

*PHYTOPHTHORA  
OCCURRENCE ASSESSMENT  
– BEMAX, CABLE SANDS,  
HAPPY VALLEY PROJECTS  
AREA*

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## Table of Contents

<b>EXECUTIVE SUMMARY</b>	<b>1</b>
Study Team	1
<b>INTRODUCTION</b>	<b>2</b>
<b>METHODS</b>	<b>5</b>
Demarcation	5
Mapping	5
<b>RESULTS</b>	<b>6</b>
Disease Distribution	6
Disease Expression	6
Sample Results	7
Area Statement	9
Data Validity	9
<b>DISCUSSION</b>	<b>10</b>
<b>RECOMMENDATIONS</b>	<b>11</b>
<b>REFERENCES</b>	<b>12</b>
<b>APPENDIX 1 – ASSESSMENT AREA MAP</b>	<b>I</b>
<b>APPENDIX 2 – PHYTOPHTHORA OCCURRENCE MAP</b>	<b>II</b>
<b>APPENDIX 3 – PHYTOPHTHORA CINNAMOMI (DIEBACK)</b>	<b>III</b>

## **Executive Summary**

The Bemax – Cable Sands, Happy Valley Projects Area has been assessed for *Phytophthora* Dieback occurrence. Before commencing the *Phytophthora* occurrence assessment, it was necessary to classify the land into two broader categories, mappable and unmappable. Approximately forty per cent of the study area is considered unmappable for *Phytophthora* disease. Within the remaining sixty per cent of mappable area, approximately fifty five percent has been assessed as infested and forty five percent as uninfested.

Fifteen soil and tissue samples were taken within the study area to support field diagnoses.

Infested areas have been demarcated and mapped. Digital line work of disease boundaries has been handed to Bemax Environmental Officer Mr. Brant Edwards.

A recommendation has been made regarding permanent demarcation of infested area boundaries.

A recommendation has been made regarding the ongoing management of protectable areas throughout the study area.

## ***Study Team***

The assessment was conducted by Peter Blankendaal from Glevan Consulting. Mr Blankendaal is accredited by Department of Environment and Conservation (DEC) in the detection, diagnosis and mapping of the Dieback disease. Mr Blankendaal is the author of this report

## Introduction

A *Phytophthora cinnamomi* occurrence assessment is the first step in developing an effective management plan for the pathogen. This assessment set out to assign four possible categories to landscape within the Happy Valley mining lease area, namely, Unmappable, Infested, Uninfested and Uninterpretable.

The following table describes *Phytophthora cinnamomi* occurrence categories as defined by the Department of Environment and Conservation in the manual “*P.c.* and disease caused by it, volume 1, management guidelines, 2003”. The superior categories “mappable” and “unmappable” definitions are not yet published by the department, but are in general use at this time.

<p><b>Unmappable</b></p> <p>Areas that are sufficiently disturbed so that <i>Pc</i> occurrence mapping is not possible at the time of assessment.</p>	<p>Further categorisation may be possible after variable regeneration periods for different types of disturbance.</p>	
<p><b>Mappable</b></p> <p>Natural undisturbed vegetation. <i>Pc</i> occurrence mapping is possible. Three categories may result.</p>	<p><b>Infested</b></p>	<p>Areas that a qualified person has determined to have plant disease symptoms consistent with the presence of the pathogen <i>P. cinnamomi</i>.</p>
	<p><b>Uninfested</b></p>	<p>Areas that a qualified person has determined to be free of plant disease symptoms that indicate the presence of the pathogen <i>P. cinnamomi</i></p>
	<p><b>Uninterpretable</b></p>	<p>Areas where indicator plants are absent or too few to determine the presence or absence of disease caused by <i>P. cinnamomi</i></p>

Table 1, Category Definitions

After *Phytophthora* occurrence information has been established, protectable and unprotectable management categories can be overlaid on occurrence information to further simplify management of the area. All infested area is unprotectable. Unmappable, Uninterpretable and Uninfested may be given protectable or unprotectable status depending on local factors and influences.

This report will give results of the *Phytophthora* occurrence assessment, stating infested, uninfested uninterpretable and unmappable area. Final

rationalisation of protectable area categories is best done by actual land managers of the area.

The Happy Valley projects *Phytophthora* occurrence assessment is a composite of four separate mining leases; M70/899, M70/900 (in part), M70/901 and M70/809. Lease areas M70/479 and M70/895 were not included in the assessment area. The assessed lease areas cover sections of Argyle Block State Forest and private property locations 4485, 4985 and 3829.

No previous *Phytophthora* occurrence assessment has been done within the M70/809 and M70/899 areas. *Phytophthora* occurrence mapping has previously been done by the former Department of Conservation and Land Management in 2001 for the entire M70901 area and part of the M70/900 area.

The total combined assessment area is 798.8 ha. Thirty nine point seven per cent (317.3 ha) of the assessment area is classified as unmappable. Unmappable area consisted mainly of pasture and Tasmanian blue gum plantations. Some recently burnt remnant native forest was also included within the mappable category.

The assessment area is shown in appendix 1.

## **Methods**

Methods for *Phytophthora* occurrence mapping are described in the Department of Conservation and Environment Guidelines – “*Phytophthora cinnamomi* and disease caused by it Volume 2, Detection Diagnosis and Mapping Guidelines”

All methods used during the assessment conformed to Department of Environment and Conservation guidelines.

Uninfested areas were assessed using stripline method. Strip lines were placed not more than 50m apart.

### ***Demarcation***

*Phytophthora cinnamomi* (*P.c.*) infestations were demarcated using a single band of “Fluoro orange” flagging tape. Knots in the tape are placed facing towards the infestation. A variable buffer width was applied to every infestation as per the “*Detection Diagnosis and Mapping Manual*”, Section 7.

Uninterpretable and unmappable areas were demarcated using a single band of white flagging tape.

### ***Mapping***

All *P.c.* boundaries, sample points and other points of evidence were captured using a non-differential global positioning system (GPS) receiver, accuracy limits for this system are quoted at  $\pm 6.7\text{m}$  95% of the time <http://users.erols.com/dlwilson/gpsacc.htm>. Plotting of the waypoints was consistent with these figures

Boundaries were captured using the track function set to automatically capture points not more than 10m apart.

## Results

### ***Disease Distribution***

55.1 percent of the mappable area is assessed as infested by *Phytophthora cinnamomi*. All streams, gullies and riparian zones within the assessment area have been assessed as infested. Many upland ridges and midslope areas are also infested, but more so within the state forest area adjacent to Gavins Road. The largest sections of uninfested area were found to be in the mid and upper slope areas of remnant forested area of locations 4485 and 4965.

Four isolated infested areas were identified within the assessment area. The first was found in a single *Xanthorrhoea gracilis* death and was verified by a positive *P. cinnamomi* result from sample 8. The second had sufficient disease expression to diagnose without sampling and is situated at MGA reference e380192 n6285128. The third is located at MGA e379699.6 n6287284.4, a circular ulceration of approximately 50m diameter. The fourth is located along Gavins Road at the very eastern edge of the assessment area. This infestation was previously identified by the 2001 assessment of the area and has spread along Gavins Road since that assessment.

### ***Disease Expression***

Current impact of the disease within the assessment area ranged from moderate to very high. There are no low impact infested sites within the assessment area. Current expression was found in dead and dying *Banksia grandis*, *Isopogon sphaerocephalus*, *Persoonia longifolia*, *Xanthorrhoea gracilis* and *Adenanthos barbiger* on lateritic upland areas, and also in dead and dying *Banksia attenuata*, *Xanthorrhoea preissii* and *Eucalyptus marginata* on lower slopes and in gullies.

*Banksia attenuata* deaths were also scattered throughout uninfested areas. A sample strategy was set up to test this particular occurrence of a known *Phytophthora* indicator species death. Samples 1 to 7 of this assessment

were taken from Scattered *Banksia attenuata* deaths, all returned negative *P. cinnamomi* results.

### **Sample Results**

The following table provides details of all soil and tissue samples taken during the assessment.

<b>Sample Number</b>	<b>MGA Location (Zone 50H)</b>	<b>Species Sampled</b>	<b>Result</b>
1	379142 6284210	<i>Banksia attenuata</i>	Negative
2	379404 6284920	<i>Banksia attenuata</i>	Negative
3	378916 6285114	<i>Banksia attenuata</i>	Negative
4	378920 6284926	<i>Banksia attenuata</i>	Negative
5	378995 6284703	<i>Banksia attenuata</i>	Negative
6	379670 6285520	<i>Banksia attenuata</i>	Negative
7	379616 6285276	<i>Banksia attenuata</i>	Negative
8	380152 6285681	<i>Xanthorrhoea gracilis</i>	Positive <i>P. cinnamomi</i>
9	379955 6287253	<i>Banksia attenuata</i>	Negative
10	379883 6285120	<i>Banksia grandis</i>	Negative
11	380093 6285320	<i>Persoonia longifolia</i>	Negative
12	380113 6285090	<i>Banksia grandis</i>	Negative
13	380143 6285953	<i>Xanthorrhoea preissii</i>	Negative
14	380638 6287080	<i>Dasypogon hookeri</i>	Negative
15	380532 6287098	<i>Banksia grandis</i>	Negative

Table 2, soil and tissue sample results

The following table provides details of soil and tissue samples taken during the 2001 assessment of State forest areas (dept. CALM 2001)

<b>Sample Number</b>	<b>MGA Location (Zone 50H)</b>	<b>Species Sampled</b>	<b>Result</b>
Csg1	380324 6284749	<i>Adenanthos barbigera</i>	Negative
Csg2	380413 6284588	<i>Isopogon sphaerocephalus</i>	Positive, <i>P. cinnamomi</i>
Csg3	379822 6284694	<i>Banksia grandis</i>	Negative
Csg4	379520 6284641	<i>Banksia attenuata</i>	Negative
Csg5	379736 6284571	<i>Banksia attenuata</i>	Negative
Csg6	380578 6286634	<i>Banksia attenuata</i>	Positive, <i>P. cinnamomi</i>
Csg7	381709 6287242	<i>Xanthorrhoea preissii</i>	Positive, <i>P citricola</i>
Csg8	381421 6287266	<i>Xanthorrhoea gracilis</i>	Positive, <i>P. cinnamomi</i>
Csg9	380717 6287308	<i>Banksia grandis</i>	Negative
Csg10	380987 6286880	<i>Stirlingia latifolia</i>	Negative
Csg11	381021 6286930	<i>Isopogon sphaerocephalus</i>	Positive, <i>P. cinnamomi</i>
Csg12	381527 6286743	<i>Isopogon sphaerocephalus</i>	Positive, <i>P. cinnamomi</i>
Csg13	380516 6286937	<i>Banksia attenuata</i>	Positive, <i>P. cinnamomi</i>
Csg14	381838 6286174	<i>Banksia grandis</i>	Negative
Csg15	381509 6286195	<i>Xanthorrhoea gracilis</i>	Positive, <i>P. cinnamomi</i>
Csg16	381231 6286190	<i>Xanthorrhoea gracilis</i>	Positive <i>P. citricola</i>

Sample Number	MGA Location (Zone 50H)	Species Sampled	Result
Csg17	381168 6286080	<i>Banksia grandis</i>	Negative
Csg18	380860 6286501	<i>Stirlingia latifolia</i>	Negative
Csg19	380911 6286636	<i>Isopogon sphaerocephalus</i>	Negative
Csg20	380870 6286528	<i>Isopogon sphaerocephalus</i>	Positive, <i>P. cinnamomi</i>

Table 3, Soil and tissue samples taken by the Department of Conservation and Land Management 2001.

### **Area Statement**

The following table provides summary areas of categories used in the assessment

Category	Area (ha)	% of mappable area
Infested	265.2	55
Uninfested	216.3	45
<b>Total mappable area</b>	<b>481.5</b>	
<b>Unmappable area</b>	<b>317.3</b>	
<b>Total study area</b>	<b>798.8</b>	

Table 4, area statement

### **Data Validity**

The *Phytophthora cinnamomi* occurrence map produced for the area has data validity age limits. Map boundaries should be checked before operations proceed if the map is older than one year (July 2009). The map should not be used if it is older than three years (July 2011). Areas that have had any soil moving operation in them become unreliable, and recheck mapping should be done prior to further/new activities.

## Discussion

A *Phytophthora* occurrence assessment has been done for mining leases within the Happy Valley projects area. *Phytophthora cinnamomi* infestations were found to be widespread within the assessment area, however, some significant uninfested protectable areas remain. Buffers have been placed, and some boundary rationalisation has been done around the protectable areas. Further rationalisation of areas downslope from infested areas could be done as part of long-term strategic management of the disease within the assessment area. These boundary alterations are best done in consultation with various land managers and users within the assessment area.

Scattered *Banksia attenuata* deaths were present across uninfested areas within some parts of the assessment area. Some of these deaths were specifically selected for soil and tissue sampling. *Phytophthora cinnamomi* was not isolated from any *Banksia attenuata* deaths within uninfested areas. Summer drought conditions are thought to be the most likely cause of death for many of these trees. The deaths often occurred in very large *Banksia* trees, which may indicate a reduction in water table level through summer months. Once the series of negative results was returned, the deaths were regarded as “background”, not indicative of *Phytophthora cinnamomi*.

Demarcation tape from the 2001 assessment was still present throughout the previous assessment area. The assessment area within Argyle Block State Forest has not been burnt since 1997. Mr. Peter Wnuk of the Department of Environment and Conservation Blackwood district, Kirup, indicated that the State Forest area would be burnt in spring burning season 2009. Current temporary demarcation will not withstand the fire and will be lost. Permanent demarcation, consisting of axe blazing and paint marking will withstand burn effects.

## **Recommendations**

Further rationalisation of protectable area boundaries be done in consultation with various relevant land managers with consideration to long-term spread of *Phytophthora* downslope and outside of existing buffer system.

The resultant final protectable areas be produced as a “Protectable Areas Map” showing rationalised protectable and unprotectable areas.

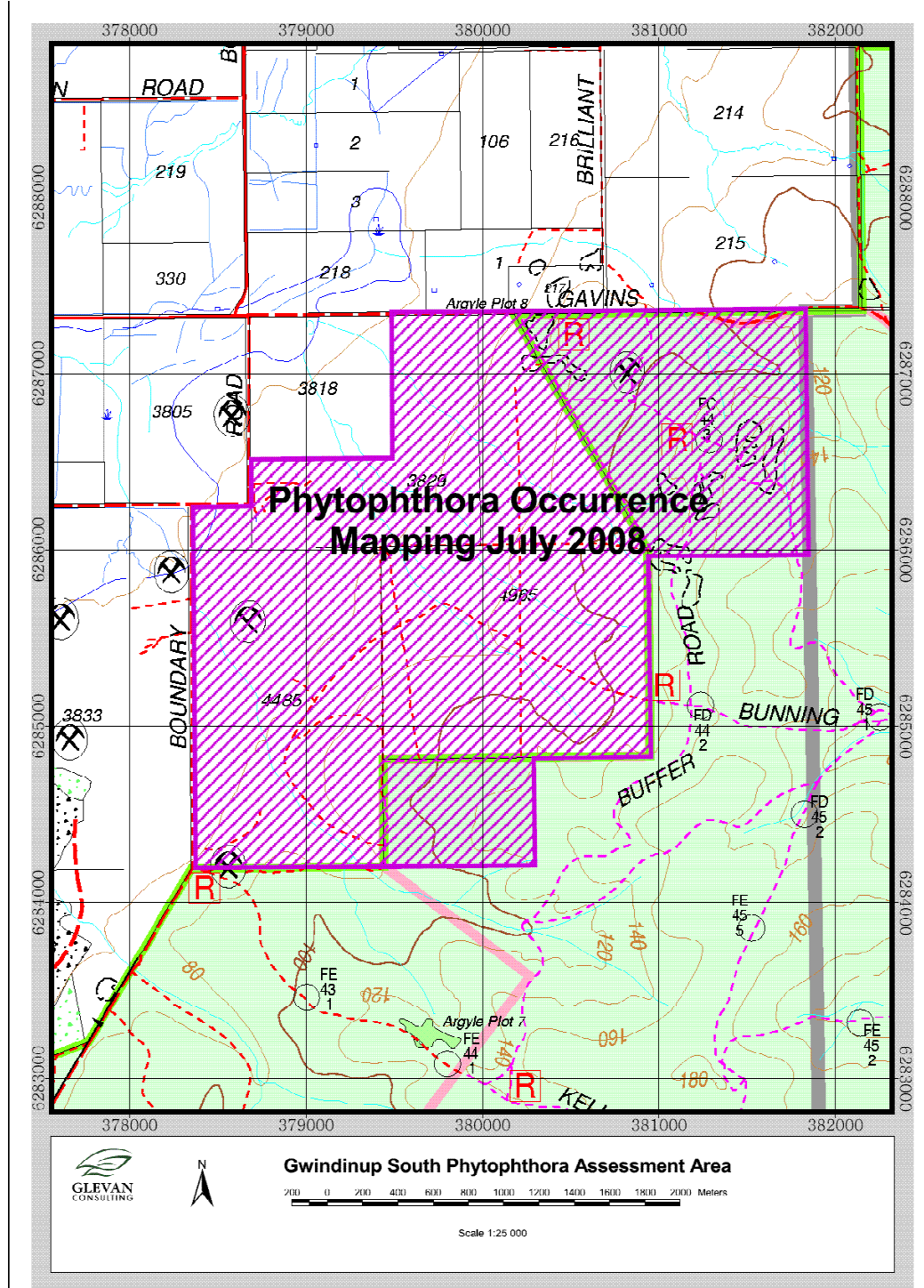
Permanent demarcation of infested area boundaries be done, especially within areas due for controlled burning.

## References

CALM (2003) *Phytophthora cinnamomi* and the disease caused by it. Volume 1 – *Management guidelines*. Department of Conservation and Land Management.

CALM (2003) *Phytophthora cinnamomi* and the disease caused by it. Volume II - *Interpreter Guidelines for Detection, Diagnosis and Mapping*. Department of Conservation and Land Management.

# Appendix 1 – Assessment Area Map





## **Appendix 3 – *Phytophthora cinnamomi* (Dieback)**

*Phytophthora cinnamomi* is an introduced soil-borne pathogen (water mould) that kills a diverse range of plant species in South West Western Australia. Jarrah Dieback, the name given to the disease associated with *P. cinnamomi* is actually something of a misnomer. The Jarrah (*Eucalyptus marginata*) is susceptible to *P. cinnamomi*, but it also demonstrates a degree of resistance to the pathogen (that most susceptible species appear to lack), and hence it is often observed to gradually 'die back'. Most susceptible species however, do not gradually dieback, but rather experience a 'sudden death' in which the entire plant dies at once.

*P. cinnamomi* is thought to have been introduced to Western Australia shortly after European colonization and has since produced a complex mosaic of infected and uninfected areas throughout the southwest of the State. The spread of the pathogen accelerated after World War II with the use of heavy machinery being used for road building and logging activities and unknowingly spreading infected soil.

The life cycle of *P. cinnamomi* depends on moist conditions that favour the survival, sporulation and dispersal of the spores. The pathogen is not capable of photosynthesis and must extract food from living plant tissue. It does this via a mass of microscopic threadlike mycelium that forms the body of the organism that grows through host tissue. The mycelia continue to grow within the host tissue when the ambient moisture content is above 80%. The mycelia may be transported in soil and host tissue and then deposited where it may infect new hosts. During favourable (warm, moist) conditions, the mycelium, are capable of producing the millions of tiny spores that reproduce the pathogen. Two spore types are produced;

### **Zoospores**

Zoospores are 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. Zoospores 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.

### **Chlamydospore**

Chlamydospores are 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 pathogen. 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

mycelia strands that form the body of the pathogen in the soil or host tissue. The sporangia release motile zoospores in free water to infect host roots. Following infection, the pathogen invades root bark and forms lesions that may extend in to the plants stem collar. In susceptible species, the infection of roots and collar will result in the death of the host.

Mycelia of different mating types may grow together inducing the production of thick walled sexual spores called oospores. The two recognised mating types are known as either A1 or A2, and only one of these mating types (A1) is known to occur in WA. As a result, the pathogen cannot reproduce sexually in WA and relies on vegetative reproduction for survival and dispersal.

*P. cinnamomi* has a very wide host range, with at least 1000 species from taxonomically diverse families reported as hosts, almost half of which have been recorded from research in Australia. Indigenous species most affected belong to four families:

- Proteaceae
- Epacridaceae
- Papilionaceae/Fabaceae
- Myrtaceae

It has been estimated that approximately 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. It is important to note however that not all genera within a family or all species within a genus are necessarily susceptible. Some species of *Eucalyptus*, for example, are highly resistant (including Karri, Marri, Wandoo and Tuart) while others, such as Jarrah, are affected but have the ability to resist the invasion of the pathogen under certain conditions (Tissue moisture content < 80%).

The survival of any *Phytophthora* species is dependant upon the presence of a combination of the pathogen, host and suitable environmental conditions. The optimum temperature for the growth of the organism is between 15°C and 30°C while the optimum temperature for sporulation is 25°C to 30°C. Temperatures less than 0°C and greater than 35°C are unfavourable to the survival of the spores and mycelium of *P. cinnamomi*.

Infertile soils are more compatible to *P. cinnamomi* where there is a good movement of water and little biomass with few antagonistic microfloras. The soil texture allows for the easy lateral movement of the motile zoospores and the easy development of mycelium. Native vegetation that has adapted to the infertile soils through a large surface area of root matter is at greater risk of infestation.

Clay and laterite are significant components of some soil types of the southwest and may act as impeding layers and cause subsurface ponding, which can facilitate the production of spores. These soils tend to drain laterally, further spreading the zoospores. The moisture content of the soil

must be at a level that provides for aerobic environmental conditions. Saturated soils may become anaerobic and will not contain the oxygen levels required for the production of sporangia.

In some areas that are environmentally suited to the establishment, survival and reproduction of the pathogen, the spread of *Phytophthora* infections has reached epidemic proportions. These areas are generally in areas receiving more than 800mm of rainfall annually. In areas receiving between 600-800mm, the occurrence of *P. cinnamomi* is less extensive and confined to water-gaining sites in the landscape.