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MACROSCALE DETECTION OF EUCALYPT CROWN DIEBACK

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1. The possibilities for macroscale detection of eucalypt crown dieback may be grouped into:

   Road surveys
   Ground surveys
   Aerial surveys
   Satellite surveys

   This paper will review the use of these methods in Australia.

   It is understood that the aim of macroscale detection of eucalypt crown dieback is to determine the location and extent of the disorder under investigation. Where the disorder is caused by a pathogen such as Phytophthora cinnamomi Rands, macroscale detection of symptoms may be several seasons behind the actual occurrence of the pathgen, 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 underestimate the occurrence of a pathogen.

2. Road Surveys

   These are taken simply to be observations from a reconnaissance using a motor vehicle. They have been used for the detection of dieback due to P. cinnamomi in Western Australia (W.A.F.D. unpublished reports, Podger 1966, Titze 1970), Victoria (Podger and Ashton 1970, Weste and Taylor 1971).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 Donn ex Sm.) forests of Western Australia (Podger and Ashton 1970).

As P. cinnamomi is generally associated with roads this is a successful method but cannot give a complete picture where infection is due to, for example, mineral exploration or movement 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 Forests Department, unpublished reports), but as the attack by this insect is not known to be causally related to roads, the method is only a rough guide to eucalypt crown dieback caused by P. glyphopa.

Similar comments would probably apply to the detection of the phasmatid Didymuria violescens Leach, in Victoria and New South Wales by road survey.

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

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

3. Ground Surveys

3.1. Information from random ground observation, such as bushwalking, is a bit like looking for a needle in a haystack and the method should not be the mainstay of any detection system. However information from any source is always useful.

3.2. Ground survey information from normal assessment plots and the tie lines to them is used in Western

Australia to record the occurrence of P. cinnamomi, Armillaria mellea in karri (Eucalyptus diversicolor F. Muell) forest, jarrah leaf miner, and fire damage. 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 a reduction in increment measured on permanent yield plots first pointed to the occurrence of regrowth dieback (Felton 1972).

3.3. Ground survey data from strip lines measured especially 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 (Tas. F.C. summary 1973). This method has the advantage of combining the ground check with the survey, but is time consuming. However, when aerial methods are too costly or unreliable this is the most useful alternative.

4. Aerial Surveys

4.1. The simplest form 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 estate is being observed and, in Western Australia, a tendency to overestimate the area infected compared to that determined from air photo interpretation was noticed.

This method can be useful to check specific areas and is not too costly if the plane is available for other purposes anyhow, such as aerial control burning.

4.2. 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 of interest has characteristic properties of absorption, emission, reflectance, scattering, and transmission of electromagnetic wavelengths. By using instruments which are sensitive enough it is therefore theoretically possible to identify any object by its unique combination of electromagnetic wavelength characteristics. Even when the instruments are not particularly sensitive, as with existing film 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 from the beginning to see which film, filter and scale combinations can detect its identifying characteristics.

In Victoria air photos have been used in phasmatid studies (Newman 1964, Mazanec 1967). There are no 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 delegatensis dieback (Tasmanian Forestry Commission 1973).

Large scale colour photos were used successfully in Western Australia to detect P. radiata drought deaths and indicate that this technique could be worth trying on crown disorders in eucalypt plantations and possibly in National Parks.

In Western Australia air photos were first used specifically for jarrah dieback mapping in 1960 (Sims, 1960) although routine air photo interpretation of forest types since 1957 has revealed patches of open and "dieback" forest. Fire damage from the Dwellingup fire of 1961 was mapped from air photos and air photos 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 9" x 9" 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 so far.

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.

As an indication of work rates and the need to ground check air photo interpretation, in Western Australia in 1969, 1.2 million acres were searched on 1:40,000, 9" x 9" photos for 84,000 acres of dieback in 40 man days of interpretation and 15 man days of field checks. The work was carried out by interpreters who had prior experience of dieback interpretation in 1966.

4.2.1 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 W.A., unpublished reports). The results indicated that the area of diseased forest was underestimated by about

5%, and that the reliability of the interpretation of affected areas was about 73%. Ground assessment plots used to check the 1969 air photo mapping of jarrah dieback indicated a 6% overestimate of affected forest.

5. Satellite Surveys

So far these have not been used in Australia to map forest disorders. The results of the recent series of E.R.T.S. photographs is not known to me but I would be surprised if a disorder could be mapped sufficiently accurately to allow field checking even if it could be detected on satellite photos. However, technology will no doubt improve and satellite surveys may become important tools in mapping forest disorders.

6. Rate of Spread

An estimate of the future extent of a forest disorder is vital for management control and a measure of the past rate of spread is a convenient indication of future trends.

Strip lines can be used to measure linear rates of intensification within, and extension of, existing patches. 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 W.A., unpublished reports). In Tasmania photos taken in 1950 and 1969 have been used to study gully dieback in the Fingal district (Tasmanian Forestry Commission, 1973).

7. MIADS (for Map Information and Display System)

Miads is mentioned as a means of using macroscale information to study the correlation of the occurrence of eucalypt crown dieback with possible causal factors.

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

8. United States Techniques

Wear et al 1966, gives a clear account of the points to consider when deciding whether to use air photo or ground survey methods to estimate insect damage and gives a detailed description 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 I would anticipate that much useful detection work will be achieved when more combinations of films and filters, scale, format and time of photography are investigated.

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

SCALE	FORMAT	SUBJECT	RESULTS
Black and White Print			
1:7920	9" x 9"	P. cinnamomi	Good
1:15840	9" x 9"	P. cinnamomi	Good. Fire - Good Leaf miner - Poor
1:40000	9" x 9"	P. cinnamomi	Very Good
1:86000	9" x 9"	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	9" x 9"	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