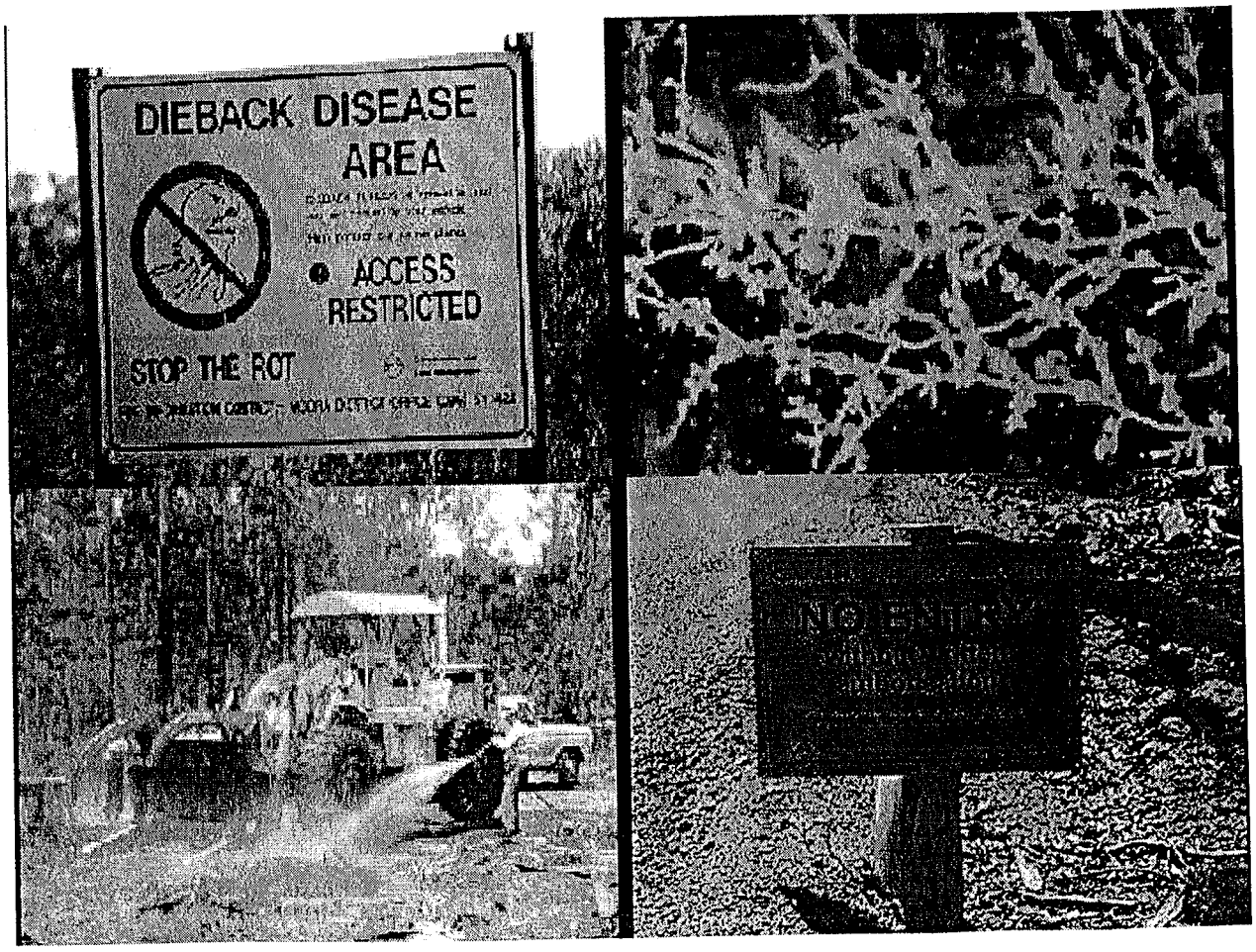
DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Phytophthora cinnamomi
and disease caused by it

Volume I – Management Guidelines



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SECTION 1 - INTRODUCTION

1.1 BACKGROUND

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 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.

In Western Australia *Phytophthora cinnamomi* will continue its autonomous spread from all its established disease fronts. The minimum rate of uphill spread via root to root contact amongst host plants is approximately one meter per annum. 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* 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 CALM and other land managers can take at present is to control the vector man. 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.

1.2 PURPOSE OF THIS MANUAL AND EACH OF ITS VOLUMES

This manual :-

- Provides CALM with a single source document on :-
  a) information about the pathogen *P. cinnamomi* and diseases it causes (Vol. I Management Guidelines & Vol. II Detection, Diagnosis and Mapping (Interpretation) Guidelines),
  b) management guidelines (Vol. I Management Guidelines),
  c) interpretation and mapping guidelines (Vol. II, Detection, Diagnosis, and Mapping (Interpretation) Guidelines)
  d) phosphite operational guidelines (Vol. III Phosphite Operations), and
  e) training curriculum and syllabi (Vol. 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 CALM's harvesting and other manuals.

- Replaces Administration Instruction No. 46 "Departmental Procedures for Approval of 7-Way Tests", the Hygiene Evaluation Proforma 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. CALM's Dieback Coordinator is responsible for authorising all updates to the manual.

1.3.2 Maintaining manuals

Manuals are issues to individual managers and their staff who are responsible for ensuring that their copy is up to date through regular liaison with the Dieback Coordinator.

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 qualified Interpreter has determined have plant disease symptoms consistent with the presence of the pathogen *P. cinnamomi.*

Uninfested areas

- Areas that a qualified Interpreter has determined to be free of plant disease symptoms which would indicate the presence of the pathogen *P. cinnamomi* .

Protectable areas

Defines areas of CALM land over which the hygiene rule, for the plant pathogen *P. cinnamomi*, of clean on entry will apply. May be an area suitable for phosphite application.

- 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 (ie not Spearwood Sand dune)
- Has been determined to be free of the pathogen *P. cinnamomi* by a qualified Interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *P. cinnamomi* are evident)
- Are positioned in the landscape and are of sufficient size such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term. (eg. > 4 ha with axis > 100m)
- Consists of areas where human vectors are controllable (eg. not an open read or private property)
- Includes high value areas (eg. a small uninfested area which contains a species of susceptible threatened flora)

Unprotectable 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 *P. 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 unprotectable areas.

Protectable Areas Map

- Defines areas of CALM land over which the Hygiene rule for the pathogen *P. cinnamomi* of clean on entry will apply. May be an area suitable for phosphite application.

Phytophthora cinnamomi Hygiene Management Map

- Prepared as part of Protectable Areas *Phytophthora cinnamomi* hygiene planning process. It records details of planned management actions and is placed in District and FMB records systems.

***Phytophthora cinnamomi* Hygiene 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. May also specify the need for the application of phosphite.

Disease

- A combination of a pathogen, host and correct environmental conditions, which results in unhealthy 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 it's 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 that *Phytophthora* species be referred to as fungi.

P. cinnamomi is an introduced soil-borne pathogen that kills a wide rage of plant species in the South West by attacking their root system. *P. cinnamomi* can also host on a wide range of 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. *P. cinnamomi* is the *Phytophthora* species most frequently isolated from areas of dead vegetation in the South West.

P. 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) within susceptible host plants. 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 attached Once attacked susceptible hosts rarely recover. Most succumb to a "sudden death" syndrome, rather than a "dying back or dieback" syndrome.

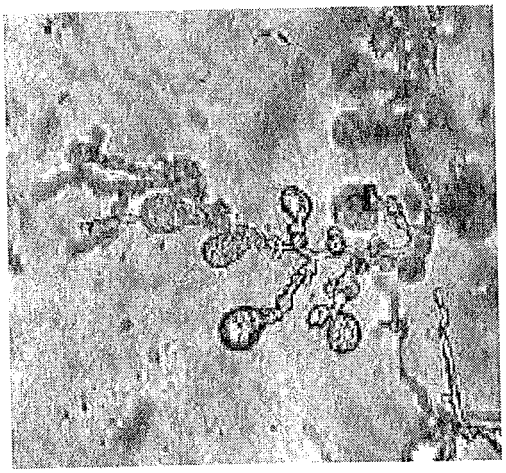


Figure 3.1 Hyphal swellings of *P. cinnamomi*

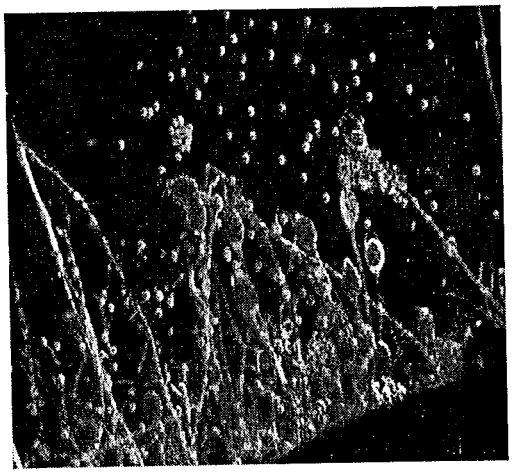


Figure 3.2 Spore sacs of *P. cinnamomi* release zoospores that swim in free water and infect nearby roots.

3.2 LIFE CYCLE OF *PHYTOPHTHORA CINNAMOMI*

The life cycle of (Fig. 3.4) of *P. cinnamomi* depends on moist conditions that favour survival, sporulation and dispersal. Being parasitic the fungus requires a living host on which to feed.

Being a pathogen which is not capable of photosynthesis the fungus needs to extract food from plant tissue. They do this via a mass of microscopic threadlike mycelium which form the body of the organism that grow through host tissue (Fig. 3 2). Mycelia growth continues when the host tissue is above 80% moisture ambient. Mycelium 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 which reproduce the fungus. Two kinds of spores are likely to be found.

Zoospores (Fig. 3.2)

Very small spores which 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 mycelium. 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.

Chlamydospore

Larger spores which are tough and long-lived within dead plants. 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 chlamydospores produce mycelium and zoospores.

When conditions are warm and moist, microscopic spore sacks called sporangia and thick walled chlamydospores are produced vegetatively from mycelial 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. Mycelium 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 which may extend in to the tree 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 3.3 *P. cinnamomi* grown on agar

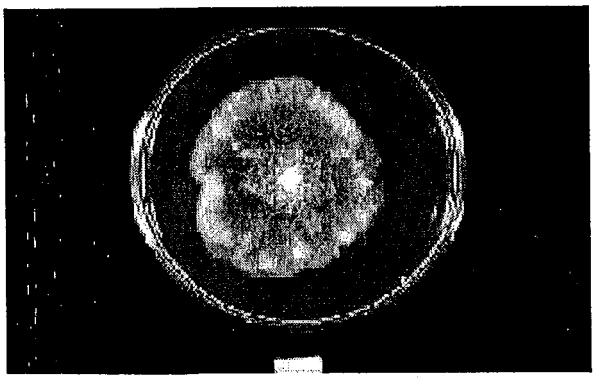
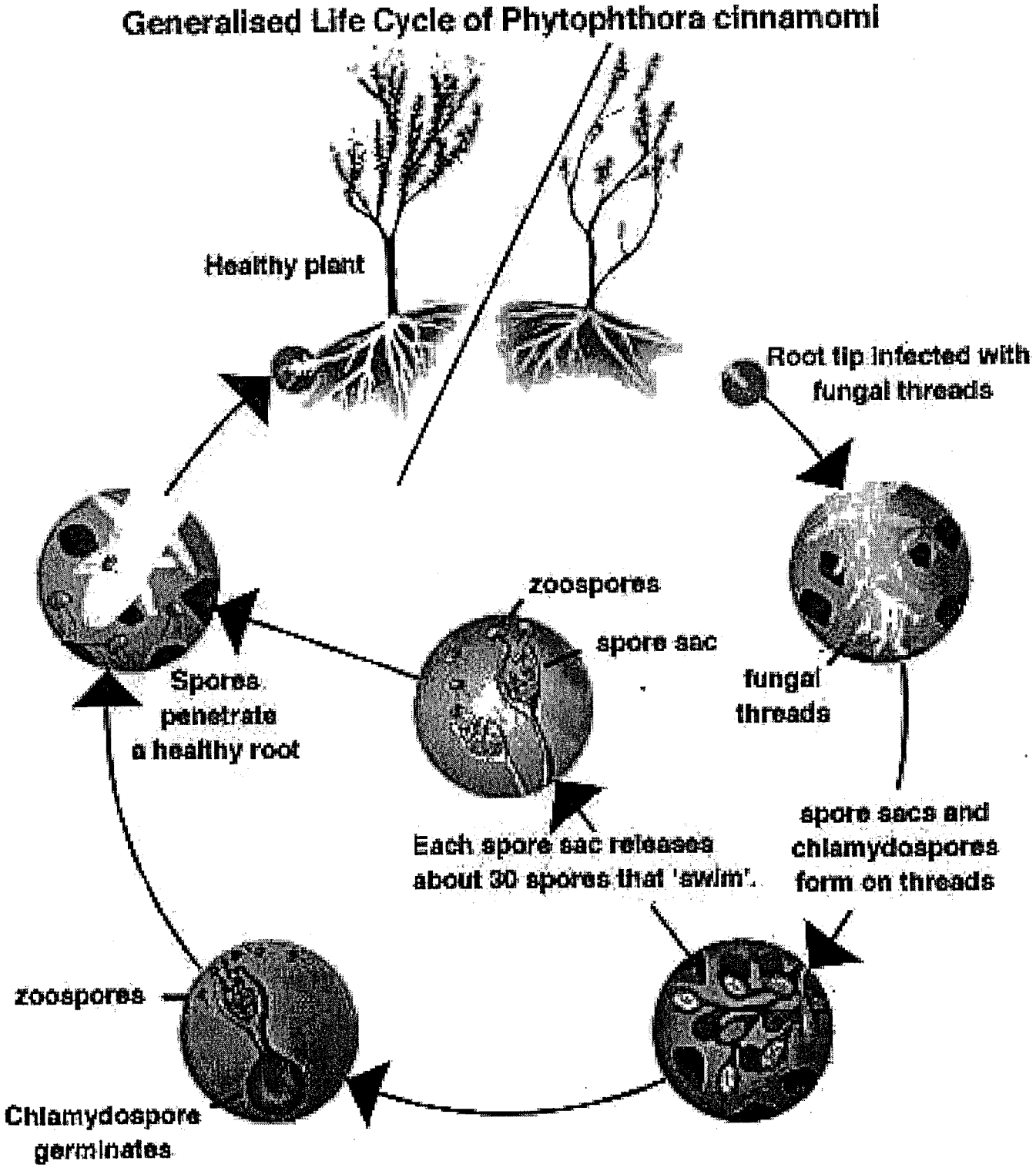


Figure 3.4


Generalised Life Cycle of Phytophthora cinnamomi
Healthy plant
Root tip infected with fungal threads
fungal threads
spore sacs and chlamydospores form on threads
Each spore sac releases about 30 spores that 'swim'.
zoospores
spore sac
Spores penetrate a healthy root
zoospores
Chlamydospore germinates

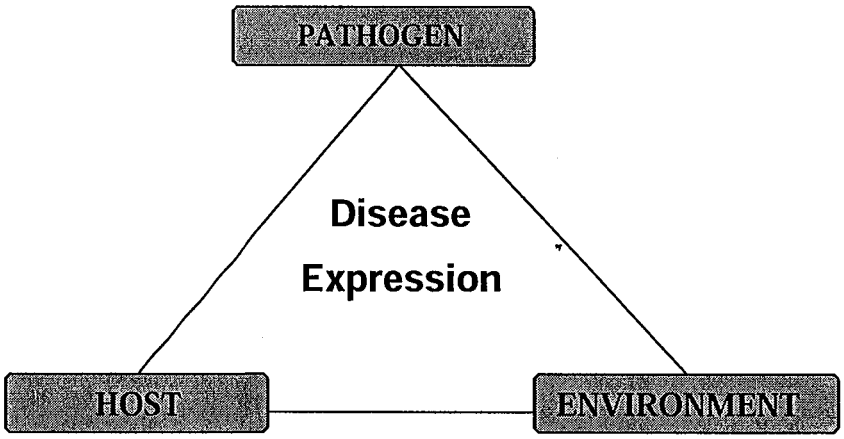
3.3 DISEASE TRIANGLE

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 which act on an individual organism during its lifetime.

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

PATHOGEN: Any organism or factor which derives its energy or nutrients from a host. Often causing disease in the host.



Removal of any factor from the equation of this triangle means that disease cannot exist at the site

3.4 Interaction with the Host

P. cinnamomi has a very wide host range. At least 1000 species from taxonomically diverse families have been reported as hosts for *P. 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 eg.: 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 chemotacticly, 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 plants cells

Once the fungus has established within the roots of a prospective host, it establishes within unlignified 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 3.5 illustrates the progressive spread of *P. cinnamomi* and it's impact on various elements of the vegetation.

The top section of figure 3.5 shows a horizontal view of a transect in uninfested jarrah forest prior to introduction of *P. 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 3.5 shows the same transect 3-5 years after introduction *of P. cinnamomi* at point X, with concurrent death ("mass collapse") of understorey of *Banksia grandis* and mature jarrah of the overstorey on a high hazard site. The distribution of *P. 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.

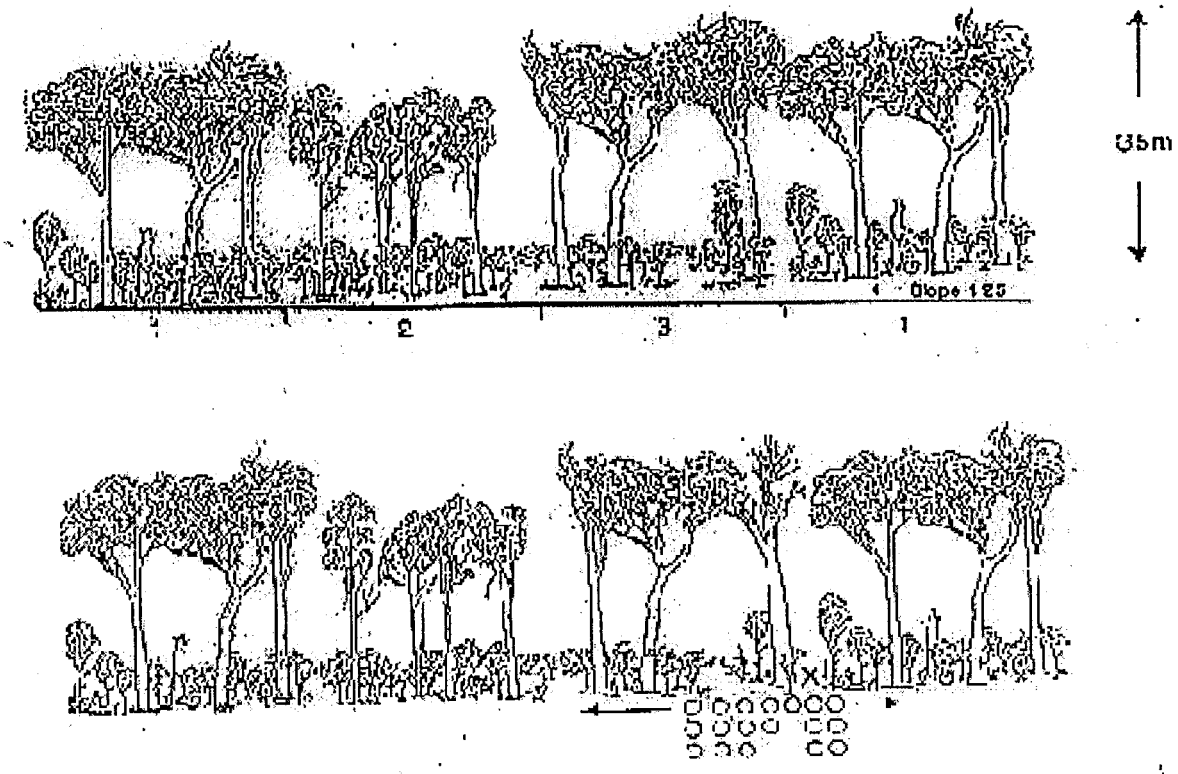


Figure 3.5

Figure 3.6 illustrates the movement of a "wave front" of high density *P. cinnamomi* at the perimeter of a diseased area and the decline in pathogen numbers in the wake of infection.

Figure 3.6

The top section of figure 3.6 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. d) inner limit of wave of active disease.

The lower section of figure 3.6 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.

3.5 DETECTION, DIAGNOSIS AND MAPPING

Detection of disease symptoms, sampling of soil and plant tissue for laboratory analysis, diagnosis and mapping for the presence of *Phytophthora cinnamomi* is described in detail in Volume 2. - Detection, Diagnosis and Mapping Guidelines

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

4.1 HISTORY OF INTRODUCTION AND SPREAD

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 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 southwestern Australia.

P. 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.

P. 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. 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 600mm and occur sporadically at lower rainfall.

In areas receiving 400 - 600 mm, root rot caused by *P. 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 *P. cinnamomi* in regions receiving < 400 mm outside irrigated horticultural activities

4.2 DISEASE SYNDROMES

The effect of *P. 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 *P. 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 *P. 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

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 :-

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 Spearwood Dune System 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, podsolic 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 *P. cinnamomi* has been long established (some 50 years or more) in sites formerly dominated by jarrah/banksia forest and has been very heavily impacted *P. 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, *P. cinnamomi* causes more muted disease than at the wave front.

4.2 PROGNOSIS – SPREAD, ERADICATION AND CONTROL

CALM 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 of the sites where the correct combination of host and environment occur (See figure 4.1 and 4.2)

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.

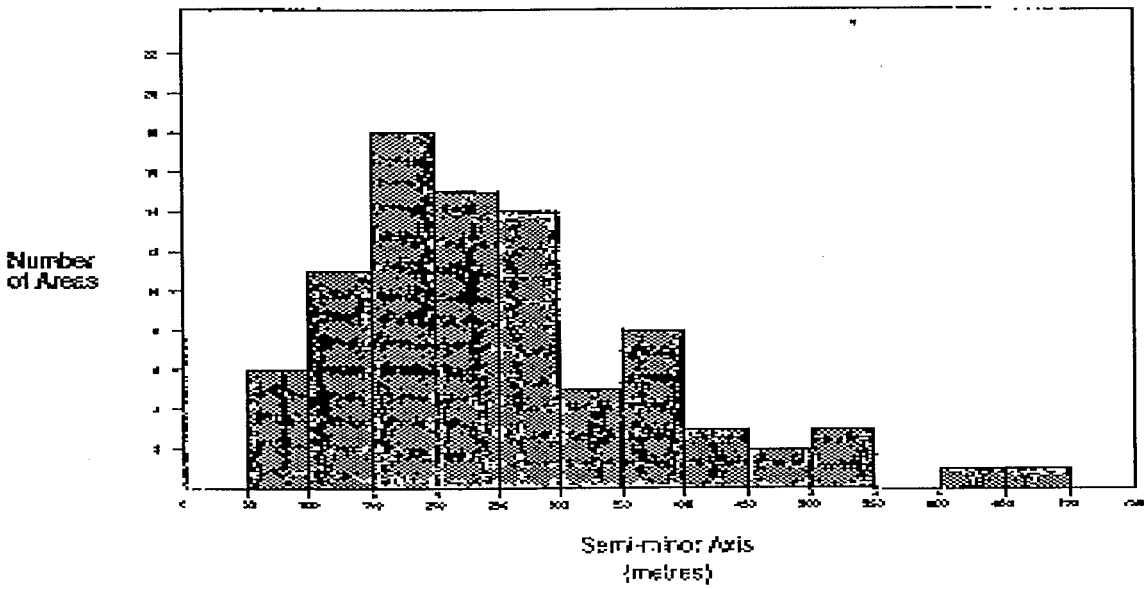


Figure 4.2 Histogram showing the frequency of compact areas (approximated as ellipses) verses the distance of their most remote point from the nearest dieback (semi minor axis of the ellipse). The behaviour at the lower end of the distance axis is strongly influenced by the cut-off in the sampling of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

SECTION 5 - CALM ACT AND REGULATIONS AND CALM POLICY

5.1 CALM ACT AND REGULATIONS

The Department of Conservation and Land Management is responsible for administering the CALM 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 therefor, and for incidental purposes".

This Act establishes the Department of CALM, the National Parks and Nature Conservation Authority, the Lands and Commission and the Forest Products Council.

The Department of CALM is established as a management authority charged with the management of lands, waters and wildlife under policies and directions set by the Minister and the above advisory bodies.

The CALM Policy Act influences (Management of Phytophthora and diseases caused by it) through the following areas of
the Act.

- 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 NPNCA of LFC.

A temporary control area classification for land or water shall only be for the purpose of public safety of 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.

5.1.1 Control and Eradication of Forest Diseases - Part 7 (Sections 79 - 86)

The purposes of Part 7 are to identify the areas of public land in which trees may 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 Act of 1933.

Steps to be taken before Minister makes recommendation

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.

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 be entering that part by a route described in the written authority or subject to conditions in the written authority.

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

Sect 120 - Power to enter and inspect land

An authorised forest 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 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, 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 officer

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 CALM to be

a) a wildlife officer;

b) a forest officer;

c) a ranger

d) a conservation and land management officer

Wildlife officers, forest 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

Part 16 - Control and Eradication of Forest Diseases

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

Regulations Part 16

106 1. An authorised person in writing may authorise

- 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

In 1996 an independent review [the Western Australian 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 CALM.

The report was endorsed by Government in 1998 and CALM is progressively implementing all 33 of the Review Panel Recommendations. (see Appendix 12.1)

5.3 COPY OF CALM POLICY STATEMENT NO.3 OF DECEMBER 1998

This section is a reprint of CALM's current policy document.

MANAGEMENT OF *PHYTOPHTHORA* AND DISEASE CAUSED BY IT

POLICY STATEMENT No.3 of DECEMBER 1998

INTRODUCTION

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 :-

" 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. CALM 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* recur 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 *P. 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 unprotectable 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 *P. cinnamomi* through the detection and analysis of the disease symptoms in native plants characteristic of disease caused by *P. cinnamomi.*

   b) The progressive identification of protectable areas, which are free of the evidence of infestation by *P. 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 *P. 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 unprotectable 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.

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, it's 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 *P. cinnamomi* and disease caused by it.

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

Dr S Shea

Executive Director
December 1998

5.4 WRITTEN AUTHORITY TO ENTER DRA

Any number of the public and /or CALM staff member, 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.

5.4.1 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.

5.4.2 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 assertion wether 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 "CALM Officer" only has authority to approve
- 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

5.4.3 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

(To be added)

6.2 KEY THREAT ABATEMENT ACTIONS FOR WESTERN AUSTRALIA

(To be added)

SECTION 7 - MANAGEMENT OF UNINFESTED PROTECTABLE AREAS

7.1 MANAGEMENT OBJECTIVE

The Western Australian Government and CALM have adopted a strategy for the management of *P. 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), prioritises them, and concentrates available resources on protecting them.

CALM's objective is to identify uninfested protectable areas and to protect them by managing human access and hygiene on entry into them, and in some cases through the application of phosphite.

7.2 MANAGEMENT STRATEGY

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 to prepare up-to-date maps of the distribution *P. cinnamomi* through the detection and analysis of the disease symptoms characteristic of root rot disease caused by *P. cinnamomi* in native plants. This supported by the laboratory analysis of soil and tissue samples by the Vegetative Health Service.
   b) The identification of Protectable areas, which are free of the evidence of infestation by *P. cinnamomi* , and which are amenable being protected from

c) the establishment of new centres of infestation arising from the activities of man through the imposition hygienic management practises.
d) The documentation, implementation and regulation of plans for hygienic human access to all Protectable areas,
e) The implementation of appropriate monitoring and review programs.

3. Where appropriate provide protection through phosphite application.

4. Provide and maintain appropriate management guidelines and training programs.

7.3 PROTOCOL FOR IDENTIFYING PROTECTABLE AREAS ON CALM LANDS

CALM 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 :-

7.3.1 On a case by case analysis of landscape units establish the need for, and scope of, the mapping required and use accredited Interpreters to prepare *P. cinnamomi* Occurrence Maps based on four categories – *Phytophthora cinnamomi* infested, Uninfested, Uninterpretable and Unprotectable.

7.3.2 Use accredited Interpreters and manager to identify Protectable areas and rationalise their management boundaries.

Table 1. Definition of Protectable areas

Defines areas of CALM land over which the hygiene rule, for the plant pathogen *P. cinnamomi* , of clean on enter will apply. May be an area suitable for phosphite application.

- 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 mm per annum rainfall zone.
- Does not have a calcareous soil (ie not Spearwood Sand dune)
- Have been determined to be free of the pathogen *P. cinnamomi* by a qualified Interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *P. cinnamomi* are evident)
- Are positioned in the landscape and are of sufficient size such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term. (eg. > 4 ha with axis > 100m)
- Consists of areas where human vectors are controllable (eg. not an open road, private property)
- Includes areas of high conservation and/or socio-economic value (eg. a small uninfested area which contains a known population of a susceptible species of threatened flora)

7.4 PREPARING *PHYTOPHTHORA CINNAMOMI* HYGIENE PLANS FOR PROTECTABLE AREAS

7.4.1 MANAGEMENT OBJECTIVE

CALM's management objective is to progressively prepare and implement *Phytophthora cinnamomi* Hygiene Plans for all Protectable areas.

Phytophthora cinnamomi Hygiene Plans enable land mangers to determine :-

a) The practical management boundaries for each area,
b) The hygiene measures to be taken to minimise human vectoring of the pathogen into each area, and
c) The efficacy of protection through phosphite application.

Table 1. Definition of Protectable areas

Defines areas of CALM land over which the hygiene rule, for the plant pathogen *P. cinnamomi* , of clean on enter will apply. May be an area suitable for phosphite application.

- 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 mm per annum rainfall zone.
- Does not have a calcareous soil (ie not Spearwood Sand dune)
- Have been determined to be free of the pathogen *P. cinnamomi* by a qualified Interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *P. cinnamomi* are evident)
- Are positioned in the landscape and are of sufficient size such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term. (eg. > 4 ha with axis > 100m)
- Consists of areas where human vectors are controllable (eg. not an open road, private property)
- Includes areas of high conservation and/or socio-economic value (eg. a small uninfested area which contains a known population of a susceptible species of threatened flora)

7.4 PREPARING *PHYTOPHTHORA CINNAMOMI* HYGIENE PLANS FOR PROTECTABLE AREAS

7.4.1 MANAGEMENT OBJECTIVE

CALM's management objective is to progressively prepare and implement *Phytophthora cinnamomi* Hygiene Plans for all Protectable areas.

Phytophthora cinnamomi Hygiene Plans enable land mangers to determine :-

a) The practical management boundaries for each area,
b) The hygiene measures to be taken to minimise human vectoring of the pathogen into each area, and
c) The efficacy of protection through phosphite application.

The following steps are used by the District Manager, in consultation with the various activity proponents and accredited Interpreters, when preparing *Phytophthora cinnamomi* Hygiene Plans for a given area of CALM land :-

a) Use a whole of landscape unit approach to analyse the *P. cinnamomi* Occurrence Map and identify the Protectable areas and rationalise their management boundaries. (See Section 7.3 above)

b) Identify all activities current and planned for the Protectable areas.

c) Use Table 2. Hygiene Guidelines as a basis for planning, implementing and enforcing the rule of being clean on entry for all human activities within Protectable areas and controlling access into them.

. For each Protectable area determine :-

i) The hygiene requirements,
ii) The measures to be taken to minimise human vectoring of the pathogen into it, the control on access each, and
iii) The efficacy of providing protection through phosphite application.

d) Analyse the risk of a hygiene failure occurring (see 7.4.7) and adopt appropriate hygiene tactics (see 7.4.6) with a view to minimising the risk of cross contamination from infested to uninfested areas.

e) Consider the consequences of a hygiene failure and amend tactics as appropriate. (see 7.4.8)

f) Document the *Phytophthora cinnamomi* Hygiene Plan (Use Proforma - see 7.4.9) listing the required management actions and accountabilities for each of the Protectable areas. This will include the preparation of a Phytophthora cinnamomi Hygiene Management Map (to be attached to the completed Proforma).

Review the results and periodically audit compliance.

7.4.5 HYGIENE GUIDELINES

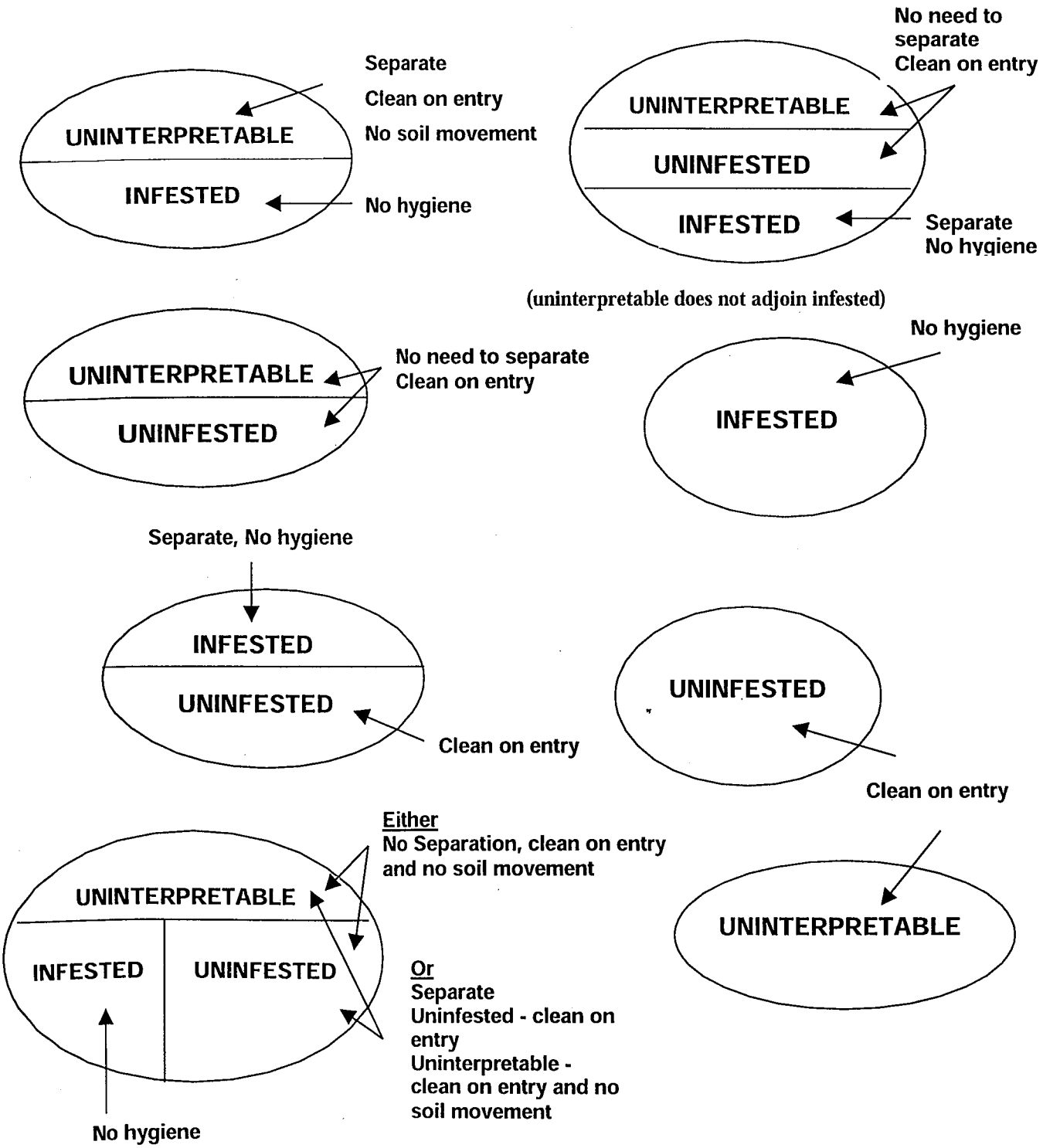
Using a process that analyses entire landscape units (the boundaries of landscape units are established by such features as creeks, ridges, saddles, open roads and/or freehold land) Managers must plan for, deploy and enforce the rule of being clean on entry for all human activities in Protectable areas and control access into them. It is not possible to survey the entire CALM estate for the presence of *P. cinnamomi,* therefore areas to be mapped annually and their boundaries will be determined on a case by case analysis of likely Protectable areas and the amount of information needed to prepare a *Phytophthora cinnamomi* Hygiene Plan for them. In most cases a whole landscape unit

approach to mapping and planning will be required, although linear mapping may be adequate for prescribed burn boundaries.

Having prepared a Phytophthora cinnamomi Occurrence Map and established the Protectable areas which may reasonably be protected from human vectoring by the use of controlled and hygienic access. Table 2 – "Hygiene Guidelines for Protectable for Protectable Areas", is used by Managers as a guide for determining appropriate hygiene strategies for each protectable area.

The aim of Table 2 "Hygiene Guidelines for Protectable for Protectable Areas" is to indicate how managers may best minimise the human vectored spread of *P. cinnamomi* into Protectable areas. Where the entire landscape unit consist of a single category – infested, uninfested or uninterpretable the analysis and determination of an appropriate hygiene strategy is made simpler. In the cases where the landscape unit consists of a mosaic of any one of the possible combinations of these categories the task is more complex.

Table 2. HYGIENE GUIDELINES FOR PROTECTABLE AREAS



7.4.6 HYGIENE TACTICS AND STANDARDS

CALM's objective in uninfested Protectable areas is to manage hygiene by planning, implementing and enforcing the rule for all human activities of being clean on entry and having entered clean to avoid cross contamination from infested to uninfested areas. This is often enhanced by removing or controlling options for access into protectable areas.

The hygiene tactics available to land managers preparing *Phytophthora cinnamomi* Hygiene Plans are :-

1. The temporary seasonal closure of roads and walk trails with barriers and signs.
2. The permanent closure, removal and rehabilitation of roads and walk trails.
3. Ensuring all potential human vectors enter Protectable areas hygienically via effectively designed, located and managed cleandown points.
4. The use, during specific activities, of split phase systems of work that physically and/or temporally separate infested and uninfested areas.

Cleandown Specification

An object (boots, vehicles, plant, or equipment) is judged to be free of soil and plant tissue, which may be infested with *P. cinnamomi,* when a visual inspection by an authorised officer reveals that it is free of a build up of :-

a) clods of soil and/or
b) slurry consisting of soil and water.

Dust and grime adhering to the sides of vehicles need not be removed before entering a Protectable area.

Field Cleandown Point - Construction and Location Standards

All cleandown points will be inspected and approved by an authorised officer. An approved cleandown point will meet the following minimum standards.

1. Construction standards

1.1 Provides physical separation between the object being cleaned and the effluent being produced.

1.2 Provides physical separation from the object being cleaned and infested soil and plants

1.3 Provides easy and safe access for both the placement of the object to be cleaned and for the person conducting the cleandown.

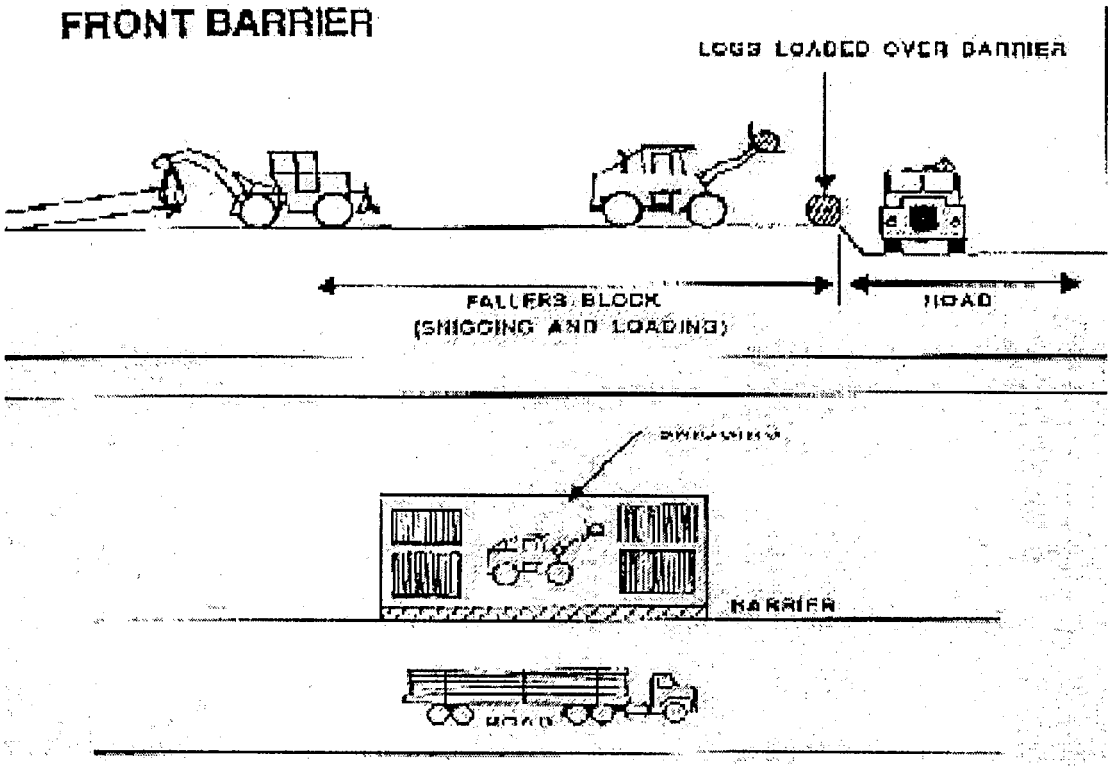
2. Field location standards

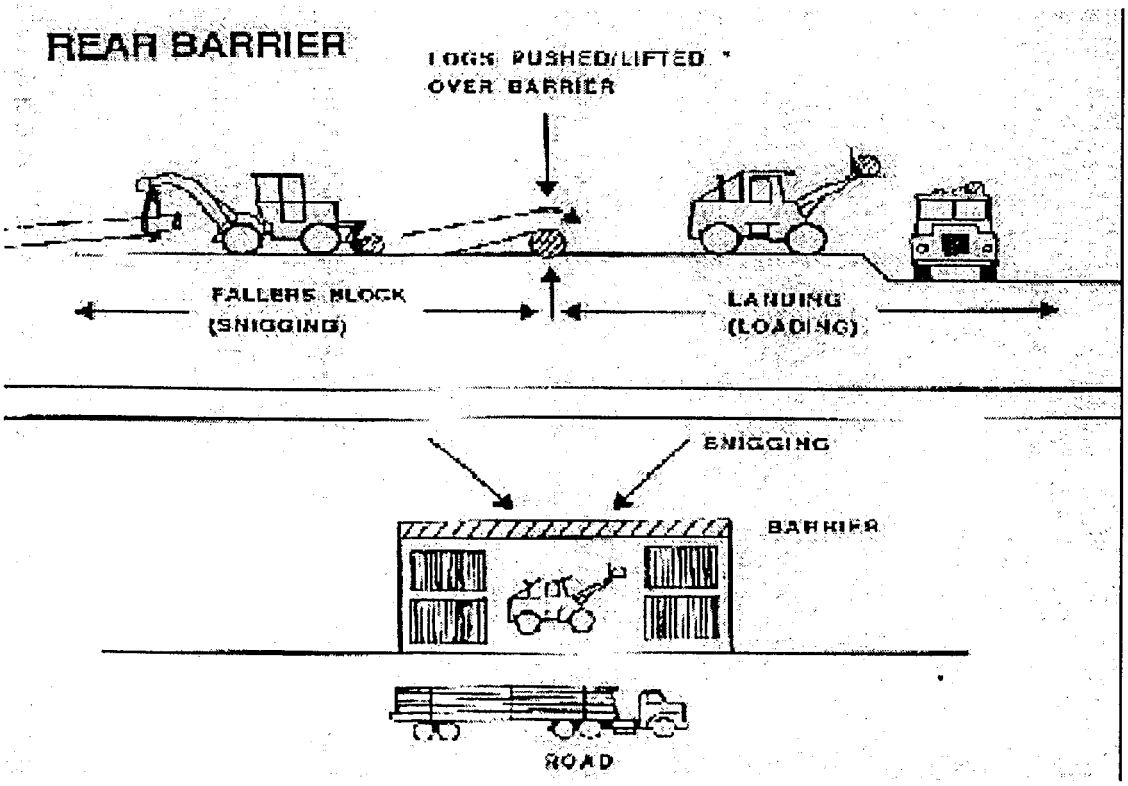
2.1 Sited for safe entry and departure of vehicles and plant

2.1 Sited either to allow effluent to fall directly onto infested soil or is constructed to capture effluent for later transport and correct disposal.

2.2 Sited to enable cleaned objects to enter uninfested areas without becoming re-infested.

Examples of split phase activities





7.4.7 RISK MANAGEMENT

The risk that the strategy of being clean on entry may fail will vary between Protectable areas.

Each step in the management of *Phytophthora cinnamomi* has its attendant risks. These risks are illustrated in Table 3 – Risk Management

High risk is associated with the following factors :-

1. Activities involving earth moving
2. Activities that are carried out when soil readily adheres to vehicles and machines in large amounts.
3. Situations where more than one access point into any given Protectable area is required – the difficulties associated with the design, location, construction, sign posting, management and regulation of cleandown points multiplies with an increasing number of access points.
4. Permanent roads are constructed – creates the need for ongoing hygiene management of potential human vectors.
5. Multiple and ongoing entry is required by legitimate activities – multiplies the number and difficulty of cleandowns.
6. Heavy trucks and machines involved – increased complexity and cost of each cleandown.
7. High level of illegal access occurs – may exceed CALM's resources and ability to control.

A winter activity with soil movement or the construction of a permanent road in a Protectable area, will always be characterised as having a high risk of a hygiene breakdown.

When preparing *Phytophthora cinnamomi* Hygiene Plans Managers should consider the need for applying the following risk mitigation tactics :-

1. Permanently close and rehabilitate roads.
2. Restrict access to summer only.

3. Plan the minimum possible number of access points – this minimises the number of interfaces between infested and uninfested areas.
4. Implement seasonal closure of roads in protectable areas.
5. Plan for increased management and supervision of cleandown points.
6. Construct, manage and audit standard high quality cleandown points (see specification section 7.4.6)
7. Increase enforcement patrols.

7.4.8 CONSEQUENCES OF A HYGIENE FAILURE

A hygiene failure may lead to the establishment of new centres of infestation in what was believed to be a Protectable area.

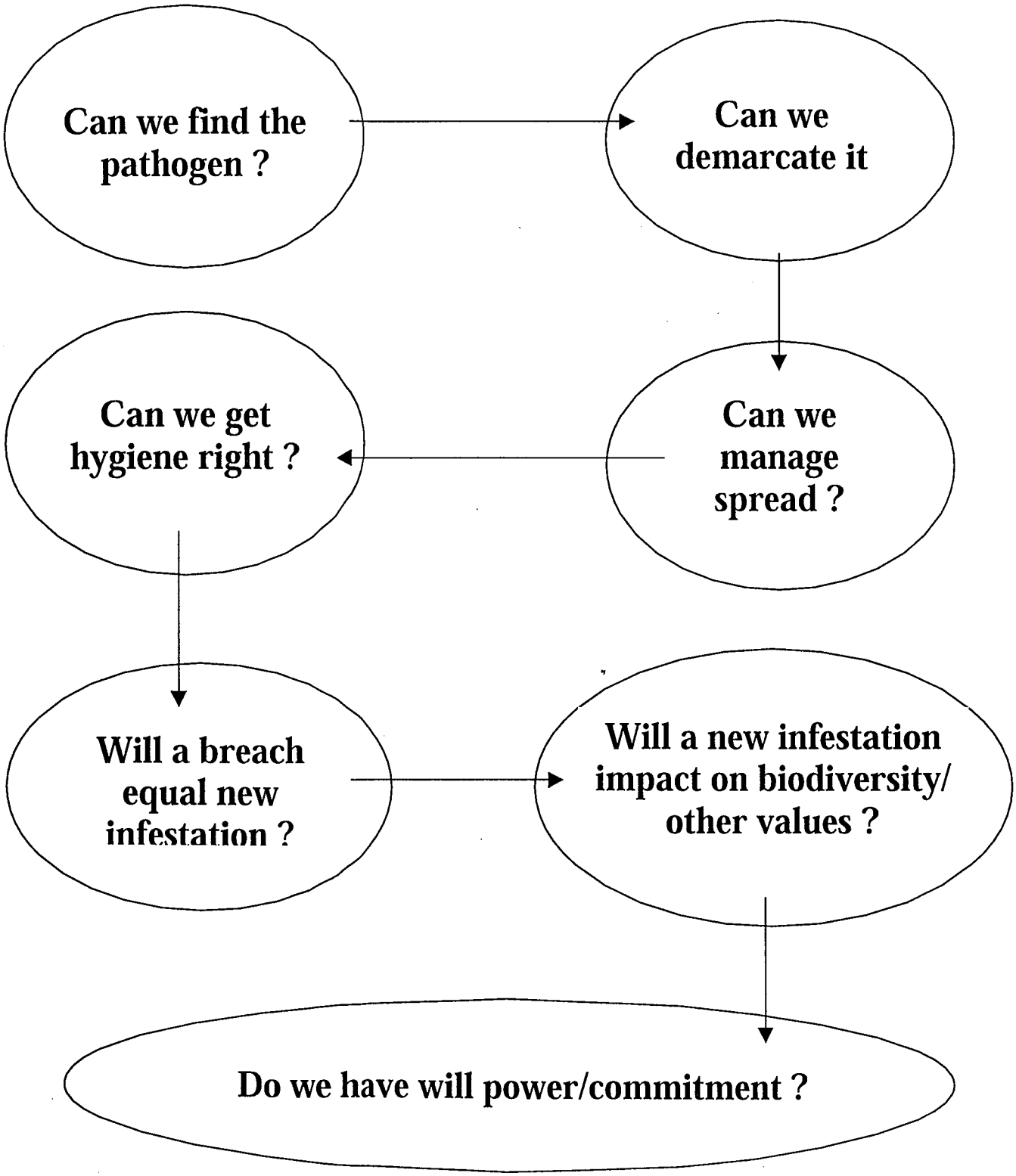
In Protectable areas where there is a high risk of a breakdown in the hygiene procedures Managers should consider options which may reduce the predicted size of any new areas of infestation that may result.

Options include :

a) Plan and build permanent roads as low in the profile as appropriate when considering all values such as conservation, visual amenity, fire management, engineering requirements, ongoing road use, maintenance issues and available resources.

b) Consider segmentation of the Protectable areas only where cleandown points may be located and operated in such a manner that resulting effluent does not lead to the infestation of the area.

Table 3. Risk Management



7.4.9 *Phytophthora cinnamomi* Hygiene Plan Proforma

PHYTOPHTHORA CINNAMOMI HYGIENE PLAN

District : ..... Location.....

***P. cinnamomi* Hygiene Plan ID No. ..... Date Valid To..... .....**

OBJECTIVE : To manage hygiene to ensure human activities are an inconsequential vector for establishment of new centres of infestation in *Phytophthora cinnamomi* free Protectable areas.

STRATEGY :

1. Establish and map the *P. cinnamomi* Occurrence and identify the Protectable areas. [Standards to be confirmed by CALM's Disease Standards Officer].
2. For the Protectable areas establish practical management boundaries and plan, deploy and enforce the rule of being clean on entry for all activities, and determine the efficacy of protection through phosphite application.
3. Apply a range of standard management and hygiene measures to minimise human vectoring of *P. cinnamomi* into Protectable areas.
4. Document the *Phytophthora cinnamomi* Hygiene Plan listing the required actions and accountabilities.
5. Review results and periodically audit compliance

IDENTIFICATION OF *PHYTOPHTHORA* FREE AREAS

The attached *Phytophthora cinnamomi* Occurrence Map No. .....and the Protectable Areas Map No. ..... which has been approved by CALM's Disease Standards Officer identify the areas to be protected by ensuring potential human vectors are clean on entry.

IDENTIFY THE ACTIVITIES WHICH ARE PLANNED FOR THIS AREA

Road maintenance	Landing construction
Road construction	Landing use
Road use	Snigging
Lignotuber survey	Open a new ravel pit
Regeneration preparation	Gravel pit use
Regeneration seeding	Gravel pit rehabilitation
Regeneration planting	Bush walking
Regeneration burn	Car rally
Burn boundary preparation	Wildflower picking
Prescribed burn	Pig hunting
Wildfire suppression	Walk trail construction
	Walk trail maintenance
	Other (specify)

HYGIENE : (Prepare and attach a *Phytophthora cinnamomi* Hygiene Management Plan) Use the table below to :-

a) Establish the practical management boundaries of each Protectable area, and

b) Describe in detail the management and hygiene measures to be taken (where, when and by whom) to minimise human vectoring of the pathogen into the Protectable areas, and

c) Assess the need for protection through the application of phosphite.

ACTIVITY DESCRIPTION	MAP IDENTIFIER	ACTION REQUIRED (add extra pages as required)

CROSS CHECK THAT THE TACTICS DESCRIBED ABOVE ARE UNIFORMLY APPLICABLE TO ALL THE ACTIVITIES CIRCLED ABOVE, WILL BE EFFECTIVE IN THE LONG TERM AND ARE COST EFFECTIVE.

District Manager: ....

(PRINT NAME) (SIGNED) (DATE)

REVIEW PROCESS (District Manager to specify as appropriate what will be done, by whom, when, where, how and why to review this plan **and** what will be done with the information generated during the review.)

District Manager: ....

(PRINT NAME) (SIGNED) (DATE)

TACTICS ENDORSED BY ACTIVITY PROPONENTS (add extra pages as required)

On entering ..... I agree to implement the *Phytophthora cinnamomi* hygiene tactics described above.

1.Activity .....

Print name ..... Signed ..... Date : .....

2.Activity .....

Print name .....Signed..... Date : .....

3. Activity .....

Print name .....Signed..... Date : .....

4. Activity .....

Print name .....Signed..... Date : .....

ENDORSEMENT :

This *Phytophthora cinnamomi* Hygiene Plan was prepared by :-

....

(PRINT NAME) (SIGNED) (DATE)

This *Phytophthora cinnamomi* Hygiene Plan has been received imput from an accredited Interpreter :-

....

(PRINT NAME) (SIGNED) (DATE)

APPROVAL :

I certify that this *Phytophthora cinnamomi* Hygiene Plan adequately protects the nominated areas and that the activities within them will be reviewed. Activity(s) number(s) ..... is/are approved.

Written authority to enter DRA required ? Y/N Authority issued Y/N

District Manager: .... Date : .....

(PRINT NAME) (SIGNED) (DATE)

REVIEW COMPLETED (Specify outcomes)

District Manager: .... Date : .....

(PRINT NAME) (SIGNED)

Distribution : Copy of approved *Phytophthora cinnamomi* Hygiene Plan to Proponent (s), FMB data base, files

7.5 MANAGING *PHYTOPHTHORA CINNAMOMI* HYGIENE PLANS

The administration process of managing *Phytophthora* cinnamomi Hygiene Plans is 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* Hygiene Plan in place and if not whether one is required before authorising entry to the CALM estate.

The flowchart (See table 3. *Flowchart of for Managing Phytophthora cinnamomi Hygiene Plans*) illustrates key steps to be followed in the process of managing activities in Protectable areas, both where a *Phytophthora cinnamomi* Hygiene Plan is in place, and where one needs to be prepared.
agreement by signing off on the completed a *Phytophthora cinnamomi* Hygiene Plan.
A fundamental requirement is the need for the District Manager as the integrated and the custodian of CALM estate, to ensure that broad agreement is reached early in the process with the activity proponent, on the scope of the planning task and the initial analysis of risk. This will often require input from an accredited Interpreter.

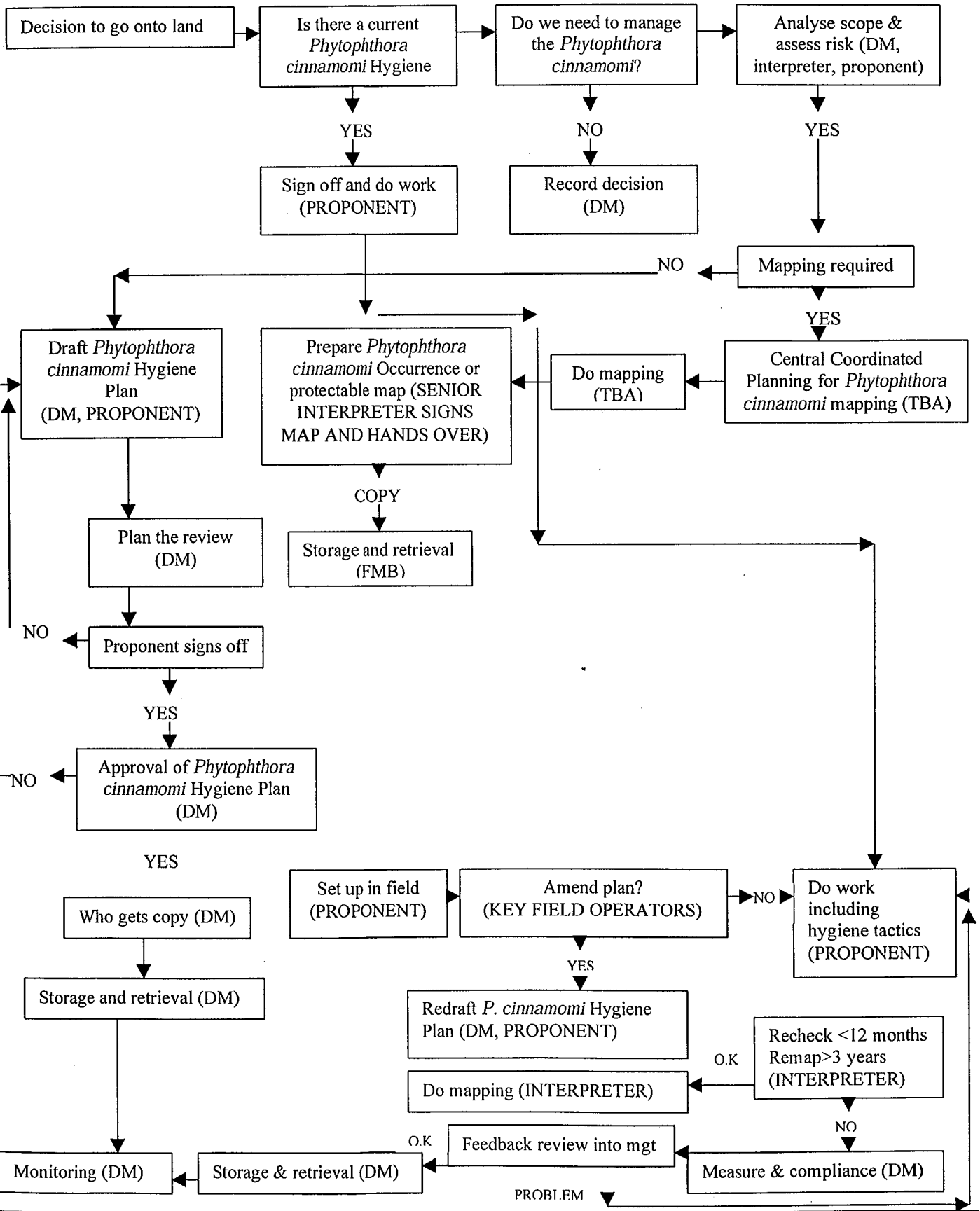
Once the *Phytophthora cinnamomi* Occurrence Map and the Protectable Areas Map are prepared, the District Manager should re-convene, as appropriate, the working session with the proponent to analyse and agree on the details of the hygiene plan. At this point consideration must be given to integrating the hygiene management of all the activities occurring within each Protectable area. Proponents are to signify their

The District Manager is accountable for designing and implementing an appropriate review process for each current *Phytophthora cinnamomi* Hygiene Plan and ensuring that there is a reliable feedback loop in the process so that new information is incorporated into the ongoing management of the Protectable areas and the activities within them.

Copies of current and past *Phytophthora cinnamomi* Hygiene Plans should be available in the District Office record system. The District Manager is accountable for ensuring that copies are forwarded to FMB for inclusion into CALM's Corporate data base systems.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

FLOWCHART OF THE PROCESS OF MANAGING A *P. cinnamomi* HYGIENE PLAN



SECTION 8 – MANAGEMENT OF INFESTED AND UNPROTECTABLE AREAS

8.1 MANAGEMENT OBJECTIVE

CALM'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 *P. cinnamomi* and sets priorities among management options for them.

8.2 MANAGEMENT STRATEGY

For the infested and unprotectable areas CALM 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.

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

9.1 MANAGEMENT OBJECTIVE

As a component of it's broader management program of threatened flora, threatened ecological communities and the habitat of threatened fauna, CALM 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.

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. 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 CALM'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 Operational Guidelines.

SECTION 10 RESEARCH, PUBLIC EDUCATION AND LIAISON

10.1 MANAGEMENT OBJECTIVES

As a component of it's broader programs of research, public education and liaison CALM's objective is to :-

(1) Implement programs of interagency research and collaboration, which 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

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.

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.*

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4. Through interaction with the *Phytophthora* Research Advisory Group establish clear research priorities and agreed allocation of those priorities amongst relevant institutions.
5. 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.*

10.4 RESEARCH PRIORITIES

[See National Threat Abatement Plan and CALM Strategic Plan]

SECTION 11 – ADMINISTRATION

11.1 DESIGNATED ROLES

11.1.1 Dieback Coordinator

11.1.2 Dieback Consultative Council

11.1.3 Regional Coordinating Groups

11.1.4 Phosphite Action Officer

11.1.5 District Manager

SECTION 12 - APPENDICES

12.1 BACKGROUND TO THE REVISION OF CALM POLICY STATEMENT No. 3 "MANAGEMENT OF *PHYTOPHTHORA* AND DISEASE CAUSED BY IT"

F.D. Podger & K.R. Vear - July 1998

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.

P. 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.

P. 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 *P. 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 *P. 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 *P. cinnamomi* in regions receiving <400mm.

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

The effect of *P. 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 *P. 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 *P. 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* woodland and in heathland on podsols, podsolic 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 *P. cinnamomi* has been long established (some 50 years or more) in sites formerly dominated by jarrah/banksia forest and has been very heavily impacted *P. 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, *P. 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 CALM 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 CALM.

CALM 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 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, 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 *P. 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 *P. cinnamomi* ?

Whereas it is now recognised that at least eight distinct species of P*hytophthora (P. boehmeriae, P. 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). *P. 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 *P. 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 which 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 *P. 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.

12.2 LIST OF OTHER RELEVANT MANUALS

- Timber Harvesting in Western Australia
- Code of practice for Timber Harvesting
- W.A Dieback Review Panel Report

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

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Authorisation to Take a Potential Carrier into a Risk Area or Disease Risk Area

In accordance with regulation 106 of the *Forest Management Regulations 1993*, the potential carriers (vehicles) and drivers listed below may enter a proclaimed risk area or disease risk area subject to the conditions contained in this document.

Authority Number: **Issued at:**

Period during which the authority to enter may be used:

Start Date **Expiry Date**

Authority to Enter

Holders Name:.....

Address:.....

Suburb:.....**Postcode**.....

Phone Number.....

Reason for Entry:.....

.....

Potential Carriers Authorised to be used:

Registration Number	Make	Colour

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

No Soil Movement:.....

.....

Soil Movement.....

.....

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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:.....

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 CALM 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.

....

Signature of Authority Holder **Date**