophthora cinnamomi* alone represents by far the greatest ongoing threat to conservation and other benefits to society which native plant communities provide. This policy therefore concentrates on *Phytophthora cinnamomi*.

MANAGEMENT OBJECTIVES

1. Progressively identify uninfested ‘protectable’ areas and manage human access to them so that the role of humans as vectors in establishing new centres of infestation is reduced to the lowest possible level,
2. Manage already infested and un’protectable’ areas in a manner which sustains an appropriate level of environmental and social benefits,
3. Implement, as a component of broader management programs to protect threatened flora, threatened ecological communities and the habitat of threatened fauna, a program for the use of the protective chemical phosphite,
4. Implement programs of interagency research and liaison which are closely linked with:



- a) management requirements, and
 - b) other Western Australian, interstate, Commonwealth and international institutions involved in research and management on *Phytophthora*.
5. Encourage community interest and participation particularly through support of the Dieback Consultative Council (DCC) and its prospective Regional Coordination Groups.

MANAGEMENT STRATEGIES

A. MANAGEMENT OF UNINFESTED AREAS WHICH ARE 'PROTECTABLE'

1. Establish and maintain a set of protocols, founded on science and logic, which guide land managers in identifying and managing 'protectable' areas and prioritise the allocation of available resources for protecting them.
2. Implement a long term management system of hygienic access to 'protectable' areas which incorporates the following elements :-
 - a) The use of accredited Interpreters, supported by the Vegetation Health Service, to prepare up-to-date maps of the distribution of *Phytophthora cinnamomi* through the detection and analysis of the disease symptoms in native plants characteristic of disease caused by *Phytophthora cinnamomi*.
 - b) The progressive identification of 'protectable' areas, which are free of the evidence of infestation by *Phytophthora cinnamomi*, and which are amenable to being protected from the establishment of new centres of infestation arising from the activities of man through the imposition of hygienic management practices.
 - c) The documentation, implementation and regulation of plans for hygienic human access to all 'protectable' areas,
 - d) The implementation of appropriate monitoring and review programs.
3. Provide protection, as appropriate, through phosphite application.
4. Provide and maintain appropriate management guidelines and training programs.

B. MANAGEMENT OF LANDS ALREADY INFESTED WITH *PHYTOPHTHORA CINNAMOMI* OR THOSE THAT ARE NOT 'PROTECTABLE'

1. Develop and maintain a set of protocols, founded on science and logic, which establish guidelines for identifying and managing infested and un'protectable' areas and for setting priorities among management options for them.
2. Where appropriate provide protection through the application of phosphite.
3. Provide appropriate management guidelines and training programs.



C. PROTECTION OF THREATENED FLORA, THREATENED ECOLOGICAL COMMUNITIES AND THE HABITAT OF THREATENED FAUNA BY THE USE OF A SCHEDULE OF TIMED APPLICATIONS OF THE PROTECTIVE CHEMICAL PHOSPHITE

1. Develop and maintain a set of protocols founded on science and logic which:
 - a) guide land managers in identifying threatened flora, threatened ecological communities and the habitat of threatened fauna that may benefit from protection through phosphite application, and
 - b) may be used to establish realistic priorities for use of available resources.
2. Implement and monitor a program using scheduled applications of the protective chemical phosphite for protection of threatened flora, threatened ecological communities and the habitat of threatened fauna.
- 3.

D. RESEARCH AND LIAISON

As a component of broader programs of research and liaison:

1. Implement coordinated programs of research and collaboration, which are closely linked to management requirements, and involve other Western Australian, interstate, Commonwealth and international land management and research institutions.
2. Through interaction with the *Phytophthora* Research Advisory Group establish clear research priorities and agreed allocation of those priorities amongst relevant institutions.
3. Provide appropriate levels of support to the Dieback Consultative Council, its Regional Coordination Groups, and the team responsible for the implementation of the National Threat Abatement Plan for *Phytophthora spp.*

E. ENCOURAGE COMMUNITY INTEREST AND PARTICIPATION

1. Encourage community interest and participation particularly through support of the Dieback Consultative Council (DCC) and its prospective Regional Coordination Groups.
2. Provide appropriate levels of information to the public on the matters related to *Phytophthora cinnamomi* and disease caused by it.

Responsibility for the maintenance and review of this policy rests with the Executive Director.

**Executive Director
December 1998**

5.5 WRITTEN AUTHORITY TO ENTER DRA

Any member of the public and/or the Department's staff, who has a valid and legal reason to enter a Risk Area or Disease Risk Area (DRA), must gain a written authority from an authorised officer prior to entry and must carry the written authority when entering a Risk Area or DRA. (see Appendix 12.8)

5.5.1 Definition of Disease Risk Area

Is any area of public land where the Executive Director considers that the earth, soil or trees may be, or may become infected with a forest disease.

5.5.2 Process for authorising entry to DRA

FIRST STAGE

Ascertain whether the applicant has had authority previously. If they haven't then they need to be briefed on why authority is required. In all cases ascertain whether the person has a valid and legal reason for wishing to take a carrier into the DRA.

If the applicant has previously had authority given to them then reiterate the reasons as to why authority is required.

SECOND STAGE

Take details from applicant as per "authority"

NOTE:

- "Forest Officer" or "Conservation and Land Management Officer" only has authority to approve entry.
- Applicant must be made aware 'authority' must be carried at all times whilst in DRA.
- Applicant must be made aware of all conditions on authority.
- Authority only valid for dates indicated on permit.

5.5.3 Conditions which the Forest Management Regulations, 1993 place on entry to Disease Risk Areas.

There are at least 21 Regulations governing DRA's. Authorising Officers must be aware of all their requirements. In particular the Forest Management Regulations require:-

- **Written Authorisation may be issued subject to such conditions as are specified in the authorisation**

- **Written** authorisation to be carried and produced upon request

A person in charge of a potential carrier in a risk area, shall carry any written authorisation issued in respect of that potential carrier, at all times when the potential carrier is being used, operated or moved in that area, and shall produce that authorisation when requested to do so by an authorised person

- **Written authorisation to terminate on breach of condition**

Written authorisation shall terminate immediately on the breach of any condition specified in that authorisation

- **Person to provide information upon request**

A person shall when requested to do so by an authorised person, provide all information within that person's power relating to any occurrence or suspected occurrence of a forest disease

- **Authorised person may stop and examine potential carrier**

An authorised person may stop and examine any potential carrier to determine whether or not it is infected and may, for that purpose, erect signposts or barricades, or both, on roads -

(a) in or leading to a risk area; or

(b) in or leading out of a disease area.



SECTION 6 - NATIONAL THREAT ABATEMENT PLAN FOR *PHYTOPHTHORA SPP*

6.1 EXECUTIVE SUMMARY

The following is an extract from Environment Australia's *Threat Abatement Plan for Dieback caused by the root-rot fungus *Phytophthora cinnamomi**

Australia's native vegetation and its dependent biota are threatened by a plant pathogenic fungus called *Phytophthora cinnamomi*. *P. cinnamomi* causes the roots of susceptible plants to rot. It is thought that it was introduced at some time after European settlement; it is now well established in many of the country's higher rainfall areas—areas with a mean annual rainfall greater than 600 millimetres—in a mosaic of infected and uninfected areas. Its effects range from devastating to inconsequential, depending on environmental factors, which vary both within and between regions. The only biomes that appear to be least threatened are the wet-dry tropics and the arid and semi-arid regions. The level of threat and its distribution, however could easily increase if human activities were to alter the site conditions to favour the spread and intensification of the species. The latter activities may include the alteration of the hydrology of an area as this could subsequently foster a rising water table and a subsequent intensification of spread of *P. cinnamomi*. In addition, *P. cinnamomi* can spread independently or with the assistance of animals or humans.

Detailed information on the nature of *P. cinnamomi* and its history in Australia can be found in the technical report entitled 'A National Overview of *Phytophthora cinnamomi* in Australia: supplementary information to accompany the draft national Threat Abatement Plan' (Podger 1999).

'Dieback caused by the root-rot fungus *Phytophthora cinnamomi*' is listed as a 'key threatening process' in Schedule X to the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999*. When it is determined that having a threat abatement plan is a feasible, effective and efficient way to abate the process a nationally coordinated threat abatement plan



must be prepared and implemented to manage the impact of *Phytophthora cinnamomi* on Australian ecosystems.

While eradication is not possible at present, well developed management plans based on current knowledge can assist in restricting the intensification and spread of known infestations and limit spread to new sites.

This Threat Abatement Plan, therefore, has two main goals:

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

To abate the threat posed by *P. cinnamomi*, action in four important areas is prescribed:

- Implementation of management programs in specific areas that are a high conservation priority as a result of the species or ecological communities under threat.
- Encourage better understanding through the collection of information that expands our understanding of the ecology and biology of *P. cinnamomi* in Australia, its effects and of methods for managing the pathogen.
- Education of land managers and relevant organisations to increase their knowledge of the effects of *P. cinnamomi* and the role of humans in spreading the pathogen and to ensure skilled and effective participation in management activities.
- Coordination of national, regional and local management activities and administration.

Specific actions in the Plan describe the measures to be used to mitigate the harm caused by the *P. cinnamomi*. The strategy advocated in the Plan involves the use of available methods to restrict the intensification and spread of *P. cinnamomi* in manageable areas that are critical to the conservation of threatened species and ecological communities. In addressing the conservation of species, close links must be established with species recovery plans and with existing State and Territory programs. Action will also be taken to ensure that *P. cinnamomi* does not become established in important 'islands' that are at present free of the pathogen. In addition, there will be a focus on collecting and disseminating information to improve our understanding of

P. cinnamomi control methods and their effects, particularly in areas that have not been infected for very long.

Implementation of the Plan will allow for consolidation and coordination of the process of managing *P. cinnamomi* impacts on native flora and vegetation. The main priority is to provide support for on-ground control programs that are necessary for the recovery of threatened species and threatened ecological communities. Control programs will have to continue for some time and the costs of this will be considerable. This Plan therefore establishes a framework for allowing the best possible use of resources that are available for managing *P. cinnamomi* infestations.

6.2 THREAT ABATEMENT PLAN – GOALS, OBJECTIVES AND ACTIONS

The following goal, objectives and actions are an extract from Environment Australia's *Threat Abatement Plan for Dieback caused by the root-rot fungus *Phytophthora cinnamomi**

GOALS

This Threat Abatement Plan (the Plan) has two broad goals:

- 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.

These goals will be achieved by implementing currently available *Phytophthora cinnamomi* management techniques, providing for the development of new techniques, and collecting information to improve our understanding of the pathogen and its effects. A critical performance indicator will be the degree of security achieved for species and ecological communities that are currently or potentially threatened by this pathogen.

OBJECTIVES

There are five primary Objectives for the Plan:

- **Objective 1:** To promote the recovery of nationally listed threatened species and ecological communities that are known or perceived to be threatened by *Phytophthora cinnamomi*.



- **Objective 2:** To limit the spread of *Phytophthora cinnamomi* into areas where it may threaten threatened species and ecological communities or into areas where it may lead to further species or ecological communities becoming threatened.
- **Objective 3:** To improve the effectiveness and efficiency of the management of the *Phytophthora cinnamomi* through appropriate research and monitoring programs.
- **Objective 4:** To inform Commonwealth, State and Territory management agencies, landholders and the public about the Threat Abatement Plan's actions and their outcomes.
- **Objective 5:** To effectively coordinate management activities.

The choice of any strategy for abating the threat posed by *P. cinnamomi* will differ according to the management purpose. If the purpose is to mitigate harm in areas already infected by and vulnerable to the pathogen, currently the choices of abatement are few, the actions may be difficult to undertake, but not impossible and, except in small areas of unique value, the financial cost could be high.

If the objective is to reduce the rate of introduction of uninfected native plant communities that are both susceptible and vulnerable to the disease, a number of more affordable strategies are available. They may not, however, be always or everywhere practicable.

Wherever possible, cost-effective and efficient management measures will be applied through regionally coordinated management partnerships involving landholders, community groups, nursery growers and all levels of government. Management of *P. cinnamomi* should be integrated with other actions relating to the management of other pest species identified as contributing to threatening processes.

To abate the threat posed by *P. cinnamomi*, action in four important areas is prescribed:

- Implementation of management programs in specific areas that are a high conservation priority (Objectives 1 and 2).



- Encourage better understanding through the collection of information that expands our understanding of the ecology and biology of *P. cinnamomi* in Australia, its effects and of methods for managing the pathogen (Objective 3).
- Education of land managers and relevant organisations to increase their knowledge of the effects of *P. cinnamomi* and the role of humans in spreading the pathogen and to ensure skilled and effective participation in management activities (Objective 4).
- Coordination of national, regional and local management activities and administration (Objective 5).

SECTION 7 - MANAGEMENT OF UNINFESTED 'PROTECTABLE' AREAS

7.1 MANAGEMENT OBJECTIVE

The Western Australian Government and the Department have adopted a strategy for the management of *Phytophthora cinnamomi* and the diseases caused by it, that identifies significant 'protectable' areas (those for which the values at risk are significant and the benefits likely to be sustained for more than a few decades – see also Table 1 *Definition of "protectable" areas*), prioritises them, and concentrates available resources on protecting them. The Department's objective is to progressively identify uninfested 'protectable' areas and to protect them by managing human access and hygiene on entry into them.

Table 1. Definition of 'protectable' areas

Protectable areas, include areas of high conservation and/or socio-economic value (e.g. a small uninfested area which contain a known population of a susceptible species of threatened flora) that:

- Are situated in zones receiving > 600 mm per annum rainfall or are water gaining sites (e.g. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600 mm per annum rainfall zone.
- Do not have a calcareous soil (e.g. not Spearwood Sand dune)
- Have been determined to be free of the pathogen *Phytophthora cinnamomi* by a qualified Disease Interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *Phytophthora cinnamomi* are evident)
- Are positioned in the landscape and are of sufficient size . (e.g. > 4 ha with axis > 100m) such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term (a period of a few decades)
- Consists of areas where human vectors are controllable (e.g. not an open road, private property)

7.2 MANAGEMENT STRATEGY

The Department will:

1. Establish and maintain a set of protocols, founded on science and logic, which guide land managers in identifying and managing ‘protectable’ areas and prioritise the allocation of available resources for protecting them.
2. Implement a long term management system of controlled and hygienic access to ‘protectable’ areas which incorporates the following elements :-
 - a) The use of accredited Disease Interpreters to prepare up-to-date maps of, and field demarcate, the distribution of *Phytophthora cinnamomi* through the detection and analysis of the disease symptoms characteristic of root rot disease caused by it in native plants. This is to be supported by the laboratory analysis of soil and tissue samples by the Vegetative Health Service.
 - b) The analysis and identification of ‘protectable’ areas, which are free of the evidence of infestation by *Phytophthora cinnamomi*, and which are amenable to being protected from the establishment of new centers of infestation arising from the activities of man through the control of access into them and the imposition of hygienic management practises on entering them.
 - c) The documentation, implementation and regulation of plans for the management of ‘protectable’ areas,
 - d) The implementation of appropriate monitoring and review programs.
3. The preparation and maintain appropriate management guidelines and training programs.

7.3 BEST PRACTICE MANAGEMENT METHODS AND STANDARDS FOR ‘PROTECTABLE’ AREAS

Best practice management of *Phytophthora cinnamomi* and disease caused by it will minimise the human assisted spread of the pathogen into uninfested areas and strategically apply repeated treatments of the protective chemical phosphite. It will involve the preparation and use of written procedures for suitably qualified people to:

- Detect, diagnosis, demarcate and map uninfested ‘protectable’ areas;
- Analyse the effect on the conservation and commercial values of uninfested areas;
- Systematically plan for, and implement, the long term management of uninfested areas
- Plan and implement hygiene regimes for all activities within uninfested areas; and
- Strategically use repeated treatments of the protective chemical phosphite.

The best practice methods and standards are described below:

7.3.1 Detection, diagnosis, demarcation and mapping of infested ‘protectable’ areas

Although the pathogen is now widely distributed throughout the South West Land Division many areas have not yet been infested. The first step in minimising the human assisted spread of the pathogen into the remaining uninfested areas is to conduct a survey using suitably qualified people to identify and demarcated them in the in the field and to record their location on a map. The survey by trained observers will discriminate between areas that exhibit the visible symptoms of plant disease in native vegetation attributable to the pathogen *Phytophthora cinnamomi*, from those areas that appear to be free of visual disease symptoms. Confirmation of the presence of the pathogen may often be made by the laboratory analysis of soil samples and root tissue taken from dead and dying plants.

Protocol for identifying ‘protectable’ areas and their priority for management

The Dieback Consultative Council will progressively develop a set of protocols for the objective identification of ‘protectable’ areas (see Table 1 - *Definition of ‘protectable’ areas*) and for their prioritisation and management. In the interim ‘protectable’ areas will be identified using the following process:

- (a) On a case by case analysis of landscape units establish the need for, and scope of, the mapping required and use accredited Disease Interpreters to prepare *Phytophthora cinnamomi* Occurrence Maps based on three categories – Infested with *Phytophthora cinnamomi*, Uninfested and Uninterpretable.
- (b) Use accredited Disease Interpreters and managers to identify ‘protectable’ areas and rationalise their management boundaries. The steps accredited Disease Interpreters use in determining ‘protectable’ areas on land managed by the Department are fully described in *Volume II –Guidelines for Detection, Diagnosis and Mapping of Disease caused by Phytophthora cinnamomi*.

7.3.2 Analysis of the effect on conservation and socio-economic values

The impact of *Phytophthora cinnamomi* upon conservation and socio-economic values is propelmatic since its effect on the health of plant communities, and upon the species in them, varies greatly. In many places, lethal root-disease destroys the structure of many native communities, reduces their floristic diversity, decimates their primary productivity and destroys habitat for much dependant native fauna, particularly its value as protection against feral predators. In some places the pathogen causes little damage at all. Unfortunately the extent of susceptible communities in vulnerable environments is much greater than that of communities that occur in environments that are inherently unfavourable to the pathogen.

No simple or single relationships exist between the presence of *Phytophthora. cinnamomi* and the development of disease because of:

- The considerable variability which exists within and between native plant species in their responses to the presence of *Phytophthora cinnamomi*; and
- The differential influence of temporal and spatial variation in environmental forces.

Despite this complexity it is evident that within the vulnerable areas a stratagem should be applied that will minimise the human assisted arrival of the pathogen into the remaining large uninfested ‘protectable’ areas.

7.3.3 Long term management of uninfested ‘protectable’ areas – methods and standards

Best practice for the long term management of uninfested ‘ protectable’ areas will involve on a priority basis:

- Permanently closing and rehabilitating unwanted roads and walk trails within them;
- Controlling the hygienic use of roads and walk trails retained within them; and
- Directing drainage from infested areas away from them.

Permanent road and walk trail closure

When permanently closing a road or walk trail sufficient work must be done to ensure that unauthorised use of the old road does not continue. Ripping of the road surface and covering it with logs, branches and rocks etc .is often necessary (See Figure 7.1 and Table 2. *Road Closure*

- *Methods and Standards*). Where the past use of a road has been at high levels signs warning of the closure should be installed.

Managing the use of roads and walk trails retained within uninfested ‘protectable’ areas

Temporary closure and the controlled use of roads and walk trails are best affected using a system of gates and signs. Gates must be designed to be highly visible to oncoming vehicles. 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 7.2)

Vehicles, machines, equipment and in some cases foot-ware must be clean before using roads retained within uninfested ‘protectable’ areas or the bushland within them.



Figure 7.1 An example of effective road closure.



Figure 7.2. Managing the use of roads retained within uninfested areas with gate & warning sign

Table 2. Road Closure - Methods and Standards

<p style="text-align: center;"><u>TYPE ONE</u></p> <p>Place one non-utilizable log (preferably with a minimum diameter of 400mm) across the road/track.</p>
<p style="text-align: center;"><u>TYPE TWO</u></p> <p>Place three non-utilizable logs (preferably with a minimum diameter of 400mm) on the road/track, one at the entrance and two within sight from the entrance.</p>
<p style="text-align: center;"><u>TYPE THREE</u></p> <p>Rip wheel tracks for a distance of 100 metres from entrance. Place three non-utilizable logs (preferably with a minimum diameter of 400mm) on the road/track, one at the entrance and two within sight from the entrance.</p>
<p style="text-align: center;"><u>TYPE FOUR</u></p> <p>Place four non-utilizable logs (preferably with a minimum diameter of 400mm) on the road/track, one at the entrance and three within sight from the entrance.</p>
<p style="text-align: center;"><u>TYPE FIVE</u></p> <p>Rip wheel tracks for 100 metres from the entrance and rip the wheel tracks in the turnaround. Place three non-utilizable logs (preferably with a minimum diameter of 400mm) on road/track, one at the entrance and two within sight from the entrance.</p>
<p style="text-align: center;"><u>TYPE SIX</u></p> <p>Place three non-utilizable logs (preferably with a minimum diameter of 400mm) on road/track, one at the entrance and two within sight from the entrance, prior to commencement of activities. Debris to be left on the track / shunt.</p>
<p style="text-align: center;"><u>TYPE SEVEN</u></p> <p>Debris to be left on road/track.</p>

Managing drainage from infested areas

Water draining from road that are likely to be infested and drainage from known infested areas should be directed away from uninfested ‘protectable’ areas or taken to the lowest possible point in the landscape before being directed into areas on native vegetation. (Figure 7.6).

7.3.4 Management of activities scheduled within the uninfested ‘protectable’ areas – methods and standards

Best practice management of activities scheduled within uninfested ‘protectable’ areas will involve:

- Ensuring, by visual inspection and/or cleaning, that vehicles, plant, equipment, and in some cases foot-ware are clean when entering uninfested ‘protectable’ areas;
- Minimising (and clearly signposting) the number of entry points into uninfested ‘protectable’ areas;
- Preventing cross contamination, often by the use of barrier systems, across the boundaries (of infested areas) during works in uninfested areas;
- Allowing only uninfested basic raw materials to be used for earthworks within uninfested ‘protectable’ areas.

Entry Points into Uninfested ‘Protectable’ Areas

Where possible only one entry point (Figure 7.5) should be provided into each uninfested ‘protectable’ area. Entry points into uninfested ‘protectable’ areas that are effective in minimising the human assisted spread of *Phytophthora cinnamomi* will be characterised as appropriate by:-

- Signage;
- An inspection and/or cleandown point (Figure 7.3 & 7.4) and cleaning equipment;
- A gate; and
- A safe place for large vehicles and equipment to turnaround and exit the area if on inspection are not clean or cannot be effectively cleaned in the field.

The timing of the installation of managed entry points is critical in minimising the probability to introducing the pathogen into uninfested ‘protectable’ areas. In the case of new roads 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 7.3 Vehicles are cleaned before entering uninfested areas



Figure 7.4 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 should 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:

- Either that the effluent will fall directly onto infested soil or will be constructed to capture effluent for later transport and disposal;

- Cleaned objects enter uninfested areas without becoming re-infested; and
- Safe entry and departure of vehicles and plant and use by operators.

Preventing Cross Contamination during Works within Uninfested Areas

Vehicles, machinery, equipment and foot-wear can enter uninfested areas (e.g. nursery sterile areas, gravel pits, mining pods, logging coupes) when they are clean 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:

- The use of barrier systems (Figure 7.6 & 7.7) that ensure that the clean equipment within the uninfested area does not come into direct physical contact with infested soil or unclean equipment operating outside the uninfested area;
- The use of demarcation and barrier systems to ensure that vehicles and equipment do not cross inadvertently into infested areas;
- Ensuring that drainage, soil and plant material from the infested areas does not enter the uninfested areas; and
- Limiting entry to periods when the soil is not moist enough to be picked up and moved by vehicles and equipment.

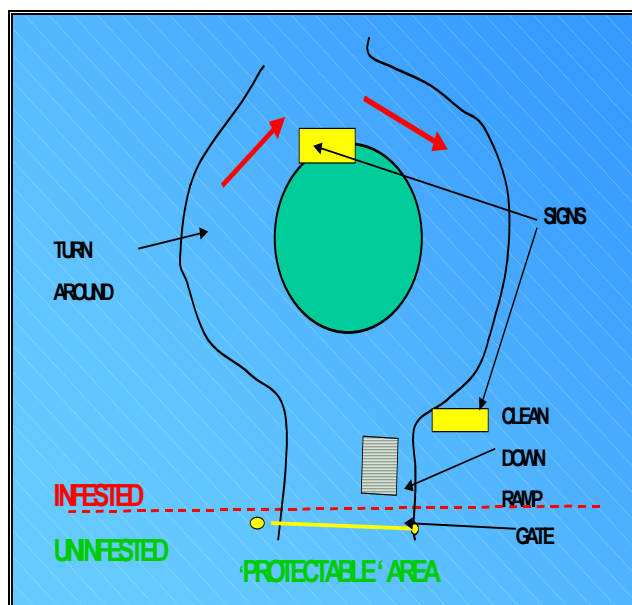


Figure 7.5 Entry Point into a 'protectable' area

Figure 7.6 - Examples of the use of barriers to prevent cross contamination

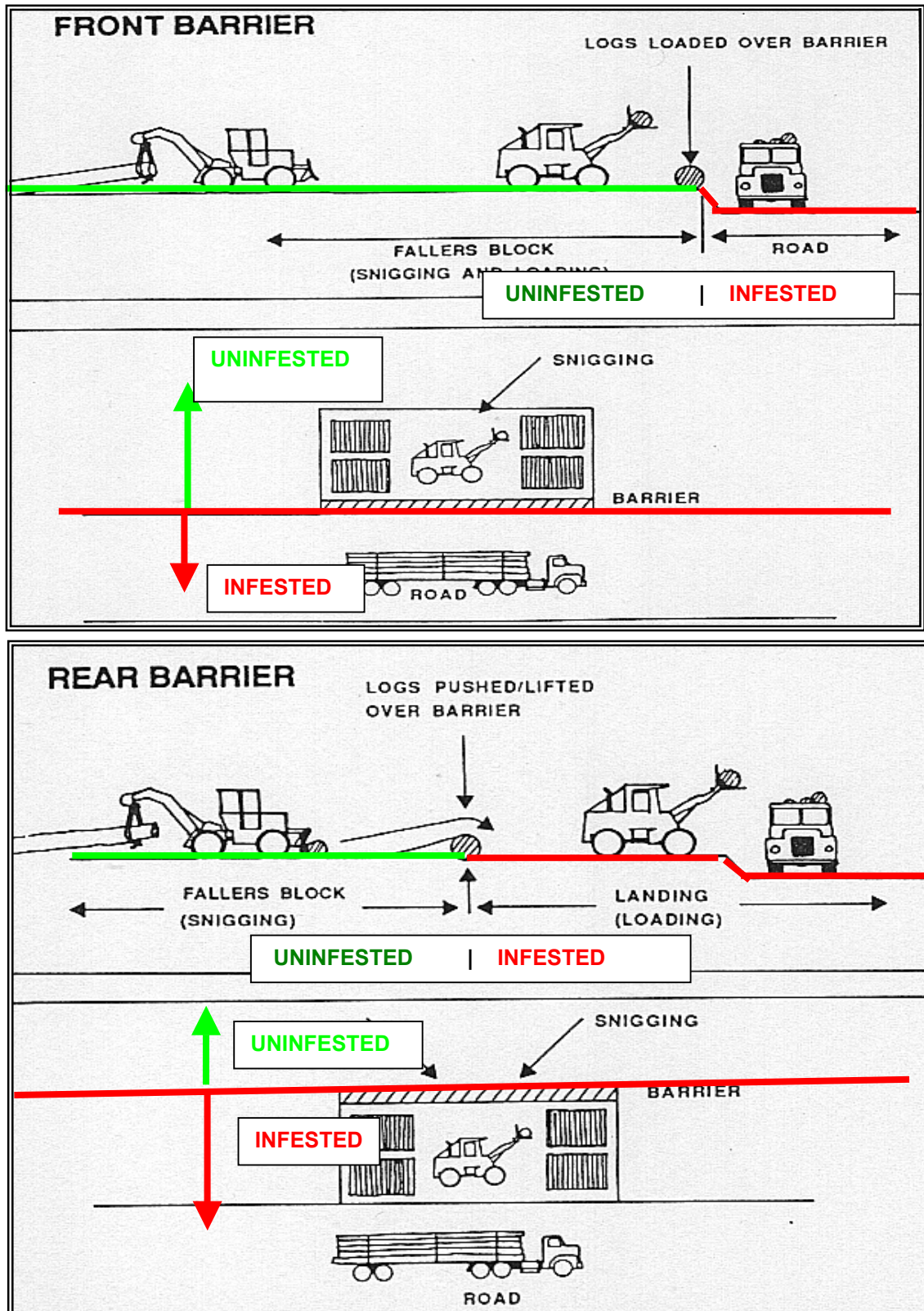




Figure 7.7 A simple log barrier helps prevent cross contamination from the road to the uninfested forest



Figure 7.8 Drainage is captured and prevented from entering uninfested areas

Uninfested Basic Raw Materials

Accredited personnel are required to assess and certify that basic raw material (BRM) borrow pits are free of the pathogen. Borrow pits can only be certified as being free of the pathogen under the following circumstances :-

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

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. *Phytophthora cinnamomi* requires plant tissue from which to derive its energy (food source) to survive in the long term. (I.e. the pathogen 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 to pit either autonomous spread or human vectoring, in most cases will allow sufficient time for any previously introduced mycelium, chlamydospores and zoospores to desiccate and die.

Where BRM is being extracted from deep pits, such as mines and quarries, 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 the pathogen.

New road construction into ‘protectable’ areas

Managing hygiene when building a new road into a ‘protectable’ area is a critical element in the long term protection of the area.

Where possible first 50 meters of the new alignment should be left un-cleared until after the remainder of the clearing has been completed. Light vehicle and machine tender vehicle access to the new alignment can be provided with appropriate attention to the hygiene requirements, provision of clean-down facilities and signage.

The retained section should be maintained relatively undisturbed for as long as is practicable.

Often it will be necessary for the bull-dozer that clears the alignment to open up the retained section prior to the commencement of the road formation and gravelling works e.g. to allow logs in pushed trees to be cut and removed. The bull-dozer should work from inside the ‘protectable’ area towards the boundary of the infested area.

At the time of opening up the retained section *Phytophthora cinnamomi* information signs need to be set-up and portable traffic control barriers placed across the road at the demarcated boundary of the ‘protectable’ area. If gravelling operations are to be delayed over substantial periods (e.g. winter) consideration should be given to temporarily blocking the new alignment with several substantial logs.

During the formation of the road the graders should work from inside the ‘protectable’ area up to the demarcated boundary working infested areas last.

Where possible to simplify the process on being clean on entry gravelling activities should work from the ‘protectable’ area into the infested area, e.g. especially where the gravel pit is within the ‘protectable’ area.

The installation of permanent gates and signs is to be programmed to coincide with the completion of the surface gravelling activities and the removal of the temporary signs and barriers.

Water binding

Water binding should be kept to a level where run-off into 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 large areas of adjoining land.

Basic Raw Materials

Site works and road building and maintenance works within uninfested ‘protectable’ areas often require the use of basic raw materials [BRM] such as sand, gravel and soil which are certified as ‘Free of *Phytophthora cinnamomi*’.

On lands managed by the Department accredited plant Disease Interpreters are available to assess and certify BRM borrow pits. Disease Interpreters will only certify borrow pits as ‘Free of *Phytophthora cinnamomi*’ under the following circumstances:

- a) For a new pit to be located in undisturbed areas where sufficient indicator plants are available for a determination to be made or
- b) For an existing pit that has records confirming that it was originally free of *Phytophthora cinnamomi*, and for which sufficient evident exists that an effective system of hygiene has been in place to ensure that the pit has remained free of the pathogen.

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. *Phytophthora cinnamomi* requires plant tissue from which to derive its energy (food source) to survive in the long term. I.e. The pathogen 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 to pit by either through autonomous spread or human vectoring, in most cases will allow sufficient time for any previously introduced mycelium, chlamydospores and zoospores to desiccate and die.



Where BRM is being extracted from deep pits, such as mines and quarries, 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 *Phytophthora cinnamomi*’.

Owners of private pits or developers may wish to have Departmental Disease Interpreters review and certify pits using this methodology.

Phytophthora cinnamomi free BRM is a valuable resource and managers are encouraged to ensure the integrity if the sites are maintained by ensuring foot-ware, vehicles, machinery and equipment entering these sites is clean .

7.3.5 Entry into uninterpretable areas or areas that have not been surveyed

Areas that are uninterpretable and located higher in the landscape that any adjoining infested areas will be treated as uninfested ‘protectable’ areas. Unwanted roads wind them will be closed and rehabilitated. Vehicles, machines, equipment and in some cases foot-ware must be clean when entering them.

Uninterpretable areas located below infested areas will have entry into them restricted for most activities to periods when vehicles, machines, equipment and in some cases foot-ware will not pick up and move soil (except for road works).

7.3.6 Guidelines for preparing *Phytophthora cinnamomi* Management Plans for “protectable” areas

Using a process that analyses entire landscape units (the boundaries of landscape units are established by such features as creeks, ridges, saddles, open public access roads and/or freehold land) managers must plan for, deploy and enforce the rule of being clean on entry for all human activities approved in uninfested ‘protectable’ areas and close and rehabilitate unwanted roads into them. It is not possible to survey the entire conservation estate for the presence of *Phytophthora cinnamomi*, therefore areas to be mapped annually (and the disease boundaries

demarcated) will be determined on a case by case analysis of likely ‘protectable’ areas and the amount of information needed to prepare a *Phytophthora cinnamomi* Management Plan for them. In most cases a whole of landscape unit approach to mapping and planning will be required.

The Department’s management objective is to progressively prepare and implement *Phytophthora cinnamomi* Management Plans for all uninfested ‘‘protectable’ areas.

Linear mapping of *Phytophthora cinnamomi* Occurrence may be adequate for activities such as walk trail development, prescribed burn boundary maintenance and the use of utility easements. However, Disease Interpreters will be required to survey at least 150 meters either side of the disturbed areas to be able to make a reliable determination of any ‘protectable’ areas adjoining them.

Best practice long term land management of the uninfested ‘protectable’ areas will utilize the following tactics applied within practical management boundaries:

- Permanently closing and rehabilitating unwanted roads and walk trails;
- Controlling the hygienic use of roads retained within the uninfested areas; and
- Directing drainage from infested areas away from the uninfested areas.

Best practice management of approved activities within uninfested ‘protectable’ areas will involve:

- The requirement of visual inspection and/or cleaning, of vehicles, plant, equipment, and in some cases foot-ware to ensure they are free of *Phytophthora cinnamomi* when entering uninfested ‘protectable’ areas;
- Minimising (and clearly signposting) the number of entry points into uninfested ‘protectable’ areas;
- Preventing cross contamination (often by the use of barrier systems) across the boundaries (of infested areas) during works in uninfested ‘protectable’ areas;
- Allowing only uninfested basic raw materials to be used for earthworks within uninfested ‘protectable’ areas.

The following steps are used by the District Manager, in consultation with the various activity proponents and accredited Disease Interpreters, when preparing *Phytophthora cinnamomi* Management Plans for a vulnerable area of land vested in the Conservation Commission:

- a) Use a whole of landscape unit approach to analyse the *Phytophthora cinnamomi* Occurrence Map and identify the uninfested ‘protectable’ areas and rationalise their management boundaries.
- b) Identify all *bona fide* activities current and planned for the ‘protectable’ areas.
- c) For each ‘protectable’ area Managers must determine:
 - i) Long term access control, and
 - ii) The measures to be taken to minimise human vectoring of the pathogen into them during short term activities that are scheduled to take place within them.
- d) Document the *Phytophthora cinnamomi* Management Plan (using the form “*Phytophthora cinnamomi* Management Plan” - see Appendix 12.1) listing the required management actions and accountabilities for each action. This will include the preparation of a ‘*Phytophthora cinnamomi* Management Map’ (to be attached to the completed form) that uses the standard legend (see appendix 12.2).
- e) Review the results of implementing the plan and periodically audit compliance using the ‘Environmental Standards Checklist – *Phytophthora cinnamomi* Management Plans’ (see appendix 12.3).

7.3.7 Administration and review of *Phytophthora cinnamomi* management plans

The administration process of managing *Phytophthora cinnamomi* Management Plans is often triggered by a request to go upon the land anywhere within the South West Land Division. District Managers are responsible for determining whether there is a current *Phytophthora cinnamomi* Management Plan in place and if not whether one is required before authorising entry to the land managed by the Department.

A fundamental requirement is the need for the District Manager as an integrator and the custodian of the land vested in the Conservation Commission is to:

- a) Ensure that broad agreement is reached early in the process with the activity proponent on the scope of the planning and management task.



- b) Undertake a preliminary analysis of likely ‘protectable’ areas and likelihood of new centres of infestation being initiated within them by the autonomous or vectored spread of the pathogen,
- c) Initiate an early reconnaissance and input from an accredited Disease Interpreter, and
- d) Program works to effect immediate road closures and establish entry points where appropriate.

Once the *Phytophthora cinnamomi* Occurrence Map is prepared, the District Manager should reconvene, as appropriate, a working session with the proponent to analyse and agree on the details of the management plan. At this point consideration must be given to integrating the management of all the activities occurring within each ‘protectable’ area. Proponents may signify their understanding and agreement by counter-signing the activity management plan.

The District Manager is accountable for designing and implementing an appropriate review of each *Phytophthora cinnamomi* Management Plan and ensuring that there is a reliable feedback loop in the planning and management process so that new information is incorporated into the ongoing management of the ‘protectable’ areas and the activities that occur within them using the ‘Environmental Standards Checklist – *Phytophthora cinnamomi* Management Plans’. Any corrective action is recorded on the checklists.

Copies of current and past *Phytophthora cinnamomi* Management Plans should be available in the District Office record system. The District Manager is accountable for ensuring that copies are forwarded to Forest Management Branch for inclusion into the Department’s corporate data base and systems.

The Department’s *Phytophthora* Management Coordinator will also conduct regular reviews of *Phytophthora cinnamomi* Management Plans using the “Environmental Standards Checklist - *Phytophthora cinnamomi* Management Plans”.

SECTION 8 – MANAGEMENT OF INFESTED AREAS AND AREAS NOT 'PROTECTABLE'

8.1 MANAGEMENT OBJECTIVE

The Department's objective is to establish and maintain a state of protocols, founded on science and logic, which establishes guidelines for identifying areas already infested and those areas that are not "protectable" from root rot caused by *Phytophthora cinnamomi* and sets priorities among management options for them.

8.2 MANAGEMENT STRATEGY

For the infested and areas that are not 'protectable' areas the Department will adopt the following:

1. Develop and maintain a set of protocols, founded on science and logic, which establish guidelines for identifying and managing infested areas and for setting priorities among management options for them.
2. Where appropriate provide protection through the application of phosphite.
3. Provide appropriate management guidelines and training programs.

8.3 MANAGEMENT GUIDELINES

[To be added]



SECTION 9 - PROTECTION OF THREATENED FLORA, THREATENED ECOLOGICAL COMMUNITIES AND THREATENED FAUNA HABITAT USING PHOSPHITE

9.1 MANAGEMENT OBJECTIVE

As a component of its broader management program of threatened flora, threatened ecological communities and the habitat of threatened fauna, the Department will develop and implement as appropriate programs for the use of the protective chemical phosphite for their protection.

9.2 MANAGEMENT STRATEGY

1. Develop and maintain a set of protocols founded on science and logic which:-
 - a) Guide land managers in identifying of threatened flora, threatened ecological communities and the habitat of threatened fauna that may benefit from protection through phosphite application, and
 - b) May be used to establish realistic priorities for use of available resources.
1. Implement and monitor a program using scheduled applications of the protective chemical phosphite for protection of threatened flora, threatened ecological communities and the habitat of threatened fauna.
2. Refine and maintain appropriate management guidelines and training programs.

9.3 PHOSPHITE OPERATIONS GUIDELINE

Strategies for management of the impacts of *Phytophthora cinnamomi* in native ecosystems may be placed in two broad but distinct approaches. The simplest approach and one that has been used in Western Australia for over 20 years directs effort at containing the human vectored spread of the pathogen. The second involves using techniques to reduce the destructive interaction between the pathogen and its hosts. Most of these theoretically available techniques for modifying the host-pathogen interaction are prospective only, are too expensive or are unsuitable for use in native plant communities.



One technique that has reached the operational stage is the application of phosphite to either single plants or whole plant communities to give a degree of protection against root rot disease caused by *Phytophthora cinnamomi*. Since the first trials of phosphite (then called phosphonate) by stem injection into jarrah and *Banksia grandis* were conducted in 1989 by researchers at the Department's Dwellingup office a great deal has been learnt about the methodology of its use in treating native vegetation.

The objectives, strategy, methodology and procedural guidelines for applying phosphite in the protection of native plants in the wild is described in detail in *Volume III - Phosphite Operations Guidelines*.



SECTION 10 - RESEARCH, PUBLIC EDUCATION AND LIAISON

10.1 MANAGEMENT OBJECTIVES

As a component of its broader programs of research, public education and liaison the Department's objective is to :-

1. Implement programs of interagency research and collaboration, that are closely linked with:
 - a) Management requirements, and
 - b) Other Western Australian, interstate, federal and international institutions involved in research and management on *Phytophthora*.
2. Encourage community interest and participation particularly through support of the Dieback Consultative Council (DCC) and its prospective Regional Coordination Groups.
3. Provide appropriate levels of information to the public on the matters related to *Phytophthora* and disease caused by it.

10.2 MANAGEMENT STRATEGIES

Implement coordinated programs of research and collaboration, which are closely linked to management requirements, and involve other Western Australian, interstate, Commonwealth and international land management and research institutions.

Through interaction with the *Phytophthora* Research Advisory Group establish clear research priorities and agreed allocation of those priorities amongst relevant institutions.

Provide appropriate levels of support to the Dieback Consultative Council, the Regional Coordination Groups and the team responsible for the implementation of the National Threat Abatement Plan for *Phytophthora spp.*

10.3 RESEARCH PRIORITIES

Eighteen of the 33 Recommendations contained in the Western Australian Dieback Review Panel Report endorsed by Government in 1997 are concerned with research. In 1999 the Dieback Consultative Council (DCC) examined the immediate need for research, and the mechanisms that



will facilitate research, in order to further enhance the appropriate management of disease caused by *Phytophthora cinnamomi* in the Western Australian flora.

A. RESEARCH PRIORITIES

The DCC identified 10 areas of priority research (Table 3 *Priority Research Areas*) for the next five years. Seven projects are related to short-term management needs (Targeted research) and three projects can be described as basic research fundamental to the understanding of the behaviour of the pathogen which may lead to break through solutions for the management of problems it causes.

Table 3. Priority Research Areas

TARGETED RESEARCH PROJECTS	NON-TARGETED RESEARCH PROJECTS
1. Optimising phosphite application regimes	1. Mode of action of phosphite
2. Reduction in autonomous spread of the pathogen using phosphite	2. Long term ecological impacts of the pathogen
3. Fire - phosphite interactions	3. Variability in phosphite tolerance of the pathogen population
4. Improving the effectiveness of hygiene/quarantine protocols	
5. Ex situ conservation and germplasm storage of <i>Phytophthora</i> - susceptible flora	
6. Role of fire in managing susceptible threatened species	
7. Seasonal and geographic variation in rate of pathogen spread and disease expression	

B. METHOD FOR RANKING RESEARCH PROJECTS

The DCC used seven criteria were used to identify the projects listed in Table 1.

1. Does the project have a demonstrated applied focus?
2. Is the project likely to contribute significantly within five years?
3. Does the project build on the results of previous work?
4. Are the objectives of the project measurable?
5. Are the project objectives able to be delivered?
6. Is the project affordable?
7. Does the project contribute to any of the following?



- Protection of threatened flora, threatened ecological communities and/or the habitat of threatened fauna.
- Review or improvements to hygiene measures.
- Operational improvements in both the delivery and the effectiveness of protecting plants using phosphite.
- Understanding the mode of action of phosphite.

The DCC suggested that the above criteria would be useful in the future ranking of research proposals for funding or other purposes.

SECTION 11 – MANAGEMENT ROLES AND RESPONSIBILITIES

The roles and responsibilities of those involved in the management of *Phytophthora cinnamomi* and diseases caused by it on lands vested in the Conservation Commission are described in this section.

11.1 PHYTOPHTHORA MANAGEMENT COORDINATOR

- Assists with policy development and interpretation.
- Develops and maintains management systems and sets standards
- Develops and maintains management guidelines.
- Develops, maintains and delivers accredited training programs.
- Liaises with managers, proponents, agencies and organisations on the problem of *Phytophthora cinnamomi* and disease caused by it.
- Plans and implements a program to protect threatened Declared Rare Flora, threatened ecological communities and the habitat of threatened fauna using phosphite treatments.
- Assists in the development of research priorities.
- Provides executive support for the Dieback Consultative Council
- Develops a strategy for the Department to progressively implement the recommendations of the Western Australian Dieback Review Panel Report.
- Develops and implements an effective communication plan for staff, contractors, agencies and the general public.

11.2 DISTRICT MANAGER

- Interprets the Department's policy and management guidelines and ensures that all management activities within the District comply with them.
- Accountable for the initiation, preparation, approval and effective implementation of *Phytophthora cinnamomi* Hygiene Plans for each uninfested 'protectable' area.
- Responsible for the regular review of *Phytophthora cinnamomi* Hygiene Plans.
- Establishes and maintains effective administration and records systems for *Phytophthora cinnamomi* Hygiene Plans.
- Ensures staff are nominated and trained as District *Phytophthora* Management Coordinator.

11.3 DISTRICT *PHYTOPHTHORA* MANAGEMENT COORDINATOR

- Coordinates and assists with the preparation, approval and effective implementation of *Phytophthora cinnamomi* Hygiene Plans for “protectable” areas.
- Monitors hygiene implementation standards and undertakes reviews of *Phytophthora cinnamomi* Hygiene Plans.
- Administers the records systems for *Phytophthora cinnamomi* Hygiene Plans including any amendments made to the plans.
- Liaises with Forest Management Branch.
- Provides advice on hygiene planning and implementation standards, work methods and policy.
- Maintains an up to date copy of the manual of guidelines titled “*Phytophthora cinnamomi* and disease caused by it. *Volume I – Management Guidelines* and destroy all out of date copies.

11.4 DISEASE STANDARDS OFFICER (Forest Management Branch)

- Develops and maintains disease detection, diagnosis and mapping systems and standards.
- Monitors systems and standards and approves *Phytophthora cinnamomi* Occurrence maps.
- Develops and maintains procedures manuals for plant disease Interpreters, including an up to date copy of the manual of guidelines titled “*Phytophthora cinnamomi* and disease caused by it. *Volume II– Detection, Diagnosis and Mapping.*” and destroy all out of date copies
- Develops, maintains and implements training programs for plant disease Interpreters
- Advises on the determination of ‘protectable’ areas and their management boundaries.
- Advises on disease biology and epidemiology and hygiene management strategies and hygiene measures.
- Conducts workplace assessments and accredits plant disease Interpreters.

11.5 SENIOR INTERPRETER

- Manages plant disease Interpreter training and works programs
- Assists with the development and maintenance of disease detection, diagnosis and mapping systems and standards.
- Assists with the approval of *Phytophthora cinnamomi* Occurrence maps.
- Assists in training and evaluating staff.

- Assists with the development of *Phytophthora cinnamomi* Management Plans for ‘protectable’ areas.
- Advises on the determination of ‘protectable’ areas and their management boundaries.
- Advises on disease biology and epidemiology and hygiene management strategies and hygiene measures.

11.6 FOREST MANAGEMENT BRANCH

- Provide up to date *Phytophthora cinnamomi* Occurrence maps of a consistent standard.
- Provides *Phytophthora cinnamomi* Management maps.
- Develops and maintains an effective Departmental corporate data base.

11.7 PROPONENT

- May assist with the preparation of *Phytophthora cinnamomi* Management Plans.
- Complies with the hygiene requirements for ‘protectable’ areas

11.8 PHOSPHITE OFFICER

- Assists with policy development and standards setting.
- Assists with policy development and interpretation
- Develop and maintain management systems, data-bases and sets standards.
- Develops and maintains management guidelines.
- Develops, maintains and delivers accredited training programs.
- Liaises with managers, proponents, agencies and organisations on the problem of *Phytophthora cinnamomi* and disease caused by it.
- Plans and implements a program to protect threatened Declared Rare Flora, threatened ecological communities and the habitat of threatened fauna using phosphite treatments.
- Assists in the development of research priorities.



SECTION 12 - APPENDICES

12.1 *PHYTOPHTHORA CINNAMOMI* MANAGEMENT PLAN – BLANK FORM

See below.



PHYTOPHTHORA CINNAMOMI MANAGEMENT PLAN	
DISTRICT/REGION PLAN ID No.	CLM

OBJECTIVE:

To ensure that approved human activities within the ‘protectable’ areas ofPark/Reserve/Block are an inconsequential vector for the establishment of new centres of infestation of *Phytophthora cinnamomi*.

MANAGEMENT (circle and complete where appropriate and complete):

(a) **Tactics for the long-term land management of** **Park/Reserve/Block:**

DISTRICT RESPONSIBILITY	Y/N or N/A	The ‘protectable’ areas no. P ₁ to have been identified on the attached map [ID No.....].
	Y/N or N/Awill close & rehabilitate to the standard specified in the manual of guidelines the roads within the ‘protectable’ areas identified at the points marked X ₁ to on the attached map by//.../200.....
	Y/N or N/A	<i>Phytophthora cinnamomi</i> management gates/signs (see attached checklist) will be installed byon the roads that enter the ‘protectable’ areas at the points marked R ₁ to on the attached map by//.../200....
	Y/N or N/A	The roads within the ‘protectable’ areas marked NSM ₁ to on the attached map can only be used when vehicles and machines will not pick up and move soil along them.
	Y/N or N/A	Drainage entering the ‘protectable’ areas at the points marked D ₁ to on the attached map is to be redirected byaway from the ‘protectable’ areas by//.../200.....



(b) **Tactics for the short-term management of** activities within Park/Reserve/Block

DISTRICT LIAISE WITH PROPONENT	Y/N or N/A	Entry into the 'protectable' areas for activities will be via entry points no. COE ₁ to identified on the attached map [ID No.....].
	Y/N or N/A	Entry into 'protectable' areas at COE to identified on the attached map will be closed and rehabilitated to the standard specified in the manual of guidelines by following the completion of
	Y/N or N/A	Vehicles, machines & equipment for activities are to be clean when entering 'protectable' areas and the number of inspections/cleandowns completed is to be recorded by.....
	Y/N or N/A	Cross contamination during activities will be prevented by the use of a barrier system when it is necessary to work across the boundaries of 'protectable' areas. A map of the location of barriers used is to be maintained by
	Y/N or N/A	Uninfested basic raw materials from pits no. BRM ₁ to identified on the attached map are to be used for all earthworks within the 'protectable' areas identified on the attached map[ID No.....].
	Y/N or N/A	Temporary <i>Phytophthora cinnamomi</i> management signs (see attached checklist) are to be installed by..... at point no..... to identified on the attached map.
	Y/N or N/A	Off road entry into the 'protectable' areas P ₁ to identified on the attached map will only occur during periods when vehicles and machines will not pick up and move soil.

APPROVED (District Manager)

..... (PRINT NAME) (SIGNATURE) (DATE)

AGREED (Activity Proponent)

..... (PRINT NAME) (SIGNATURE) (DATE)

12.2 PHYTOPHTHORA CINNAMOMI MANAGEMENT MAP – LEGEND

<p>NAME DISTRICT NAME BLOCK</p> <p>Compartment No. PHYTOPHTHORA CINNAMOMI OCCURRENCE MAP</p> <p>MAP LEGEND</p> <p>UNINFESTED (PROTECTABLE) Determined by a qualified interpreter to be free of plant disease symptoms which indicates the presence of <i>Phytophthora</i></p> <p>UNINTERPRETABLE (PROTECTABLE) Where susceptible plants are absent or too few to enable the interpretation of <i>Phytophthora</i> presence or absence</p> <p>INFESTED Determined by a qualified interpreter to have plant disease symptoms consistent with the presence of <i>Phytophthora</i></p> <p>UNPROTECTABLE Where current <i>Phytophthora</i> symptoms may spread into these areas automatically</p> <p>BOUNDARY OF INTERPRETATION</p> <p><small>*NB - Boundaries determined from field interpretation by qualified interpreters and transferred from large scale Depositories or Base plan</small></p> <p><small>Map Limitations - The smallest area of interpretation that can be portrayed on this map are 1 millimetre in diameter, representing 12.5 metres diameter on the ground. Areas less than this are approximated to this size.</small></p> <p>Interpreted & Compiled By - name Date Completed - date Digitized By - name & date</p> <p>INTERPRETED USING 200 mm PHOTOGRAPHY FLOWN - DOMMYNY INTERPRETED USING STRIP LINE SURVEY INTERPRETED USING BROADSCALE SURVEY BOUNDARIES CAPTURED USING GPS BOUNDARIES POSITIONED RELATIVE TO MAP FEATURES</p> <p>This File - Related Files - Print File -</p> <p>AREA STATEMENT</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Area No</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table> <p>SCALE 1:8000 FOR THIS MAP</p> <p><small>Map Boundaries should be checked before Operations proceed if this map is older than 1 year (July 2005)</small></p> <p><small>This map should not be used if it is older than 3 years (July 2008)</small></p> <p><small>Areas that have had an Operation in them become unreliable and should be checked prior to further / New activities.</small></p> <p>PREPARED BY THE FOREST MANAGEMENT BRANCH UNDER THE SUPERVISION OF DR MALCOLM JACQUES, DIRECTOR OF THE DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT, WESTERN AUSTRALIA. THIS MAP IS FOR INFORMATION ONLY AND DOES NOT CONSTITUTE A WARRANTY. THE STATE WILL NOT BE RESPONSIBLE FOR ANY PROBLEMS WHICH MAY BE ENCOUNTERED BY USERS.</p>	Category	Area No	Name				<p>NAME DISTRICT NAME BLOCK</p> <p>Compartment No. PHYTOPHTHORA CINNAMOMI PROTECTABLE AREAS MAP</p> <p>MAP LEGEND</p> <p>UNINFESTED (PROTECTABLE) Determined by a qualified interpreter to be free of plant disease symptoms which indicates the presence of <i>Phytophthora</i></p> <p>UNINTERPRETABLE (PROTECTABLE) Where susceptible plants are absent or too few to enable the interpretation of <i>Phytophthora</i> presence or absence</p> <p>INFESTED Determined by a qualified interpreter to have plant disease symptoms consistent with the presence of <i>Phytophthora</i></p> <p>UNPROTECTABLE Where current <i>Phytophthora</i> symptoms may spread into these areas automatically</p> <p>BOUNDARY OF INTERPRETATION</p> <p><small>*NB - Boundaries determined from field interpretation by qualified interpreters and transferred from large scale Depositories or Base plan</small></p> <p><small>Map Limitations - The smallest area of interpretation that can be portrayed on this map are 1 millimetre in diameter, representing 12.5 metres diameter on the ground. Areas less than this are approximated to this size.</small></p> <p>Interpreted & Compiled By - name Date Completed - date Digitized By - name & date</p> <p>INTERPRETED USING 200 mm PHOTOGRAPHY FLOWN - DOMMYNY INTERPRETED USING STRIP LINE SURVEY INTERPRETED USING BROADSCALE SURVEY BOUNDARIES CAPTURED USING GPS BOUNDARIES POSITIONED RELATIVE TO MAP FEATURES</p> <p>This File - Related Files - Print File -</p> <p>AREA STATEMENT</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Area No</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table> <p>SCALE 1:8000 FOR THIS MAP</p> <p><small>Map Boundaries should be checked before Operations proceed if this map is older than 1 year (July 2005)</small></p> <p><small>This map should not be used if it is older than 3 years (July 2008)</small></p> <p><small>Areas that have had an Operation in them become unreliable and should be checked prior to further / New activities.</small></p> <p>PREPARED BY THE FOREST MANAGEMENT BRANCH UNDER THE SUPERVISION OF DR MALCOLM JACQUES, DIRECTOR OF THE DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT, WESTERN AUSTRALIA. THIS MAP IS FOR INFORMATION ONLY AND DOES NOT CONSTITUTE A WARRANTY. THE STATE WILL NOT BE RESPONSIBLE FOR ANY PROBLEMS WHICH MAY BE ENCOUNTERED BY USERS.</p>	Category	Area No	Name				<p>NAME DISTRICT NAME BLOCK</p> <p>Compartment No. PHYTOPHTHORA CINNAMOMI MANAGEMENT MAP</p> <p>MAP LEGEND</p> <p>UNINFESTED (PROTECTABLE) Determined by a qualified interpreter to be free of plant disease symptoms which indicates the presence of <i>Phytophthora</i></p> <p>UNINTERPRETABLE (PROTECTABLE) Where susceptible plants are absent or too few to enable the interpretation of <i>Phytophthora</i> presence or absence</p> <p>INFESTED Determined by a qualified interpreter to have plant disease symptoms consistent with the presence of <i>Phytophthora</i></p> <p>UNPROTECTABLE Where current <i>Phytophthora</i> symptoms may spread into these areas automatically</p> <p>BOUNDARY OF INTERPRETATION</p> <p>ROAD CLOSURE</p> <p>CLEAR ENTRY</p> <p>HYGIENE MANAGEMENT POINT</p> <p>AREA NUMBER</p> <p>ROAD CLOSURE</p> <p>AREA BOUNDARY</p> <p>PROPOSED ROADS</p> <p><small>*NB - Boundaries determined from field interpretation by qualified interpreters and transferred from large scale Depositories or Base plan</small></p> <p><small>Map Limitations - The smallest area of interpretation that can be portrayed on this map are 1 millimetre in diameter, representing 12.5 metres diameter on the ground. 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THE STATE WILL NOT BE RESPONSIBLE FOR ANY PROBLEMS WHICH MAY BE ENCOUNTERED BY USERS.</p>	Category	Area No	Name				<p>NAME DISTRICT NAME BLOCK</p> <p>Compartment No. PHYTOPHTHORA CINNAMOMI RECHECK</p> <p>MAP LEGEND</p> <p>UNINFESTED (PROTECTABLE) Determined by a qualified interpreter to be free of plant disease symptoms which indicates the presence of <i>Phytophthora</i></p> <p>UNINTERPRETABLE (PROTECTABLE) Where susceptible plants are absent or too few to enable the interpretation of <i>Phytophthora</i> presence or absence</p> <p>INFESTED Determined by a qualified interpreter to have plant disease symptoms consistent with the presence of <i>Phytophthora</i></p> <p>BOUNDARY OF INTERPRETATION</p> <p>Recheck Interpreted By - name Date Recheck Completed - date Recheck Digitized By - name & date</p> <p>INTERPRETED USING 200 mm PHOTOGRAPHY FLOWN - DOMMYNY INTERPRETED USING STRIP LINE SURVEY INTERPRETED USING BROADSCALE SURVEY BOUNDARIES CAPTURED USING GPS BOUNDARIES POSITIONED RELATIVE TO MAP FEATURES</p> <p>Recheck File - Recheck Related Files - Recheck Print File -</p> <p>AREA STATEMENT</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Area No</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table> <p>SCALE 1:8000 FOR THIS MAP</p> <p><small>Map Boundaries should be checked before Operations proceed if this map is older than 1 year (July 2005)</small></p> <p><small>This map should not be used if it is older than 3 years (July 2008)</small></p> <p><small>Areas that have had an Operation in them become unreliable and should be checked prior to further / New activities.</small></p> <p>PREPARED BY THE FOREST MANAGEMENT BRANCH UNDER THE SUPERVISION OF DR MALCOLM JACQUES, DIRECTOR OF THE DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT, WESTERN AUSTRALIA. 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Category	Area No	Name																									
Category	Area No	Name																									



PHYTOPHTHORA CINNAMOMI MANAGEMENT PLAN

DISTRICT:.....PLAN & MAP ID No :



CLM

OBJECTIVE:

To ensure that approved human activities within the ‘protectable’ areas ofPark/Reserve/Block are an inconsequential vector for the establishment of new centres of infestation of *Phytophthora cinnamomi*.

ACTION REQUIRED: (Circle and complete where appropriate)

(1) TACTICS FOR THE LONG-TERM LAND MANAGEMENT OF THE AREA.

THE DEPARTMENT IS RESPONSIBLE FOR:

YES NO N/A	The ‘protectable’ areas no. P ₁ to and their boundaries have been identified on the attached map.
YES NO N/Awill close & rehabilitate to the standard specified in the manual of guidelines the roads within the ‘protectable’ areas identified at the points marked X ₁ to on the attached map
YES NO N/A	<i>Phytophthora cinnamomi</i> management gates/turn around points/cleandown points signs (see attached sign checklist) will be installed byon the roads that enter the ‘protectable’ areas at the points marked R ₁ to on the attached map by//..../200....
YES NO N/A	The roads within the ‘protectable’ areas marked NSM ₁ to on the attached map can only be used when vehicles and machines will not pick up and move soil along them.
YES NO N/A	Drainage entering the ‘protectable’ areas at the points marked D ₁ to on the attached map is to be redirected by away from the ‘protectable’ areas by//..../200.....



(2) TACTICS FOR THE MANAGEMENT OFACTIVITIES
THE PROPONENT IS RESPONSIBLE FOR: [PLAN & MAP ID No :]

YES NO N/A	Entry into the 'protectable' areas will be via entry points no. COE ₁ to identified on the attached map.
YES NO N/A	Entry into 'protectable' areas at COE to identified on the attached map will be closed and rehabilitated to the standard specified in the manual of guidelines by following the completion of activities.
YES NO N/A	Vehicles, machines & equipment are to be clean when entering 'protectable' areas and the number of inspections/cleandowns completed is to be recorded by..... before
YES NO N/A	Cross contamination will be prevented by the use of a barrier system when it is necessary to work across the boundaries of 'protectable' areas. A map of the location of barriers used is to be maintained by
YES NO N/A	Uninfested basic raw materials from pits no. BRM ₁ to identified on the attached map are to be used for all earthworks within the 'protectable' areas identified on the attached map.
YES NO N/A	Temporary <i>Phytophthora cinnamomi</i> management signs (see attached checklist) are to be installed by..... at point no..... to identified on the attached map.
YES NO N/A	Vehicle and machine movement off road into the 'protectable' areas P1 to identified on the attached map will only occur during periods when vehicles and machines will not pick up and move soil within the 'protectable' area(s).

PREPARED & RECOMMENDED BY: Yes/No Comment:

.....

.....
(PRINT NAME) (SIGNATURE) (DATE)

AGREED BY ACTIVITY PROPONENT: Copy provided: Yes/No/NA

.....
(PRINT NAME) (SIGNATURE) (DATE)

PLAN APPROVED BY DISTRICT MANAGER:

.....
(PRINT NAME) (SIGNATURE) (DATE)



12.3 ENVIRONMENTAL STANDARDS CHECKLIST - *PHYTOPHTHORA CINNAMOMI* MANAGEMENT PLAN

<p>ENVIRONMENTAL STANDARDS CHECKLIST</p> <p>DISRTICT..... PLAN ID No.</p>	 CLM ...
---	-----------------

REASON FOR CHECK: (CIRCLE) Progress Inspection/Audit/Close Out

<u>PHYTOPHTHORA CINNAMOMI MANAGEMENT PLAN</u> forPark/Reserve/Block		Complies	Action Required	Not Applicable
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT RESPONSIBILITIES	1. <u>Long-term land management of the area</u>			
	1.1 The ‘protectable’ areas were clearly identified on the map attached to the plan. ‘Protectable’ area has been maximised and effective boundaries have been identified.			
	1.2 The work to close and rehabilitate roads into the “protectable” was completed to the standard specified in the manual of guidelines by the nominated target date.			
	1.3 <i>Phytophthora cinnamomi</i> management gates/signs/turn around points/cleandown points were installed on the roads entering the ‘protectable’ areas by the nominated target date.			
	1.4 Works to redirect drainage entering the ‘protectable’ areas was completed by the target date.			
	1.5 Records cited that confirm that roads leading to the ‘protectable’ areas identified for use only when soil will not be picked up and moved along them were only used under the correct conditions.			



		Complies	Action Required	Not Applicable
PROPONENT RESPONSIBILITIES	2. <u>Short-term management of.....activities</u>			
	2.1 Entry into the 'protectable' areas has only been via approved entry points.			
	2.2 Entry points into the 'protectable' areas identified for the proponent to close and rehabilitate were clearly nominated and the works completed to the standard specified in the manual of guidelines by the nominated target date.			
	2.3 Records that confirm that vehicles, machines & equipment were clean when entering 'protectable' areas & that the required number of inspections/cleandowns completed.			
	2.4 Cross contamination was prevented by the use of a barrier system when it was necessary to work across the boundaries of 'protectable' areas. A copy of the map of the location of barriers used was copy cited.			
	2.5 Only uninfested basic raw materials within the 'protectable' areas.			
	2.6 Records cited confirm that entry by vehicles and machines off road into the uninfested 'protectable' areas situated downslope of infested areas only occurred during periods when they would not pick up and move soil.			
	2.7 Signs that comply with the manual of guidelines were installed by the nominated target dates. Signs identified for removal by the proponent at the completion of their activities have been removed.			
	3. <u>Field Cleandown Points : Required in the management plan? Yes/No</u>			
	3.1 Provide physical separation between the object being cleaned & the effluent being produced, and between the object being cleaned and any infested soil and plants.			
	3.2 Allows the effluent to fall directly onto infested soil or to be captured for transport & correct disposal (Effluent collected has been deposited at an infested site).			
	3.3 Cleaned objects can enter 'protectable' areas without becoming re-infested.			
	3.4 Provide easy and safe access for both the placement of the object to be cleaned and for the person doing the cleaning.			



12.4 STANDARD SIGN WORDING

Sign Type 1



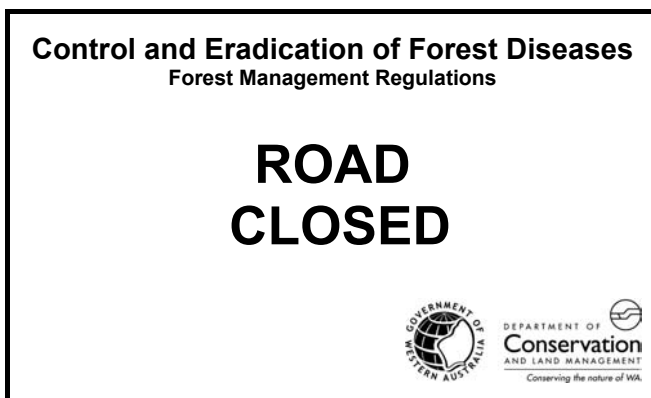
600 x 350mm – Black lettering on white background

Sign Type 2



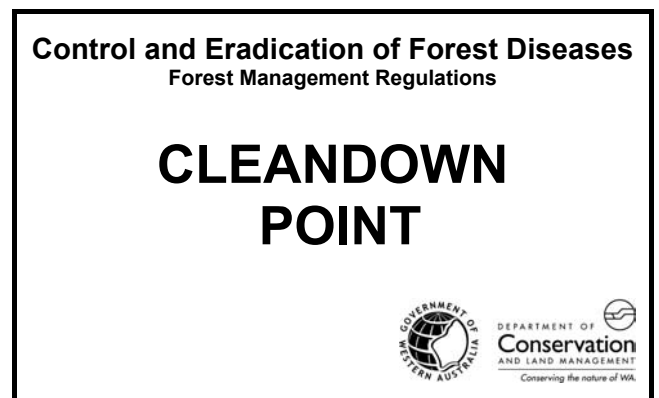
600 x 450mm – Black lettering on white background

Sign Type 3



600 x 350mm – Black lettering on white background

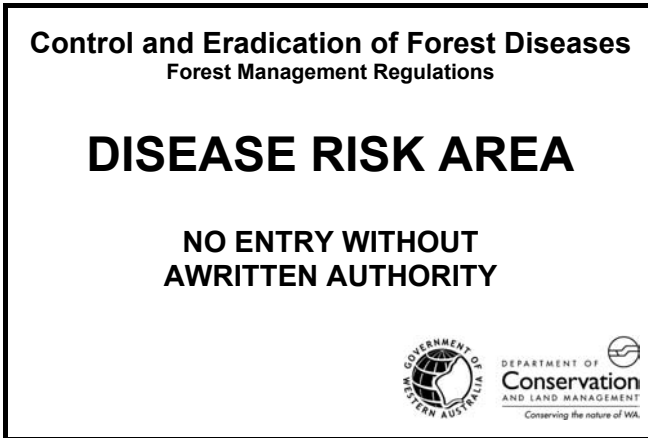
Sign Type 4



600 x 450mm – Black lettering on white background



Sign Type 5



600 x 350mm – Black lettering on white background



12.5 SIGN MANAGEMENT CHECKLIST

SIGN MANAGEMENT CHECKLIST

REQUIREMENTS FOR BLOCK

1. Sign Type/Name of Sign	Number Required
S1 Clean on Entry	
S2 Clean on Entry. Do not pick up and move soil.	
S3 Road Closed - Control and Eradication of Forest Diseases	
S4 Cleandown Point	
S5 Disease Risk Area	
S6 Other - Specify	

2. SIGN ORDERING

To be ordered by by

(Print name) (Date)

3. FIELD DETAILS (Sketch details of sign field placements; add pages as required)



4. SIGN PLACEMENT AND REMOVAL CHECKLIST

SIGN ID	ERECTED BY	DATE	REMOVAL Yes/No & When	REMOVED BY	DATE



12.6 RECORD OF ENTRY INTO A 'PROTECTABLE' AREA

RECORD OF ENTRY INTO A 'PROTECTABLE' AREA

I agree to implement the *Phytophthora cinnamomi* hygiene measures applicable to the activities I manage within the 'protectable' areas described in this plan.

1. Activity
Print name Signed Date :

2. Activity
Print name Signed Date :

3. Activity
Print name Signed Date :

4. Activity
Print name Signed Date :

5. Activity
Print name Signed Date :

6. Activity
Print name Signed Date :



12.7 BACKGROUND TO THE REVISION OF DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT POLICY STATEMENT No. 3 “MANAGEMENT OF *PHYTOPHTHORA* AND DISEASE CAUSED BY IT”

HISTORICAL BACKGROUND

Since 1921 it has been evident that an increasing number of patches of formerly healthy jarrah forest has become afflicted with a lethal disease now known as “jarrah dieback” (‘JDB’).

Until 1964, the cause of this malady had been the subject of contending speculation. In that year proof of the role of the plant pathogen *Phytophthora cinnamomi* as the cause of ‘JDB’ was established. At the same time, it was recognised that this exotic microbe was also intimately associated with similar damage in other plant communities of sclerophyllous natives, whether jarrah was dominant, a minor component only, or not present at all. The period of intensive research which followed is ongoing and has resulted in revised perceptions of the nature of the pathogen and of the diseases which result from its interactions with the enormously diverse native vegetation of southwester Australia.

Phytophthora cinnamomi is a soil-borne micro-organism of foreign origins. It almost certainly entered Western Australia for the first time on soil around the roots of cultivated plants, shortly after European settlement in 1827. Until the effective implementation by Australia of quarantine of import of exotic soil and plant products there must have been innumerable introductions at many points of entry around the continent and its redistribution within the country over a period of some 150 years.

Phytophthora cinnamomi has now extended its largely unfettered colonisation of the southwest by both human movement of infested soils and autonomous spread, the latter largely by growth of the pathogen in the root systems of highly susceptible native plants. This epidemic of colonisation, which has produced a complex mosaic of infested and



uninfested areas, is now well on its way toward the middle stages of its ultimate potential to occupy all of those sites which are environmentally suited to its establishment, survival and multiplication. Such

sites are very widely distributed over some 20% or more of the natural vegetation in areas throughout that part of the Southwest Land Division which receives mean annual rainfall in excess of 800mm and occur sporadically at lower rainfall.

Within the 600-800mm rainfall zone the occurrence of *Phytophthora cinnamomi* is also widespread but much less extensive. In this zone severe damage to native vegetation is largely confined to water-gaining sites or to years of abnormally high summer rains. In these circumstances localised patches of the vegetation may periodically suffer severe damage with intervals of recovery during dryer periods.

In areas receiving <600mm dieback due to *Phytophthora cinnamomi* is restricted to circumstances where localised hydrological effects, such as the shed from granite bosses or rising ground water tables associated with upslope land clearance in the catchment, cause effective rainfall to substantially exceed the regional patterns.

There is no record of *Phytophthora cinnamomi* in regions receiving <400mm.

NATURE OF THE EFFECT OF THE PATHOGEN ON CONSERVATION AND COMMERCIAL VALUES

The effect of *Phytophthora cinnamomi* upon the health of plant communities, and upon the species in them, varies greatly. In many places, lethal root-disease destroys the structure of many native communities, reduces their floristic diversity, decimates their primary productivity and

destroys habitat for much dependant native fauna, particularly its value as protection against feral predators. In some places the pathogen causes little damage at all. Unfortunately the extent of susceptible communities in vulnerable environments is much greater than that of communities which occur in environments which are inherently unfavourable to the pathogen.



No simple or single relationships exist between the presence of *Phytophthora cinnamomi* and the development of disease because of :-

- a) the considerable variability which exists within and between native plant species in their responses to the presence of *Phytophthora cinnamomi*,
- b) the differential influence of temporal and spatial variation in environmental forces,

However, within the spectrum of variable disease, response of numerous hosts to particular environmental circumstance, at least four specific nodes can be recognised. These are due to either distinct processes or to different stages in the development of disease which occur upon and after the arrival of the pathogen and its persistence in previously uninfested areas. Each of these circumstances presents a different problem which require separate sets of management response. It is now evident that among the variety of plant communities which occur within that part of the South West Land Division which receives more than 800mm mean annual rainfall the four sets of distinctive consequences are:-

1. No apparent disease at all: this applies *inter alia* to those areas of karri and wandoo forest which contain no floristic elements of the dry sclerophyll (jarrah) forest type and to plant communities on the Spearwood Dune System of the Swan Coastal Plain and pedogenically 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*
3. woodland and in heathland on podsols, podsollic and lateritic landform. It is characterised by:-
 - a) devastation soon after the first arrival of the wave front of infestation,
 - b) steady extension of epidemic disease soon after arrival of the pathogen,
 - c) complete or near complete elimination of important structural elements of the plant community.
 - d) a relative insensitivity of the degree of damage to variation in soil characteristics.

3. A much more variable epidemic occurs within the dominant jarrah tree component of the jarrah forest. - this is characterised by :
 - a) a much more 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 overstorey.
 - b) high sensitivity to subtle differences in soils characteristics particularly those effecting drainage.

All variants in the response of jarrah are coincident with, or preceded by, mass deaths in susceptible elements of the understorey. In jarrah, their behaviour 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.

4. Where *Phytophthora cinnamomi* has been long established (some 50 years or more) in sites formerly dominated by jarrah/banksia forest and has been very heavily impacted *Phytophthora cinnamomi* behaves in a manner characteristic of endemic pathogen. The forest is often replaced by an Open woodland of marri/parrot bush. Periodic outbreaks of mortality in parrot bush (*Dryandra sessilis*) follow, with subsequent regeneration by seed. At this late stage, *Phytophthora cinnamomi* causes more muted disease than at the wave front.

RATIONALE OF THE NEED FOR A REVISION OF POLICY.

Statements of policy , protocols for management, and manuals of practice first developed in the early 1970's have been periodically revised to take account of advances in knowledge and wider managerial experience.

Prior to the present document the most recent statement of policy was encapsulated in the Department's Policy Statement No. 3. "*Phytophthora* Dieback" of January 1991.

The objective of that statement read :-



“To **prevent the introduction, spread or intensification** of the plant diseases caused by *Phytophthora* species **throughout the state**, with particular emphasis on the southwest... (and to monitor for *Phytophthora*)...activity in the remainder of the state, **especially in tropical areas.**”

In 1996 an independent review [the WA Dieback Review (Podger *et al*)] was conducted for the government, a process of public input completed, and an appraisal of the recommendations of the review panel completed by the Department.

The Department has now accepted that eradication and prevention of the establishment of new centres of infection is not a realisable objective, even were it both a socially acceptable strategy of denial of human access for any purpose and involved an eradication program of native animals which vector the pathogen. Similarly insurmountable problems of scale and cost would attend efforts to map and treat the thousands of kilometers of invasion front now established within 17 million ha of remnant native vegetation in the Southwest Land Division.

Further, despite intensive research and extensive field tests over three decades, the delivery of ameliorative treatments (which might favourably modify those environmental influences responsible for destructive interaction between plant species which are susceptible to the pathogen) though biologically well founded has so far proved to be impracticable.

Earlier concerns that other species of *Phytophthora* might cause similarly severe and extensive damage are largely unsubstantiated. *P. citricola* and *P. drechsleri* are known to cause very minor damage despite their widespread distribution. Several taxa within each of the species complexes usually assigned to *P. megasperma* or *P. cryptogea* are generally restricted to seasonally inundated sites. Records of *P. nicotianae* are few and derived almost entirely to native plants in cultivation. Whereas research to clarify the role of *P. cryptogea* and *P. megasperma* is on-going, the current revision of policies is focussed on *Phytophthora cinnamomi*.

A further question, of now reduced concern, is the extent to which species of *Phytophthora* might threaten native vegetation in tropical latitudes. Nowhere on earth has any species of *Phytophthora* proved to be a serious pathogen of undisturbed native vegetation in the wet-dry tropics (eg. the Kimberley and Northern Territory) or in the arid zone (eg. Hamersley and McDonnell Ranges.). There are no records of *Phytophthora* species from any source other than



irrigated crop culture in these climatic regions within W.A. and none at all of *P. cinnamomi*. This assessment does not however preclude effort to diagnose the cause of any unusual disease in naturally occurring native plant ecosystems that might occur in the future in these regions.

As a result of these processes it is now accepted that Policy No 3 of 1991 is founded on outdated concepts and is both unaffordable and unattainable and should be revised.

CHOICE AMONG POLICY ALTERNATIVES

Three alternative strategies, other than to retain the existing and extremely optimistic policy No 3 of June 1991, are available.

a. The first alternative

“Acceptance of the inevitability of defeat and liquidation of material assets”

is argued by very few and is extremely unlikely to be socially acceptable.

b. A second alternative

“Prohibition of all human access”

is expected to be attractive to a very small minority. Apart from its impracticality it has serious adverse socio-economic consequences.

c. The third alternative

“Adoption of attainable objectives within a framework of socially affordable cost”

will of necessity prove less optimistic than the present policy and will require improved methods of priority setting and greater operational efficiencies including the removal of unnecessary constraints on access and a simplification of operational guidelines.

ESSENTIAL ELEMENTS OF A NEW POLICY.

1. Focus effort principally on *Phytophthora cinnamomi* ?

Whereas it is now recognised that at least eight distinct species of *Phytophthora* (*P. boehmeriae*, *Phytophthora cinnamomi*, *P. citricola*, *P. cryptogea*, *P. drechsleri*, *P. gonapodyides*, *P. megasperma* & *P. sojae*) occur at various places in native plant communities of Western Australia (and that the potential importance of several of them still require some further elucidation). *Phytophthora cinnamomi* represents by far the greatest ongoing threat to conservation and other benefits to society which native plant communities provide. This policy should concentrate therefore on *Phytophthora cinnamomi*.

2. A uniform policy across the State ?

The policy should apply uniformly across the South West Land Division only. There is no problem to address in the Eremaea or the wet/dry tropics. Furthermore the distinction in Policy No 3 between lands north and south of the Preston River should be abandoned together with guidelines based upon it. The scientific basis for that distinction has never been apparent and there is little evidence that it has been beneficial.

CLARITY OF CONCEPTS AND TERMINOLOGY

1. The existing confusion in the use of terms and their conceptual basis needs urgent address. This includes tautological and counter-intuitive usage and extends to an entrenched lexicon which inhibits rather than promotes understanding of underlying principles and processes.
2. Use of the term '7 way test' implies some form of mathematical calculation and encourages a false sense of prescriptive rigour. It is in fact no more than a checklist based on flawed concepts and terminology. It would be better to refer to a set of guidelines for consideration of factors that should normally be taken into account in planning operations.



3. Much of the classification for hygiene purposes is now seen to be superfluous. A particular example is the confusion of risk and hazard. The former is a vital consideration for planning hygienic access. The latter refers only to a forecast of the probable level of damage should *Phytophthora cinnamomi* establish in an area not yet colonised by it. Hazard is determined by both site factors and host susceptibility. Even in the same place it differs depending upon the plant species under consideration. Hazard for jarrah for example may vary greatly over an area which is of uniformly high hazard for species of *Banksia*. Furthermore it has been clearly demonstrated that it is unreasonable to expect that even trained and experienced interpreters should be able to diagnose hazard with any degree of reliability at all. Its use should be abandoned.



4. The matter of reform of terminology will not be simple due to more than 20 years of indoctrination and recital. An organised program of retraining is required.



12.8 WRITTEN AUTHORISATION TO TAKE A POTENTIAL CARRIER INTO A RISK AREA OR DISEASE RISK AREA

12.8.1 Card example

FRONT OF CARD

 	
<p>AUTHORISATION TO TAKE A POTENTIAL CARRIER INTO A RISK AREA OR A DISEASE RISK AREA</p> <p>[See other side]</p> <p>AUTHORITY NO:</p>	
<p>..... [Authority Holder – print name]</p>	<p>..... [Authorised person – print name]</p>
<p>..... [Authority Holder – signature]</p>	<p>..... [Authorised person – signature]</p>
<p>Date issued:</p>	<p>Expiry date:</p>

BACK OF CARD

In accordance with Regulation 106 of the *Forest Management Regulations 1993* [Full Name] may take a potential carrier into a proclaimed risk area or disease risk area within [Add District(s) and/or Region(s)] whilst engaged on the *bona fide* the business of the [Full name of employer] subject to compliance with the requirements of any relevant *Phytophthora cinnamomi* Management Plan(s) or in the absence of such a plan(s) after ensuring the potential is clean prior to entry to, and that it will not pick up an move soil while within, a proclaimed risk area or disease risk area.

WARNING: The regulations provide penalties for failure to comply with this authorization.



Potential Carriers Authorised to be used:

Registration Number	Make	Colour

Authorised Access Route(s) (Map must be attached):

No soil Movement :

.....

.....

.....

Soil Movement :

.....

.....

.....

Hygiene Requirements:

- Are access conditions, requirements and other activities in accordance with the approved *Phytophthora* Hygiene Plan Yes No

For No Soil Movement:

- All vehicles, plant and equipment must be free of soil and root material prior to entering and whilst in the restricted access areas.
- No soil or root material may be moved at any time.
- After a rain event, the authority holder must obtain specific endorsement from an authorised person in the district from which the authority to enter was issued prior to entering the forest.



Rainfall Endorsement

Date:.....

Officer:.....

For Soil Movement Conditions:

- All access and other activities must be in accordance with the approved hygiene plan access routes.
- Soil movement may not occur in any areas not specifically approved as soil movement.

General Requirements:

- The authority holder must be able to interpret a Departmental map and be able to navigate the designated route(s)
- The authority holder is only authorised to travel the roads and tracks as specifically authorised in the authority to enter.
- Vehicles and plant may only enter or remain in the restricted access areas with a valid authority to enter.
- All conditions and information contained in hygiene approvals, sign posts and gates must be adhered to.
- All operations must be undertaken in accordance with the Conservation and Land Management Act 1984, Forest Management Regulations 1993, Wildlife Conservation Act and Regulations and Bush Fires Act.

Authority to Enter Approved:

Officers Name:.....

Officer's Signature:.....

Date:.....

I have read and understood the above authority to enter and I agree to observe the conditions of this authority to enter and regulations made under the Conservation and Land Management Act 1984.



12.9 LIST OF OTHER RELEVANT MANUALS AND REPORTS

W.A Dieback Review Panel Report 1996