

HYGIENE LOGGING TRIALS  
RESULTS OF MONITORING  
BEATON

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<u>CONTENTS</u>	<u>PAGE</u>
SUMMARY	1
INTRODUCTION	3
METHODS	5
General	5
Dieback Mapping	6
Disease Hazard	7
Roding	7
Logging	8
Collection of Data	10
During Operations:	10
Post Operations:	10
RESULTS OF DIEBACK DISEASE MAPPING	11
Phytophthora cinnamomi	11
Phytophthora citricola	13
Unidentified species of Phytophthora	14
Roads	16
Areas Placed At Risk	16
DISCUSSION	16
Disease Spread	16
Infections in Fallers Blocks:	17
Infection on Roads:	17
Hygiene Roding Techniques	18
Hygiene Logging Techniques	19
New Hygiene Logging Techniques Developed	21
Modified Split Phase Landing Management:	21
Waiver of Washdown Requirement on Entry to Coupe:	22
Rubber Matting for Washdowns	23
Two Fallers Block to One Landing	23
Cost Of Hygiene	24
Roding Costs	24
Logging Costs	26
Interpretation Window	27
DEVELOPMENT OF DIEBACK TERMINOLOGY AND MAPPING	28
SUMMARY OF RECOMMENDATIONS	28
REFERENCES	31

## SUMMARY

From January 1980 to June 1982 the Forests Department of Western Australia carried out a trial to develop methods of minimising the spread of dieback disease (*Phytophthora cinnamomi*) during logging and associated roading operations in all seasons. Techniques used are collectively known as "hygiene". The trial was carried out in Beaton State Forest near Nannup in the south west of Western Australia. Monitoring has continued up until September 1990.

A comparison of disease presence before and after operations was made by air photo interpretation, strip line assessment and laboratory analysis of soil and root tissue samples.

Monitoring of disease presence in areas originally mapped as disease free has shown;

- An additional 21.86 ha (3.80%) of the trial area logged and 4350m (25.01%) of road drains in the trial were infected by *P. cinnamomi*;
- 0.13 ha (0.02%) of the trial area logged and 40 m of road drains were infected by *P. citricola*;
- 0.06 ha of the trial area logged were infected by unidentified Phytophthoras.

There is a strong correlation between operations carried out during periods of moist soil and infections by *P. cinnamomi*. Roads used to access moist soil coupes also show a high correlation with disease presence.

There appear to be several possible reasons why *Phytophthora* sp have been spread within the trial. These include; inaccurate initial mapping and demarcation of disease presence, incipient dieback and; ineffective hygiene during roading and logging operations or spread by unauthorised access.

Hygiene techniques developed during the trial included the use of rear barriers on landings to facilitate extraction and load out of logs simultaneously; the use of rubber matting for washdowns, the waiver of washdowns for trucks entering the trial area during periods of very dry soil and the use of one landing to service two fallers blocks.

Techniques for reducing the chance of disease spread in future operations include; confining operations to dry soil conditions; ensuring a high level of supervision, training and positive attitude is maintained and; ensuring engineering standards of roads, landings and other works are met to prevent the spread of Phytophthora species.

A brief study of the cost of implementing hygiene showed that the cost of both roading and logging was approximately double the cost of traditional methods and that building roads at least 12 months in advance of operations was cheaper than building roads for immediate use.

## INTRODUCTION

Several species of root rotting fungi of the genus *Phytophthora* are causing severe damage to native vegetation in the south-west of Western Australia. This disease is known locally as dieback disease. Spread of these fungi is in soil and infected root material transported on vehicles and machinery (Batini 1973). During the early 1970's the then Forests Department introduced the concept of operational hygiene for forest operations to reduce the introduction and spread of the disease into uninfected areas (Underwood and Murch 1983). In 1976 Disease Risk Areas (DRA) were introduced for control of access into large areas of State forest.

Disease Risk Areas were introduced to large areas of state forest in order to:

- i) allow time for disease symptoms to express themselves;
- ii) control the artificial spread of disease;
- iii) develop techniques for mapping the disease;
- iv) allow time for research development and logging trials to occur.

Currently 719,561 ha or 36% of the total forest area is within DRA (General Working Plan (GWP) 87 - 1982). The majority of this area is good quality forest and was thought to be predominantly disease free. The need to access timber and other resources within DRA required commitment to operating with minimal introduction and spread of disease. Therefore an evaluation of the success of hygiene techniques.

In the late 1970's a number of trials were developed within DRA to determine whether forest could be logged with conventional equipment during all seasons using hygiene techniques to minimise the introduction or spread of dieback disease. This report examines one of those trials carried out in Beaton State forest in the Nannup District of the Department of Conservation and Land Management (CALM) in south-west Western Australia.

The specific aims of the Beaton Logging Trial were:

1. To develop practical, and hygienic techniques for logging in quarantine areas in the Central Forest Region using dieback-free maps produced by interpretation of aerial photography.

2. To develop a practical operational system of dieback terminology and mapping.
3. To test hygiene techniques for logging in both dry soil and wet soil conditions.
4. To evaluate after logging whether the techniques used were practical and hygienic and what changes or additional trials were necessary.

Operations commenced in January 1982 and ceased in June 1984. Surveys for dieback disease post operations were carried out at various times up until September of 1990, some 10 years after initial disease mapping of the area.

Operational hygiene involves significant inputs at both the planning and implementation stages. The hygiene techniques tested were designed to minimise additional costs due to changes in traditional machinery and methods and were based on experience gained in previous logging trials at Amphion and Taree in the Dwellingup district.

The basic principles of hygiene (Underwood and Murch, 1983) are:

- \* Planning to incorporate hygiene as an integral part of each and every phase of an operation.
- \* Mapping disease to allow the segregation of operations which reduces the chance of cross contamination between dieback and dieback-free areas.
- \* To operate in dry soil conditions when the chances of picking up soil and the survival of the fungus is reduced.
- \* Cleaning potentially infected soil and root material from vehicles, machinery and implements when moving from one area to the next.
- \* Minimising the number of entries which may introduce disease into an area.
- \* The use of rubber tyred machinery as opposed to the use of tracked machinery to reduce the chance of soil being spread .

- \* Segregation of operations into sub-catchment units to minimise the area that may be infected if all other hygiene efforts fail.
- \* Construction of roads with hard well drained surfaces and placed low in the landscape to minimise the area below the road put at risk of infection.
- \* The use of physical barriers and time intervals to separate different stages within an operation (split phase).
- \* Effective training and control throughout all phases of an operation.

These hygiene techniques were applied to the Beaton Logging Trial. Evaluations of the success of these techniques were then made from records kept during the trial and from a comparison of disease extent before and after the trial.

## **METHODS**

### **General**

The area selected for the trial was in slightly undulating jarrah (*Eucalyptus marginata*) forest on lateritic gravel and leached grey sandy soils (Strelein 1988) approximately 10km south east of Nannup in the south west of Western Australia (fig 1).

Operational planning for the trial commenced with disease mapping in May 1980.

There were 9 logging coupes (including 5A) totalling 668 ha and 3 control areas totalling approximately 663 ha (fig 2). Control areas were not cut and were left to provide the opportunity to assess whether disease patterns are related to logging activity or to other factors. Control areas could not be re-surveyed for dieback disease due to wildfires and prescribed burning. It is expected that these areas will be available for re-mapping in about 1993.

Logging coupes and associated roading were located in areas mapped as dieback free and except for coupe 5A were entirely above dieback infected areas to reduce the risk of natural spread into the coupes from surrounding infections. Coupe boundaries were located 25m above the dieback demarcation which was located on the infection front. Coupe 5A was located below dieback and considered unprotectable from natural disease spread and as a consequence was not surveyed for disease presence

after logging however, one infection found during operations in this coupe is included in the results.

Advance burning was carried out after completion of dieback demarcation and prior to roading. Some areas to be logged received only a patchy burn and so these areas were scrub rolled prior to logging.

Roading commenced in January of 1982 under dry soil conditions and the first logging activities commenced in March of the same year. Logging activities ceased in June 1984.

### **Dieback Mapping**

Mapping dieback disease location in the Beaton Trial was carried out by interpreting large scale (1:4500) 70mm format colour positive aerial photographs (Bradshaw and Chandler 1978) to identify areas exhibiting symptoms of dieback disease. Interpretation was supported by ground truthing and laboratory testing of root tissue and/or soil samples for the presence of Phytophthora species. Areas were identified as either dieback-free, dieback infected, uninterpretable, suspect or interpreted risk. The definitions used were:

- |                                     |   |
|-------------------------------------|---|
| <u>Dieback-free:</u>                | Forest apparently free of dieback.  |
| <u>Dieback:</u>                     | Forest in which dieback symptoms evident as dead or dying susceptible vegetation are present.   |
| <u>Uninterpretable for dieback:</u> | Forest in which susceptible plants are absent or too few to enable the interpretation of disease presence or absence.   |
| <u>Suspect:</u>                     | Forest in which the evidence for disease presence or absence is inconclusive.   |
| <u>Interpreted risk:</u>            | Dieback free forest in which inoculum is potentially present due to a proven dieback occurrence higher in the topography. This definition infers that the area classified as "interpreted risk" will, in time, become infected naturally. |

The dieback free map was used to plan the implementation of the various components of the operations so as to reduce the risk of spreading soil between dieback, uninterpretable and dieback free areas.

### Disease Hazard

A measurement of the consequence of dieback infection (hazard) was not given for the trial as systems for rating hazard or impacts had not been developed at that time. Current systems using landform types rate hazard in the trial as high on ridges and slopes, low in valley bottoms and high around swamp fringes. High hazard predicts a final impact of more than 10% overstory death and most susceptible understory and shrub species killed. Low hazard predicts a final impact of only a few susceptible shrub species killed.

### Roading

Roading was recognised to have the greatest potential to introduce or spread the disease. Consequently, defining the road network and standards of construction were important features of the planning process and were reflected in the job prescriptions for the trial. Prescriptions specified that roads were to be:

- \* As low in the landscape as possible so that the area of forest below the road put at risk of infection was minimised.
- \* A minimum of 25m above dieback demarcation as there is always the possibility that *Phytophthora* is present in the soil in advance of visible symptoms. This is referred to as incipient disease.
- \* Selected and marked with survey pegs.
- \* Located within one disease category wherever possible - ideally dieback-free. (90% of roads were constructed in this category) The remaining 10% occurred where roads entered coupes from the infected Gold Gully Road or crossed infected creek lines within the coupes.)
- \* Positioned such that snig distance would average 200m with a maximum of 400m to minimise operational extraction costs.

- \* Constructed, gravelled and graded in dry soil conditions only.
- \* Prescriptions specified that roads were to be gravelled with dieback free gravel from within the same micro-catchment.
- \* Maintenance to fill small pot holes could occur at all times of the year.

More stringent specifications were defined for all weather roads than roads to be used in dry soil conditions.

#### Dry Soil:

- Shallow road drains.
- Culverts at defined drainage lines only.
- Gravel only required where risk of disease transport occurs (wet areas).

#### All Weather Access:

- Deep table drains.
- Well drained - culverts every 200m or where required.
- Prominently crowned profile.
- 10-15 cm depth of gravel on the running surface.
- Water binding to use water treated with fungicide.
- Running surface to be compacted by vibrating roller at time of construction.

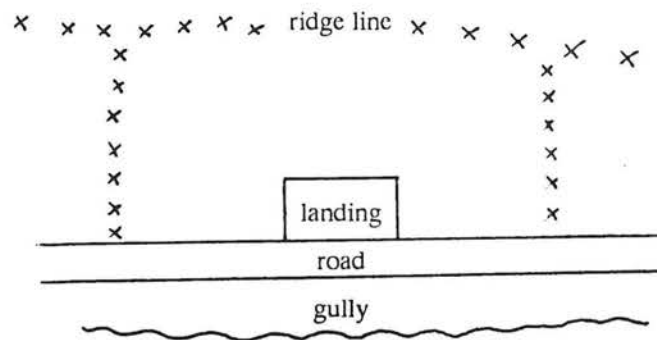
All other roads within and accessing the trial area were closed off.

### Logging

Hygiene that was applied to the logging phase of the trial is summarised below.

- Demarcation in the field of all disease category boundaries.
- Demarcation in the field of mini-catchments.
- Demarcation in the field of fallers block boundaries.

A fallers block is the smallest unit of management within a coupe. A coupe is a cutting unit which normally contains many fallers blocks. The fallers block is normally serviced by one landing but in this trial the servicing of two fallers blocks by the one landing was tested. Fallers block boundaries are, wherever possible, formed by ridge lines to the rear and a haul road on the lowest side of the fallers block (fig 4).



**Figure 3.** Diagram of fallers block layout.

- Dry and moist soil coupes allocated (see Results tables 1, 2 and 3).
- Logging and hauling commenced from the rear of each coupe.
- Landings were located low in the profile.
- A 6m uncleared strip was left between the landing and the road until the fallers block was certified as complete and blocked off from the landing.
- Split phasing of landings and fallers blocks. Split phasing usually involves extraction of all logs to the landing and blocking off snig tracks to the landing prior to loading logs onto trucks for haulage. Split phasing of the fallers block from the landing using a rear barrier across snig tracks to the landing was tried later in the trial.
- Logging machinery was cleaned down before moving from one fallers block to the next.
- Run-off water from snig tracks was directed away from the landing.
- Trucks and vehicles were washed down on entry to the coupe. As the trial progressed the requirement for trucks to clean down on entry during dry soil conditions was waived.
- Snig patterns were planned to minimise machine activity in fallers blocks.
- Rubber tyred machinery was used.

- Large volume log trucks were used- resulting in less entries to the road network.
- A 40m uncut buffer was left on ridges between fallers blocks where drainage was indistinct.

### Collection of Data

#### **During Operations:**

A diary of events was kept between 18/1/82 and 3/2/84 during the operational phase of the trial.

Dieback symptoms found by operations personnel in areas previously mapped as dieback-free were sampled. Where these resulted in positive recoveries of Phytophthora species the location was recorded and appropriate hygiene applied for that location. Two sites were found in this way. Details are incorporated into the results.

Sequential sampling of roads and landings was carried out at fixed sample points over the life of the trial.

#### **Post Operations:**

A method of strip line assessment known as Ground Reconnaissance Intensive Monitoring (GRIM) was used to survey coupes for disease. GRIM involves a team of trained observers walking parallel survey lines 10 or 20m apart depending upon visibility. The central observer follows a predetermined compass bearing. This method is designed to give 100% coverage of the area by observers. When an observer saw a dead plant the team stopped and a root tissue and soil sample was taken, visual assessment of the area for disease presence and biophysical characteristics was made and the location plotted. Samples were sent to the laboratory for analysis. If the sample proved positive the location of the infection was marked on a map. GRIM surveys were carried out at least 3 years after operations ceased to allow for disease expression.

GRIM surveys in this trial were carried out as follows;

- Coupes 6 and 7 - April 1986,
- Coupes 2,3 and 4 - October 1986,

- Coupe 1 (part) - September 1989,
- Coupe 1 (part) - September 1990,

Coupe 5 was not surveyed by GRIM due to silvicultural treatment with herbicides which masked true disease symptoms.

Boundaries of most infections found by monitoring were re-checked in December 1991. The map (figure 4) reflects boundaries at that time.

## RESULTS OF DIEBACK DISEASE MAPPING

The following results are estimates of areas and distances derived from:

- field estimates;
- dot grid measurement of areas shown on maps produced by GRIM surveys;
- allocation of 0.01 ha (10m x 10m) to spot infections as a minimum size based on field observations of a number of spot infections;
- sampling of landings and snig tracks;
- results from sampling of road drains.

Although GRIM survey lines were placed to allow as close as possible to 100% coverage of the area, dense vegetation, primarily *Bossiaea aquifolium*, reduced the ability of GRIM teams to confidently observe all parts of their allocated survey line. This was further compounded by the need of observers to concentrate on safe movement through the dense vegetation and frequent logging debris. In periods of wet weather, high humidity or high temperatures concentration of observers also lapsed. Confidence of earlier surveys may be higher because the vegetation was younger and easier to move through though it was noted that similar problems were encountered from time to time.

### Phytophthora cinnamomi

The estimated increase in area of *P. cinnamomi* infection found since the original dieback free maps were produced in 1980 is 21.86ha or 3.80% of the total area surveyed. This consisted of 18.25ha contiguous with existing infections and 3.61ha which were not contiguous with existing infections. Additionally 4350m of roadsides are now infected (considers both sides of road as the same infection). Data is presented in Table 1 and Figure 4.

**Table 1:** Areas and distances of *Phytophthora cinnamomi* infections within individual coupes of the Beaton Logging Trial after logging.

COUPE	AREA (HA)	SEASON LOGGED and soil conditions	ADDITIONAL P.c IN COUPE (HA)	NO. OF SITES	ROAD DRAINS INFECTED(M)
1	143	Summer (dry)	0	0	0
2	63	Autumn (moist/cool)	0.25	1	500
3	102	Winter (wet)	13.50	1	0
4	93	Spring (moist/warm)	2.60	1	50
5	85	Summer (dry)	Not surveyed	-	-
5a	9	Summer (dry)	0.25	1	0
6	45	Autumn (moist/cool)	2.50	2	1700
7	85	Winter (wet)	2.75	5	2100
8	43	Spring (moist/warm)	0.01	1	0
TOTALS	668 574	logged surveyed	21.86 ha	12	4350m

Coupe 3 logged in winter of 1982 contained the largest area of *P. cinnamomi* infection found by monitoring surveys. The area infected was 13.50 ha which represented 13.24% of that coupe. Coupes 7 and 6 logged in winter and autumn respectively showed the next highest incidence of *P. cinnamomi* infection post monitoring. These were 2.75 ha in coupe 7 and 2.25 ha in coupe 6. This represented 3.24% and 5.56% of the area of respective coupes (Figure 5 - page 15).

The next highest incidence of *P. cinnamomi* infection was in coupe 4 logged in spring with 2.60 ha of infection or 2.80% of the area of the coupe. The southern most infection in coupe 4 (near the wording "ROAD I" in Figure 4) is thought to have been present prior to operations, as re-examination of 1980 aerial photographs subsequent to the GRIM survey shows evidence of two banksia and one shrub species deaths in the centre of the infection site.

Remaining coupes were found to have only low amounts of *P. cinnamomi* infections. These coupes were autumn spring and summer coupes. These results indicate a trend towards a higher incidence of *P.cinnamomi* introduction and spread in coupes logged in wet soil conditions.

### Phytophthora citricola

The estimated area of *P. citricola* infection found during monitoring is 0.13 ha from 13 sites. (Table 2 and Figure 3).

**Table 2:** Areas and distances of *Phytophthora citricola* infections within individual coupes of the Beaton Logging Trial after logging.

COUPE	AREA (HA)	SEASON LOGGED and soil conditions	ADDITIONAL P.cit IN COUPE (HA)	NO. OF SITES	ROAD DRAINS INFECTED(M)
1	143	Summer (dry)	0.05	5	30
2	63	Autumn (moist/cool)	0.01	1	0
3	102	Winter (wet)	0.02	2	0
4	93	Spring (moist/warm)	0	0	0
5	85	Summer (dry)	Not surveyed	-	10
5a	9	Summer (dry)	0	0	0
6	45	Autumn (moist/cool)	0.01	1	0
7	85	Winter (wet)	0.04	4	0
8	43	Spring (moist/warm)	0	0	0
TOTALS	668 574	Logged Surveyed	0.13ha	13	40

### Unidentified species of Phytophthora

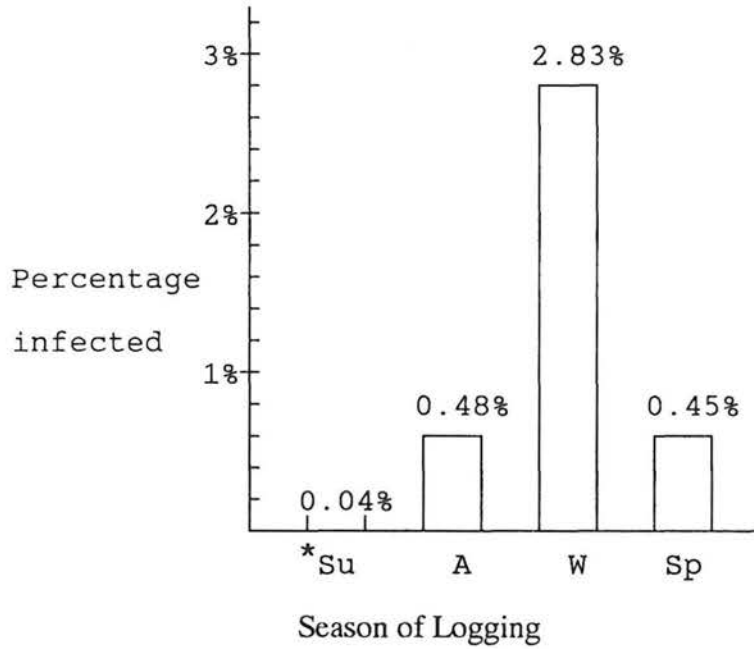
The estimated area of unidentified species of Phytophthora is 0.06 ha from 6 sites (Table 3 and Figure 4).

**Table 3:** Areas and distances infected by unidentified species of Phytophthora in individual coupes of the Beaton logging trial after logging.

COUPE	AREA (HA)	SEASON LOGGED and soil conditions	ADDITIONAL P.? IN COUPE (HA)	NO. OF SITES	ROAD SURFACE INFECTED(M)
1	143	Summer (dry)	0	0	0
2	63	Autumn (moist/cool)	0	0	0
3	102	Winter (wet)	0.03	3	0
4	93	Spring (moist/warm)	0	0	0
5	85	Summer (dry)	Not surveyed	-	-
5a	9	Summer (dry)	0	0	0
6	45	Autumn (moist/cool)	0.02	2	0
7	85	Winter (wet)	0.01	1	0
8	43	Spring (moist/warm)	0	0	0
TOTALS	668 574	Logged Surveyed	0.06ha	6	0

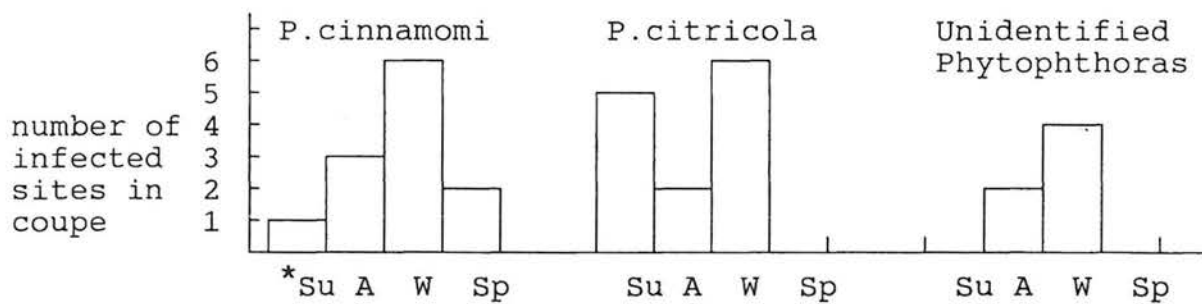
Infections of *P. citricola* and unidentified Phytophthoras are small and do not show an obvious trend in terms of season of logging (Figure 6 - page15).

**Figure 5.** Percentage of total trial area infected by *Phytophthora cinnamomi* versus season of logging.



\*Su = summer, A = autumn, W = winter, Sp = spring

**Figure 6.** Number of infected sites versus season of logging



## Roads

25% of the roads used within the trial were constructed and used exclusively for summer operations (road A). On these roads two recoveries of *P. citricola* were made from;

- i) a fixed sampling point in the road drain,
- ii) an infection discovered during GRIM surveys.

these infections represent 0.64% of the summer roading network.

Of all roads within the trial used in wet conditions;

- 25.01% of road drains were found to be infected with *P. cinnamomi*,
- 0.11% of road drains were found to be infected with *P. citricola*,
- 0.22% of road drains were found to be infected with unidentified Phytophthora species.

## Areas Placed At Risk

The area within the trial placed at risk from natural spread of *P. cinnamomi* is estimated at 13.5 ha. The area within the trial placed at risk from natural spread of *P. citricola* is estimated at 2.9 ha. These figures represent the area downslope from infections to the roads forming the boundary of each coupe that would most likely be infected by downhill spread of inoculum.

## DISCUSSION

### Disease Spread

The presence of dieback disease in addition to that shown on dieback-free maps produced in 1980 indicates that either:

- i) Some infections were present prior to 1980 but missed by the original mapping.  
and/or
- ii) Incipient disease was present at the time of mapping, and/or
- iii) The logging and associated operations have introduced and/or spread the disease and/or;

iv) Unauthorised, uncontrolled access has introduced the disease.

Monitoring is not able to determine conclusively which may have been the case for individual infections. Re-examination of the original photography may help to resolve whether disease was present prior 1980 in some cases in i) above. This is scheduled to occur in the near future.

### **Infections in Fallers Blocks:**

Most Infections within fallers blocks are associated with landings and/or snig tracks. This strongly suggests that logging or subsequent activities have spread dieback.

### **RECOMMENDATION 1**

**All machinery entering fallers blocks must continue to be inspected and cleaned down if necessary, a ramp to isolate machine from table drains should be used.**

Of interest is the presence of *P. citricola* and the unidentified Phytophthora species mostly at sites of disturbance ie; road, landing, snig tracks. These Phytophthoras require more study to determine their biology and impacts on Western Australian vegetation.

### **RECOMMENDATION 2**

**The findings of research into the biology and impacts Phytophthoras other than *P. cinnamomi* should be used to improve dieback disease interpretation and subsequent application of hygiene.**

### **Infection on Roads:**

In coupe 7 which was logged in winter 60% of road drains were infected with *P. cinnamomi* yet in coupe 3 also logged in winter *P. cinnamomi* was not recovered from any road drains. Both coupes had fixed sample points in the road drains and were sampled at about the same intensity.

In coupe 6 logged in autumn *P. cinnamomi* infections in road drains accounted for 68% of road E which serviced that coupe. Figure 4 shows the majority of *P. cinnamomi* infections to be extensions of existing dieback infections and shows indications of linear spread along roadways. The disease is starting to spread up and out of table drains on the uphill (coupe) side of these roads.

Roading, including construction, maintenance and use, appears to be the greatest single factor in the spread of dieback disease. In this trial dieback found along roads after operations may be as a result of any or all of the following:

- i) inaccurate original dieback free maps and demarcation,
- ii) road construction activities, including gravelling and maintenance
- iii) reluctance of roading crews to cease work due to rain during dry soil activities, (D. Meehan, pers comm)
- iv) ineffective cleandown of vehicles on entry to the road network,
- v) Unauthorised use of the road,
- vi) Subsequent maintenance of the road,

### **Hygiene Roding Techniques**

Observations of good hygiene or benefits of hygiene techniques include:

- Vibrating roller with water binding produced a good road surface but at a higher than normal cost.
- Construction of a suspect creek crossing was made last and separately from remainder of road construction.
- The roads constructed in the trial area endured very well and required little maintenance overall. Notably the roads which were not used for 12 months after construction performed best.
- Roads with a good crown stood up to hauling much better than roads with a flat surface.

Additional observations made about the roads include:

- Specifications were not always met, eg: Gravel was spread too thin on at least one occasion resulting in the collapse of a set of culverts. The problem was compounded by insufficient depth in the drains feeding the pipes. *P. cinnamomi* was recovered from the collapsed culvert.

Improvements to road construction standards suggested during the trial included:

- Increased crowning of road surfaces to improve water shedding ability of the road.
- Increasing the number of culverts to improve drainage.
- Clear, written guidelines detailing when work should stop in the event of rain during dry soil and when work can recommence
- Construction of haul roads a minimum of 12 months ahead of logging operations to allow them to consolidate. This would improve the length of time the road was useable, improve hygiene and reduce maintenance.
- Stringent field supervision to ensure that road construction is carried out to specification.

### **RECOMMENDATION 3**

**That the most accurate methods of determining dieback disease location and producing dieback free or hygiene plans continue to be used and applied to all areas where operations involving soil movement are to take place where Dieback is a threat.**

### **RECOMMENDATION 4**

**That the alignment of roads and/or access tracks continue to be directed to the lowest point possible in the profile below dieback free and uninterpretable areas.**

### **RECOMMENDATION 5**

**That logging roads be constructed at least 12 months in advance of hauling operations to allow consolidation.**

**That the use of rollers for compaction of new and graded road surfaces becomes a standard practice for logging roads.**

**That engineering standards are maintained at a level such that log haul roads do not break up during wet weather and that budgets for roading reflect those standards.**

### **Hygiene Logging Techniques**

Hygiene logging techniques implemented in the Beaton Trial were the most stringent that could be devised at the time.

It was noted from the diary kept of day to day activities in the trial that occasional breaches of hygiene occurred. Most of those noted were related to access by vehicles or machinery into the coupe or fallers blocks without washing down. It was not recorded what weather conditions existed at the time of these breaches. It appears that the majority of these breaches took place in summer or autumn.

The exact consequences in terms of introduction or spread of disease will never be known because details such as location, soil conditions at the time and whether soil was introduced or spread were not measured for each incident. Follow up inspections of the places where these breaches took place was not carried out except by GRIM survey. GRIM survey results did not show a clear correlation of infection with the recorded hygiene breaches.

Comments made in reports referring to these incidents indicated that supervision and training of people involved in the trial has to be at a high level and reinforced periodically.

#### **RECOMMENDATION 6**

**Personnel involved in hygienic operations should be managed to ensure effective hygiene is achieved at all times. This will require a balanced approach to the provision of information, training and motivation of practitioners and supervisors alike.**

Coupes 5,6,7 and 8 were logged for marri chipwood in addition to logging specifically for jarrah sawlogs. All other coupes were logged for sawlogs only. The number of passes over each fallers block by logging machines was doubled where chipwood removal took place.

Theoretically, split phase logging, even with removal of chipwood would not result in multiple entries of machinery into fallers blocks. Whether multiple entries occurred into fallers blocks or landings by machinery during sawlog only or sawlog and chipwood removal has not been documented. There appears to be no strong correlation between to disease presence and chipwood removal but there is a correlation between sawlog and chipwood removal and logging during wet soil conditions.

### New Hygiene Logging Techniques Developed

Four significant new or modified hygiene techniques were developed during the implementation of the trial. They are:

- \* Modified split phase landing management;
- \* Reduction of requirement for washdown on entry to coupe;
- \* Use of rubber matting for washdowns;
- \* Use of one landing to service two fallers blocks.

#### **Modified Split Phase Landing Management:**

This technique (now referred to as the rear barrier technique) involves snigging logs to a physical barrier (usually a non-commercial but substantial sized log) at the entry point to the landing from the fallers block.

Log products are then pushed over the barrier from the fallers block by the machinery used for snigging. Snigging machinery does not cross the barrier. On the landing the loader sorts the logs and may load trucks simultaneously while the fallers block is being pulled. The loader can move between rear barrier landings via the road network without cleaning down.

The differences of this method compared to classic split phase are:

- \* The loading and hauling of log products is concurrent with snigging;
- \* No access to fallers block by loader thus minimising the chance of contamination of the fallers block from the landing;
- \* Smaller landings;
- \* An area of disturbance on the fallers block side of the landing where log products are pushed by skidders;
- \* Numerous landings can be loaded out simultaneously;
- \* There is a requirement for two machines, one to snig the other to load trucks.

The rear barrier logging technique resulted in greater productivity during the Beaton Logging Trial in that the loader was free to move between landings without cleandown to facilitate loading log products collected from more than one landing.

The barrier log being used has to be long enough to accommodate the longest logs from the fallers block and be of sufficient size not to move when logs are pushed over it. Because the landing is open to the road network it has a higher probability of infection. If the barrier moves forward there is the likelihood of cross contamination of inoculum from the landing to the coupe. The barrier log should be a non-commercial product and bedded in with a soil ramp on the fallers block side to allow the skidder to push logs over it. Where this can be achieved this system should work without jeopardising the hygiene status of the fallers block.

Areas used by the skidder for pushing logs over the barrier have been observed to become quite large (2 machine lengths) and dished out forming a water gaining depression during wet conditions. This results in an area of compacted soil more favourable to the survival and intensification of the fungus. It was hoped that the actual landing size would decrease as a result of using the rear barrier method but observations indicate the saving is not that great when the area of disturbance caused by pushing logs onto the landing is taken into account.

It should be noted that both techniques (split phase and rear barrier landing) leave the landing open to infection from the road network.

#### **RECOMMENDATION 7**

**That all landings should be managed to isolate the landing from the road both during and after logging activities and that hygiene barriers be left in place until all post logging activities such as rehabilitation, silviculture and burning are completed.**

#### **Waiver of Washdown Requirement on Entry to Coupe:**

After consultation with experts and because *Phytophthora* is transported in soil, roots or water, it was decided that it would not be necessary to washdown vehicles during very dry conditions in summer unless they had wet mud on them. Log trucks travelling between the trial area and either Nannup Mill or Manjimup Chip-mill were only required to washdown once per day if the roads they travelled were completely dry, the mill landings were also dry and free from mud and trucks were not servicing other coupes. All other vehicles were washed down on entry to the coupe.

If washdowns in dry soil conditions are not required for log trucks then the washing down of vehicles other than trucks was also not necessary provided that vehicles were not carrying soil or mud. This implies a requirement to inspect vehicles (including trucks) upon each entry. It is not recorded how often inspections occurred during the trial. The presence of *P. citricola* infection on dry soil roads, although at low levels emphasises the need for vigilance.

#### **RECOMMENDATION 8**

**On dieback free road networks inspection of vehicles should be mandatory upon entry in dry soil operations with cleandown if required. During wet conditions washdown of vehicles should be mandatory upon to entry.**

#### **Rubber Matting for Washdowns**

Rubber matting was placed under the wheels of machinery moving into fallers blocks from roads to prevent the machinery from contacting the soil and to allow effluent from the machine to be washed away from the tyres. This was successful and resulted in a greater level of confidence in the success of washdowns particularly as it is known that road drains can become extensively infected.

#### **RECOMMENDATION 9**

**That a portable washdown pad be used at the washdown site for entry of machines into the fallers block from roads.**

#### **Two Fallers Block to One Landing**

It was decided during the trial that provided they were within the same mini-catchment, two adjacent fallers blocks could be pulled to the same landing. Snigging machinery was not required to washdown between these fallers blocks but was required to washdown prior to entering the next "set" of two blocks. There does not appear to be any records of areas in which this technique was used.

Effectively this means that if an infection is present in one side of a mini-catchment (ie; the sub-catchment) then the whole of the mini-catchment is at risk due to contamination from the fallers block in which the disease occurs.

## RECOMMENDATION 10

**That each fallers block should be a discrete minicatchment and serviced by it's own landing.**

### Cost Of Hygiene

Limited reports on costs of hygiene relate to winter logging for sawlogs in 1982. These show an increase in costs for both roading and logging phases of the operation when compared against costs for standard roading and logging methods not involving hygiene. Standard roading and logging with no hygiene cost \$9.69m<sup>3</sup>. It is not clear whether this was for sawlog only or included chipwood as well. Hygiene roading and logging cost an additional \$10.15m<sup>3</sup> which represents an increase of 102%. (It was estimated that costs would have been \$2.67m<sup>3</sup> less if chiplogs had been removed as part of the same operation.) The total cost of hygiene (\$10.15m<sup>3</sup>) consisted of \$4.59 (45%) for roading and \$5.56 (55%) for logging (fall, extract and load) (A. Price pers comm).

### Roading Costs

Roading costs ranged from \$760/km to \$5980/km for summer and winter roads respectively . Average roading costs for the trial were slightly more than \$4000/km with summer roading being approximately 25% of the total roads constructed.

Roading which does not consider hygiene incurs a lower cost because;

- Wherever possible roads are located on existing tracks and roads which reduces construction costs.
- New roads are generally located higher in the landscape profile such that soil types allow for better flotation and therefore less engineering effort for the required road.
- Drainage of road surfaces is given much less consideration and importance.
- Roads are not compacted with vibrating rollers.

- Roads are constructed at a time of year when sufficient soil moisture is available for binding of the road surface. In dry soil operations water tankers are used to supply the required moisture.
- Gravel, when required, is located as close as possible to the job.
- Roads continue to be used in a state of deterioration with the minimum maintenance.

Reasons given for higher than anticipated roading costs during the trial were:

- location of roads lower in the profile which resulted in additional expenditure to engineer the road in soils where flotation is reduced and where side cutting is generally increased and there is a greater volume of run-off above the road ;
- roads were built to tolerate heavy rain which required a properly constructed road with respect to drains, culverts, elevation, camber and surfacing.
- to handle heavily laden trucks under winter conditions at between 40 and 60 kmph.
- meeting the specifications required the use of vibrating rollers and water trucks for water binding of the road building material.

Where autumn, winter and spring roads were left for about 12 months prior to use their costs dropped by approximately \$1000 - \$1200/km. This was attributed to the omission of compaction and water binding of those roads using vibrating rollers and water trucks as a distinct part of the roading operation. Allowing 12 months for roads to "settle in" and then achieving compaction from normal haulage during logging operations was considered to be a satisfactory alternative to the use of vibrating rollers and waterbinding. The opportunity cost of building roads 12 months in advance was not factored into cost comparisons.

Whether the additional cost of hygiene roading has achieve hygiene objectives is debateable. In the Beaton Trial at least 25 % of road drains have been found to be infected since the operation with the majority of these infections in drains of roads used during wet weather.

Roads constructed with a well drained, quick drying hard surface such as those in the trial are less likely to favour the survival of inoculum if dropped onto the road surface and soil from the road surface is less likely to be picked up and spread by vehicles. Money spent on achieving this quality of road in the wetter times of the year may be justified.

### RECOMMENDATION 11

**That research be instituted that will allow expenditure to be balanced against the probability of hygiene success for roading logging coupes hygienically. This would require additional information on dieback survival on roads and in drains.**

### Logging Costs

Additional costs generated by hygiene for activities other than roading are provided below.

	<u>Price/m<sup>3</sup></u>
- Additional loader for split phase methods	\$3.00
- Washdown equipment	\$0.69
- Supervisors vehicle	\$0.11
- Supervisors vehicle running costs and washdown	\$0.18
- Supervisors wages	\$0.43
- Lost production of log truck at washdowns	\$0.86
- Lost production sundry and bush vehicles washdown	\$0.29
<b>Total</b>	<b>\$5.56</b>

These costs result from the hygiene conditions included in the prescriptions for logging. Additional costs for supervision of hygiene by Forests Department personnel was not recorded nor was the additional cost of training, committees and other meetings held in relation to the trial.

Costs of hygienic operations involve a significant increase on conventional operations and that this needs to be considered in planning operations and in setting the price of forest products.

### **RECOMMENDATION 12**

**That the cost per m<sup>3</sup> for the implementation of various hygiene practices be identified.**

### **Interpretation Window**

The area in coupe 3 was revisited approximately 4 years after it was burnt in a wildfire. The reduced density of shrub species and the presence of many more reliable indicator species in the burnt area compared to unburnt areas within the trial make this area a relatively easy area to field survey for dieback disease.

As time passes the area will become less interpretable due to the vegetation becoming denser with a reduction in shrub layer indicator species. The comparison of burnt and unburnt areas would indicate that for a period of between 2 and 5 years there exists a "window of field interpretability" following a fire in which easy, reliable surveys for dieback disease presence would best be carried out.

This has implications for the length of time necessary after fire to obtain the results of monitoring. The requirement for tops disposal and or silvicultural burning should be programmed to allow the most effective application of sound forest management principles together with monitoring programs.

Recent (April 1991) 1:4500 aerial photography of the trial was examined for infections found during monitoring. Photography of coupe 3 shows some of the larger shrub deaths in the infection burnt by wildfire. Photography of other coupes not burnt do not show shrub deaths because these symptoms are masked by the presence of tall *B. aquifolium*. Evidence of the understory species *Banksia grandis* dying at an infected site occurs once in coupe 6. Dieback interpretation of the trial from either 230mm photography or GRIM survey would currently be extremely difficult due to the presence of tall dense *Bossiaea* over the majority of the trial.

### RECOMMENDATION 13

**Monitoring requirements should be factored into operational planning of hygiene operations**

## **DEVELOPMENT OF DIEBACK TERMINOLOGY AND MAPPING**

Development of dieback terminology and mapping procedures tends to occur in an ad hoc fashion over time. No specific development of terminology or mapping were documented for the Beaton Hygiene Logging Trial. The use of different or improved terminology and if improved mapping standards as a result of this trial would most certainly have been implemented in subsequent operations as appropriate.

## **SUMMARY OF RECOMMENDATIONS**

### RECOMMENDATION 1

All machinery entering fallers blocks must be inspected and cleaned down if necessary - ramp to isolate machine from table drains should be used.

### RECOMMENDATION 2

The findings of research into the biology and impacts *Phytophthoras* other than *P. cinnamomi* should be used to improve dieback disease interpretation and subsequent application of hygiene.

### RECOMMENDATION 3

That the most accurate methods of determining dieback disease location and producing dieback free or hygiene plans continue to be used and applied to all areas where operations involving soil movement are to take place where dieback is a threat.

### RECOMMENDATION 4

That the alignment of roads and/or access tracks continues to be directed to the lowest point possible in the profile below dieback free and uninterpretable areas.

### RECOMMENDATION 5

That logging roads be constructed at least 12 months in advance of hauling operations to allow consolidation.

That the use of rollers for compaction of new and graded road surfaces becomes a standard practice for logging roads.

That engineering standards are maintained at a level such that log haul roads do not break up during wet weather and that budgets for roading reflect those standards.

#### RECOMMENDATION 6

Personnel involved in hygienic operations should be managed to ensure effective hygiene is achieved at all times. This will require a balanced approach to the training, motivation, policing and provision of information to practitioners and supervisors alike.

#### RECOMMENDATION 7

That all landings should be managed to isolate the landing from the road both during and after logging activities and that hygiene barriers be left in place until all post logging activities such as rehabilitation, silviculture and burning are completed.

#### RECOMMENDATION 8

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RECOMMENDATION 12

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RECOMMENDATION 13

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**REFERENCES**

Batini, F.E. (1973), Bulletin 84, Jarrah Dieback - A Disease Of The Jarrah Forest Of Western Australia. Forests Department. Perth, Western Australia.









Bradshaw, F.J. and Chandler, R.S. (1978), Full coverage at large scale. Symposium on remote sensing for vegetation damage assessment. Seattle, Washington, United States of America.

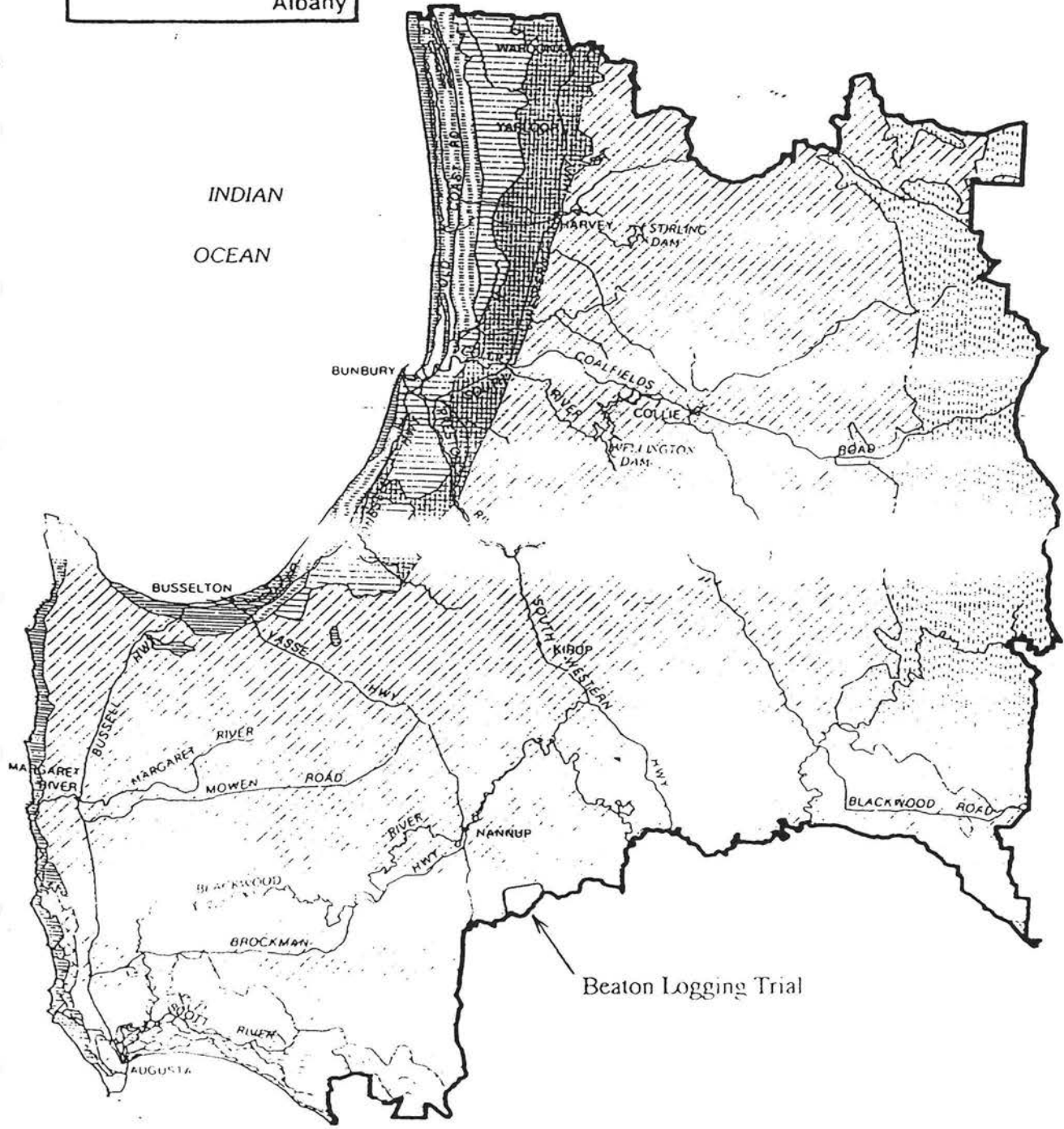
Forests Department of Western Australia (1982), General Working Plan for State Forests in Western Australia - Working Plan No 87. Conservator of Forests, public document.

Underwood, R.J. and Murch, J.H. Forests Department Western Australia, (1983), Hygiene logging in the Northern Jarrah Forest. Reprinted from Australian Forestry, Vol 47 No 1 pp 39-44.

**Figure 1. LOCATION OF THE BEATON LOGGING TRIAL**

**CENTRAL FOREST REGION VEGETATION**

-  JARRAH-MARRI FOREST
  -  TUART WOODLAND/FOREST
  -  MARRIWANDOO/JARRAH WOODLAND
  -  SWAMP WITH SOME SAND RIDGES
  -  BANKSIA/OTHER LOW WOODLAND
  -  KARRI/MARRI/JARRAH FOREST
  -  MARRI WOODLAND
  -  HEATH/SCRUB/DRIFTSAND/ROCK
- Based on Beard (1981)



SCALE  
0 10 20 30 40 50 km

Figure 2

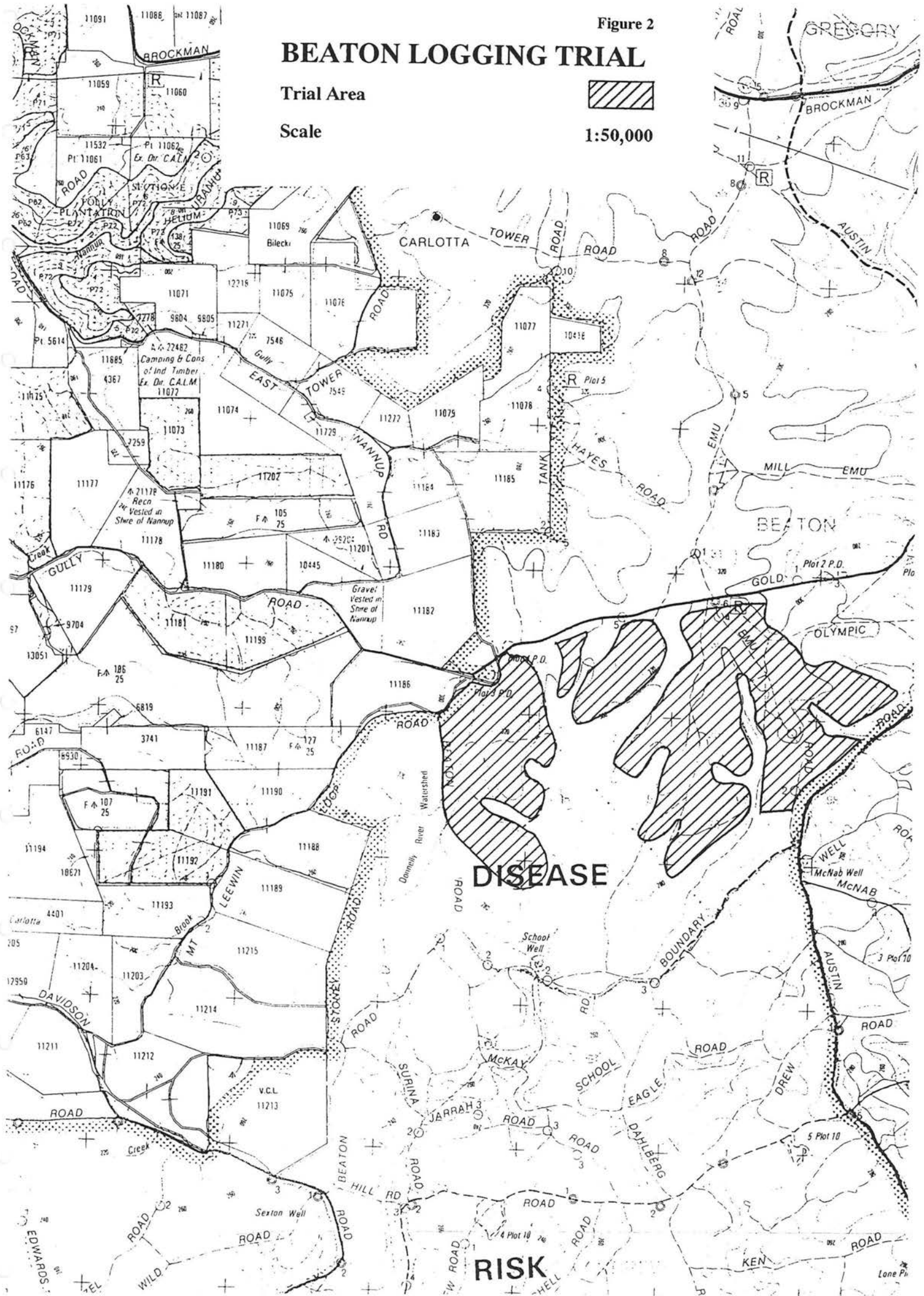
# BEATON LOGGING TRIAL

Trial Area




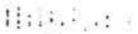



Scale




1:50,000



LEGEND

- Coupe Boundary 
- Dieback Infected 
- Interpreted Risk 
- Uninterpretable For Dieback 
- Wash Down Ramp 

POST MONITORING DISEASE LOCATION

- Phytophthora cinnamomi 
- Phytophthora citricola  ← P. cit.
- Unidentified Phytophthora species  ← P. ?

NOTE Contours are form lines only  
Revised from 7/5/82 photos

500 400 300 200 100 0 500 1000metres

