Department of Conservation and Land Management
50 Hayman Road, Como, WA 6152

CALM BRIEFING PAPER 5/91

A BRIEF SUMMARY FOR CALM STAFF

DIEBACK DISEASE IN WESTERN AUSTRALIA

1. Introduction

"Dieback" (referred to in this paper as dieback disease) is a serious threat to indigenous ecosystems in the south west of Western Australia as well as to some commercial horticultural enterprises and to private gardens. Its control and eventual eradication is a matter for the whole community; however, because CALM has taken a lead role in research, management and education the Department is seen as a leader in the fight. Fighting dieback disease is not only CALM's responsibility, it is everyone's responsibility.

While there is no long term solution to dieback disease at present, many positive things can be done to prevent its further spread and minimise its impact, so that when a method of eradication becomes available the area of impact and the number of plants and animals affected is minimised.

2. Cause

The plant disease variously called dieback disease, jarrah dieback, wildflower dieback, dieback, or root-rot disease is caused by microscopic fungi belonging to the genus *Phytophthora*.

The most common and destructive species is *P. cinnamomi*, also known as the cinnamon fungus. Other taxa known to occur in Western Australia and which kill native plants are *P. citricola, P. cryptogea, P. drechsleri, P. megasperma* var. *megasperma, P. megasperma* var. *sojae, P. nicotiana var. nicotiana* and *P. nicotiana* var. *parasitica*. Other unidentified and/or un-named taxa have also been isolated occasionally.

Most data available are from *P. cinnamomi* and the following descriptions relate to it unless specifically stated otherwise.

Phytophthora belongs to the evolutionary primitive group of fungi called Oomycetes or 'water moulds'. *Phytophthora* species are both parasitic (requiring living plant tissue as food), or saprophytic (living off dead plant tissue). Many are pathogenic, causing disease in or death of the host.

All *Phytophthora* species occurring in bushland in WA attack plants via the roots. They kill their hosts by killing the fine roots that take up water, or by girdling major roots or the base of the trunk.

Dieback disease should not be confused with canker-causing fungi. These fungi are spread by aerially-dispersed spores and infect plant shoots and stems, sometimes spreading down the plant and killing it. Several canker fungi that affect native plants in bushland areas are known from Western Australia. These fungi include *Botryosphaeria ribis* and unidentified species from the genera *Diplodina, Cytospora,*

Microsphaeropsis and *Zythiostroma*. Banksias are particularly affected, and at present the Scarlet Banksia, *Banksia coccinea*, is extensively diseased, with large areas dying.

3. Origin

Phytophthora species are not native to Western Australia. They are thought to have been introduced at least 70 years ago, probably in soil associated with the import of living plants. Unexplained deaths of native plants, including jarrah, were noted for many years before the cause was identified by Dr Frank Podger of CSIRO in 1965.

The original natural occurrence of most *Phytophthora* species is not known because they had been unknowingly spread around the world, probably mainly by the horticulture industry, before *P. cinnamomi* was scientifically described in 1922. *Phytophthora* species also occur and cause plant diseases in Victoria, Tasmania, New South Wales and Queensland.

4. Reproduction

Phytophthora species are probably of tropical origin and require warm, moist conditions to survive, sporulate and disperse. Three kinds of spores may be produced. When conditions are suitable, microscopic spore sacks called sporangia, and thick-walled chlamydospores are produced vegetatively from the mycelial strands that form the body of the fungus in the soil or host tissue. The sporangia release motile zoospores in free water and these can infect new host roots. Mycelium of different mating types may grow together inducing the production of thick-walled sexual spores called oospores. These mating types are called A1 and A2. Both types are present in Western Australia, but only A2 is common. Chlamydospores and oospores can survive for many months in soil.

The life cycles of other taxa of *Phytophthora* species differ somewhat from *P. cinnamomi*. For example, *P. citricola* and *P. megasperma* var. *sojae* do not need different mating types in order to produce sexual spores and *P. cryptogea* can produce sporangia under drier conditions than other taxa.

5. Spread

The disease can be spread in three main ways.

Firstly, it can be spread in moist, infected soil. This is by far the most significant method of dispersal and has probably been responsible for the initial spread from the first points of infection in the State and for almost all the new infections now occurring. Infected soil can be spread on or in vehicles, by earth-moving machinery, with plants being moved from one place to another, and, if conditions are right, on the feet of bushwalkers and by native animals such as kangaroos and bandicoots or by introduced animals such as pigs and horses. Infection of nurseries can lead to the spread of the disease in pots or on the roots of seedlings.

Secondly, it can spread naturally from one infected plant to another, chiefly where a root from an uninfected plant contacts a root from an infected one. This method is responsible for most uphill spread of disease fronts in bushland.

Thirdly, zoospores can be spread in free water. Thus, streams in infected areas can carry the disease to places downstream. Zoospores can also spread through water in soil pores, either passively in moving water

or actively by swimming through soil water. A hard pan (clay or rock) a short distance below the soil surface can provide a suitable moist place for the survival of *Phytophthora* in what otherwise appears to be a dry area and can also promote the spread of the disease over large distances. Many Western Australian soils have such a hard pan.

Humans have been the main agents of dispersal through the movement (usually unknowingly) of infected soil and plant material. The disease is now widespread in the south-west of Western Australia. It is known to occur from Kalbarri to Boyagin Rock (near Brookton) and eastwards along the south coast to Cape Arid. It is particularly widespread in the wetter parts of the jarrah forest and in the south coast heathlands. Most infections are by *P. cinnamomi*, but other *Phytophthora* species are being increasingly found in bushland areas.

6. Plant susceptibility

Not all plants are susceptible to *Phytophthora*. Indigenous species most affected belong to four families: Proteaceae, Epacridaceae, Fabaceae and Myrtaceae. These four families account for a very high proportion (over 50%) of the plants in ecosystems of the south west of Western Australia. Species from several other families are also affected. (Table 1)

Not all genera within a family or all species within a genus are necessarily susceptible. For example, some species of *Eucalyptus* (including karri, marri, yarri, wandoo and tuart) are highly resistant while some, such as jarrah, are affected but have the ability to resist the invasion of the fungus under certain conditions, and within *Hakea, Hibbertia* and *Boronia* some species are killed while others are resistant. In the case of jarrah, research has shown that resistance to the disease has a genetic basis and that it is possible to select for resistance and breed resistant lines. However, resistance occurs in only a very few affected species.

Data on the response of indigenous species to infection are inadequate to make accurate estimates of the total number of susceptible species. Broad estimates are that perhaps 1 500 to 2 000 species of the estimated 8 000 species of vascular plants in the south west may be susceptible to infection.

Many threatened plant species could become extinct through infection by *Phytophthora* in the coming decades. For example, all known populations of *Banksia brownii,* the Feather-leafed Banksia, are infected and all infected plants die.

Phytophthora is also a major disease of horticulture. Various *Phytophthora* species infect plants such as potatoes, soya bean, peaches, plums, avocado, azaleas, camellias, chestnuts, apples, cranberries and other berry fruits.

Table 1. Families and genera with susceptible species

Proteaceae	Banksia, Dryandra, Adenanthos, Conospermum, Franklandia, Stirlingia, Lambertia, Persoonia, Isopogon, Petrophile
Epacridaceae	Andersonia, Astroloma, Cosmelia, Leucopogon, Lysinema, Sphenotoma, Styphelia, Trochocarpa
Fabaceae	Bossiaea, Burtonia, Eutaxia, Daviesia, Jacksonia, Oxylobium, Pultenaea
Myrtaceae	Agonis, Beaufortia, Calothamnus, Eremaea, Hypocalymma, Kunzea, Leptospermum, Thryptomene, Verticordia
Casuarinaceae	Allocasuarina
Cycadaceae	Macrozamia
Cyperaceae	Lepidosperma
Dasypogonaceae	Dasypogon, Lomandra
Dilleniaceae	Hibbertia
Goodeniaceae	Dampiera
Haemodoraceae	Phlebocarya, Conostylis
Iridaceae	Patersonia
Mimosaceae	Acacia
Restionaceae	Anarthria
Rutaceae	Boronia
Sterculiaceae	Lasiopetalum, Thomasia
Tremandraceae	Tetratheca
Xanthorrhoeaceae	Xanthorrhoea

7. Effect on plant communities

During the relatively short time that it has been present, *Phytophthora* has irreversibly changed the structure and diversity of many plant communities in the State. The rate of spread of the disease may be slow and many infections have yet to reach their full expression. The effect on plant communities varies with the proportion of susceptible species, with the importance of those species in the community and with soil type. Species-rich communities and communities growing on leached sands are particularly susceptible. In some communities, the change following infection is small, with only a few plants dying. However, in the kwongan vegetation of the south-west, changes can be highly significant with a species-rich closed shrubland being replaced with a relatively depauperate open shrubland with sedges and grasses. In some jarrah forest areas that were infected long ago a marri woodland with a reduced understorey has now developed. Resistant plant species are favoured following infection of an area by dieback disease.

8. Effect on animals

There have been few studies on the changes in animal communities following infection of an area by *Phytophthora*. Indications are that the effect can be dramatic, with a reduction in the numbers of or the elimination of those species dependant on particular plants for their food. Species such as honey possums, which depend on the availability of flowers year-round, might be greatly reduced in abundance or eliminated from infected areas. Many insect and other invertebrate species are doubtless eliminated from areas where infection has eliminated plant species important in their life cycle. Some animal species may be favoured by the change in vegetation composition and structure.

9. Environmental relationships

The relationships between *Phytophthora* and its environment are complex. The reproduction of the fungus and its survival may be affected by such factors as temperature, moisture, soil type, the aeration of the soil, the nutritional state of the host, the presence of resistant plant species and the presence of other fungi in the soil. Reproduction and survival are enhanced by warm, moist conditions; in the south-west of Western Australia optimum conditions occur in late spring and autumn, when the soil is saturated and warm, and following heavy summer rainfall.

10. Research

In Western Australia a great deal of research has been carried out into *Phytophthora* since the mid-1960s. Research has also been conducted in the eastern States. Overseas, there has been much research carried out into the spread and control of the disease in horticultural situations.

11. Control

There is no known method of eradicating *Phytophthora* in native vegetation. Disinfectants and fumigants used in horticulture are toxic to plants and if used in bushland could do more damage to native vegetation than the fungus. Recently a number of systemic fungicides have become available and are being increasingly used in horticulture. The most promising one for use in bushland is neutralised Phosphorous Acid (H_3PO_3). CALM has a number of experiments underway in a variety of plant communities to evaluate this fungicide and preliminary results are favourable. Research is also being conducted into methods of application.

12. Disease Management

The aims of disease management are to prevent introduction of the disease to uninfected areas, and to restrict spread and intensification of the disease in infected areas.

Disease management can be divided into six main areas:

i) Rating disease hazard (the recognition of the most vulnerable sites so that they can be afforded most protection);

ii) Assessing the risks of introduction (these are affected by factors such as the proximity of diseased areas, the season of access and the type of operation planned);

iii) Hygiene (e.g. cleaning of machinery, vehicles and footwear, control of earth-moving (e.g. not using gravel from pits that are infected) and conducting operations only under dry soil conditions);

iv) Quarantine (closing access to areas, principally to protect and enable detailed mapping of uninfected areas);

v) Manipulation of conditions to disfavour the disease and enhance host resistance (e.g. by appropriate road and path construction, manipulation of drainage, use of resistant species, stimulation of antagonistic microflora, use of fungicides); and

vi) Education and training.

Because roads, tracks and public lands are used by many people and because of the burgeoning use of off-road vehicles, quarantine and hygiene procedures are difficult to implement except where the land is intensively managed and patrolled.

Disease management is of great importance in containing the disease. However, it can never be totally effective and must be considered a holding action until better control measures or techniques for eradication become available.

13. What was done prior to 1985

Identification of the causal agent of the disease in 1965 allowed research work by CSIRO and the Forests Department to become more focussed. Work concentrated on the biology of the fungi causing the disease, plant species susceptibility, modes of spread and the development of hygiene techniques. Broadscale mapping identified the more severely affected areas of the jarrah forest.

Quarantine was declared over 750 000 ha of State Forest in 1975 and 1977. The prime purpose of the quarantine was to allow time for existing infections to manifest themselves so that diseased areas could be more accurately mapped. Future activities could then be conducted in the full knowledge of the distribution of infected areas, thereby allowing hygiene to be instituted.

A large scale aerial photography technique was developed to map early symptoms and the first operational program was carried out in 1979. An annual program of mapping has been conducted since then.

The first hygiene procedures were developed after the identification of the pathogen in the mid-1960's. In the late 1970s and early 1980s detailed hygiene procedures were developed for application in disease risk areas. These have been applied, monitored and progressively refined in the succeeding decade.

The other agencies that formed CALM did not have the same resources or expertise in dieback disease as did the Forests Department. Nevertheless, dieback disease was considered during some planning and operations and lead, for example, to areas of Two Peoples Bay Nature Reserve being quarantined.

14. What has CALM done?

Since the formation of CALM in 1985 priority has been given to dieback disease research, detection, mapping, hygiene and management and the broader responsibilities of CALM have focussed attention beyond State Forests. The first multi-disciplinary team set up in the new Department addressed the problems of *Phytophthora* in the South Coast Region where very little work had previously been done.

Early in 1986 a Dieback Protection Plan was completed by this team for the South Coast Region and implementation began. The plan was reviewed and modified in 1989. Since 1986 most priority areas for protection from the disease have been mapped, dieback protection measures have been spelled out in Interim Management Guidelines for all major national parks, ten new washdown facilities have been installed, mobile washdown units have been purchased, a permit system has been introduced to control access to parts of Stirling Range and Fitzgerald River National Parks, all staff in the Region have been trained in dieback recognition, sampling, hygiene and management, a full-time officer has been employed to map dieback infections and identify disease-free areas, new research projects have commenced and a community awareness program has been commenced. Similar measures are being instituted in the Greenough and Wheatbelt Regions.

In the three forest Regions, dieback hygiene and management have continued to be a high priority. Improvements in management, resulting from research and experience, have been instituted, including, where appropriate, restricting most logging and management activities to periods when dry-soil conditions exist and the risk of dieback disease spread is minimised, extensive mapping, locating roads low in the landscape and monitoring.

15. What is CALM doing now?

CALM has three major roles in relation to dieback disease. These are to prevent additional infections within public lands managed by CALM, to minimise the impact on indigenous flora and fauna throughout the State and to help the public and other organizations combat the disease outside CALM-managed lands. CALM is constantly reviewing its policies and procedures to ensure that they are based on the latest research information. It also develops dieback disease protection plans for CALM-managed public lands and other areas, carries out research, and provides education kits and other material for use by a variety of people (such as the speaker's kit produced recently for Rotary International District 946), and trains its staff in dieback disease recognition and hygiene.

In a nutshell, CALM's strategy for fighting dieback disease is: to undertake research, to educate the community and build community support, and to develop field procedures that ensure disease spread and impact are minimised.

16. What are the positive things that people in the community can do?

The general public can make an important contribution to the fight against dieback disease by:

* Complyimg with road and track closures in forests, national parks, etc., as these are necessary to restrict the spread of the disease.

* Driving only on well-formed, well-drained and hard-surfaced roads in bushland areas under wet conditions when the likelihood of picking up infected soil is high.

* Keeping vehicles clean of mud, wet soil or vegetation, since these can harbour and spread the disease. It is especially important to wash down vehicles before moving from one area of bush to another.

* Notifying the local CALM office of new areas of dead and dying vegetation in national parks, nature reserves and forests in the south west.

* Contacting the local CALM office before venturing off hard-surfaced roads in our national parks, nature reserves or forests to find out where it is safe and legal to do so.

* Encouraging friends and relatives to understand dieback disease and help in the fight against it.

* Purchasing plants only from nurseries accredited by the Nursery Industry Association of Western Australia as complying with their Nursery Hygiene Standards.

* Supporting all Government and local Government organizations as they consider dieback disease when planning and implementing work in bushland areas.

Large organizations with the potential to spread dieback disease need to have policies and procedures in place to allow them to minimise the risk of spreading the disease during their activities.

17. The need for CALM to set an example

CALM must practise what it preaches. It is vital that CALM staff follow the highest standards of dieback hygiene when conducting any operations, and when visiting any bushland areas, whether managed by CALM or not.

Specifically, CALM staff who work in the bush of south-western Australia must be familiar with Part 7 of the CALM Act, Policy Statement No. 3, the Forest Diseases Regulations, the Dieback Disease Hygiene Manual and, where appropriate, the Manual of Logging Specifications, Region Dieback Disease Protection Plans and management plans or interim management guidelines for particular parks or reserves, where dieback disease is a threat.

18. Publicity

Phytophthora is a national problem with several other States having similar, if mostly less dramatic, impacts on their native species and communities.

Within Western Australia *Phytophthora* is not simply CALM's problem, nor has CALM the capacity to single-handedly manage dieback disease. A publicity campaign to enlist voluntary community support and responsibility has been waged for 25 years. Other Government Departments (e.g. Main Roads and SECWA), and some Local Government Authorities, mining companies and wildflower growers are among those who have active dieback disease management programs.

Syd Shea
Executive Director
CALM

September 1991

GLOSSARY

Chlamydospore
Thick-walled asexual spore that is able to survive adverse conditions.

Cleandown
The removal of all potentially infected material from an object. This can be achieved by using a high pressure water jet (washdown), compressed air (blowdown) or a brush (brushdown).

Dieback disease
The disease of plants caused by infection by soil-borne fungi of the genus *Phytophthora*.

Dieback disease risk area
An area of land declared by the Minister to be at risk from dieback disease. The area usually contains infected land, but is mainly uninfected land. Pedestrian access is permitted, but any other access requires a permit.

Hazard (in relation to dieback disease)
The combination of environmental, climatic and management factors that influence the potential impact of dieback disease on a site.

Host
The plant or animal that is invaded by a pathogen or parasite and from which the pathogen or parasite derives its energy.

Hygiene (in relation to dieback disease)
Actions that decrease the risk of the pathogen being introduced, spread, intensified or surviving.

Hygiene barrier
An object around or over which it is difficult to pass infected material during an operation.

Hygiene map
A map showing the location of infected and uninfected land and areas where dieback disease presence or absence can not be determined.

Incipient dieback disease
An infection that has not had time to establish and express symptoms of dead and dying plants.

Indicator species
A species of plant known to be susceptible to a pathogen and consistent in its expression of symptoms, whose death generally indicates disease presence at a site.

Low profile roading
Roads placed as low in the landscape as possible so as to minimise the area down-slope from the road.

Mini-catchments
An area within a larger catchment which is self contained in terms of surface water runoff.

Mycelium

The vegetative part of a fungus, usually made up of filaments called hyphae.

Oospores

Thick-walled spores produced by the mycelium under certain conditions.

Pathogen

Any organism that causes disease.

Resistant taxa

Taxa of host plants that are not killed when infected with *Phytophthora* species.

Risk (in relation to dieback disease)

The probability of an operation introducing, spreading or intensifying dieback disease, or allowing the pathogen to survive at a site.

Split phasing

The separation of component tasks of an operation in time and/or space, so as to minimise opportunities for dieback disease spread.

Susceptible taxa

Taxa of host plants that are known to be killed when infected with *Phytophthora* species.

Taxon (taxa)

General term for a taxonomic group, whatever its rank; i.e. it may be a species, subspecies or variety.

Zoospore

A motile spore that swims by the beating of a flagellum or several flagella.