Macroscale Detection of Eucalypt Crown Dieback

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Contents

1. INTRODUCTION

The mascroscale methods of detecting eucalypt dieback may be grouped into road surveys, ground surveys, aerial surveys and satellite surveys. This paper will review the use of these methods in Australia.

The aim of macroscale detection of eucalypt dieback is to determine the location and extent of the disorder. Where the disorder is caused by a pathogen such as *Phytophthora cinnamomi*, macroscale detection of symptoms may be several seasons behind the actual occurrence of the pathogen, depending on seasonal conditions, soil type, topography and understorey vegetation. In such cases it must be accepted that mapping by macroscale methods is likely to under-estimate the actual distribution of a pathogen and the area that is likely to become diseased.

2. ROAD SURVEYS

These consist of observations made from a motor vehicle. They have been used for detecting dieback due to *P. cinnamomi* in Western Australia (Western Australia Forests Department unpublished reports, Podger 1966, Titze 1970), and Victoria (Podger and Ashton 1970, Weste and Taylor 1971). In 1966 a rapid survey of forest along the coastal highway between Beerwah, Queensland, and Bateman's Bay, New South Wales, revealed no sign of disease comparable to that in the jarrah (*Eucalyptus marginata*) forests of Western Australia (Podger and Ashton, 1970).

As *P. cinnamomi* is generally associated with roads this method is partly successful but cannot give a complete picture where infection is spread, for example, by mineral exploration or water moving down gullies.
Road surveys are used for the detection of jarrah leaf miner, *Perthida glyphopa* (Lepidoptera: Incurvariidae) in Western Australia (Western Australia Forests Department unpublished reports), but as attack by this insect is not known to be causally related to roads, the method is only a rough guide to eucalypt dieback caused by *P. glyphopa.*

Similar comments would probably apply to road surveys of the phasmatid *Didymuria violescens* in Victoria and New South Wales.

Biennial surveys of insects infesting trees bordering a route of some 1000 km extending from Canberra to Euroa in Victoria, have been carried out during the past eight years (Carne 1965, 1973).

In general, road surveys are a cheap first approach to detecting eucalypt dieback but more comprehensive survey methods would generally be needed to provide a complete picture.

3. GROUND SURVEYS

3.1 Random Observations

Information from random ground observation, such as bushwalking, has only limited use because of its unreliable nature.

3.2 Plots

Information from timber assessment plots and the survey ties to them, is used in Western Australia to record the occurrence of *P. cinnamomi* and *Armillaria mellea* in karri (*Eucalyptus diversicolor* F. Muell), forest, jarrah leaf miner, and fire damage. Numerical codes indicate the severity of attack from each source. Information gathered in this way is well documented with respect to location and date and can easily be transferred from field sheets to maps when desired.

In Tasmania mortality recorded on permanent yield plots first pointed to the occurrence of regrowth dieback (Felton, 1972).

3.3 Strip Lines

Ground survey data from strip lines measured to detect eucalypt crown dieback have been used in Western Australia to record the occurrence of *P. cinnamomi*, and in Tasmania to map gully dieback on the east coast (Tasmania Forestry Commission, 1973). This method has the advantage of combining the ground check with the survey, but is time consuming. When aerial methods are too costly or unreliable this is the most useful alternative.

4. AERIAL SURVEYS

4.1 Visual Reconnaissance

The simplest form of aerial surveys is visual reconnaissance and this has been used to detect *P. cinnamomi* in Victoria (Marks *et al*., 1972) and in Western Australia. There are problems of knowing exactly what part of the forest is being observed and, in Western Australia, a tendency was noticed to over-estimate the area infected as compared to that determined from aerial photographic interpretation.

This method can be useful to check specific areas and is not too costly if the plane is already available.

4.2 Air Photos

The other significant use of aerial survey involves the interpretation of air photos.

In general terms, the basis of remote sensing is that each object has characteristic properties of absorption, emission, reflectance, scattering, and transmission of electromagnetic wavelengths. By using instruments which are sensitive enough it is theoretically possible to identify any object by its unique combination of electromagnetic wavelength characteristics. Even when the instruments are not particularly sensitive, as with some existing film and filter combinations, it is still possible to identify many objects. This is the challenge of remote sensing with aerial photographs. The state of the art is still such that each object of interest, or in the context of this seminar, each patch of affected forest under investigation, has to be studied separately to see which film, filter and scale combinations can detect its identifying characteristics (Murtha, 1969).

In Victoria, air photos have been used in phasmatid studies (Newman 1964, Mazenec 1967). There are no

Table 1: Summary of Film Type, Scale, Format tried in Western Australia

FILM TYPE AND SCALE	*FORMAT*	*SUBJECT*	*RESULTS*
Black and White Print			
1 : 7920	23 x 23 cm	*P. cinnamomi*	Good
1 : 15840	23 x 23 cm	*P. cinnamomi*	Good
		Fire	Good
		Leaf miner	Poor
1 : 40000	23 x 23 cm	*P. cinnamomi*	Very Good
1 : 86000	23 x 23 cm	*P. cinnamomi*	Fair (location problems)
1 : 100000	Mosaic	*P. cinnamomi*	Fair (severe location problems)
1 : 3500	70 mm	*P. cinnamomi*	Poor
Colour Print			
1 : 15840	23 x 23 cm	*P. cinnamomi*	Poor (too much green)
1 : 3500	70 mm	*P. cinnamomi*	Good
1 : 4000	70 mm	*P. radiata* drought deaths	Good
Colour Transparency			
1 : 2500	70 mm	*P. cinnamomi*	Very good
1 : 3500	70 mm	*P. cinnamomi*	Very good
Colour Infra-red Transparency			
1 : 2500	70 mm	*P. cinnamomi*	Fair
1 : 4000	70 mm	*P. radiata* drought deaths	Fair
1 : 30000	70 mm	Fire control evaluation	Good

Table 2: Summary of Film Type, Scale, Format tried in Tasmania

FILM TYPE AND SCALE	*FORMAT*	*SUBJECT*	*RESULTS*
Colour Transparency from Kodak type 2445			
1 : 1000	70 mm	Euc. Regrowth Dieback	Fair
1 . 2000	70 mm	Euc. Regrowth Dieback	Fair
1 : 3000	70 mm	Euc. Regrowth Dieback	Good
1 : 4000	70 mm	Euc. Regrowth Dieback	Fair
1 : 6000	70 mm	Euc. Regrowth Dieback	Fair
1 : 8000	70 mm	Euc. Regrowth Dieback	Poor
Colour Infra-Red Transparency from Kodak film type 2443			
1 : 2000	70 mm	Euc. Regrowth Dieback	Poor
1 : 4000	70 mm	Euc. Regrowth Dieback	Poor

reports of the use of air photos to detect *P. cinnamomi* in Victoria* or New South Wales.

In Tasmania air photos have been used to map gully dieback in the Fingal district (Palzer, 1973), regrowth dieback in southern forests (Myers, 1973) and high altitude *E. delegatensis* dieback (Tasmanian Forestry Commission 1973).

Large-scale colour photos were used successfully in Western Australia to detect *P. radiata* drought deaths and this indicates that the technique could be worth trying on crown disorders in eucalypt plantations and possibly in national parks.

In Western Australia air photos were first used for mapping jarrah dieback in 1960 (Sims, 1960) although routine air photo interpretation of forest types since 1957 has revealed patches of open and 'dieback' forest. Air photos have been used to map the damage from the Dwellingup fire of 1961 and have been used in an attempt to map the distribution of jarrah leaf miner . (Table 1 summarises the film and scale combinations used in Western Australia.)

The most useful air photos for mapping dieback in the northern region were 1 : 40 000 scale black-and-white 23 x 23 cm format. In the southern region, due to different understorey species, *P. cinnamomi* does not render the jarrah forest as open as in the north and 1 : 40 000 photos used in conjunction with 1 : 3000 scale, 70 mm format, colour film taken as sample strips have been the most successful to date (Bradshaw, 1972).

Colour infra-red photos have not proved successful for detecting jarrah dieback or leaf miner, but show promise in monitoring the quality of aerial control burns (Bradshaw, 1971).

As an indication of work rates and the need to ground check air photo interpretation, 480 000 ha were searched on 1 : 40 000, 23 x 23 cm photos for 34 000 ha of dieback in 40 man-days of interpretation and 15 man-days of field checks. The work was carried out in Western Australia in 1969 by experienced interpreters.

4.3 Tests of Accuracy

In Western Australia ground survey strip lines were used to check the accuracy of the 1966 air photo mapping of jarrah dieback (Forests Department of Western Australia, unpublished reports). The results indicated that the area of diseased forest was underestimated by about 5 per cent, and that the reliability

* *Ed. note.* Also investigated by McKimm, F. C. V. and Weste, Univ. of Melbourne. Information submitted after seminar.

Table 3: Summary of Film Type, Scale, Format tried in Victoria (McKimm, Vic. For. Comm., unpublished).

FILM TYPE AND SCALE	*FORMAT*	*SUBJECT*	*RESULTS*
VERTICAL PHOTOGRAPHY			
Black and White Print			
1 : 24000	23 x 23 cm	All forms of crown dieback	Good
1 : 15840	23 x 23 cm	*P. cinnamomi*	Good
Colour Print			
1 : 25600	23 x 23 cm	All forms of crown dieback	Poor. Too much green.
Colour Transparencies			
1 : 54900	35 mm	*P. cinnamomi*	Very poor. Haze excessive. 50 mm lens.
1 : 36600	35 mm	All forms of crown dieback	Fair. 35 mm lens.
1 : 33100	35 mm	*P. cinnamomi*	Fair. 35 mm lens.
1 : 30500	35 mm	All forms of crown dieback	Good. Excessive radial displacement and hotspot are undesirable characteristics of 20 mm lens used.
1 : 17400	35 mm	All forms of crown dieback	Very good. 35 mm lens.
1 : 15700	35 mm	All forms of crown dieback	Good. 35 mm lens.
1 : 12200	35 mm	All forms of crown dieback	Good. 35 mm lens.
Colour I.R. Transparencies			
1 : 54900	35 mm	*P. cinnamomi*	Poor. 50 mm lens.
1 : 33100	35 mm	*P. cinnamomi*	Fair. 35 mm lens.
OBLIQUE PHOTOGRAPHY			
Colour Prints			
Flying height 1000 ft. above ground level. (A.G.L.)	35 mm	*P. cinnamomi*	Low oblique—fair. High oblique—poor.
1000 ft. (A.G.L.)	35 mm	All forms of crown dieback	Low oblique—good. High oblique—good.
Colour Transparencies			
1000-2000 ft. A.G.L.	35 mm	Phasmatid defoliation	Low oblique—fair. High oblique—poor.
Colour I.R. Transparencies			
600-1000 ft. A.G.L.	35 mm	Phasmatid defoliation	Low oblique—excellent. High oblique—very good.

of the interpretation of affected areas was about 73 per cent. Ground assessment plots used to check the 1969 air photo mapping of jarrah dieback indicated a 6 per cent over-estimate of affected forest.

5. SATELLITE SURVEYS

So far satellite surveys have not been used to map forest disorders in Australia. Although the results of the recent series of Earth Resources Technology Satellite (E.R.T.S.) photographs have not been seen by the author, it is considered unlikely that a disorder, if detected on satellite photos, could be mapped with sufficient accuracy to allow field checking. However, technology will no doubt improve and satellite surveys may become important tools in mapping forest disorders, as with the recent Skylab series of tests.

6. RATE OF SPREAD

An estimate of the potential threat of a forest disorder is vital for management control and a measure of the past rate of spread may give an indication of future trends.

Strip lines can be used to measure linear rates of disease intensification within existing patches and their linear extension. Air photos give the best estimate of rate of extension in area for both existing patches and new infections.

In Western Australia rate of spread studies have used photos taken in 1943, 1951 and 1965 (Forests Department of Western Australia, unpublished reports). In Tasmania photos taken in 1950 and 1969 have been used to study gully dieback in the Fingal district (Tasmanian Forests Commission, 1973).

7. MAP INFORMATION AND DISPLAY SYSTEM

MIADS (or Map Information and Display System) is mentioned as a means of using macroscale information to study the correlation of the occurrence of eucalypt crown dieback with possible environmental factors.

The computer program was written in the United States (Amidon, 1964). It enables many maps to be superimposed and provides area statements of the resultant combinations. The program has been adapted for West Australian use, where contingency tables and chi squared tests were used to give an indication of the correlation between dieback and roads, streams, rainfall, cutting history and soil type (Batini, 1973).

8. UNITED STATES TECHNIQUES

Wear *et al.* (1966), gave a clear account of the points to consider when deciding whether to use air photo or ground survey methods to estimate insect damage and provided detailed descriptions of procedures to adopt when using double sampling with regression. A similar approach is relevant to eucalypt crown dieback studies.

9. CONCLUSIONS

Ground, road and aerial surveys have been used to map the occurrence of eucalypt crown dieback in Australia. Air photos with their associated ground checks appear to offer the most promise in macroscale detection and we can expect that much useful detection work will be achieved when more film, filter and scale combinations are investigated.

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11. SUMMARY OF DISCUSSION

Air photos are being used in Victoria both for detection and to study site conditions associated with occurrences of *Phytophthora cinnamomi* dieback.

In Tasmania large-scale colour and colour infra-red photos are being used to study regrowth dieback.

C.S.I.R.O. have used filtered colour infra-red large-scale photos for vegetation analyses.

Photos have been used in W.A. to select landform types in relation to rate of spread studies and for predicting the future extent of a disease.

Timing of photography is a key factor in detection work with both insect and disease situations.

A systematic approach to film-filter-scale detection possibilities would be desirable and this could include spectral reflectance studies.

The need for ground checks of air photo work should not be overlooked.

While emphasis had been placed on the use of air photos, the need to continue ground and road surveys was stressed.

Ground surveys are important in connection with insects as incipient attack can often be detected.

A high degree of mapping accuracy is not needed for management purposes where rough figures are better than no figures, and these can be improved with later experience.

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