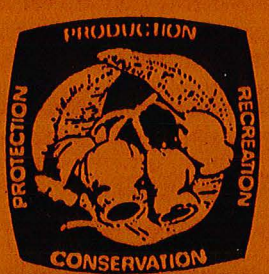
HYGIENE LOGGING TRIALS
PRELIMINARY RESULTS



FORESTS DEPARTMENT

WESTERN AUSTRALIA MAY 1984

INDEX

Protection Branch
Forests Department
WESTERN AUSTRALIA

HYGIENE LOGGING TRIALS

PRELIMINARY RESULTS

SUMMARY

Five hygiene logging trials, established between 1980 and 1982, were evaluated in spring 1983. Monitoring involved the systematic sampling of roads, snig tracks and landings. Seven coupes were intensively monitored using a ground survey technique. Parts of the Taree trial were monitored from 70 mm photography. All recently dead indicator plants were sampled.

Phytophthora cinnamomi was recovered from some roads used for logging in the Amphion, Taree, Beaton and Inglehope trials. Some positive recoveries were obtained prior to logging and road upgrading. These results emphasise the importance of keeping roads low in the profile. Sampling yielded one positive recovery from a snig track, but *P. cinnamomi* was not recovered from any landings.

P. cinnamomi was also recovered from four sites logged under moist soil conditions, within the Taree trial. If *P. cinnamomi* were to become active and to spread from these sites, 23 hectares of dieback-free forest is downslope, and will be placed at risk. This represents less than 3 per cent of the logged-over forest which was intensively monitored by ground survey. *P. cinnamomi* was also recovered from one site logged under dry soil conditions, within the Beaton trial.

Further monitoring of these trials is warranted to assess the reliability of the results obtained to date.

Frank Batini
Inspector
Environmental Protection

INTRODUCTION

Jarrah dieback is a disease caused by a microscopic root-rotting fungus *Phytophthora cinnamomi*. This fungus is widespread in south-western Australia, causing death of jarrah *(Eucalyptus marginata)* and many of the associated species in the forest understorey (1).

The disease was first reported in 1921 as small, discrete patches of dead jarrah near Karragullen. Further small pockets of dead and dying jarrah were observed in 1928, some 80 km further south (2). Research on dieback commenced in 1948. A further programme started in 1959 finally isolated *Phytophthora cinnamomi*. By November 1965 the fungus was shown to be consistently associated with diseased areas of forest.

Prior to 1965 the disease was unwittingly spread through the forest in roading, gravelling, logging, mining exploration and other activities. Post 1965, following a period of "doom and gloom" when the imminent collapse of all the forest was forecast, the first attempts at hygiene were made in field operations. Additional research was commenced during the late 1960s.

The fungus is readily spread by man transporting soil and root material from infected into healthy forest (3). It may also be spread by spores carried in water, or by direct growth along roots or in soil. In order to minimise artifical spread of the disease, several hygiene procedures and techniques have been developed and are applied to operations in the forest (4).

The extent and location of diseased areas are diagnosed primarily on the visible symptoms in the susceptible indicator plants, e.g. *Banksia grandis*) (5). The Forests Department's mapping programme is based on these visible symptoms. Because indicator plants die some time after infection, it was necessary to quarantine areas of forest to prevent further introduction of the disease and allow visible symptoms of all current infections to develop (6). It is then possible to map the diseased areas and their perimeters accurately, and subsequently, by using appropriate hygiene measures, limit the artificial spread of diseased soil and plant tissue. A quarantine period of three years was nominated as a safe interval on which to base future planning.

Following Cabinet approval, detailed proposals were prepared, and the Forests Act Amendment Act (No. 77 of 1974) was passed and proclaimed (7). A total of 719,561 ha is currently in "quarantine" and subject to the Forest Diseases Regulations. Within the Disease Risk Area (DRA), unrestricted vehicular access is limited to the main public highways and entry to private property. Vehicle access, under permit and along specified routes, is available for essential services under stringent hygiene conditions.

Following a suitable period to allow symptoms to develop, areas of forest were photographed and mapped. The development of full coverage, large scale (1:4500), colour, 70 mm format aerial photography allows for the detection and interpretation of most of the indicator plants that die within the forest. This system represents a major advance over the 1:40,000 scale, black and white photographs which were used in earlier mapping (2), (8).

In 1978 a team of interpreters began a programme aimed at detection and mapping of jarrah dieback in Disease Risk Areas. To date, 282,350 ha have been photographed and 185,400 ha interpreted and mapped using this system, at an average cost of $8.45/ha. The highly skilled dieback mapping group has been able to establish a logical procedure for the interpretation of disease symptoms, which includes field sampling and laboratory processing of soil and plant tissue (9), (10). Dieback-Free and Hygiene Plans are now available for several areas.

Concurrently, a number of logging trials were established to determine whether forest could be logged with conventional equipment during all seasons, maximising hygiene techniques, and without major introduction or spread of dieback. Trials were located at Dwellingup (Amphion, Taree, Inglehope), Nannup (Beaton) and Manjimup (Warrup). The earliest trials were located in Amphion/Taree and commenced in winter 1980. Dieback-Free Plans for these areas are available, the most up-to-date hygiene techniques were used, and Departmental staff and industry personnel were intensively trained and supervised during these operations (11).

DIEBACK POLICY REVIEW

The various stages described in the Introduction were designed to test whether resource utilisation within the Disease Risk Areas could be permitted, subject to dieback mapping and adequate hygiene. Cabinet approval in 1974 was given "on the understanding that the quarantine period is for a limit of 3 years, with periodic reviews to shorten this period, where practicable."

However, the Forests Act Amendment Act (No. 77) did not specify a minimum or maximum time limit for the Disease Risk Areas.

By 1982, the Research programme enabled a better understanding of the disease (12). A Task Force began a review of dieback policy in July 1982. This involved a comprehensive report by nineteen groups of experts, a seminar, with discussion papers, and a report (13), (14). At all stages the Task Force maintained a close liaison with the Policy Review Group, Regions, Divisions and Specialist Groups. The Task Force recommended a series of new policies (15). These were accepted by the Conservator and by Government and were made public in January 1983 as the Dieback Policy 1982 (16).

Dieback Policy 1982 proposed twentyfour policies covering aspects such as resource utilisation, access, disease risk areas, mapping, staff, resources and information. The Policy stated that access to resources within Disease Risk Areas would be permitted, subject to the availability of Dieback-Free Plans and adequate hygiene (Policies 11 and 12). It also proposed that forest operations be subject to a 7-Way Test as follows:

POLICY NO. 1

Before forest operations are permitted, the following factors must be evaluated:

Type of Operation
Degree of Hygiene
Risk of Introducing *Phytophthora cinnamomi*
Forest Type
Likely Impact
Land Use, and
Consequences of Impact on Land Use.

LOGGING TRIALS

The five logging trials which have been established cover a range of climatic zones, forest types and silvicultural prescriptions. For each trial area, dieback-free plans developed from 70 mm photography and interpretation were available. The most up-to-date hygiene prescriptions were used. These included aspects such as:

availability of dieback-free maps
definition of dieback risk categories
definition of cutting coupes and fallers blocks
clean machinery and washdown or cleandown (as required)
nominated access routes only
access by permit only
access routes selected to be low in the profile
split-phase management of landings
operations based on natural mini-catchments
preparation of hygiene prescriptions for all operations
consultation with industry and advisors
training of personnel
supervision of activities

A comparison between these trials on some major criteria is shown in Table 1. A number of coupes in the Amphion, Taree and Beaton trials were deliberately logged under wet soil conditions, to test the hygiene techniques under the best possible conditions for fungal spread and survival.

A number of Departmental reports document the objectives of these trials, the procedures used, the prescriptions employed and also present some preliminary results. These reports include:

a. The Dwellingup Hygiene Logging Trial, 1980

b. Jarrah 81, 1981

c. Dieback Logging Seminar, Bunbury 1982

d. Interim Report - Beaton Logging Trial, 1983

e. Hygienic Logging in the Northern Jarrah Forest. R. Underwood and J. Murch, 1983 (in press)

f. Procedures to be used for ground intensive monitoring (GRIM). Kelmscott Inventory and Planning Branch, 1983.

g. Reinterpretation of Taree Logging Trial. J. Gillard, K. Helyar, 1983.

MONITORING

The objectives of the monitoring programme were to obtain data on the introduction or spread of *Phytophthora cinnamomi* by logging. This was done by sampling of soil and/or root material from recently dead and dying indicator plants (isd's). All samples were then laboratory tested for the presence of *P. cinnamomi*. In addition, systematic sampling of soil from roads, table drains, landings and snig-tracks was undertaken. Natural spread from sites identified as dieback was monitored. The accuracy of the initial interpretation was also kept under review and any new infections were noted. Monitoring commenced at the beginning of each trial and is likely to continue for several years, (5 to 10), after its completion. The current report should therefore be regarded as an interim progress report of results.

RESULTS TO NOVEMBER 1983

A summary of results is shown in Table 2.

a. Roads

Systematic sampling of both existing and newly constructed roads yielded several recoveries of *P. cinnamomi* from some (but not all) roads in the Amphion, Taree, Inglehope and Beaton trials. The roads in the Warrup trial were not sampled. Positive samples were recovered from the table drains and sometimes from the wheel ruts. Indicator plants in the forest adjacent to these sample points were not dying and have not died to date. At Amphion, Taree and Inglehope, a number of positive samples were recovered before logging or road upgrading commenced. There is no positive cause and effect relationship between these recoveries and the trial logging.

These results indicate that many of the roads in the forest may be infected with *P. cinnamomi*. It emphasises the importance of using and building roads which are low in the profile. A more detailied research study for George Road was conducted by Dwellingup Research, but the results have not yet been published.

b. Snig Tracks

Extensive sampling of 34 snig tracks (544 subsamples) during spring 1983 yielded one recovery of *P. cinnamomi* from Taree (Coupe No. 12, Landing No. 1, Snig Track No. 4). This coupe was logged under dry soil conditions.

c. Landings

Extensive sampling of 34 landings (544 subsamples) did not yield any recoveries of *P. cinnamomi*.

d. Indicator Plant Deaths Within Coupes

Seven cut-over coupes within the Taree (4) and Amphion (3) trials were systematically surveyed for deaths of indicator plants using a ground intensive monitoring system (GRIM). The survey crews were supervised by a trained dieback interpreter. In all, 75 indicator plants which had died recently were sampled and processed at the Dwellingup laboratory. *P. cinnamomi* was recovered from four samples (Taree Coupe 5, Taree Coupe 9 and Taree Coupe 10 (2 sites)). All these coupes were logged under wet soil conditions. One site (Taree Coupe 5) was located downslope of a logging road. All other sites were upslope from these roads.

The four sites within coupes and the one snig track from which *P. cinnamomi* was recovered were visited, described in detail, and resampled on two occasions. *P. cinnamomi* was not recovered from any of these samples. One site yielded a species identified as *Phytophthora citricola* (E. Davidson, Murdoch University). Another site yielded an unidentified species of *Phytophthora* (Dwellingup Research). The sites will continue to be monitored and sampled at regular intervals.

P. cinnamomi was also recovered from dying plants within a coupe at the Beaton trial. This portion of Coupe 2 had been logged for sawlogs under dry soil conditions.

e. 70 mm Photography

Parts of the Taree trial had been rephotographed in 1982. This film was viewed by two trained interpreters, recently dead indicator plants were detected and later located in the field. Samples were taken from these dead plants, as necessary. No recoveries of *P. cinnamomi* were obtained. The reinterpretation showed that the original dieback-free plans prepared for Taree were quite accurate. A plan comparing the two sets of interpretations was prepared.

f. Further Sampling

As a further check, 30 recently dead zamia palms within the Taree trial were sampled. No recoveries of *P. cinnamomi* were obtained.

g. Controls

As a check on the sampling and laboratory techniques, control samples were obtained periodically from known dieback sites. From 30 samples, 16 yielded *P. cinnamomi* and a positive result was obtained from each of the seven sampling sites. Recovery percentages were as follows:

tissue 69%, soil 50%, zamia palms 17%.

h. Indicator Plants Not Apparent on 70 mm Photography

In a few cases some patches of dead indicator plants were detected by industry or Forests Department field staff. These plants had died after the 70 mm photographs were taken.

Seven such areas were located, one at Taree (an extension) and six at Beaton (three extensions, two not apparent on the original film and one in an area difficult to interpret due to a dense understorey of tolerant species). All of these areas were excluded from the trial and were not logged. However, it is also likely that some similar areas were not detected.

i. Other Phythiaceous Fungi

Fungi other than *Phytophthora cinnamomi* were periodically recovered from samples taken from roads, snig tracks, landings, dead indicator plants, zamia palms and occasionally from the control samples. The fungi are being subcultured for further identification. They include *Phythphthora citricola*, unidentified species of *Phytophthora* and of *Pythium* (Table 3).

DISCUSSION

Observations and sampling were based on recently dead indicator plants. The elapsed time between logging and sampling ranged from 23 to 38 months. This is considered to be a reasonable time span, particularly in view of the disturbance caused by the logging operation and the heavy summer rain which occurred in 1982 and 1983. Incipient dieback is usually stimulated by these activities, and results in deaths of indicator plants, especially *Banksia grandis*. The areas will however, continue to be monitored to see if further deaths occur.

P. cinnamomi was recovered at five sites within coupes in the Taree trial and at one site within the Beaton trial. These are the only recoveries to date within the logged-over areas. Four of these sites were close to a snig track (the exceptions being in Coupes 2 and 9). Pig activity was common in the Dwellingup trial areas, especially in the wetter (dieback) gullies and on disturbed soil such as snig tracks and landings. It is possible that pigs act as a disease vector. Four of the sites were logged in moist soil conditions (the exceptions being in Coupes 2 and 12). Assuming that on all these sites *P. cinnamomi* becomes active and spreads, it has been calculated that 23 hectares of dieback-free forest will be placed at risk (3 hectares in the high potential risk and 20 hectares in the low potential risk categories).

The recovery of *P. cinnamomi* from a number of roads, in some cases prior to the commencement of logging, re-emphasises the importance of using roads which are low in the profile. The survival of the fungus in this harsh road environment was not expected to be high (4), but further work may be necessary to clarify this point. The recovery of *P. cinnamomi* from road gutters, where there are no indicator plant deaths in the adjacent forest, suggests that the policy of hygiene grading based on visual symptoms needs to be reassessed.

Sampling recovered *P. cinnamomi*, *P. citricola* and as yet unidentified species of *Phytophthora* and *Pythium*. In one case two separate species of *Phytophthora* were identified from a single split-sample. *P. cinnamomi* cannot be absolutely identified from mycelial characteristics. Further laboratory work is required, for example - plating on a range of agars,

incubating at a range of temperatures, subculturing and mating with appropriate strains. Additional laboratory assistance for this work appears to be highly desirable. The failure to recover *P. cinnamomi* from subsequent sampling is disturbing, especially since the original host plants were relocated and resampled.

Shearer (pers. comm.) has demonstrated that whereas *P. cinnamomi* is highly pathogenic to banksia, other isolates of *Phytophthora* are not. However a number of *Phytophthora* species, including *P. citricola* can invade jarrah and may cause mortality of seedlings in pot trials. It is likely that *P. cinnamomi* is the one species which has the ability to build up high levels of inoculum in understorey plants. *P. citricola* is homothallic and has a lower temperature optimum. It is likely to be recovered with greater frequency from both drier and cooler soils.

The 1983 spring was fairly dry and the soil dryness index at Dwellingup ranged between 650 and 750 during the main survey period. One rainfall event of 20 mm and three of less than 4 mm were recorded during the survey. The recovery of *P. cinnamomi* from dieback affected controls, though lower than reported by the Dieback Mapping Group (10), is considered as acceptable, especially from the tissue samples. The very low recovery of *P. cinnamomi* from these monitoring trials is not considered to be due to either poor technique or to inadequate sampling procedures.

Overall, the preliminary results from these trials have been encouraging. The trials fostered a good spirit of co-operation between Industry and the Department. Many individual sections of the Forests Department were involved. The observed spread

of *P. cinnamomi* has been confined to few sites and 23 hectares of dieback-free forest has been placed at risk. This represents less than 3 per cent of the area intensively ground monitored. Further monitoring is desirable, both in time and in space, to assess the reliability of the results obtained to date. This monitoring should include the unlogged control coupes.

ACKNOWLEDGEMENTS

These trials could not have been implemented without the co-operation and assistance of the timber industry. An excellent spririt of co-operation was fostered and it is essential that this be maintained in future logging operations. Many separate branches of the Department were also involved. The list of individual contributors is long. However the assistance provided by staff members from the following groups is gratefully acknowledged:

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Bunbury Inventory and Planning
Kelmscott Inventory and Planning
Manjimup Inventory and Planning

Busselton Division
A.P.I. Branch Bunbury
Protection Branch

Murdoch University

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(16) Forests Department (December 1982) - Dieback Policy 1982.

TABLE 1

BASIC DATA FOR THE FIVE TRIAL AREAS

Trial	Division	Industry	Rainfall mm	Silvicultural Operation	No. Coupes			Date Started	Date Finished	Remarks
					Dry Soil	Other	Controls			
Amphion	Dwellingup	Bunnings	1100	Sawlog; some poles	2	5	3	2/81	6/83	Good quality jarrah forest on laterite.
Taree	Dwellingup	Bunnings	1050	Sawlog; some poles	4	11	1	5/80	5/83	First hygiene logging operation in Disease Risk Area.
Inglehope Pindalup	Dwellingup	Ridolfo	1100	Light pole cut	9	0	0	10/82	4/83	Dry soil only. Snig 1/83 to 4/83.
Beaton	Nannup	Millars & Bunnings	1150	Sawlog and integrated sawlog and woodchips.	3	6	1	3/82	2/84	Four coupes were chipped in addition to sawlog removal.
Warrup	Manjimup	Millars & Bunnings	850	Sawlog, chip, removal of minor forest produce, unmerchantable thinning.	2	0	1	1/82	4/83	PWD hydrology study area. Cut in summers 82 & 83. Silvicultural treatment completed 12/83. Some roads used by hydrographers under all weather conditions.

TABLE 2.

RECOVERIES OF PHYTOPHTHORA CINNAMOMI

	SOIL SAMPLES			SOIL AND TISSUE SAMPLES		
Trial	Roads	Snig Tracks	Landings	Coupes isds	70 mm Photos isds	Remarks
George Road	Yes 8 sites (wheelruts and table drains)	N.A.	N.A.	N.A.	N.A.	Extensively monitored by Dwellingup Research
Amphion	Yes 8 sites 2 roads (table drains)	None	None	None	N.A.	3 coupes (7a, 9, 10) intensively monitored by ground survey. 8 landings and 8 snig tracks were sampled.
Taree	Yes 22 sites 3 roads (table drains)	Yes 1 snig track	None	Yes 4 sites 3 coupes	None	4 coupes (5, 8, 9, 10) intensively monitored by ground survey. 10 landings and 10 snig tracks were sampled.
Inglehope Pindalup	Yes 3 sites 3 roads (table drains)	None	None	N.A.	N.A.	10 landings and 10 snig tracks were sampled.
Beaton	Yes 4 sites 2 roads (table drains)	None	None	Yes 1 site (H6)	N.A.	3 landings and 3 snig tracks were sampled. *P. cinnamomi* recovered from below a wash-down ramp (1), latent infections (3), natural extensions (2).
Warrup	Not sampled	None	None	N.A.	N.A.	3 landings and 3 snig tracks were sampled.

TABLE 3.

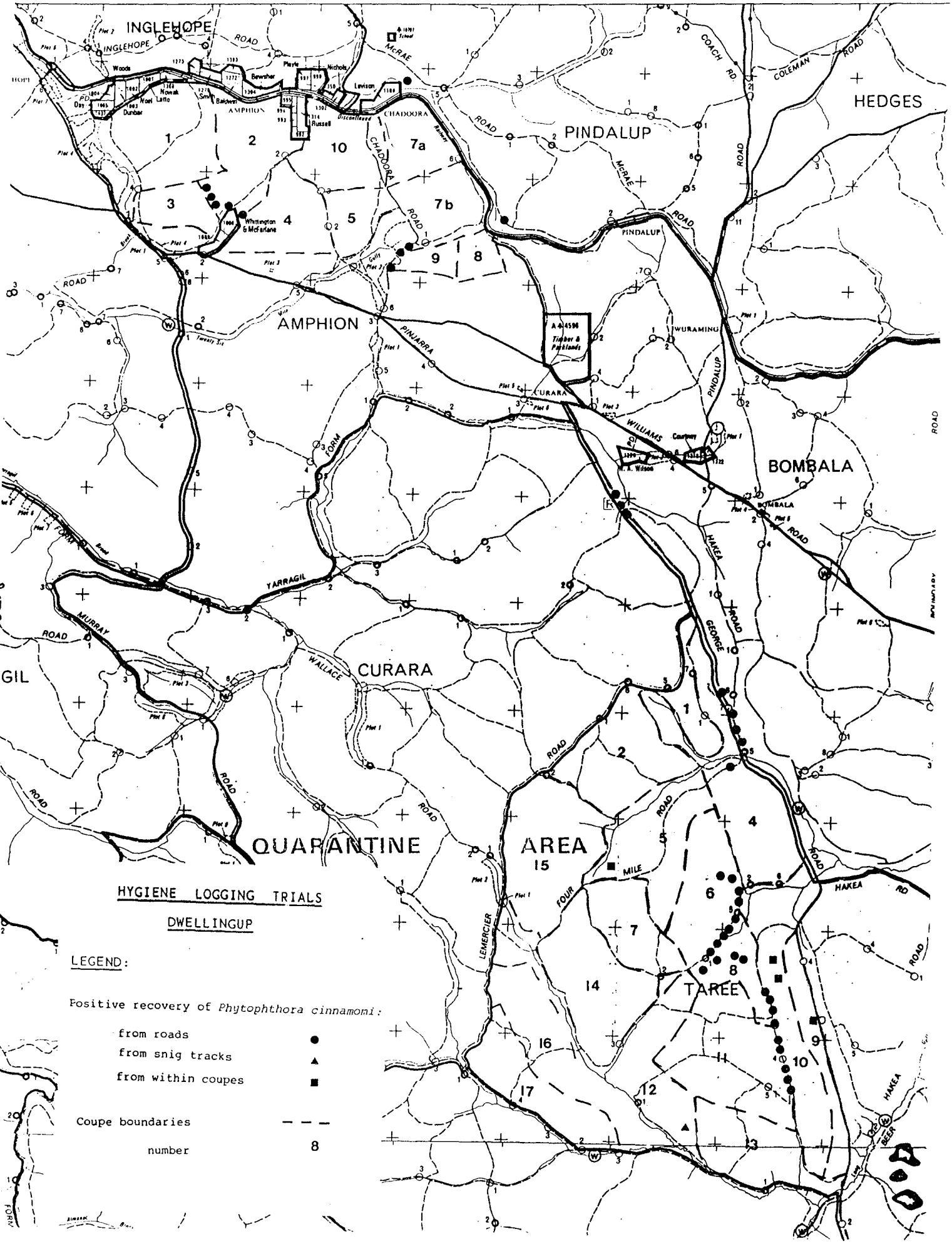
RECOVERIES OF OTHER PHYTOPHTHORA SPECIES

Trial	Roads	Snig Tracks	Landings	Coupes isd's	70 mm Photos isd's	Remarks
George Road	Yes *P. citricola* 8 sites	N.A.	N.A.	N.A.	N.A.	
Amphion	Yes *P. citricola* 3 roads	Yes *Phytophthora sp* 5 snig tracks	Yes *Phytophthora sp* 2 landings	None	N.A.	*P. citricola* recovered below a wash-down ramp.
Taree	Yes *P. citricola* 9 roads	None	Yes *P. citricola* 1 landing	Yes *Phytophthora sp* 4 sites	None	
Inglehope Pindalup	Yes *P. citricola* 3 roads *Phytophthora sp* 5 roads	Yes *P. citricola* 3 snig tracks *Phytophthora sp* 1 snig track	Yes *P. citricola* 1 landing *Phytophthora sp* 1 landing	N.A.	N.A.	
Beaton	Yes *P. citricola* 3 roads *Phytophthora sp* 5 roads	None	Yes *P. citricola* 2 landings *Phytophthora sp* 1 landing	N.A.	N.A.	*Phytophthora sp* also recovered from 3 "suspect" sites, within coupes.
Warrup	N.A.	None	None	N.A.	N.A.	

TABLE 3.

RECOVERIES OF OTHER PHYTOPHTHORA SPECIES

Trial	Roads	Snig Tracks	Landings	Coupes isd's	70 mm Photos isd's	Remarks
George Road	Yes *P. citricola* 8 sites	N.A.	N.A.	N.A.	N.A.	
Amphion	Yes *P. citricola* 3 roads	Yes *Phytophthora sp* 5 snig tracks	Yes *Phytophthora sp* 2 landings	None	N.A.	*P. citricola* recovered below a wash-down ramp.
Taree	Yes *P. citricola* 9 roads	None	Yes *P. citricola* 1 landing	Yes *Phytophthora sp* 4 sites	None	
Inglehope Pindalup	Yes *P. citricola* 3 roads *Phytophthora sp* 5 roads	Yes *P. citricola* 3 snig tracks *Phytophthora sp* 1 snig track	Yes *P. citricola* 1 landing *Phytophthora sp* 1 landing	N.A.	N.A.	
Beaton	Yes *P. citricola* 3 roads *Phytophthora sp* 5 roads	None	Yes *P. citricola* 2 landings *Phytophthora sp* 1 landing	N.A.	N.A.	*Phytophthora sp* also recovered from 3 "suspect" sites, within coupes.
Warrup	N.A.	None	None	N.A.	N.A.	


INGLEHOPE
AMPHION
CHADOORA
PINDALUP
HEDGES
WURAMING
CURARA
BOMBALA
TAREE
QUARANTINE AREA
HYGIENE LOGGING TRIALS
DWELLINGUP
LEGEND:
Positive recovery of Phytophthora cinnamomi:
from roads
from snig tracks
from within coupes
Coupe boundaries
number 8