
Diebackfree Forest Mapping Workshop
HARVEY
April 1981

DIEBACK FREE FOREST MAPPING WORKSHOP - HARVEY 2 APRIL, 1981

AGENDA:

0800 - 0830	Assemble Harvey I&P Office
0830 - 0835	Welcome and introduction
0835 - 0845	Dieback Hygiene Management Policy Statement - A.J. Williamson
0845 - 0915	Inherent difficulties associated with mapping dieback. 70mm aerial photography system. - K. VEAR
0915 - 0930	Interpretation procedures - J. Asher
0930 - 1000	Interpretation standards development - A. Lorkiewicz
1000 - 1015	MORNING TEA
1015 - 1045	Diebackfree maps - definitions, terminology - I. Old
1045 - 1115	Hygiene Management Planning - G. Heberle
1115 - 1145	Hygiene Operations Implementation and Control - G. McArthur
1145 - 1200	Embark on bus
1200 - 1245	Travelling
1245 - 1300	LUNCH
1300 - 1530	Field Inspection
1530 - 1545	Summary
1630	Days end at Harvey

PRELIMINARY GLOSSARY OF DIEBACK TERMS

1. Dieback Symptoms :

Deaths of indicator species in a location and/or pattern strongly suggestive of presence of Phytophthora cinnamomi.

2. Dieback:

(also "Dieback forest"): Forest in which dieback symptoms are present.

2.1 Proven Dieback: forest where deaths of indicator species are associated with recovery of Phytophthora cinnamomi.

(This replaces: known dieback, certain dieback.)

2.2 Suspect: forest in which the evidence for dieback presence or absence, is inconclusive.

(This replaces: possible infected forest, likely dieback, questionable dieback, doubtful dieback, assumed dieback, probable dieback.)

2.3 Incipient Dieback: forest in which Phytophthora cinnamomi is present or suspected, but dieback symptoms are yet to appear

(This replaces: unexpressed dieback, latent dieback.)

2.4 Uninterpretable for Dieback: forest in which susceptible plants are absent or too few to enable interpretation for dieback presence or absence.

2.5 Interpreted Risk: forest in which innoculum is potentially present due to a proven D'b occurrence higher in the topography, but due to site factors is otherwise uninterpretable for dieback presence or absence.

3. Infection:

The presence of Phytophthora cinnamomi in a particular locality, as revealed either by recovery of the fungus and/or development of dieback symptoms.

4. Dieback-Free Forest:

Forest apparently free of dieback.

(This replaces: unaffected forest, green forest, clean forest, healthy forest, non-infected forest, uninfected forest.)

5. Dieback-tolerant Forest:

Forest in which site factors and/or species combine so that tree deaths will not occur if Phytophthora cinnamomi is introduced.

Note: (i) lack of deaths does not infer no effects,
(ii) a dieback tolerant forest can have a susceptible understorey.

(This term replaces: Resistant forest, non-susceptible forest, low impact forest, stands not predisposed to dieback, low risk forest.)

6. Dieback Spread:

An increase in the area of forest in which dieback symptoms occur.

6.1 Natural Dieback Spread: the growth of the fungus through the soil, or its dissemination by natural agencies such as gravity of water.

6.2 Artificial Dieback Spread: transport of the pathogen by man or animals, into dieback-free forest. This can involve expanding the area of existing infection, and/or the creation of new infections at a point or points removed from the original source of infected material.

These Terms Replace: the expressions "intensification" and "extensification" as they were applied to spread.

7. Dieback Intensification:

The build-up of fungal activity in a locality, leading to decline and death of susceptible species.

7.1 Terminal Expression: the end-point of intensification of the disease at a particular site. Can range widely from death of single understorey species to "graveyard".

7.2 "Graveyard": where P.C. has caused death of most plant species in a community.

8. Dieback Susceptibility:

An expression of the ease and rapidity with which the pathogen is able to bring about the decline and death of species in the forest.

Note: strictly speaking, susceptibility refers only to species, and not to sites.

9. Dieback Hazard:

An expression of the degree to which site factors combine to favour infection by the fungus and intensification of the disease.

10. Dieback Risk:

The likelihood of Phytophthora cinnamomi introduction by either natural or artificial spread.

Can therefore have: Natural dieback risk or artificial dieback risk (see definitions 6.1 and 6.2)

11. Biological Impact:

The implication of the disease to the plant and animal communities of the forest.

12. Management Implications:

The implication of the disease to forest management and land use.

13. Site Sensitivity to Dieback:

An expression which combines the degree to which a site/species combination favours infection and intensification (hazard), the likelihood of infection (risk) and disease effects (biological and management implications).

14. Safe Road:

A road on which it is not possible for a given machine or vehicle to pick up and transport Phytophthora cinnamomi.

14.1 Unsafe Road: a road on which it is possible that Phytophthora cinnamomi can be picked up and transported.

Note: any definition of roads or access must be qualified by further definition of such factors as surface, season/weather and type of unit using it.

15. Protectable Forest:

Dieback-free forest upslope from dieback or suspect dieback infection.

In protectable forest the risk of natural dieback spread is considered to be nil or low.

16. Non - Protectable Forest:

Forest downslope from dieback or suspect dieback infection in which the risk of natural dieback spread is high.

Note: The expressions "protectable" and non-protectable" refer only to risks from natural spread of the fungus. They imply nothing about disease impacts or rate of disease intensification.

"DIEBACK MAPPING AND DISEASE IDENTIFICATION"
(70MM COLOUR AERIAL PHOTOGRAPHY TECHNIQUE)

K.R. VEAR
A.D.F.O.

2/2/81

CONTENTS

1. INTRODUCTION

The plant pathogen *P. cinnamomi* has had a dramatic effect upon the ability of large areas of the Jarrah forest to produce two major valuable natural resources- water and Jarrah timber. The potential remains today for this disease to further decimate our forests, both through natural and man assisted spread.

It is part of the Forests Department's protection policy to implement stringent hygiene controls on all operations in the jarrah forest in an effort to minimise the spread of this disease. However, accurate, detailed information about the actual field location of the disease, together with a sound understanding of the disease biology and an appreciation of the variations which may, and often do occur in the field expression of the disease, are essential prerequisites for effective hygiene management programmes within the jarrah forest.

The Forests Department is currently putting a large amount of time, money and effort into implementing a mapping system which is capable of providing the Field Forester with a level of dieback information which is reliable and accurate enough to enable the formulation of satisfactory and meaningful hygiene operations. It is indicative of the depth of the Forests Department's concern about hygiene management that it persevered with the six year development period which was required to bring this new mapping system into commission.

The effectiveness of any hygiene management programme is ultimately determined by the implementing field foresters. Their attitude to the reliability and accuracy of the new Diebackfree Forest Maps, and their understanding of what these maps, in reality depict, will have a direct influence on future hygiene operations.

Hopefully, these notes, by describing the 70mm Aerial Photography Technique for mapping dieback, and aspects of disease recognition in the field, will provide the reader with the necessary background information from which to develop a more confident and improved basis from which to practise disease hygiene - not only when using the new Diebackfree Forest Maps as they become progressively available, but also when using existing dieback information sources, eg. current dieback plans, the field expression of the disease.

2. REVIEW OF PREVIOUS SYSTEMS OF MAPPING DIEBACK

Between 1956 and 1962 attempts to map dieback were made using various aerial photography types and scales.

Intermediate scale (1:15,800) black and white air photos had been successfully used to produce forest type maps so these were investigated for dieback mapping. However, these photographs showed too little land contrast - due to the over emphasis of natural gaps in crown cover - to enable accurate interpretation for dieback.

Intermediate scale colour photographs are generally not as effective as black and white photographs of the same scale for mapping dieback, as the contrast in colours between affected and unaffected forest is generally less than the variations in grey scale contrast on the black and white photographs.

Experiments with false colour infra red film and multi-spectral analysis of black and white infra red film have likewise yielded very poor discrimination of diseased forest. More recently satellite multispectral scaning imagery has had cursory examination by the C.S.I.R.O. for dieback, but is unlikely to be effective for detailed mapping due to the current coarse resolution and locational accuracy of the system.

The most effective conventional system of broadscale aerial photography is 1:40,000 scale black and white photo interpretation. This approach was combined with road reconnaissance and off road field checks to provide the basis of the Forests Department's Dieback Mapping Programme. The Northern Jarrah forest was successfully mapped in 1965, 1969/73, 1976 and dieback risk maps were prepared in 1974.

These maps have served the Department well in defining the gross amount of dieback in the forest and the location of it's major concentrations. The maps also emphasise in a broad way, the nature of disease spread and the coarse environmental factors which favour the disease.

It is from this base that the 70mm colour photography interpretation for dieback occurrence has been advanced in an attempt to produce very accurate and highly detailed maps which may be directly and reliably applied to the control of field operations with the objective of minimising the spread of the disease. These detailed maps i.e. Diebackfree Forest Maps, are progressively becoming available now.

(NB Refer Appendix II "Four Different Methods of Mapping Dieback. i.e. Road Surveys, Field Surveys, Small Scale A.P.I. and Large Scale A.P.I. - advantages and disadvantages")

3. DIFFICULTIES ASSOCIATED WITH MAPPING DIEBACK ACCURATELY

The reason for the various approaches to mapping dieback having been investigated in the past is due largely to the intrinsic difficulties in detecting indicator species plant deaths in the field, positively recognising the deaths which are P. cinammomi infections, and then accurately recording the extent of the infection. Add to this the requirement for mapping accurately over very large areas of forest which cover a range of ecotypes and disease expressions, with the complication of current and past operational activities in the mapping area which often obscure disease expression, then one forms some conception of the natural problems associated with mapping dieback.

The nature of the mapping difficulties depend on the specific type of mapping employed, however, the following general problems exist which affect all types of dieback mapping:-

3.1 Early Stage Infections are Difficult to Distinguish, due to:

- a lack of uniformity of indicator species in the forest.
- suppression of dieback expression on tolerant sites.
- the occurrence of many false symptoms in the forest, eg. plants also die from drought stress, insect attack, fire etc.
- dense forest overstorey and/or middle strata canopy which hide and suppress symptoms.
- very early (or incipient dieback) by definition is undetectable.
- tissue sampling of indicator plants is not 100% reliable.
- dieback expression varies markedly from area to area and region to region.
- forest activities destroy evidence of disease presence and create false evidence eg. burning , logging impact.
- lack of obvious causal agent/disease vector can be confusing.

3.2 Established Infections are Difficult to Map Because:

- salvage and "non-protectable" logging operations ruin dieback evidence and create false evidence.
- fire creates false impressions on the ground and on aerial photographs.
- sites may have revegetated with tolerant species obscuring the disease impact.
- boundaries are often extremely diffuse on the ground and hence are very subtle on aerial photographs.
- same natural site types look like dieback on aerial photographs.
- often there is a lack of fresh indicator species deaths in the field to highlight and define infections.
- patchy infections have to be interpolated.

3.3 Problems Associated with Establishing Uniform Interpretation Standards

The task of interpreting aerial photographs for the evidence of the biological impact of a dynamic disease upon a variety of dynamic ecosystems is intrinsically difficult.

The interpreter must skilfully scan an often bewildering array of visual symptoms and from it decipher disease expression. Often the decisions an interpreter must make are as simple as differentiating between black and white. However, when it comes to the grey areas in decision making, the experienced interpreter comes into his own. i.e. It requires fine judgement founded upon a wealth of experience to proportion the suspect areas correctly into either diebackfree or dieback forest categories. Sometimes areas must remain simply suspect as there is insufficient evidence to allow the interpreter to logically decide whether P. cinnamomi is present or absent.

The maintenance of a common interpretation standard is very difficult between interpreters, due to the subjectivity of the perceived evidence. It is always difficult to compare, contrast and accumulate mentally, evidence over large areas in to useful experience and, to be able to make other less experienced people understand what that experience is telling one about the disease and its behaviour on a given site.

It is only through the adoption of logical scientific and uniform procedures that one can ever hope to maintain a reliable standard of decision making when dealing with something as nebulous as disease impact within a complex forest system.

(NB: The procedures adopted by the A.P.&.I. Section for interpreting disease expression are described in Sections 5,8 and Appendix I)

4. THE PRESENT 70MM AERIAL PHOTOGRAPHY MAPPING SYSTEM

4.1 Rationale

New infections of P. cinnamomi or extensions to previously established infections will first become apparent to the observer as characteristic death amongst a variety of highly susceptible forest understorey plants - known as indicator species. Once a P. cinnamomi zoospore makes contact with the roots of one of these plants fungal hypae develop, growing rapidly up to the plant stem where the fungus girdles the cambium just above ground level. Plant death quickly follows.

One of the pieces of evidence used in deciding whether P. cinnamomi is present on a given site, is this sudden death syndrome amongst the understorey indicator species. Despite radically different physiology blackboys and zamia palms also suffer the sudden death syndrome exhibited by banksias and persoonias. However, the researchers still do not understand the biology of the attack upon these plants as they do not have a stem with a clearly defined cambium layer.

The complete crown of the P. cinnamomi infected indicator plants rapidly turns lime-green following girdling of the cambium. Over a period these leaves then turn orange to yellow to brown. They remain on the dead plant stems until removed by strong winds or heavy rainfall.

It is these dead highly coloured leaves of the indicator plants which provide the key to the interpretation of dieback occurrence in the forest, as they are readily observed by a trained interpreter when viewed stereoscopically (three dimensional image obtained) at a scale of about 1:4500 upon colour positive photographs.

4.2 Photography Constraints

In reality, the task of photographing the relatively small understorey indicator plants below the jarrah canopy is controlled by several severely limiting constraints, i.e.

(a) Season: There appears to be a strong seasonal link with the development of suitable soil temperature and moisture regimes which favour fungal activity. A major flush of indicator species deaths occurs about February each year following late summer season breaking rainfall. These dead plants remain viable for photographing until the end of the following June.

(b) Overstorey Shadow: Any shadow cast by the overstorey canopy renders the photographs largely uninterpretable by simply making it impossible to distinguish the understorey plants - dead or otherwise, i.e. under conditions of bright sunlight, the jarrah canopy is beautifully highlighted whilst everything beneath it is blackened.

Shadow is eliminated by exposing the film when a diffuse light source is illuminating the forest, such as occurs when a high continuous cloud layer covers the target area. There are only approximately 15 days per autumn when suitable cloud conditions prevail over the various target areas - effectively limiting the annual photography and mapping programme to a maximum of ≃ 80,000 ha/year.

(c) Scale: In order to be able to see indicator plants on film, a scale of 1:4500 is desirable. In theory this represents no great problem as one merely changes altitude or the focal length of the camera lens in order to achieve the necessary photo-scale.

However, due to the requirement that all dieback photography must occur under cloud, which in the S.W. has a cloudbase of 800 metres a.s.l. achieving the correct scale with the type of cameras available for this type of work, produces in turn, a few potentially overwhelming problems. eg. The aircraft flies at 50m /sec at an altitude of 500 metres a.g.l. At this height the camera photographs a swath of only 240 metres. A navigation system is therefore required which is capable of guiding the pilot accurately over flight lines at 180 metres offsets and up to 40Km length.

(d) Coverage: To ensure that no infection, however small or isolated from major infections, is overlooked at mapping, complete photo-coverage of the target area is essential. i.e. no photo-gaps must occur between flight lines. The aircraft navigation system must be capable of guiding the pilot along each flight line without deviating more than 20 metres to either side of the centre of each flight line.

(e) Stereo-overlap: Film interpretation is enhanced by viewing stereoscopically the 3 dimensional image of the forest.

(f) Photo-location Recording: Each photograph covers ≈ 6ha, with 40% forward lap, thus a 35,000 ha target area will generate approximately 33,000 photographs. A photography system had to be developed which was capable of accurately and reliably locating and recording the origin of many thousands of photographs.

(g) Forest Quarantine: To ensure the maximum opportunity for the detection of all isolated small infections and to minimise the probability of the creation of new incipient infections prior to mapping the target area should be Quarantined before being mapped for dieback.

It requires a minimum of 3 growing seasons for new infections to establish and express themselves in the understorey plants or for a disturbed understorey community to return to a semblance of normality, allowing interpretable disease expression to occur.

(h) Normal aerial photography constraints also apply to this operation eg. the need for aircraft stability, speed control, compliance with D.O.T. regulations, light etc.

4.3 70mm Aerial Photography System

Following several years of intense developmental work, a system was devised which overcomes the technical difficulties presented by the combined photography constraints. The system involves the integrated use of:

a) A Britten Norman Islander - as the photography platform.

b) Two Vinten Aerial Reconnaissance Cameras - robust enough and fast enough to provide the large number of photographs required in stereo-pairs. Two cameras are used to enable continuous photography runs without breaks for film reloading.

c) A Quantum Intervalometer - allows the cameraman to control the interval between exposures and to adjust the lens appeture. Also monitors film usage, controls the film numbering units and is interfaced with the M.R.D.P. (described below) to enable individual photo principal point locations to be determined.

(d) Motorola Mini Range III System - determines the position of the aircraft in flight with respect to two reference stations located at known fixed points.

(e) Mini Ranger Data Processor (MRDP) - a micro processor based computing and control unit. Its basic functions are:

(i) to determine the aircrafts present position within an artificial grid co-ordinate system which encompasses the target area.

(ii) compare present position with previously planned flight lines and out put the result in the form of guidance information which can be readily used by the pilot to position his aircraft.

(iii) outputs various data forms onto storage peripherals eg. plotter magnetic tape and printers.

(iv) interfaces with the Intervalometer, enabling photographic information to be recorded eg. roll and frame number, principal point location.

(v) provides a post-plot facility for recalling stored data from magnetic tapes in various forms at any time in the future.

(vi) calculates aircraft ground speed, enabling the cameraman to adjust photo-interval as necessary to maintain stereo-overlap.

5. INTERPRETATION PROCEDURES - OFFICE AND FIELD

The task of interpreting dieback occurrence commences in the office with an initial examination of the 70mm film together with a review of all other information sources available which may in some way shed light on the likely manner in which the disease and the forest may interact on that site eg.

(a) Small scale B & W photographs (1:40,000) of the area would be examined to obtain an overview of the geomorphology, topography, broad vegetation and climatic variations etc.

(b) Management records are perused for information relating to the possible impact of fire or forest produce utilisation or management activities upon disease occurrence and expression in the area.

(c) A broad scale ground reconnaissance for the mapping area is undertaken to identify major ecotype variations, and determine whether major false symptoms are present.

During this early work the interpreter forms crude film visual and field standards for interpreting dieback expression and occurrence in the mapping Cell by noting against his growing level of background information, such features as:-

(a) Obvious understorey indicator plant deaths either as single isolated deaths, scattered deaths, group deaths or combinations of various species dying within an area.

(b) The absence of indicator species on what appears to be a normal prime ecozone for the establishment and growth of those particular plants.

(c) The occurrence of obvious false symptoms.

One can never be truly convinced of hat one is seeing and interpreting from a photograph of the forest, without going into the field at some stage to physically check and ground truth ones interpretation. The initial office work generates many (often hundreds) of field sites which require field checking for the verification of the presence or absence of the disease.

Having located the field site to be checked, using the 70mm film as a navigational aid, and having identified the particular indicator plants in the field previously singled out for field investigation, the interpreter undertakes a detailed ecological examination f the area.

Indicators species deaths are noted initially, together with any obvious pattern development amongst them. All site factors which could influence the behaviour of the indicator plants and P. cinnamomi if present, are also noted. All observations are recorded on a field sheet (see Appendix III for example) together with the interpreters decision as to whether or not the site is P. cinnamomi infected. (Refer Section 8 for greater detail).

Having completed his field assessment of the site the interpreter then collects soil and tissue samples from dead indicator plants on the site for later laboratory analysis (Refer also Section 8.5 and Appendix I)

It is only by the often long and arduous process of continually formulating, substantiating and sometimes rejecting concepts about disease expression within a given area - concepts derived by analysing information extracted from the film, the various background sources and the field checks; by having to make field decisions about dieback occurrence; and by comparing all this knowledge with the insight gained about disease field behaviour from each positive laboratory result - that the interpreter is able to build up a set of dieback interpretation standards and commence mapping the disease location.

6. DISEASE MAPPING

Having made the value judgement of what is andwhat is not dieback, the actual mapping process is a relatively simple procedure involving:-

(a) The close comparison and checking of the infection boundaries in the field with those boundaries plotted in the office onto the film.

(b) The transfer of information to a map base by scaling off each piece of dieback information from the principal point of the 70mm frame on which it occurs.

Each principal point is plotted on a map base to an accuracy of ± 3 metres.

(c) Final map printing and duplication in colour with contours shown at 1:25,000 scale..

7. DIEBACKFREE FOREST MAPS

In order to correctly utilise the Diebackfree Forest Maps one must fully understand the information appearing upon them. At the time of writing the following map categories (and their attendant definitions) were being used by the A.P.&.I. Section to describe information about the disease appearing upon the Diebackfree Forest Maps:-

(a) Diebackfree forest: Forest free of dieback - currently shown as white on Diebackfree Forest Maps.

(b) Dieback: Forest in which dieback symptoms are present. This category includes "Proven Dieback" i.e. forest where deaths of indicators species are associated with the recovery of Phytophthora cinnamomi - currently shown as red on Diebackfree Forest Maps.

(c) Suspect: Forest in which the evidence for dieback presence or absence is inconclusive - currently shown as blue on Diebackfree Forest Maps.

(d) Uninterpretable for Dieback: Forest in which susceptible plants are absent or too few to enable interpretation for dieback presence or absence - currently shown as purple on Diebackfree Forest Maps.

NB The Suspect Class is a legitimate class not just a haven for indecision. A significant proportion of sites visited will exhibit some but not all the diagnostic elements of an infection - these are most accurately described as suspect.

(e) Interpreted Risk: Forest in which innoculum is potentially present due to a proven dieback occurrence higher in the topography, but due to site factors is otherwise uninterpretable for dieback presence or absence - currently shown as yellow on Diebackfree Forest Maps.

8. DISEASE RECOGNITION IN THE FIELD

Recognition of plant deaths caused by P. cinnamomi is an essential precursor to effective forest hygiene. However, as there is a marked difference in the way in which P. cinnamomi interacts within and between ecotypes, and with the way a variety of site factors act to confuse disease expression on any particular site, there are no rules or prescriptions currently uniformly applicable or reliable whichrender dieback recognition in the field a simple decision process rather than an exercise of judgement.

It i impossible to pass on in the written form, the more subtle aspects of disease recognition which the A.P.&.I. Section has painstakingly gleaned from its intensive investigation and sampling programmes in several areas of the jarrah forest. The following summary may be used as a guide to improved decision making in the field.

In assessing whether or not the disease is present, one must always consider (a) Disease expression, (b) Indicator species deaths, (c) Pattern of deaths (d) Site factors, and (e) Soil and tissue sampling. Each must be evaluated individually and then for the way they interact.

8.1 Disease Expression

Dieback expression is quite variable. One should not sustain a standard "model" for the expression of the disease, but should approach each new situation or piece of forest with an open mind, ready to judge each on its own merits i.e. Expression of the disease can vary :

(a) with time, since infection eg. seasonal influences such as drought, heavy rainfall, warm winters, cool summers, etc.

(b) as a result of ecotype or relative minor site differences over short distances.

(c) over large areas or zones due to potentially identifiable causes such as soil changes, topography differences, climate variations or unexplained or unexpected causes.

(d) or a host of other factors eg. fire, drought, waterlogging, disturbance, insects, old age, may kill dieback susceptible species, creating a false impression of the disease presence.

8.2 Indicator Species

Indicator species are not equally susceptible to either dieback or other causes of death. The significance of each plant death must be considered in relation to the pattern development amongst the indicator species deaths and the prevailing site factors.

Banksia grandis is extremely susceptible to dieback and as a rapid reactor to the disease is the most commonly encountered early sign. It is also prone to dying in large numbers for causes unrelated to dieback. In terms of gross numbers, B. grandis is far more often presented as a false symptom.

Banksias die extremely quickly from either drought or dieback, requiring only two weeks to proceed from slight chlorosis to deep brown leaves. Dieback mortality is always a sudden death syndrome and never kills only part of a Banksia. Epicormic growth on partly killed Banksia or Persoonias indicates damage by something other than dieback, usually fire. Whilst epicormic shoots do not preclude dieback infection, it may be a good indication that the deaths are not due to P. cinnamomi.

Coppicing of dieback killed Banksias is rare but regrowth in dieback affected areas is common, although not often persistent, succumbing to the disease after two or three years.

The disease may or may not make a clean sweep of all the Banksias within an area of infection. The remaining live plants tend to hide the disease impact on some sites.

Xanthorrhoea preissei (blackboys) often survive in infected areas and should not be regarded as evidence for the absence of the disease. Total frond death invariably indicates complete plant death. There is commonly a light scattering of old blackboy deaths throughout the forest (especially on drought sites or as a result of past "hot" fires), but when indicative of dieback they usually have a readily observable range of ages of death - often accompanied by the death of other susceptible species. Death amongst very young/small Xanthorrhoea preissei is also an indicator of possible P. cinnamomi presence despite the occurrence of healthy larger plants on the site.

Macrozamia reidleii (zamia palms) are extremely prone to drought stress and growth stress from overshadowing scrub, and therefore must be treated cautiously. Frond death is not proof of complete plant death.

Persoonia longifolia (Snoddy pebble) has a similar susceptibility to Banksia, but because of its scattered distribution is usually only complimentary evidence for a multiple species death expression. Persoonia deaths from other causes are also common.

Ground cover species may be useful in the complete absence of the taller indicators as they may confirm whether the site is naturally devoid of the main indicators or has been denuded by some other influence such as dieback. A discontinuity of ground cover species at the edge of a suspected infection site is useful complimentary evidence to the major indicators. Some ecotypes, however, have a naturally low density of ground covers unrelated to dieback.

Jarrah is not an indicator for early stage infections as it takes several years to die, in which time the disease has decimated the understorey. On many sites the jarrah may remain unresponsive to the disease long after a new resistant understorey has invaded the denuded area. Occasionally where moisture and temperature regimes are very favourable for P. cinnamomi young jarrah saplings and poles may succumb, but the dieback pattern is usually also readily observable amongst the other indicators as well.

Very old or well advanced dieback infections amongst the susceptible understorey plants may be identified by the complete absence of indicators by the colonisation and disproportionate abundance of resistant species or merely by the imbalanced composition of the healthy remnant overstorey and regrowth; particularly on low hazard sites.

The death of combinations of more than one indicator species is often indicative of dieback occurrence.

8.3 Pattern Development Amongst Indicator Species Deaths

Indicator species (especially Banksia) can die as individuals or in groups throughout the forest. If the cause of death is dieback a sequence of deaths radiating away and mainly downslope from the original infection point should be apparent.

The probability of finding no pattern development even in a small infection is low - although very new infections may have little or no obvious pattern development.

False symptoms caused by drought or fire often confuse dieback patterns and may even have an additive effect to an existing pattern.

A patchy or discontinuous distribution of indicator species is the most disruptive influence on pattern development.

With Banksiasthe progression of annual deaths may be observed from the degree of deterioration of the stags.

Only week pattern development occurs amongst Zamias and Blackboys.

8.4 Site Factors

The impact on any particular piece of forest of the host pathogen interaction is largely determined by the environmental factors characterising each site. Recognition of the disease is largely dependent on its expected impact.

High Hazard Dieback Sites

Moist, or water gaining sites.

The slightest depression, no matter how small and regardless of topographical location, greatly enhances the dieback hazard of that site. Indicator species deaths occuring in these high hazard sites should attract very close scrutiny. A strong pattern of deaths usually develops within the boundaries of water gaining sites.

Warm understorey.
Breaks in canopy cover of the overstorey admit extra heat which can increase the dieback hazard of a site or intensify an existing infection.

Problem Sites

Jarrah Regrowth Stands are particularly difficult to interpret for dieback because of the suppression of the susceptible understorey which results in few indicator species and many false symptoms from death by competition.

Lateritic Breakaways especially those with a hot aspect, commonly exhibit patterns of indicator species deaths somewhat suggestive of dieback. Usually, the deaths are due to drought stress and can be recognised by incomplete pattern development and partial death of indicator species.

Erosional Surfaces such as major valley slopes produce ready drought stress in indicators (esp. Blackboys) due to shallow soils. Dieback expression on these sites is subdued so correct interpretation is often difficult.

Casuarina Groves appear to induce mortality in adjacent indicator species, perhaps due to fire damage.

Flats can be difficult to interpret due to the sporadic death of indicator species (Swamp Banksia, Blackboy) and high stress from fire and drought. Resistant species can camouflage infections.

Wandoo Types interpretation is almost entirely dependent on Blackboy as an indicator with its relatively poor pattern development.

Forest Condition as affected by burning and logging, strongly influences dieback detection and interpretation. Indicator species (esp. Banksia) can die some time after burning or mechanical damage (one or two years). Partial death or progressive death of indicator species is not caused by dieback.

Random Deaths of indicator species are very common throughout the forest and do not show any obvious cause. A methodical process of close observation and the application of these guidelines should be employed.

Causal Agents

The absence of any obvious means of infection at any site must never be considered an argument for a disease free condition. When interpreting a site one should reach a conclusion based on the existing evidence before in any way contemplating how the infection arrived at the site.

8.5 Soil and Tissue Sampling

Wherever possible when assessing forest areas for the presence or absence of P. cinnamomi soil and plant tissue samples should be collected for laboratory analysis. (Note: Sampling success is dependent upon the use of the correct technique - refer to F.D. Research Branch, A.P.&.I. Section, Manjimup, and Appendix I attached.)

The most important value to be derived from sampling field sites, apart from the possible positive proof of P. cinnamomi presence on a site, is the background knowledge it will engender to the field officer concerned. eg.

(a) If a field decision is that P. cinnamomi is present on a site and the laboratory analysis confirms this fact, then the decision maker knows that his original interpretation standards are largely reliable.

(b) If a field decision is that P. cinnamomi is not present and the laboratory analysis proves positive, then the decision maker is made aware of the need for better observation in the field or that some modification to his interpretation standards is necessary.

(c) Negative laboratory results are largely reliable (depending upon how long the plant has been dead and the sampling techniques adopted). If a negative laboratory result tends to confirm that a site is not P. cinnamomi infected, then the field decision maker may be confident that his interpretation standards are also acceptable for that type of site. However, if the original field decision was that P. cinnamomi was present on the site but the laboratory result was negative, then a careful reassessment of that site is necessary - complete with further samples being collected and analysed. Where further field investigation fails to resolve completely a site to be either P. cinnamomi infected or not, then it must remain in the suspect class and be classified and treated as such.

APPENDIX I

Procedure for Examining and Sampling Possible P. cinnamomi infected field sites.

There is no specific prescription for recognising dieback symptoms. The espression of the disease can vary with the age of infection, season, forest ecotype and forest condition.

A thorough working knowledge of the disease biology is essential for all staff involved with making field decisions regarding P. cinnamomi presence or absence.

When assessing whether or not the disease is present on a site you must consider:-

(a) Indicator species deaths.

(b) The pattern of plant death.

(c) The site factors influencing that area.

Each must be carefully evaluated individually (eg. refer to notes) and compared for the way they interact.

All observations should be written down, whilst undertaking an extensive ground reconnaissance of the area, and reviewed before a final field decision is made for that site. (See appendix III)

Collect soil and tissue samples from the site for laboratory analysis. Where possible delay field operations until laboratory results are known.

Sampling Technique - as currently used by A.P.&.I. Section.

1. Select a recently killed plant, wherever possible, i.e. one with lime-green leaves.

2. Using a sterilised implement dig down and expose the roots and stem of the plant to a depth of approximately 20cm.

3. Cut sections of root, bark, and cambium material from at least 3 sides of the plant. (The older the death the deeper the cut into the cambium region should be.)

4. Place the tissue and some soil (2 or 3 large handfulls) from around the plant base into a plastic bag and seal. Clearly label the sample and record its origin and location; in summer irrigate the sample with distilled water and store and transport in cool conditions.

5. If possible sample more than one plant per site.

6. The same procedure is used for indicator plants except for blackboys where the sample site is the small radiating brittle roots from 6cm and deeper under the surface and Zamias where the plant bole is dug into, and sections of the woody fibrous tissue removed.

NOTE: It requires a minimum of five days from the date of delivery for the sample to be analysed in the laboratory.

APPENDIX II

"Four Different Methods Used for Mapping Dieback - road surveys, field surveys, small scale A.P.I. and large scale A.P.I. - advantages and disadvantages."

The following analysis lists in point form the answer to the enquiry:-

What methods can one employ to map dieback and what are that advantages and disadvantages of the methods?

"Four Different Methods Used for Mapping Dieback"

1. Road Survey - Observers drive along all accessible roads and record observed dieback directly onto the map.

2. Field Surveys - Observers walk through the forest on compass lines (with or without chainage along the line) and note any dieback observed. Dieback observations are then grouped across adjacent lines on the map. Line spacing varies but is usually 50 - 100 metres.

3. Small Scale A.P.I. - An interpreter maps dieback from 1:40,000 or 1:25,000 aerial photography. Some ground checking or field experience is necessary.

4. Large Scale A.P.I. - Interpreters detect dieback and suspect areas on large scale colour photographs by direct observation of understorey indicator species deaths. A great deal of field checking of individual sites is required to correctly identify dieback.

Advantages/Disadvantages of each method

Road Survey

Advantages:

- large proportion of dieback is distributed along roads and gullies.
- infections along roads are the most dangerous w.r.t. spread.
- cheap and quick to conduct.
- mapping simple and easy.

Disadvantages:

- does not detect off road infections.
- proper on foot investigation of sites discouraged by transport.
- road access difficult.
- further spread of dieback by surveyors.

Field Survey

Advantages:

- practical for small areas but slow for large areas (15,000; 20,000ha/an/team)
- detect some off road infections
- close field view of a proportion of the indicator species deaths.
- capacity to take some field samples.

Disadvantages:

- requires a lot of different interpreters to do large areas with commensurate loss of standards.
- very difficult to control standards as feedback is limited.
- little monitoring capacity or revisiting capability to suspect sites.
- only moderate locational accuracy.
- limited tissue sampling capability.
- coverage inadequate, easy to miss symptoms.
- difficult to get overall impression of I.S.D. situation and site types prior to commencing the work.
- indicator species death patterns not obvious.
- fairly expensive.

Small Scale A.P.I.

Advantages:

- very fast survey
- finds bulk of diseased area.
- very cheap
- few interpreters required - standards therefore more uniform.
- easily converted to maps.
- some broadscale monitoring possible.
- covers extensive areas.
- aerial photography cheap and readily available.

Disadvantages:

- too inaccurate for detailed planning of forest operations.
- too inaccurate for hygienic field operations.
- does not predict new intensification of the disease in mostly healthy forest.
- does not allow detailed study of the disease.
- does not recognise differences in disease expression.
- does not provide information for detailed interpretation standards formation.
- can erroneously condemn healthy forest as diseased.

Large Scale A.P.I.

Advantages:

- nearly all infections found (except incipient dieback)
- very accurate locational mapping.
- high proportion of dieback discovered is proven dieback.
- interpretation standards tightly controlled.
- regional view of I.S.D. patterns and site types available.
- remonitoring, revisiting, and group analysis of sites routinely undertaken.
- increase in understanding of disease experience and behaviour is possible.

Disadvantages:

- expensive
- aerial photography limited and difficult to acquire.
- fairly large team required to do large areas.
- highly trained personnel required.
- laboratory facilities and staff required.
- fairly slow productivity (10,000 - 15,000 ha/an/team)
- restrictions on forest operations and access required, for aerial photography.

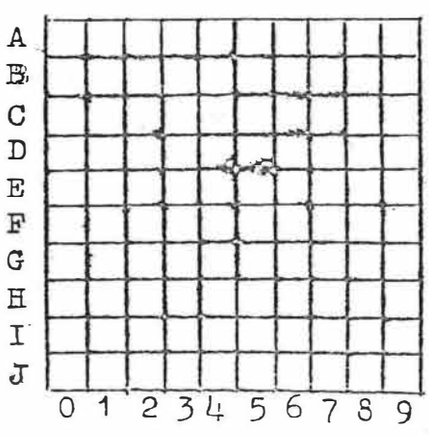
NOTE:

The comparison is for the way the different systems have been operated by the Department and does not compare them with any factor held equivalent eg. cost, accuracy, productivity etc.

Each system has particular advantages and the best overall approach is to combine systems to best suit ones resources and objectives.

70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

DIEBACK HYGIENE GUIDE

An aid for planning forest operations so that dieback spread is prevented or minimized

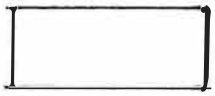
Comprises: Introduction
How to use the guide
Planning Routines A to I
Glossary of terms

Prepared by: R.J. Underwood
West Australian Forests Department

1980

TO USE THE GUIDE

Enter at Routine A and follow through to Routine I, as directed.

The symbol  denotes an action.

and  denotes a question.

Routine A deals with the different impact of the disease in the major forest types.

Routine B concerns operations planned in dieback-tolerant forests.

Routine C provides for the definition of dieback risk categories.

Routine D provides for dieback-free and protectable stands.

Routine E provides for stands non-protectable from infection.

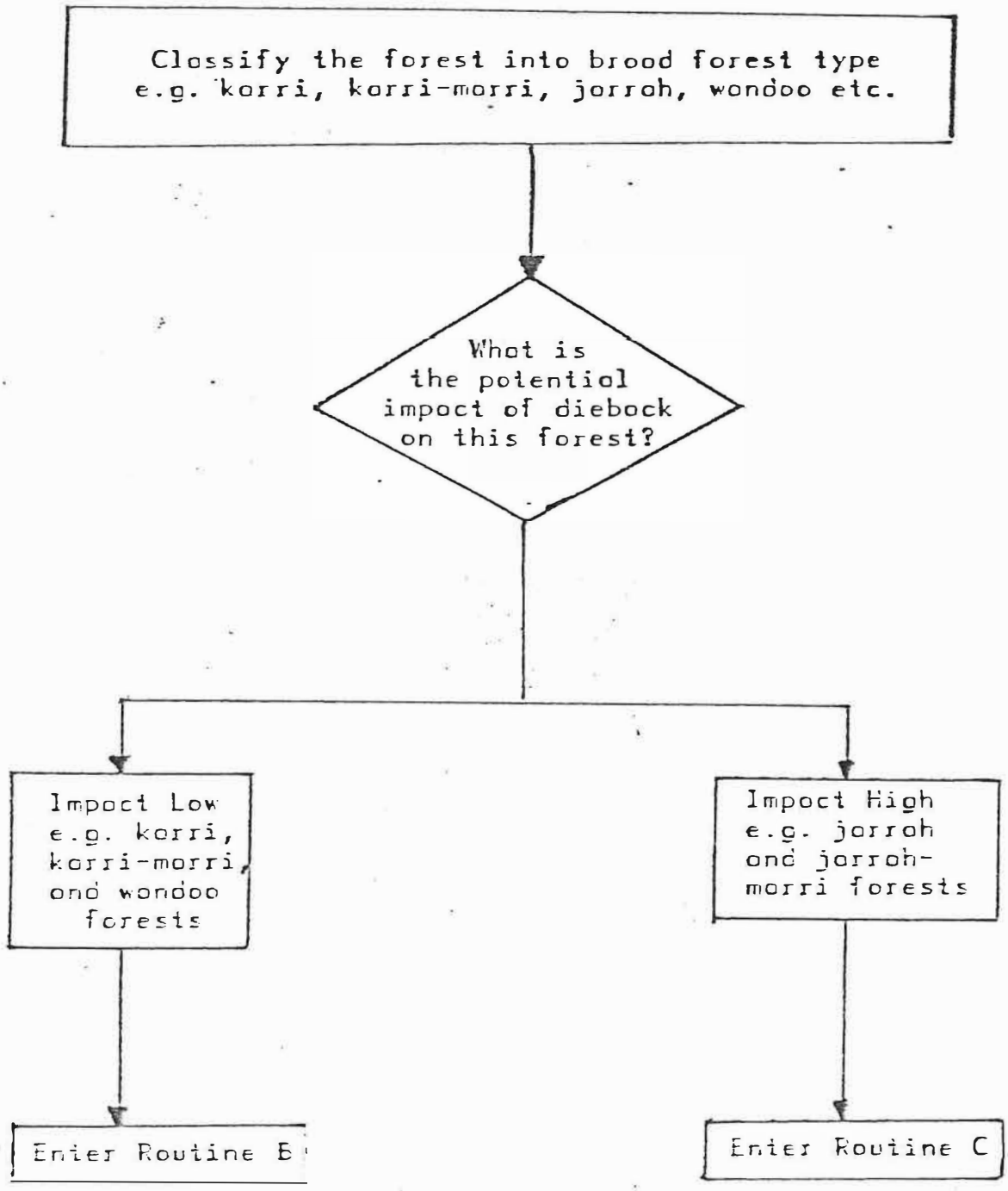
Routine F provides for dieback or suspect dieback stands.

Routine G concerns access planning.

Routine H is a hygiene failure test.

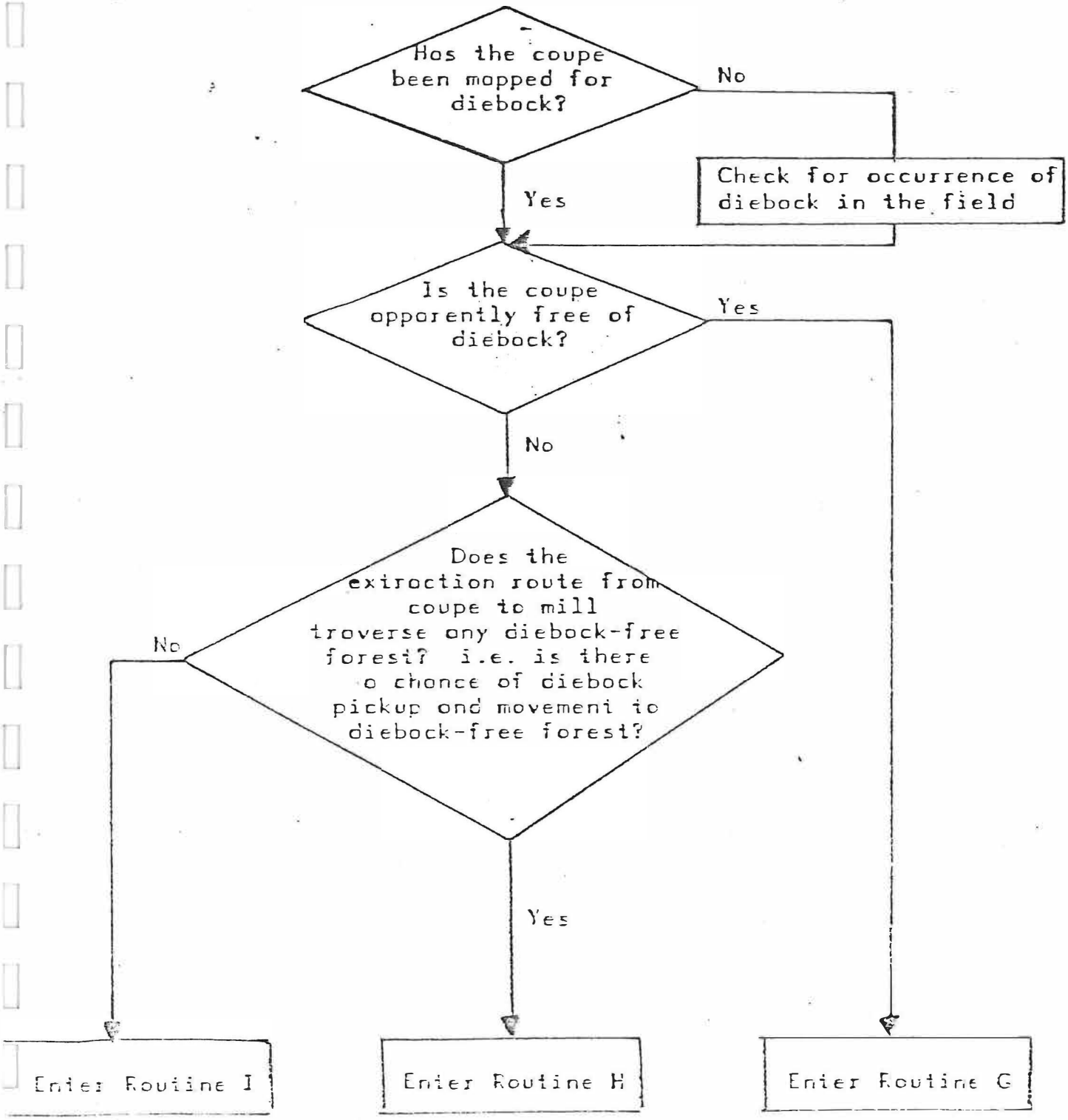
Routine I is a mechanism for prescription and control.

ROUTINE A : DIEBACK IMPACT



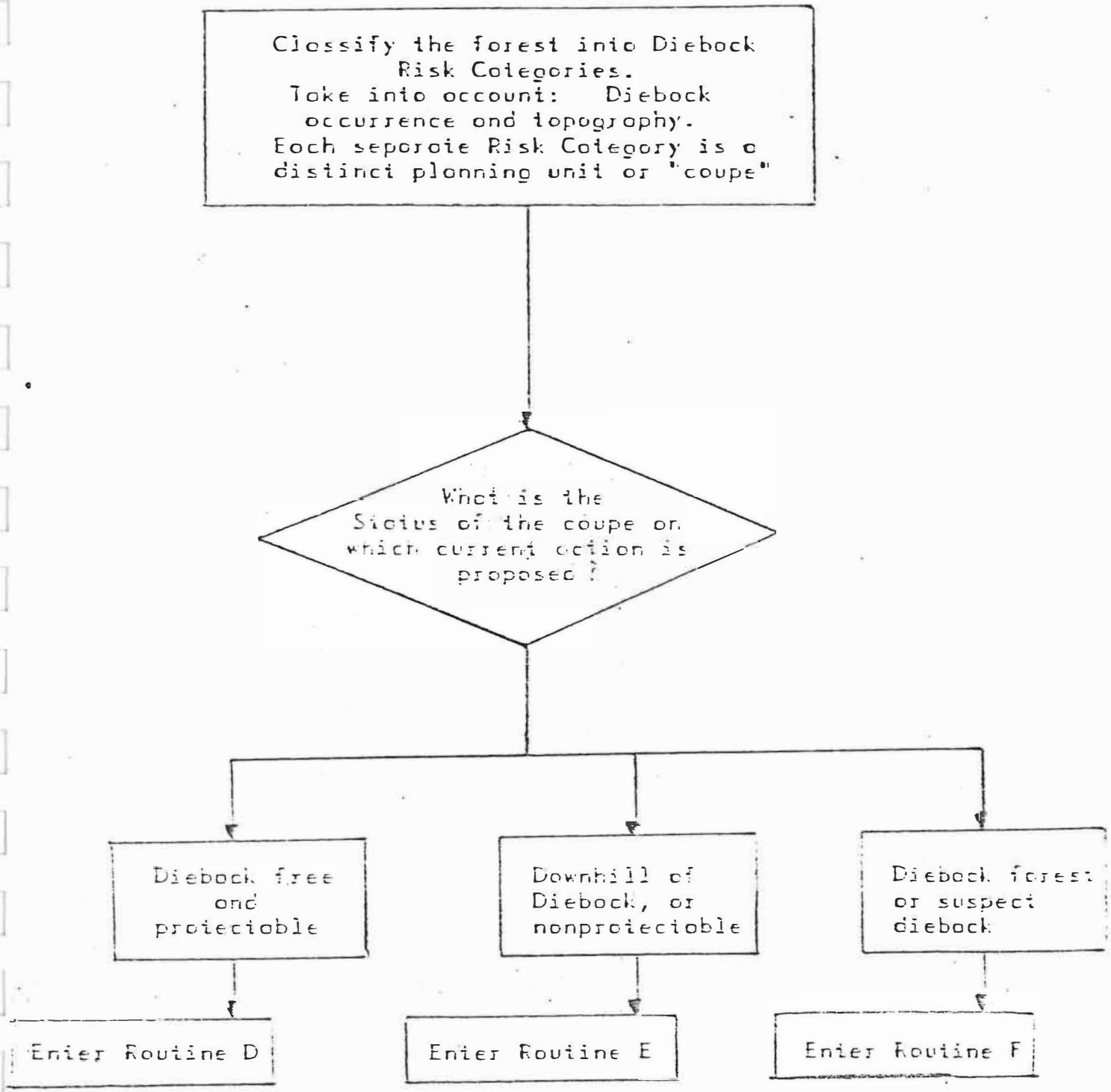
ROUTINE B : DIEBACK TOLERANT FORESTS

For an operation in diebock-tolerant forest:



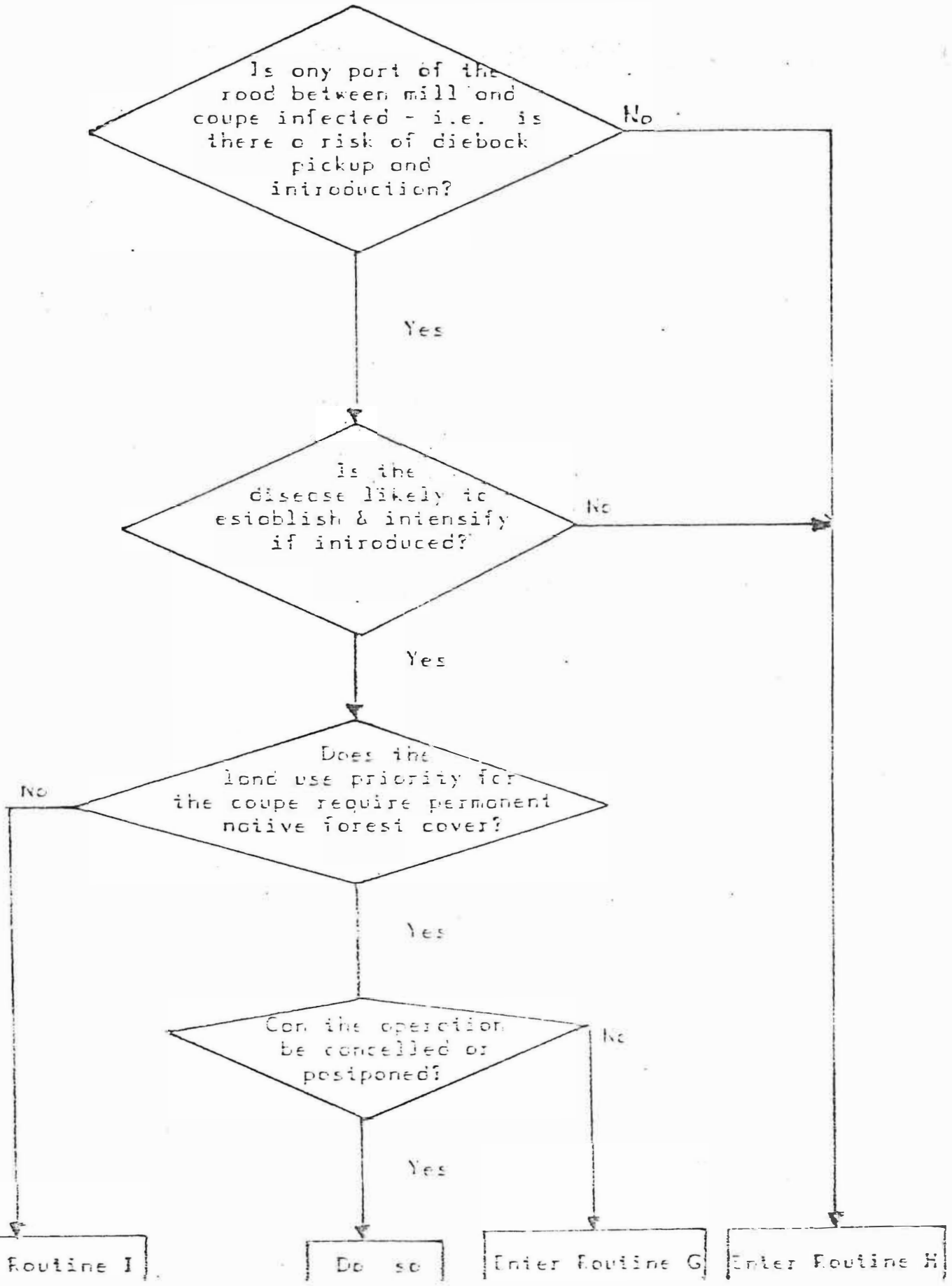
ROUTINE C : DIEBACK RISK CATEGORIES

For forest in which the impact of diebock could be high:



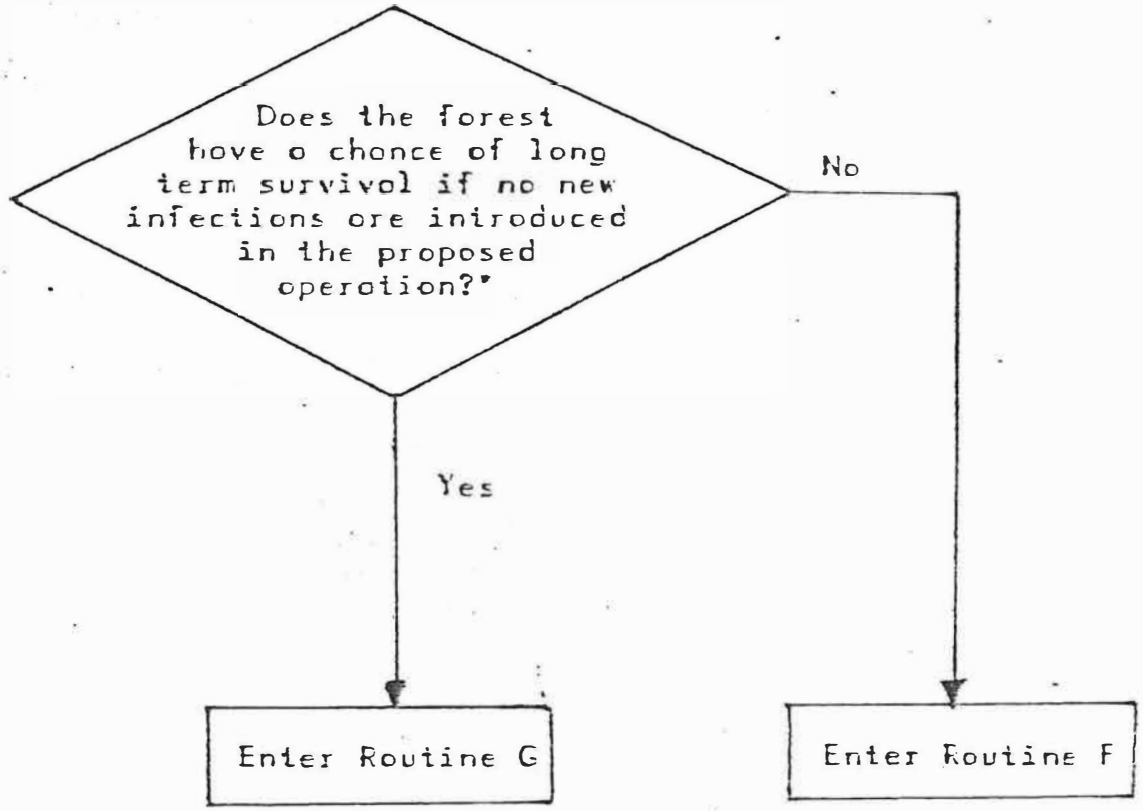
ROUTINE D : THE COUPE IS DIEBACK FREE AND PROTECTABLE

For forest apparently free of infection and upslope of any known infections:-



ROUTINE E : THE COUPE IS NONPROTECTABLE FROM INFECTION

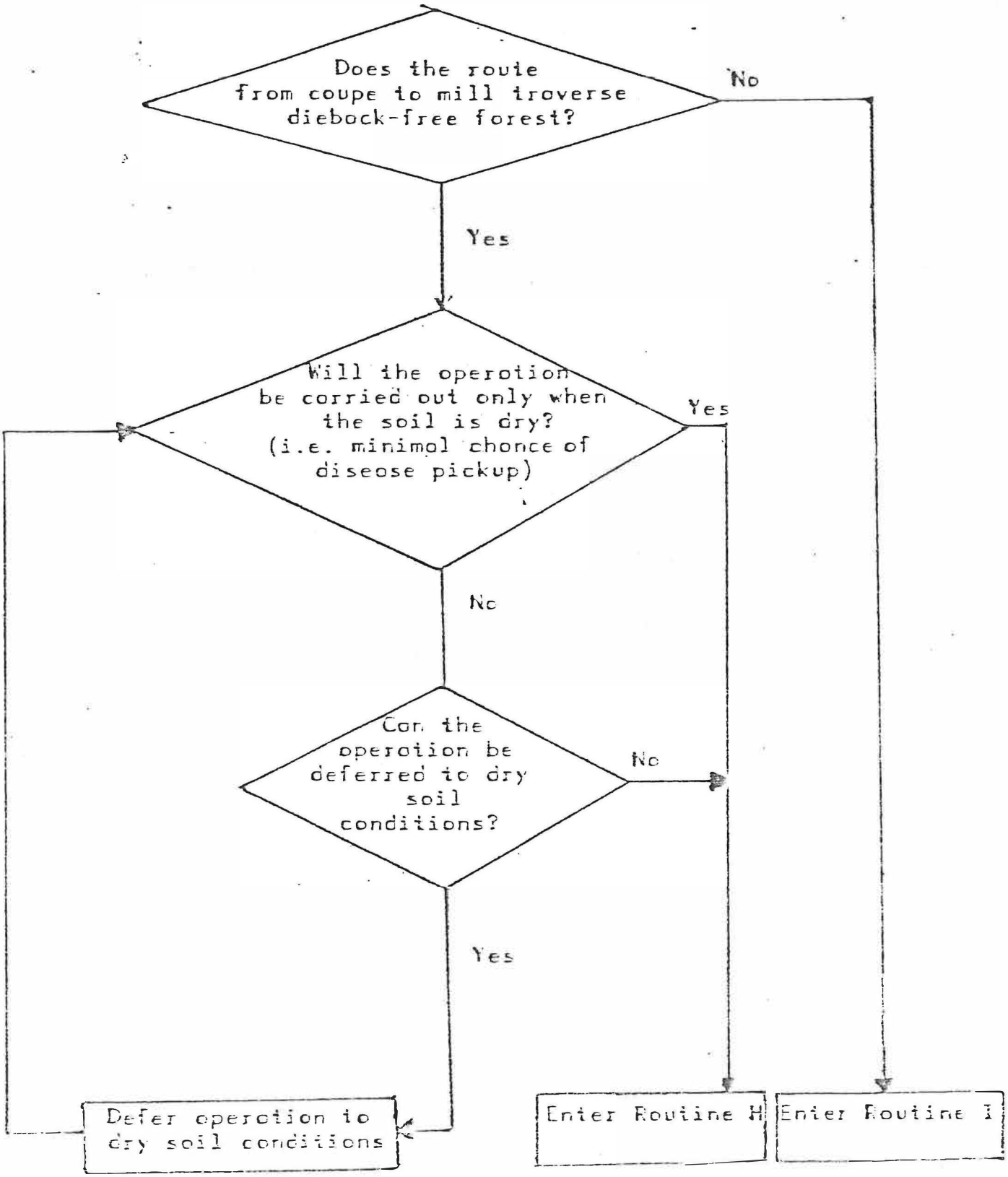
for forest which is downslope of an area already infected with dieback.



* This requires, with present knowledge, a value judgement. If in doubt, check your assessment against that of experienced foresters and research scientists.

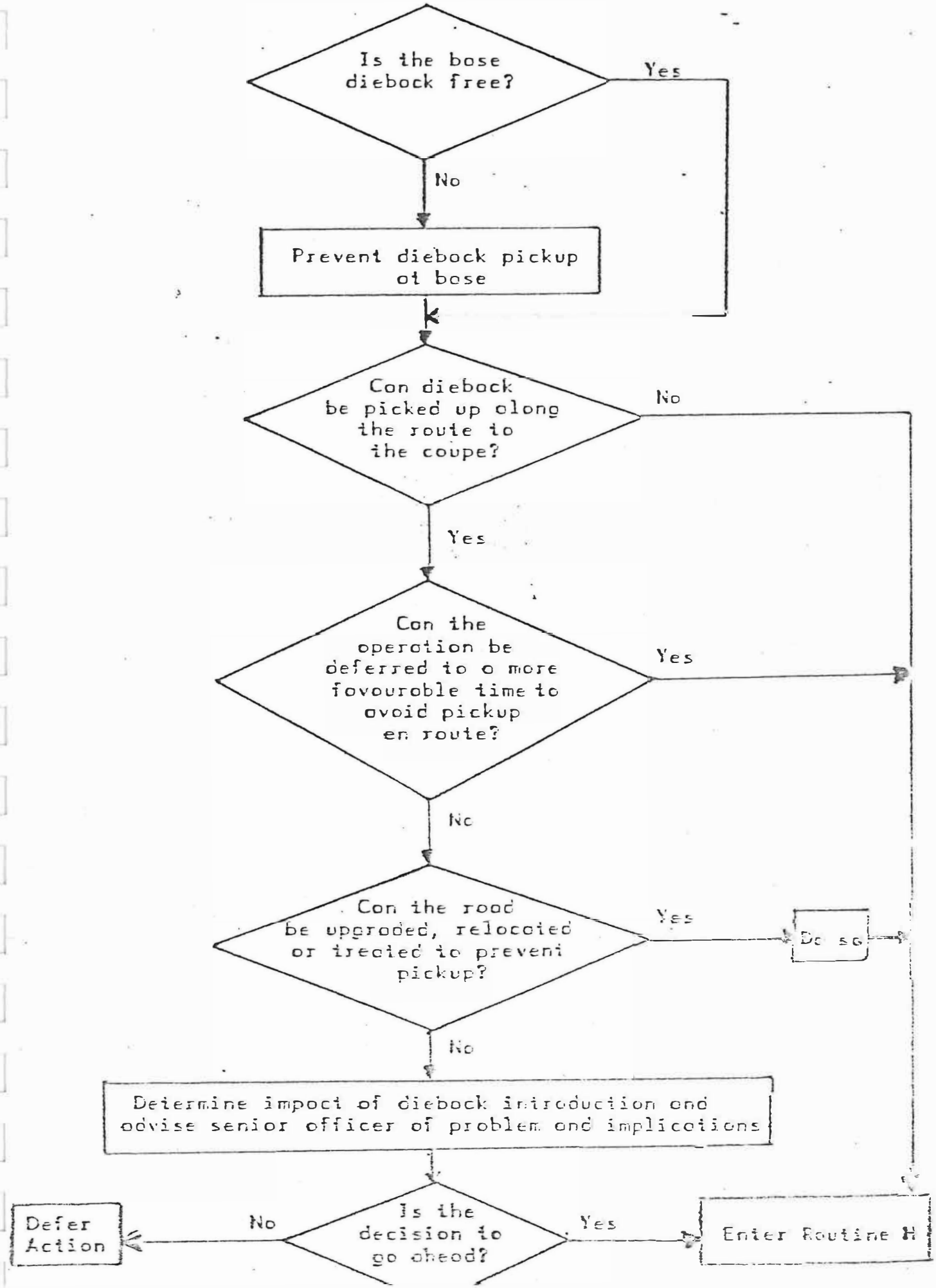
ROUTINE F : THE COUPE IS DIEBACK OR SUSPECT DIEBACK

If an operation is proposed in forest which is already infected, or suspected of being infected, the main risk is of disease pickup and transport to diebock-free forest elsewhere.



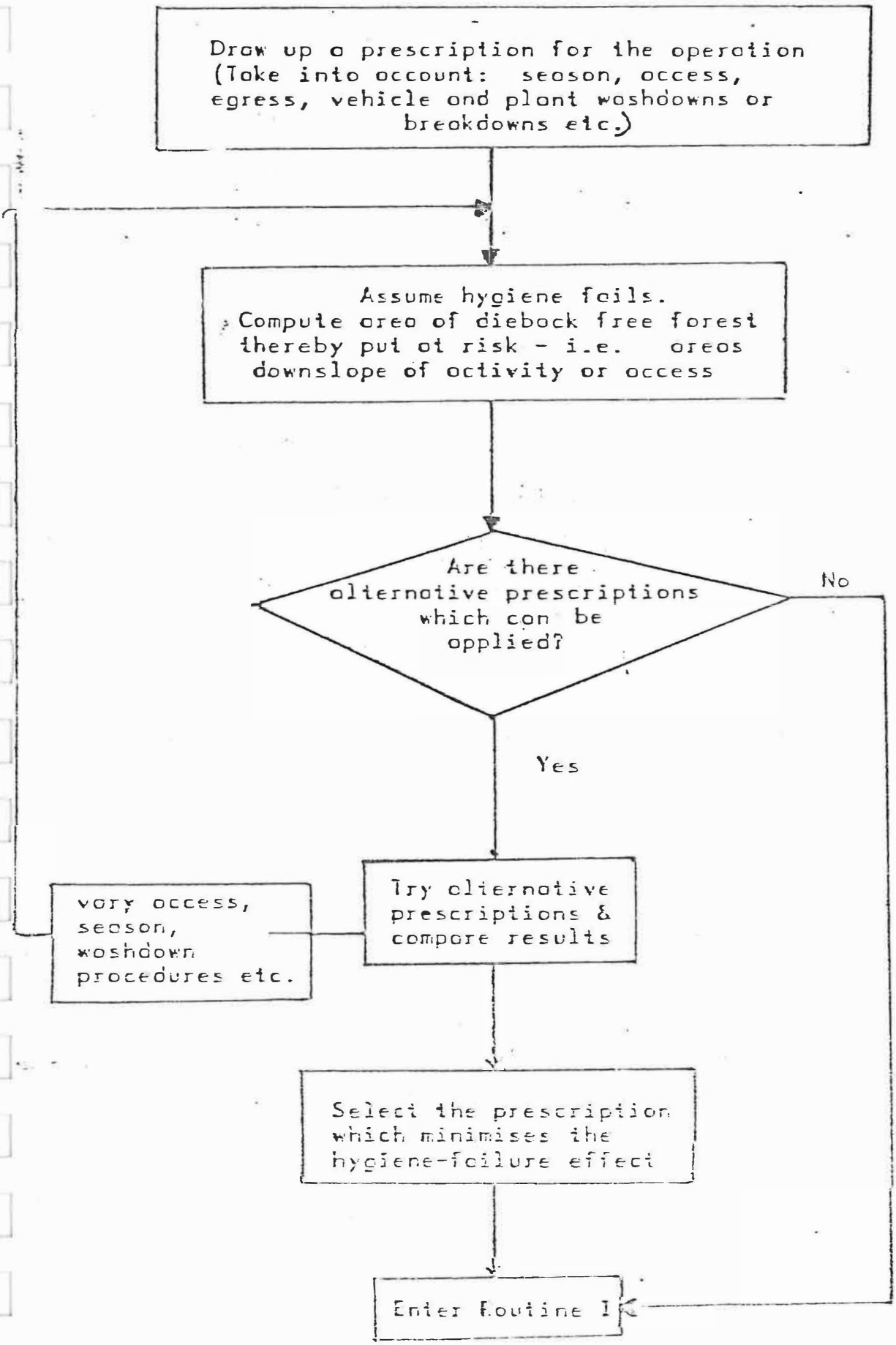
ROUTINE G : ACCESS

For any operation, diebock pickup can occur at the base (i.e. mill landing) or along the route to and from the forest operation.

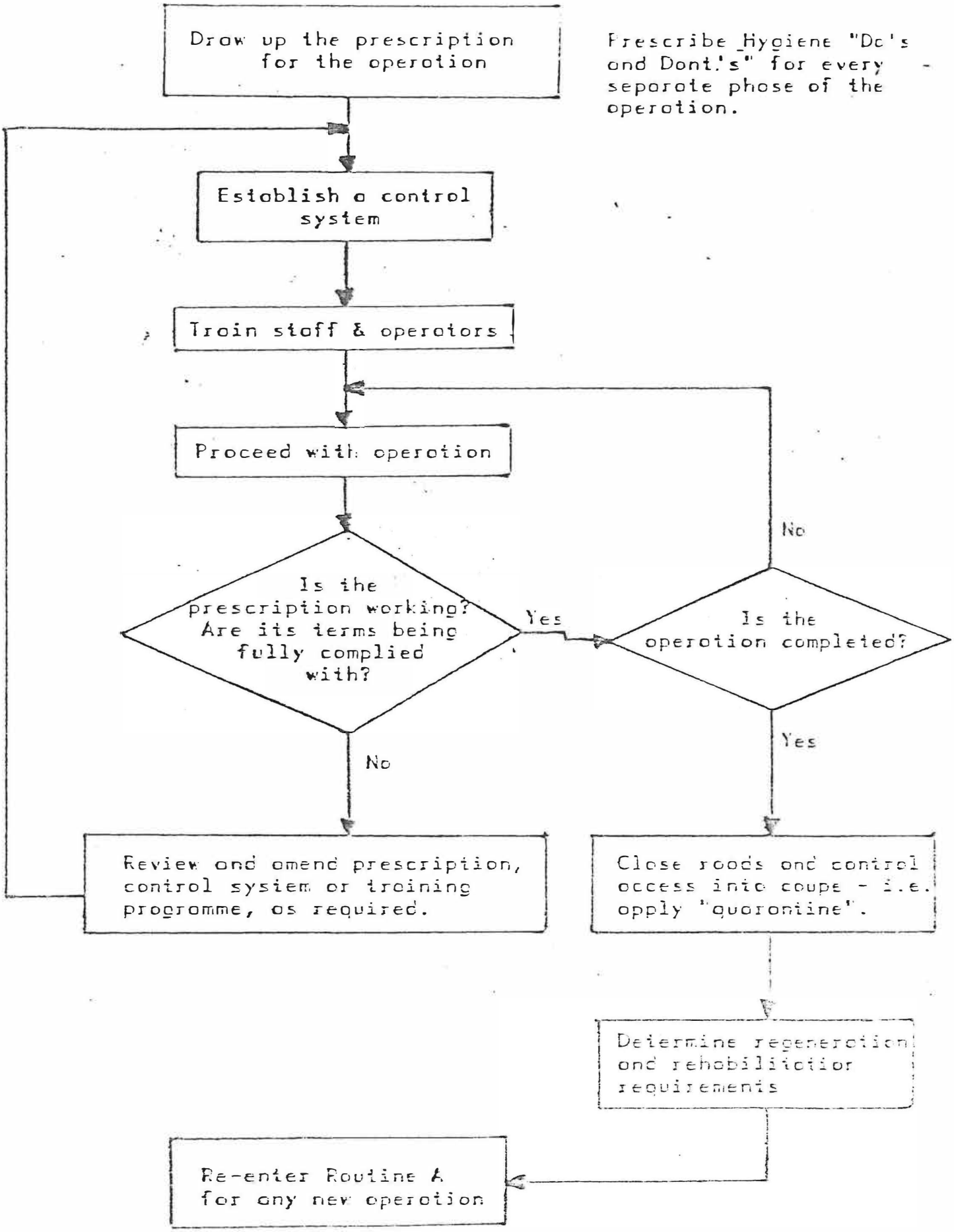


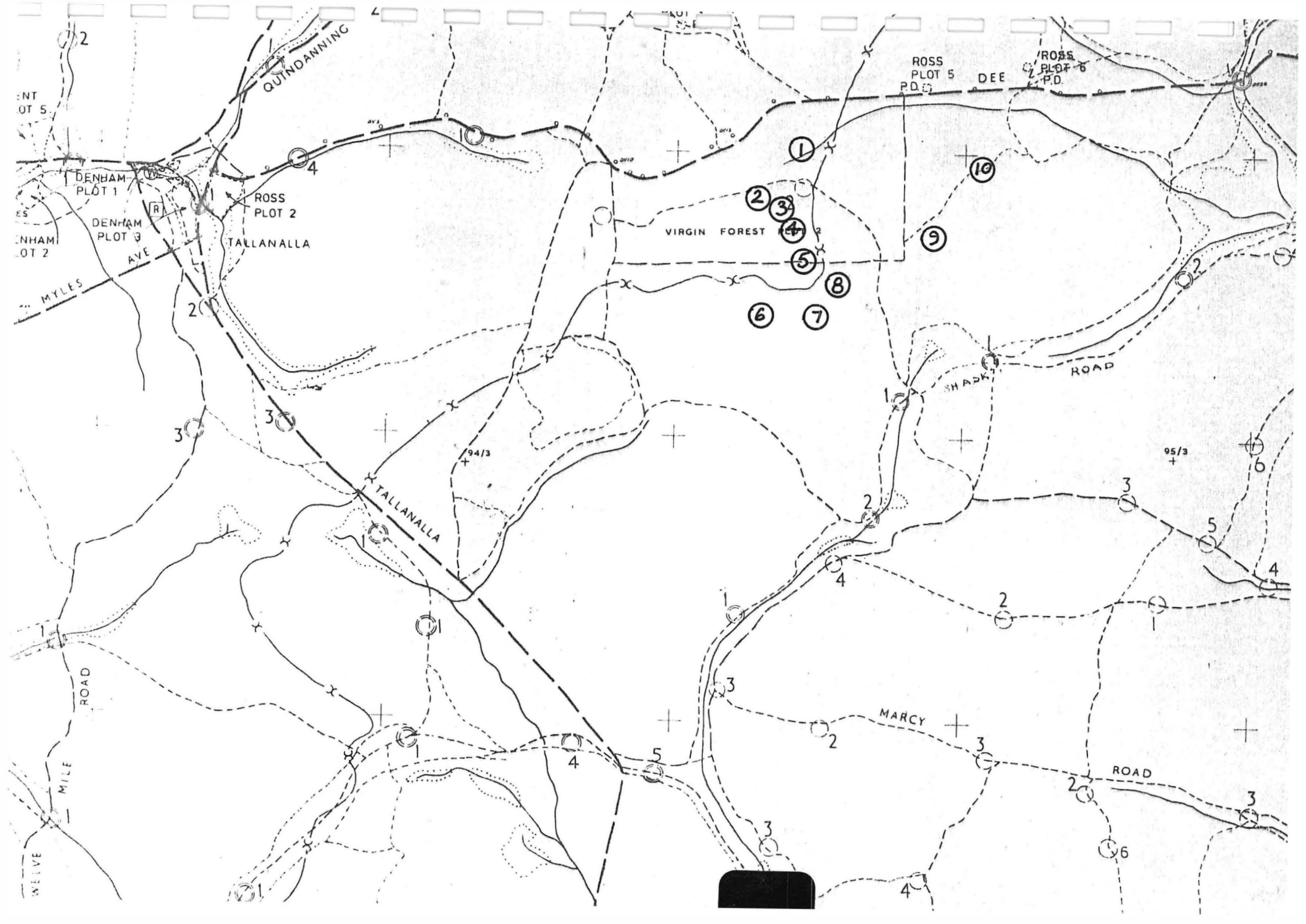
ROUTINE H : THE HYGIENE-FAILURE TEST

For any proposed operation it is necessary to examine the implications of possible hygiene failure.



ROUTINE I : THE OPERATION




QUNDANNING
ROSS PLOT 5 P.D.
DEE
ROSS PLOT 6 P.D.
DENHAM PLOT 1
ROSS PLOT 2
DENHAM PLOT 3
TALLANALLA
AVE
MYLES
VIRGIN FOREST
SHARK
ROAD
94/3
95/3
TALLANALLA
ROAD
MILE
MARCY
ROAD

Pc Recovery Compared with Field Site Interpretation

By Topographical Locations

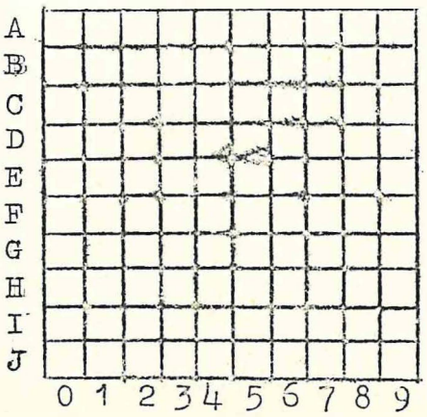
Prepared

Note: Some samples are still undergoing Laboratory Processing

Location Class	Field Interpretation No. of Sites				Laboratory positive Results							% Wrong within Topographical Classes	% Wrong from Total Field Site Interpretations.
					No. of Sites				% Field Interpretation				
	Not Pc	Sus	Pc	Total	Not Pc	Sus	Pc	Total	Not Pc	Sus	Pc		
Gully	21	66	21	108	1	7	10	18	4.8	10.6	47.6	0.9	
Road	22	47	35	104	5	15	28	48	22.7	31.9	80.0	4.8	
Upland	58	85	83	226	7	38	60	105	12.0	44.7	72.3	3.1	2.9%
Total	101	198	139	438	13	60	98	171	12.9	30.3	70.5	-	
VISITED NOT SAMPLED	34	6	51	91								%WRONG INCL. ALL FIELD VISITS	2.4%

70 mm AERIAL FILM FIELD SHEET

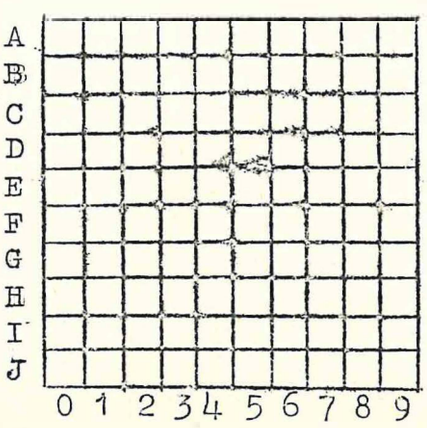
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER	DATE:
FOREST TYPE	JM
NDERSTOREY ESCRIPTION	
ASPECT & LOCATION LASS	
SOIL TYPE	loam sand
NDICATOR SPECIES EATHS	B.grandis ☑ X.preissei ☐ M.reidlei ☐ P.longifolia ☑ E.marginata ☑ OTHER:.....
IEBACK DEATH PATTERN MONGST I.S.D.'S	YES ☐ NO ☑ DESCRIBE:..... ....
LANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☑ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☑ COMMENTS:..... .....
POSSIBLE DISEASE ECTOR	NONE APPARENT ☑ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
THER BSERVATIONS	
PECIES SAMPLED	
NTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☑
OCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

SUBJECT: AN AREA OF FOREST IN WHICH THE INTEREST FOR THE PRESENCE OF

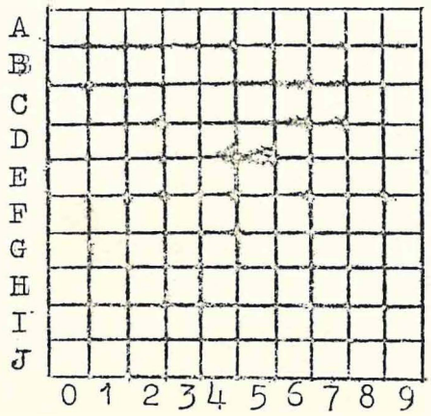
70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER	DATE:
FOREST TYPE	
NDERSTOREY DESCRIPTION	
SPECT & LOCATION LASS	
OIL TYPE	
INDICATOR SPECIES EATHS	B.grandis ☐ X.preissei ☑ M.reidlei ☑ P.longifolia ☐ E.marginata ☑ OTHER:.....
DIEBACK DEATH PATTERN MONGST I.S.D.'S	YES ☑ NO ☐ DESCRIBE:..... .....
LANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☑ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE ACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☑ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:.....
POSSIBLE DISEASE ECTOR	NONE APPARENT ☑ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
THER OBSERVATIONS	
PECIES SAMPLED	
NTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☑
OCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

70 mm AERIAL FILM FIELD SHEET

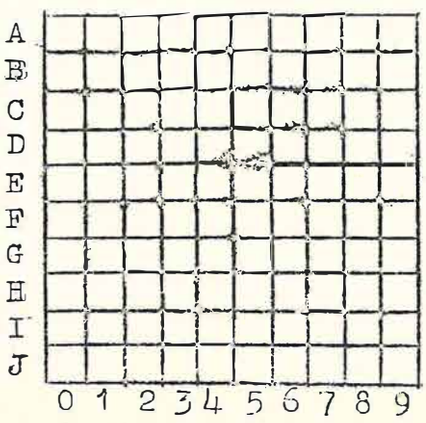
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	Virgin
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	loam - gravel
INDICATOR SPECIES DEATHS	B.grandis ☑ X.preissei ☐ M.reidlei ☑ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☑ DESCRIBE:..... ....
PLANT DEATHS	SUDDEN DEATH ☑ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☑ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☑ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☑ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

SET OUT BELOW IN WHICH LIE EVIDENCE FOR THE PRESENCE OR

70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER	DATE:
FOREST TYPE	Virgin Jarrah.
NDERSTOREY DESCRIPTION	
SPECT & LOCATION LASS	
OIL TYPE	
INDICATOR PECIES EATHS	B.grandis ☑ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN MONGST I.S.D.'S	YES ☑ NO ☐ DESCRIBE:..... ..... :.....
LANT DEATHS	SUDDEN DEATH ☑ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE ACTORS	ROCK OUTCROPS ☑ DROUGHT PRONE AREA ☑ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE ECTOR	NONE APPARENT ☑ ROADSIDE ☐ TRACK ☐ ANIMAL ☑ OTHER:.....
THER OBSERVATIONS	
SPECIES SAMPLED	
NTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☑
OCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER | DATE:

FOREST TYPE J.M.

NDERSTOREY DESCRIPTION

SPECT & LOCATION LASS

OIL TYPE Mainly gravel.

INDICATOR PECIES EATHS

B.grandis ☑ X.preissei ☐ M.reidlei ☑ P.longifolia ☐

E.marginata ☑ OTHER:.....

DIEBACK DEATH PATTERN MONGST I.S.D.'S

YES ☑ NO ☐ DESCRIBE:.....

.....

.....

LANT DEATHS

SUDDEN DEATH ☑ ½ DEATH ☐ DEATH BY STAGES ☑ OLD AGE ☐ FIRE ☑ EPPICORMICS PRESENT ☐

COPPOCING ☐ COMMENTS:.....

SITE ACTORS

ROCK OUTCROPS ☑ DROUGHT PRONE AREA ☑ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐

COMMENTS:.....

.....

POSSIBLE DISEASE ECTOR

NONE APPARENT ☐ ROADSIDE ☑ TRACK ☐ ANIMAL ☐

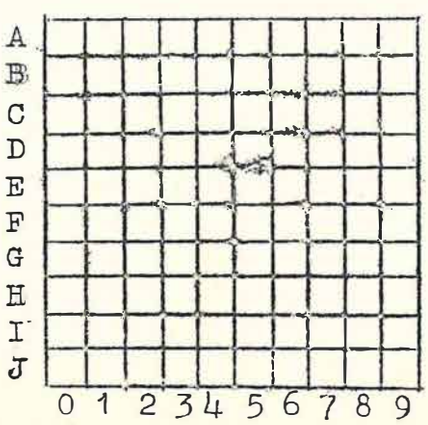
OTHER: Logging.....

THER OBSERVATIONS Spread from old death site.

SPECIES SAMPLED

NTERPRETATION DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☑

LOCATION FORMATION



ROLL NO. .....

FRAME NO. .....

FRAME REF: .....

SAMPLE RESULT:.....

70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER | DATE:

FOREST TYPE

UNDERSTOREY DESCRIPTION

ASPECT & LOCATION CLASS

SOIL TYPE

INDICATOR SPECIES DEATHS

B.grandis ☑ X.preissei ◪ M.reidlei ☑ P.longifolia ☐

E.marginata ☐ OTHER:.....

DIEBACK DEATH PATTERN AMONGST I.S.D.'S

YES ☐ NO ☑ DESCRIBE: Sheoak - sand gravel - more drought

PLANT DEATHS

SUDDEN DEATH ☐ ½ DEATH ☑ DEATH BY STAGES ☑ OLD AGE ☐ FIRE ☑ EPPICORMICS PRESENT ☐

COPPOCING ☐ COMMENTS: 1 Sudden death - Drought

SITE FACTORS

ROCK OUTCROPS ☑ DROUGHT PRONE AREA ☑ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐

COMMENTS:.....

POSSIBLE DISEASE VECTOR

NONE APPARENT ☑ ROADSIDE ☐ TRACK ☐ ANIMAL ☐

OTHER:.....

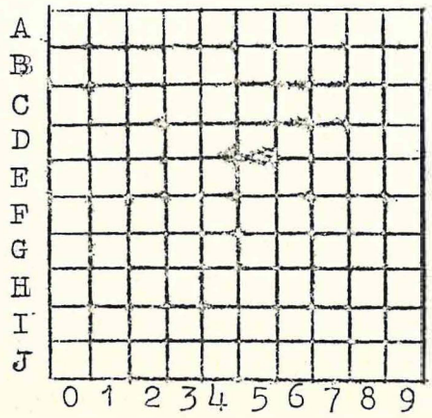
OTHER OBSERVATIONS

SPECIES SAMPLED

INTERPRETATION

DIEBACK FREE ☐ SUSPECT ☑ But DIEBACK ☐

LOCATION FORMATION



ROLL NO. .....

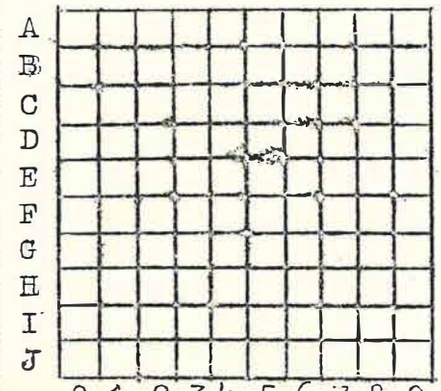
FRAME NO. .....

FRAME REF: .....

SAMPLE RESULT:.....

70 mm AERIAL FILM FIELD SHEET

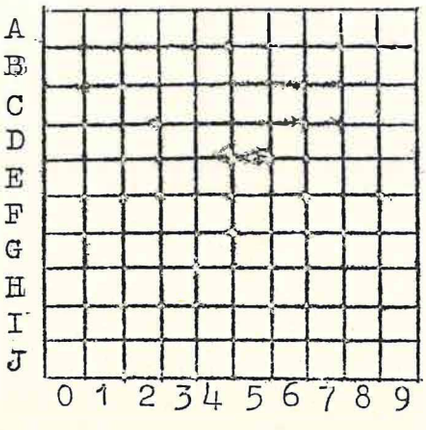
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER	DATE:
FOREST TYPE	
NDERSTOREY DESCRIPTION	
SPECT & LOCATION LASS	
OIL TYPE	
INDICATOR SPECIES EATHS	B.grandis ☑ X.preissei ☐ M.reidlei ☑ P.longifolia ☐ E.marginata ☐ OTHER: Some Zanai dying off.
DIEBACK DEATH PATTERN MONGST I.S.D.'S	YES ☑ NO ☐ DESCRIBE: .....
LANT DEATHS	SUDDEN DEATH ☑ ½ DEATH ☐ DEATH BY STAGES ☑ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS: .....
SITE FACTORS	ROCK OUTCROPS ☑ DROUGHT PRONE AREA ☑ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS: .....
POSSIBLE DISEASE TECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☑ ANIMAL ☐ OTHER: .....
THER OBSERVATIONS	
SPECIES SAMPLED	
NTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☑
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT: .....

THE INTERPRETER FOR THE PRESENCE OR

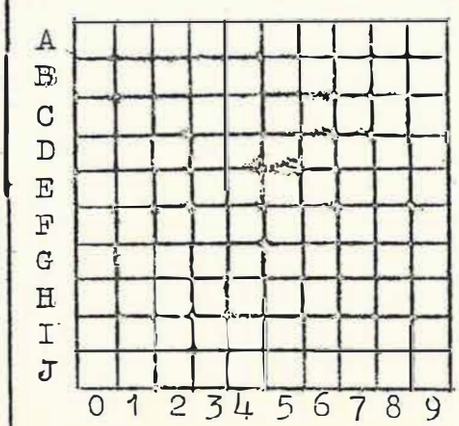
70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER	DATE:
FOREST TYPE	
NDERSTOREY ESCRIPTION	
ASPECT & LOCATION LASS	
SOIL TYPE	
NDICATOR SPECIES EATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
IEBACK DEATH PATTERN MONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ....
LANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
OSSIBLE DISEASE ECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
THER OBSERVATIONS	
PECIES SAMPLED	
NTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
OCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

70 mm AERIAL FILM FIELD SHEET

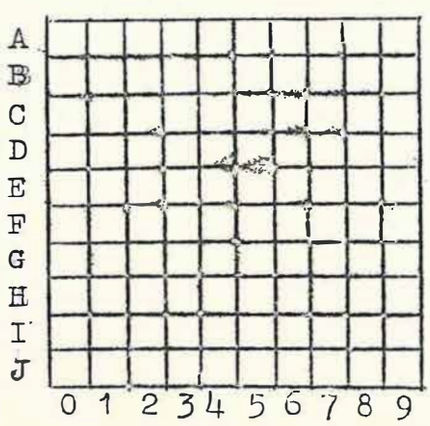
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

INSPECT AN AREA OF FOREST IN WHICH THE EVIDENCE FOR THE PRESENCE OR

70 mm AERIAL FILM FIELD SHEET

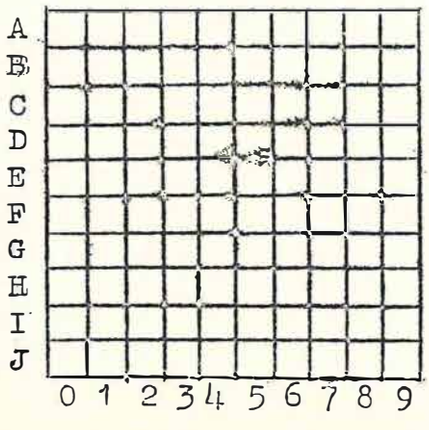
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

SUSPECT: AN AREA OF FOREST IN WHICH THE EVIDENCE FOR THE PRESENCE OR

70 mm AERIAL FILM FIELD SHEET

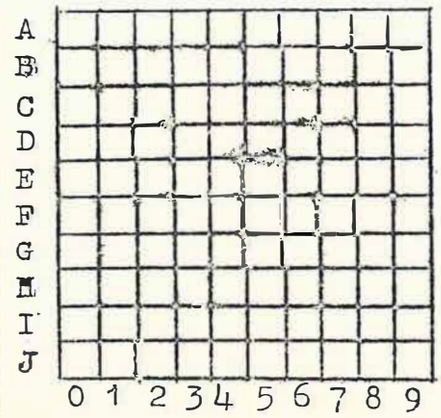
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

...THE TISSUE FOR THE PRESENCE OR

70 mm AERIAL FILM FIELD SHEET

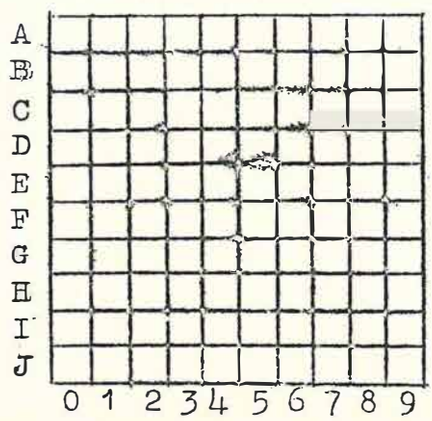
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

IMPORTANT - USE AREA ON PHOTO WHICH PUT EVIDENCE FOR THE PRESENCE OR

70 mm AERIAL FILM FIELD SHEET

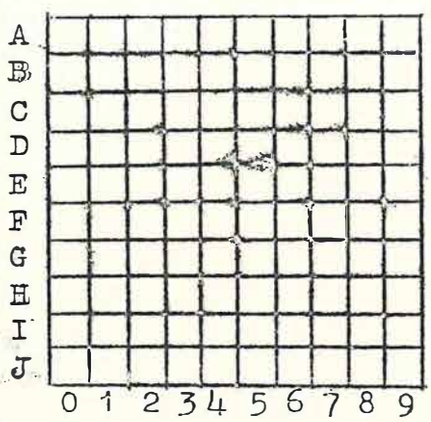
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... .....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:.....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

INSPECT: AN AREA OF FOREST IN WHICH THE EVIDENCE FOR THE PRESENCE OR

70 mm AERIAL FILM FIELD SHEET

FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

INTERPRETER	DATE:
FOREST TYPE	
UNDERSTOREY DESCRIPTION	
ASPECT & LOCATION CLASS	
SOIL TYPE	
INDICATOR SPECIES DEATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH PATTERN AMONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ..... :.....
PLANT DEATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE FACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE DISEASE VECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
OTHER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....

SUSPECT: AN AREA OF FOREST IN WHICH THE EVIDENCE FOR THE PRESENCE OR

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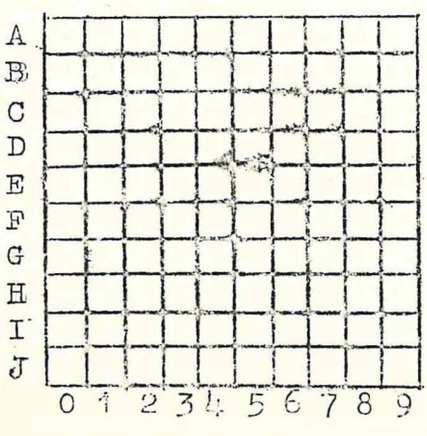
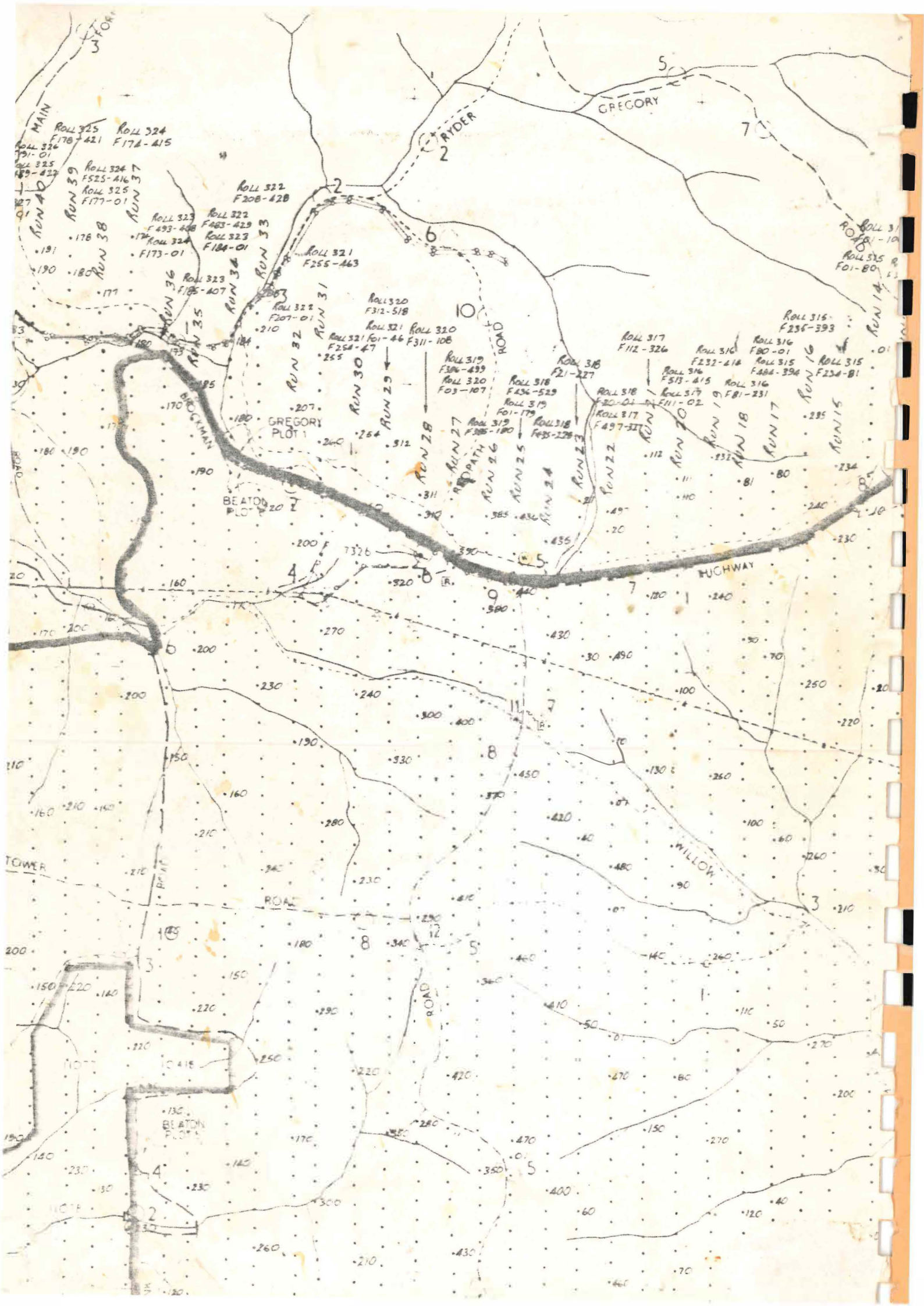
FIELD OBSERVATIONS & I.S.D. TISSUE SAMPLE INFORMATION

NTERPRETER	DATE:
OREST TYPE	
NDERSTOREY DESCRIPTION	
SPECT & LOCATION LASS	
OIL TYPE	
INDICATOR PECIES EATHS	B.grandis ☐ X.preissei ☐ M.reidlei ☐ P.longifolia ☐ E.marginata ☐ OTHER:.....
DIEBACK DEATH ATTERN MONGST I.S.D.'S	YES ☐ NO ☐ DESCRIBE:..... ..... :.....
PLANT EATHS	SUDDEN DEATH ☐ ½ DEATH ☐ DEATH BY STAGES ☐ OLD AGE ☐ FIRE ☐ EPPICORMICS PRESENT ☐ COPPOCING ☐ COMMENTS:.....
SITE ACTORS	ROCK OUTCROPS ☐ DROUGHT PRONE AREA ☐ COMP-ETITION ☐ WATER GAINING DEPRESSION ☐ CREEK ☐ COMMENTS:..... .....
POSSIBLE ISEASE ECTOR	NONE APPARENT ☐ ROADSIDE ☐ TRACK ☐ ANIMAL ☐ OTHER:.....
THER OBSERVATIONS	
SPECIES SAMPLED	
INTERPRETATION	DIEBACK FREE ☐ SUSPECT ☐ DIEBACK ☐
LOCATION FORMATION	 ROLL NO. ..... FRAME NO. ..... FRAME REF: ..... SAMPLE RESULT:.....


GREGORY
RYDER
MAIN
ROAD
HIGHWAY
WILLOW
TOWER
ROAD
GREGORY PLOT 1
BEATON PLOT 2
BEATON PLOT 3
RUN 40
RUN 39
RUN 38
RUN 37
RUN 36
RUN 35
RUN 34
RUN 33
RUN 32
RUN 31
RUN 30
RUN 29
RUN 28
RUN 27
RUN 26
RUN 25
RUN 24
RUN 23
RUN 22
RUN 21
RUN 20
RUN 19
RUN 18
RUN 17
RUN 16
RUN 15
ROLL 325 F178-421
ROLL 324 F174-415
ROLL 326 F91-01
ROLL 325 F159-427
ROLL 324 F525-416
ROLL 325 F177-01
ROLL 322 F208-428
ROLL 323 F493-498
ROLL 324 F173-01
ROLL 322 F483-429
ROLL 323 F184-01
ROLL 323 F185-407
ROLL 321 F255-463
ROLL 322 F207-01
ROLL 320 F312-518
ROLL 321 F01-46
ROLL 321 F254-47
ROLL 320 F311-108
ROLL 319 F386-499
ROLL 320 F03-107
ROLL 318 F436-529
ROLL 319 F01-179
ROLL 319 F385-180
ROLL 318 F435-228
ROLL 318 F21-227
ROLL 317 F112-326
ROLL 318 F20-01
ROLL 317 F497-321
ROLL 316 F232-418
ROLL 316 F513-415
ROLL 317 F111-02
ROLL 316 F80-01
ROLL 315 F484-394
ROLL 316 F81-231
ROLL 316 F236-393
ROLL 315 F234-81
ROLL 325 F01-80