Review of Dieback in Western Australia

Report to the Western Australian Minister for the Environment

Volume 1 – Report and Recommendations

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Report
by
The Western Australian Dieback Review Panel
to
The Honourable Minister for the Environment

DIEBACK IN WESTERN AUSTRALIA
VOLUME 1
REPORT AND RECOMMENDATIONS

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Cover Illustration:

Bluff Knoll, Stirling Range National Park, February 1982: a quintessential example of key factors in the biological tragedy which is dieback.

Emma and Michael Williamson, as if on a magic carpet ride over one of the earth's great centres of biodiversity, survey the damage in the bush below which followed the introduction of Phytophthora cinnamomi during the construction of the tourist road winding north westward. These two young people were innocently unaware that their boots, like those of other climbers before and since them, might lift infested soil from the lower muddy slopes onto the summits of the highest peaks and from there down in to almost every reach of the park.

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THE PANEL

MEMBERS

Associate Professor Sid James BSc (Syd), MSc (Syd), PhD (Syd)
Professor James is a botanist who has published extensively on the population genetics of the native plants of Western Australia. He has authored 40 scientific papers and supervised 18 PhD theses. He teaches at the University of Western Australia.

Dr Maurice Mulcahy AM, BSc (For) Aberdeen, PhD (UWA), Hon DSc (Murdoch), FAIAS
Dr Mulcahy has a distinguished record of research leadership in CSIRO's Division of Soils and is recognised as a pioneer of the study of landform morphology and soil development in Western Australia. He also served as a senior scientific adviser in the former Department of Conservation and Environment. He has served on bodies which determined the distribution of research funds of the Jarrah Dieback Foundation and on the amalgamation of state land management agencies as an integrated agency in CALM. He continues to advise government on research and management issues in land and water conservation.

CHAIR

Dr Frank Podger BSc (For) UWA, Dip For (Canb), MSc (For) Melb, PhD (Auckland)
Dr Podger has had experience in forest management with the former Western Australian Forests Department and in research with CSIRO where he specialised in diseases of native vegetation and in ecological effects of fire. In the 1960s he led the Western Australian research which determined the cause of jarrah dieback. In recognition of this work he was awarded an inaugural Scientific Achievement Award of the International Union of Forest Research Organisations of the Food and Agricultural Organisation of the United Nations. He is now a consultant on environment and forestry.

ADMINISTRATIVE SUPPORT

Executive Officer
Mr Paul Jones BSc (For) Canb, is a senior officer in the Department of Conservation and Land Management (CALM). He has had experience in fire research, as a district manager with the former Forests Department, in policy development for both the Australian Department of Primary Industries and for CALM in State Federal negotiations concerning implementation of the National Forest Policy. Currently he is manager of CALM's recently established Management Audit Branch.

SECRETARIAL ASSISTANCE

Sharon Eccleston
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INTRODUCTION

This review, the latest in a long line of seminars, workshops, conferences and reviews at state and national level, addresses the problems for conservation and commerce which *Phytophthora cinnamomi* poses to the native vegetation of the south-west of Western Australia.

The review follows prior consideration of dieback by:

- The Legislative Council of the Parliament of Western Australia which on the motion in 1991 of the Honourable P G Pendall MLC, established a Select Committee chaired by the Honourable W N Stretch MLC to inquire into and report on 'the extent to which the disease *Phytophthora* dieback has infected the State's system of national parks and conservation reserves ... and the measures being taken to combat the further spread of the disease ...'. Hereafter the findings of this committee are referred to as the Stretch Report.

- Publication by the Liberal/National Party Coalition of its statement of environment policies, prior to its election to government, in which it committed to new initiatives in address of the State of Western Australia's problems with dieback.

- Advice to the then Minister by Dr S R Shea, Executive Director of CALM, following his discussion with other scientists concerning changing perceptions of the nature of the problems caused by *Phytophthora* and the efficacy of existing policies and prescriptions for the management of dieback in the forest and conservation estates.

The Minister for the Environment, The Honourable Kevin Minson MLA, in 1993 commissioned an independent reappraisal of the dieback problem and the strategies needed for its effective address.

The Western Australian Dieback Review Panel was required to report on seven comprehensive terms of reference which have allowed unconstrained opportunity to consider any issue pertinent to the purpose of the review. The terms of reference are at Appendix 1.

Our interpretation of the purpose of the terms of reference is that the review should evaluate the extent to which effective management, based on realistic policy objectives and sound science, is being delivered and to make such recommendations as might be necessary to achieve the best possible response to the problems caused by *P. cinnamomi*.

We have addressed the following subjects:

- the nature of the disease and its importance for conservation of nature and maintenance of natural productivity;

- the scientific basis and efficacy of management practices for control of the disease;

- research programs and future directions;

- organisation and funding of research, maintenance of standards and translation

of research findings to management practice; and

- comment on the recommendations of the Stretch Committee.

In arriving at our conclusions we have consulted widely, chiefly with those government agencies and industrial institutions whose operatives in going upon land contribute to the problem and who have the greatest capacity to ameliorate the vectored spread of the pathogen.
The Panel did not seek public input because the Stretch Committee had effectively addressed that need.

Formal discussions were held with the research and dieback planning managers of ALCOA and with representatives of the Bushfires Board, the Association of Mining Exploration Companies, and the Department of Environmental Protection. Discussions were held with academic staff of all four public university campuses. Input was also sought from the Conservation Council.

Meetings were held individually with all six senior directors of CALM, branch heads in environmental protection, fire control, timber harvesting, land information, forest management and the Director of the WA Threatened Species and Communities Unit. The Panel interacted also with members of CALM Dieback Coordinating Committees at Albany, Manjimup and Bunbury.

The Panel placed major importance on field inspections, direct interaction with researchers where possible at their field study sites and a program of on-site discussion with field managers. Many such visits were attended by all members of the Panel and others by the Chairman and one other member.

Field visits were made to a number of conservation areas, Fitzgerald River, Stirling Range, Two Peoples Bay, Shannon-D'Entrecasteaux, Lane-Poole, Serpentine, Monadnock, Yanchep and Moore River. Inspection of forestry and mining operations were made at various locations in the forest region to cover timber harvesting, fire control, and bauxite mining. During these visits the Panel interacted with key research staff and many field managers in CALM and ALCOA.

We have decided to present our report in two volumes. Volume 1 is the work of the Panel at large and deals with its conclusions and resulting recommendations.

The second volume is a review of the large body of scientific and technical material on which the Panel's conclusions are based. It has been collated by the Chairman and is attributable solely to him. Citations for the various documents consulted are to be found in short form throughout the text of Volume 2.

The Panel presents its findings in the context of changing perceptions, particularly in the last ten years or so, of the nature and significance of disease caused by *Phytophthora cinnamomi.* Although formerly regarded mainly as a threat to the timber industry of the jarrah forest, it is now seen in broader perspective. It threatens a range of values for conservation, recreation, tourism and extractive industries of the natural areas of the south-west, not only in the forest estate, one of Western Australia's most valuable and extensive conservation resources, but also in heathlands and sandplains of the south coastal and lower west coastal regions which include biodiversity of international importance.

NATURE AND IMPORTANCE

THE PATHOGEN AND NATURE OF THE DISEASE

The slow moving epidemic of destructive root disease in natural areas known as dieback was first observed in Western Australia in 1921. It was probably introduced by early European settlers soon after 1828 with planting stock of domestic fruit trees. The causal agent, *Phytophthora cinnamomi*, is a member of the same genus as *P. infestans*, the microscopic fungus which blighted potato crops across Europe and caused the great famines of Ireland from the 1840s.

Other pathogens, both native and introduced, are also present in the wild but none have as severe an impact as *P. cinnamomi*. Of the 59 species of *Phytophthora* known to science 27 have been recorded in Australia, 15 of them in Western Australia, including three species in the subtropics restricted to annual crops. Of the five species isolated from natural areas of native vegetation in the south-west *P. cinnamomi* is by far the most damaging.

In warm and wet weather *P. cinnamomi* has the ability to produce large numbers of infective motile spores which move autonomously in saturated soil. Suitable conditions are experienced on at least some days in every year in south-western Australia.

In addition to autonomous spread, the pathogen may be carried by water flow and with soil moved by a great variety of vectors, including vehicles and earth moving machinery, animals and bush walkers. Thus its distribution is strongly related to watercourses, tracks and roads, and infestation is most common where there is frequent traffic.

In the native vegetation of Western Australia there appear to be at least three distinct syndromes of disease due to infection by *P. cinnamomi*. The first two follow closely on the advancing wave front of initial infestation by the pathogen. The third is expressed years later in a changed plant community which has replaced the original jarrah forest.

The three syndromes are characterised as follows:

- Highly susceptible species are killed in heathlands, *Banksia* woodlands, and in the understorey and ground layers of a number of forest types including the jarrah forest. Progression is uniformly destructive of many susceptible species, is relatively insensitive to site conditions where annual rainfall is greater than 800 mm, and is readily observable.

- Death in the overstorey of jarrah trees, which can be highly variable in frequency is very sensitive to variation in site conditions particularly as they affect drainage. There may be near complete mortality in both the overstorey and understorey, commonly known as 'mass collapse', creating so-called 'graveyards' of dead trees.

- Where the *Banksia* understorey and most jarrah trees have been long dead the former forest is replaced by a woodland of the resistant marri (*Eucalyptus calophylla*) and parrotbush (*Dryandra sessilis*). At this stage *P. cinnamomi*

behaves as an endemic pathogen, attacking *D. sessilis* in wet years, but with little or no impact on the marri.

Importance in Agriculture

One or another of the 15 species of *Phytophthora* so far recorded in Western Australia has caused damage across much of the range of cultivated plants in the south-west including vegetables, flowers, fruits, ornamentals, pastures and forage crops.

In a survey in the Perth area eight species of *Phytophthora* were isolated from fourteen wholesale nurseries with the number of species recovered per nursery ranging from one to eight. Three species of *Phytophthora* have caused crop damage in the subtropics two at Carnarvon and two in the Kimberley all from annual crops grown under irrigation.

Estimates of annual losses provided by officers of Agriculture WA for a Rural Resources Development Corporation survey in 1993 total $1 200 000 for horticulture and $500 000 for floriculture. Losses due to *P. clandestina* in clover have not been made but are believed to be substantial.

Crop plants, even the longer lived perennials such as avocado, are amenable to a variety of costly techniques of control including drainage, organic amendment, chemical treatment and the use of resistant lines. Overall the state has the necessary knowledge to handle these agricultural problems and to marshall the scientific resource necessary to address others which might arise should further species of *Phytophthora* enter the state.

Control of *Phytophthora* root-rot in naturally occurring communities of native plants of much lower commercial value is far more difficult. The remainder of this report therefore focuses on problems of dieback in natural plant communities.

Importance in Native Vegetation

The eminent Australian immunologist Frank Fenner FRS, in his 'History of Microbiology in Australia' observed:

> *'There are no comparable records in the history of plant pathology of a pathogen invading native forests and destroying whole natural communities on the scale observed in the dry sclerophyll plant communities of Western Australia'.*

The importance of a disease in natural communities can be measured by a number of criteria related to both existing and potential effects. These include:

- direct and indirect effects on plant communities and their dependent biota;
- the extent of areas affected;
- the rate at which infestation increases;
- the ultimate extent of epidemic spread; and
- the degree of damage and the extent of disruption of access to the natural benefits the vegetation confers.

By all these measures the arrival and subsequent spread of *P. cinnamomi* in the native vegetation of Western Australia is now seen to be a biological disaster of global significance for conservation of areas of great biodiversity and a major problem for wood-based and other extractive industries. A number of plant species face extinction unless recently formulated programs of phosphonate treatment and the use of appropriate fire regimes to exploit the phenomenon known as 'disease escape' (see p. 17) are effectively implemented and maintained.

Current extent

Records of the presence of *Phytophthora* species in naturally occurring plant communities appears to be restricted to those

parts of the South-West Land Division receiving more than 400 mm of average annual rainfall.

Among the objectives of CALM Policy No. 3 is an undertaking to monitor native vegetation in the tropical areas of the state for the presence of *Phytophthora*. The Panel has made specific enquiry on this matter and has found no evidence of record of species of *Phytophthora* in wildlands north of Geraldton with a single, apparently ephemeral, occurrence of *P. citricola* near Kalbarri. Furthermore the low environmental tolerances of *Phytophthora* species to heat and soil dryness are not theoretically consistent with the likelihood of a problem developing in the wildlands of the wet/dry tropics or the semi-arid regions.

Although reports of poor health of native vegetation should be investigated as a routine procedure there does not appear to be at this stage a case for particular emphasis or expense in monitoring for *Phytophthora* in the tropics.

Conservative estimates made in 1975 indicate that 15 per cent of the forest region is infested, mainly in the western higher rainfall parts where natural extension of infestation by *P. cinnamomi* moves upslope at almost one metre per year on average, and is much faster downslope.

Outside the forest areas the extent of infestation is more variable and in some cases the degree of damage is much worse. For example, it is estimated that about 60 per cent of the Stirling Range National Park is infested. In the Shannon D'Entrecasteaux National Park banksia woodlands on seasonally inundated landscapes are devastated over as much as 70 per cent of their area. On the other hand there is relatively little damage in the Fitzgerald River National Park, perhaps no more than five per cent, and no evidence of consequential damage at all in the Lesueur National Park.

Future extent

Where annual rainfall is less than 400 mm it is unlikely that *P. cinnamomi* will establish in natural ecosystems. Between 400 mm and 800 mm damage is likely to be localised and confined to areas prone to seasonal waterlogging. These may increase in extent, or new ones appear after land clearing or other operations which reduce vegetative cover and so increase soil moisture levels.

Where annual rainfall is greater than 800 mm almost the whole landscape will be affected, with the exception of the well drained calcareous and yellow sand dune systems of the west and south coasts. Colonisation by *P. cinnamomi* on the well drained uplands of the Darling Range can be expected ultimately to be almost total but will proceed at a much slower pace. There conservative estimates indicate that *P. cinnamomi* might need several centuries more to effect complete colonisation. The grey sands and seasonally inundated flats of the coastal plain are likely to be completely infested and irreparably damaged within decades.

Impact on conservation values

This will vary enormously. Individual species such as *Banksia brownii* and *Darwinia oxylepis* are under imminent threat of extinction unless recently formulated programs of phosphonate treatment and the use of firing regimes to promote 'disease escape' can be effectively implemented and sustained.

The structure of communities significant for their floristic diversity and importance as habitat for native fauna, such as the *Banksia* thickets on poorly drained sandy soils with clay subsoils of the Swan Coastal Plain, are certain to suffer rapid and massive disruption over much of their range. This will have dire consequences for small to medium sized native animals following severe structural damage of the vegetation which reduces primary productivity of the site, increases exposure of

the native animals to extremes of weather and makes them more vulnerable to feral predators.

Impact on wood production

The diverse history of timber harvesting and the complex structure of the slow growing forests of jarrah make for great difficulty in estimating growth rates even in healthy forest. The problem is further compounded by the highly variable impact of *P. cinnamomi* on mortality and growth of jarrah which is dependant on variation in site as well as the time elapsed since first colonisation of a site by *P. cinnamomi*. The best available projections of the impact of dieback on future availability of saw timber supply must accordingly be based on data of great inherent variability. Assuming, for example, an annual increase of five per cent in the area of infestation and maintenance of past average rates of mortality and growth depression, the expectation is for no change in available volumes for at least 50 years. Thereafter a steady decline to a finite but as yet unidentified level of sustainable supply from sites of intermediate and low hazard can be expected. On sites of high hazard sustainable forest production will not be possible.

CONCLUSION

Until the epidemic has run its course over the next century or so, it will continue to degrade the quality of conservation areas and the productivity of important and otherwise renewable resources. Efforts to slow the progress of the epidemic will require that ongoing operations are conducted hygienically, and that access to certain areas be restricted at certain times. These restrictions must inevitably diminish benefits otherwise available from legitimate recreational and commercial pursuits.

We conclude that the problem is of great seriousness and importance, comparable to salinisation in the farming areas, and likely to be just as difficult to repair.

MANAGEMENT

INTRODUCTION

Ideally a comprehensive approach to management of the problems which the seemingly inexorable advance of *P. cinnamomi* poses for vegetation health would be based on a strategy of three main elements.

These are:

- implementation of practices which ameliorate the damaging effects of *P. cinnamomi* where it has already established;
- containment or retardation of further autonomous spread at the boundaries of existing infestation;
- reduction of the rate of vectored spread and establishment of new centres of infestation.

Very considerable research effort has been directed at all three elements over many years. Despite this endeavour the several lines of research related to elements one and two which *inter alia* included attempts to stimulate the density of *Acacias* and to reduce that of *Banksia* have not led to affordable and practical methods for reduction of disease.

With the sole exception of the promise of phosphonate current approaches to management must remain based almost exclusively on the third or 'hygiene' strategy.

All access to the forest and heathland entails some degree of risk that *P. cinnamomi* will be brought in at some time. This is the case with the use of heavy machinery for the building of roads, the traffic on them, and even the seemingly unobtrusive passage of bush walkers and native animals. Managers face challenges which are already formidable if the various and often conflicting requirements of sustainable multiple use are to be accommodated, even in healthy forests. Where *P. cinnamomi* is present the complexity of the task is increased immensely.

THE FOREST ESTATE

This is almost entirely managed by CALM, whether as production forest or in the various categories of parks and reserves. Coordination of the operations of CALM and the mining and timber industries is provided for by legislation and regulation; access by other forest users is controlled by a requirement to hold a permit to enter areas gazetted as 'disease risk'. Management by a single agency facilitates coordination of operations and control of traffic. It is important that responsibility for such coordination be maintained in a single agency and extended to ensure control of access by all operators.

COASTAL HEATHLANDS AND WOODLANDS OF THE SANDPLAINS

In these and other areas beyond the forest estate coordination and control are less well provided for. Land may be in a variety of tenures, public and private, where traffic levels from significant industries such as sand mining and tourism are increasing. Both

CALM and the Environmental Protection Authority (EPA) have regulatory powers which are not always employed in a coordinated way.

MANAGEMENT STRATEGIES

On the basis of knowledge currently available the Panel finds little if any prospect at all that science might deliver a novel, affordable and effective cure in the foreseeable future. This is not to argue that search for a cure should not be ongoing. However it follows that in the present circumstance management strategies need to be based on an assumption that the autonomous element of spread of the epidemics will continue unabated and that *P. cinnamomi* might ultimately occupy all land suited to it.

The only broadly applicable stratagem which remains is to continue to target the vectored spread of the pathogen and to constrain as far as is possible the establishment of new centres of infestation. Uniform application of this stratagem across the 17 million hectares of remnant native vegetation in public and private ownership in the South-West Land Division is also likely to be well beyond the capacity of the State.

The principal element in the existing dieback management strategy expressed in CALM Policy No. 3 issued in 1991 is to prevent all spread of the disease. Even when this is taken to mean spread of the pathogen and even if only for the tightly controlled forest estate, this objective is impossible to deliver because of the inevitable autonomous spread from established infestations along perimeters now thousands of kilometres long. Vectored spread by non-human agents will not be contained because a sufficiently high level of control is impracticable even on quite small areas.

Nevertheless there are situations where, for a variety of reasons, an area may be protectable. Such areas include those which are of significant size, isolated, where the density of animal and other traffic is low, and where environmental conditions do not often favour the establishment of the pathogen. Such areas merit attempts to identify and protect them, especially if they are of high conservation value. Fortunately the total area which is likely to be protectable from vectored spread is still very substantial and the skills and technology required for success are available. It is to be expected, however, that the boundaries of such areas will continue to be eroded by autonomous extension of existing infestation. Furthermore the distributions of both extensively infested and protectable areas is far from uniform and always changing. Some areas including large parts of the Swan Coastal Plain south of Perth, the wetlands of the Shannon D'Entrecasteaux National Park and the Stirling Range National Park, are so clearly unprotectable even in the short term that effort should be withheld from them except for targeted protection of rare species with phosphonate.

A revised policy directing available resources at those prioritised areas of natural vegetation which are of the highest value for conservation and/or commerce and are most amenable to enduring benefit from protective effort is urgently needed.

Recommendation

1. *That Government adopts a dieback management strategy which identifies significant protectable areas (those for which the values at risk are significant and the benefits of hygiene likely to be sustained for more than a few decades), prioritises them and concentrates available resources on rigorous application of hygiene for their protection.*

Recommendation

2. *That fewer restrictions on access be applied to and within essentially unprotectable areas.*

Adoption of a management strategy which concentrates resources on protectable areas will require comprehensive consideration of the biological, physical and human factors influencing the risk of infestation of areas to be considered for protection. The task will require close interaction between scientists and managers.

Recommendation

3. *That CALM urgently develop protocols for the objective identification of protectable areas and for their prioritisation and management.*

The primary strategy for management in protectable areas must be hygienic use of machinery in soil conditions which are not conducive to the artificial dispersal or establishment of the pathogen.

Recommendation

4. *That industry, institutions and government agencies jointly address the extent to which operational schedules can be modified to ensure that activity on the protectable areas is focused on minimising access during conditions which are conducive to dispersal of the pathogen and its establishment.*

COORDINATION OF CONTROLS

In respect of the forest estate the proposed strategy of concentrating resources on protectable areas could readily be implemented since it is largely under integrated management by CALM.

In respect of the heathlands and other areas beyond the forest estate formal coordination of controls is in most places almost non-existent. We propose the establishment of joint planning arrangements for significant industries such as timber extraction, mining, tourism, beekeeping, wild flower harvesting and road making. Since the mix of operations varies from region to region these arrangements should be made on a regional basis and receive technical support from CALM. The Northern Sand Plains Dieback Working Party provides a useful model.

Recommendation

5. *That joint planning and management arrangements be facilitated by establishment of regional coordination groups for industries and organisations with extensive operations that have a potential to spread the pathogen. CALM should provide the necessary technical advice and support.*

The Panel noted the establishment of the Dieback Coordinator position in CALM and that it has subsequently lapsed. At present it seems CALM's dieback management initiatives are widely dispersed with the result that there is variation in the interpretation and delivery of prescriptions. In addition, CALM has a wider responsibility for the implementation of effective dieback hygiene through its responsibilities for flora under the Wildlife Conservation Act throughout the State. This advisory and coordination function needs more effective effort.

Recommendations

6. *That CALM re-establish a staff position (the Dieback Coordinator role) with responsibility for internal coordination and for more effective discharge of its responsibilities for protection of the biota against* P. cinnamomi *in areas both inside and outside its estate.*

7. *That the Dieback Coordinator also have responsibility for facilitating field coordination between agencies in the Regional Coordination Groups and promoting close collaboration between research scientists and land managers.*

The Panel received advice that there have been a number of instances in which the Department of Environmental Protection has imposed restrictions on exploration activities contrary to the advice solicited by DEP and provided by CALM staff. A senior officer of

DEP advised the Panel that the Department does not have expertise in this area and relies on CALM for advice.

Recommendation

8. *That the Department of Environmental Protection and CALM together ensure uniform application of restraints on access by all significant users in threatened areas.*

TRAINING

The level of understanding and training of personnel in dieback hygiene needs improvement and wider application within the various agencies and industry sectors. Training should be frequently updated in the light of experience.

Recommendation

9. *That a training and accreditation program be instituted to ensure that all who go on protectable areas, including industry operators, CALM staff and research scientists, are fully aware of what is needed to ensure integrity of hygiene.*

MANUALS AND PRESCRIPTIONS FOR HYGIENE

With the proposed change in policy and changing perceptions of the nature of the disease there is a need to review prescriptions and ensure procedural manuals reflect the most up-to-date knowledge.

Recommendation

10. *That the revision of manuals pertaining to dieback hygiene be improved and promptly distributed.*

MAPPING OF PROTECTABLE AREAS

Effective hygiene in protectable areas depends on accurate maps of location of the disease. The categories at present mapped are complex and some, e.g. hazard, are not yet soundly based in science.

Recommendation

11. *That the ability to meet operational mapping requirements be promptly expanded through the simplification of mapping categories.*

The skills and experience required for field interpretation of the distribution of *Phytophthora* and the classification of risk, on which the delineation, mapping and planning of hygienic operations is critically dependant, are considerable. As a consequence the effort invested in training staff for this task is costly and is made more so due to the short stay of most interpreters in this function, which appears not to offer rewards commensurate with its difficulty and importance.

Recommendation

12. *That such inducements as are necessary to maintain a cadre of experienced interpreters be identified and implemented.*

PROTECTION OF RARE FLORA

Dieback is a key threatening process for some rare flora. Existing arrangements to identify populations at risk, determine priorities for protection and ensure appropriate preventative action is taken, are not yet fully comprehensive. Current procedures leading to field implementation are cumbrous and slow, particularly where spraying with phosphonate is the appropriate treatment.

Recommendation

13. *That CALM develop a more effectively coordinated and adequately resourced operation for the priority treatment of populations of rare flora, especially with phosphonate.*

TERMINOLOGY

Terminology associated with disease management is confusing, lacks precision, and as a result is an impediment to the level of understanding required for knowledgeable implementation of prescriptions.

Recommendation

14. *That terminology used in dieback management be revised, standardised and published.*

RESEARCH PROGRAMS

CURRENT STATUS

Following the identification of *P. cinnamomi* as the key causal factor in jarrah dieback, research focused primarily on four topics relevant to forest management. The first was refinement of an understanding of how *P. cinnamomi* kills its hosts. The second was to develop approaches to hygienic management and to modify the effects of the pathogen in the jarrah forest. The third was in the identification, propagation and breeding of resistant lines in *Pinus radiata* and jarrah. The fourth was to classify the landscapes according to hazard so that predictive estimates of impact might be available to planners.

Although *P. cinnamomi* was known to be present in the conservation estate outside the forest areas, it attracted little research attention or management action by the relevant authorities. Following the departmental amalgamation that formed CALM in 1986 a deliberate decision was made to redirect research emphasis to the previously neglected non-forest areas. This led also to a focus on the use of phosphonate for chemical control of established infections within host species and to research on other pathogens, notably *P. citricola*, *P. megasperma*, *Armillaria* root rot and *Cryptodiaporthe* canker.

The research on the two *Phytophthora* species, *P. citricola* and *P. megasperma*, both first recorded in native vegetation in the 1960s, has focused principally on their biology and distributions. Systematic studies, initiated in 1995, have yet to be completed to define variability within species of *Phytophthora* other than *P. cinnamomi* and to evaluate their capacity to cause damage.

With the change of research emphasis to nature conservation problems in woodlands and heathlands there has been a relative decline in research of direct relevance to management of the epidemic in forests. Only in the last twelve months has there been a vigorous move to redress this situation. Issues currently being addressed include treatment of road pavements, and water points, logging coupe amalgamation and evaluation of the distribution and pathogenicity of *Phytophthora* species.

FUTURE DIRECTIONS

The number of areas of prospective research enquiry in such a difficult and complex problem as dieback are innumerable. There are, however, several areas of advance which are either particularly encouraging or in urgent need of resolution and therefore particularly deserving of increased effort.

The Panel's views on opportunities for further research follow.

Genetics of the pathogen and host interaction

Effective management of plant diseases requires accurate identification of both the pathogens and their hosts, as well as the nature and extent of genetic variation which affects the capacity of the pathogen to cause damage (virulence), its environmental

tolerance, and the capacity of the host to resist infection (resistance).

Until 1994, identification by CALM of the five *Phytophthora* species commonly recorded in native vegetation in Western Australia was based on classical morphological or α taxonomy, i.e. using microscopic examination of organs produced in pure culture. On this basis *Phytophthora cinnamomi* in Western Australia was considered to be essentially clonal and of low genetic variability.

Recent research using isoenzyme analysis of Western Australian isolates previously assigned to one or another of the five α species has revealed the existence of at least 20 entities each sufficiently discrete to be considered 'biological species'. On evidence currently available it is unlikely that any other 'biological species' in *Phytophthora* represents as great a threat as *P. cinnamomi*. Isoenzyme analysis has also shown *P. cinnamomi* to be more variable than previously thought. DNA analyses are likely to reveal even higher levels of genetic variation in populations. It is now seen that *P. cinnamomi* is a genetically capable and dynamic adversary. There is a need to know if all the variants of the various species of *Phytophthora* present in the native vegetation are equally pathogenic, whether their pathogenicity is broadly based or host specific, whether pathogenic virulence is transferred within populations of particular species of *Phytophthora* or even between species as their ranges continue to extend and overlap. The extent of this variation and genetic capabilities of the pathogens need to be determined and recognised in the formulation of long term management prescriptions. It is likely that much of this variation would be selectively neutral, but some of it may be of significance, or linked to genes of significance. It should be possible to relate the virulence of isolates with molecular markers and thereby identify fungal genes associated with pathogenicity.

Recommendation

15. *That research into the reproductive biology and virulence of species of* Phytophthora *which occur in native vegetation, and which is necessary for a clearer understanding of both their population genetics and their importance as pathogens, be actively promoted.*

Breeding for host resistance

Early in the history of dieback research, management was based on assumptions of generally high levels of susceptibility in hosts such as jarrah and *Pinus radiata* as well as great uniformity in the pathogen. Later research has shown that there is greater genetic diversity in characters which may influence the disease producing interaction than was first postulated for both pathogens and their hosts.

The selection for resistance in *Pinus radiata* and breeding to incorporate the traits into the wider genetic improvement program is well advanced. It has provided much of the basis for the remarkable success of radiata plantations in poorly drained and *Phytophthora* infested sites in the south-west.

Considerable advance has also been made in the identification of field resistant lines in jarrah, their vegetative propagation and their breeding. It is possible that resistant lines might be available for selection in other native plant species of commercial potential such as the banksias of value to floriculture.

Selection, cloning and verification are slow processes and relatively labour intensive, so that breeding of resistant stocks will necessarily be targeted to economically important or otherwise critical species. Application of molecular techniques to progenies of known pedigree might allow for the identification of host genes associated with resistance and susceptibility.

Recommendation

16. *The programs of breeding for resistance in* Pinus radiata *and jarrah be sustained and similar programs for other appropriate species be encouraged.*

Molecular biology of host pathogen interactions and plant defence mechanisms

A more difficult area in wildland plant pathology in Australia which has been addressed only relatively recently is basic research into host pathogen interactions and plant defence mechanisms. A detailed understanding of the molecular and genetic basis of the chemical communication between host and pathogens which determines resistance and susceptibility may enable the assembly of novel mechanisms for the interdiction of the infection process, especially in association with an understanding of phosphonate action. This field is one of sophisticated biochemical, cell physiological and molecular genetic research. It would integrate and build upon the knowledge gained from and the materials used in the population genetic analysis of the pathogen, in host selection programs, and in research programs into phosphonate action. Western Australia is very well serviced with the technical competence to undertake such research, however it is largely confined to medical research. Building bridges between *Phytophthora* research and medical research may be an extremely productive enterprise.

Recommendations

17. *That basic research into the cellular biochemistry of host/pathogen interactions be encouraged. These fields of research may best be conducted in University Departments and CSIRO, and where appropriate should enlist the capabilities of medical and paramedical research laboratories.*

Biological control

Biological control is commonly seen as an environmentally friendly strategy for crop protection. Its greatest successes have been recorded from the fields of animal, insect and weed control. Some progress is being made in biocontrol of other soil-borne pathogens in several short-lived plant crops. It is also believed to be a component of the success of integrated management in protection against root rot of avocados caused by *P. cinnamomi* which, however, cannot be achieved without major costly chemical and physical modifications of the soil environment.

While the potential of biological control for management of *P. cinnamomi* in natural vegetation has been promoted in some quarters, commentators disagree about its likely success. Some take an optimistic view that this speculative strategy is perhaps the only prospect for controlling *P. cinnamomi* over immense areas of wildlands of low commercial value. Partial biocontrol of epidemic disease is found in certain vascular wilt diseases of trees, such as the Dutch elm disease, but this group of pathogens has biological bases which differ from *P. cinnamomi* root rot.

Other workers conclude, in the light of disappointing results of the numerous studies so far conducted on biocontrol of root rot diseases of long lived perennials, that agents effective in long term control of epidemic root rot and suited to the great variety of soil environments in Western Australia's conservation estate are unlikely to be found. Formidable practical difficulties can be anticipated in the discovery, introduction and delivery of exotic biocontrol agents into the complex natural ecosystems of the state.

Recommendation

18. *Research proposals which show some clear prospect of leading to development of successful mechanisms for biocontrol should be considered for support.*

Ex situ conservation

It is likely that some species which are very highly susceptible to *P. cinnamomi*, especially those whose distribution is restricted naturally or to remnants at high risk of infection, may be forced to extinction before effective management prescriptions are formulated and implemented. Representative living materials of these critically endangered species may be preserved by *ex situ* cultivation in disease free gardens, as seed collections, by tissue culture collections, and by cryostorage. The most economical method of long term storage appears to be cryostorage in liquid nitrogen. Although Western Australian research in this area is of world class, knowledge concerning the optimum tissue types for cryostorage, methods for tissue revitalisation and the preservation of genetic integrity following cryostorage is still quite limited.

Recommendation

19. *That research into methods for* ex situ *conservation and germplasm storage be encouraged.*

Use of phosphonate

Modifications to schedules of treatment developed for use of this cheap and safe fungicide in horticulture have been developed to meet the special requirements of native vegetation in Western Australia. As a result a vital tool for the protection of root-rot affected native vegetation has become available. Its current use in the protection of flora threatened by *Phytophthora* needs to be far more widely employed. Further refinements of techniques of application and management strategies for setting priorities for treatment are urgently needed.

The capacity of this chemical to induce resistance in *Banksia* prior to infection might also be exploited to slow the rate of autonomous spread of *P. cinnamomi* at the perimeter of infestations.

At a more basic level the encouragement of work on the mechanism of the action of phosphonate might lead to innovative though as yet unpredictable approaches to disease control.

Recommendation

20. *That refinement of techniques for application of phosphonate and the development of understanding of the mechanism of action should be encouraged.*

Hazard rating of forest sites

Hazard rating is a concept based usually on the physical factors of a site which enables prediction of the ultimate impact of introduction of the pathogen. Since hazard is dependent on the degree of susceptibility of the host it is usually specific to a particular species. Its use in WA usually refers to impact on jarrah. A reliable system of hazard rating is badly needed for the jarrah forest, where there are substantial forestry and mining operations with potential to spread the pathogen.

The soils of the jarrah forest are generally deep and well drained so that spread of the pathogen is likely to be slow and amenable to some degree of containment by sound management. There are, however, a number of generally small localised sites where subsurface features leading to impeded drainage favour development of dieback. They are not readily detected due to the mantle of lateritic materials clothing the gently undulating landscape.

Geophysical and remote sensing techniques have been successfully used in farming areas to detect such subsurface features. They affect salinisation, success of revegetation, and hence site selection for eucalyptus and mallee plantations. Such techniques cannot be directly transferred to the jarrah forest because of the depth and extent of superficial materials. Further development work is needed.

Recommendation

21 *That geophysical and remote sensing methods be further investigated with a view to their use in location of subsurface features affecting the hazard rating of forest sites.*

Hygiene strategies

It has long been recognised that the crowns and shoulders of minor unsealed roads are often colonised by native plants where they constitute a potential food base for species of *Phytophthora* from which they may be spread during operations such as grading.

Prescriptions for hygienic practice in road repair and maintenance include demarcation of infested areas, diagnosed by observation of symptoms in susceptible species. At the same time it has been assumed that unvegetated and unsealed heavy duty pavements were inhospitable to species of *Phytophthora*. Recent research has indicated an unexpectedly high frequency of five separate species of *Phytophthora* on pavements including numerous sites in which there was no symptom of disease in the adjoining forest. These observations would seem to indicate that hygienic practice along unsealed public roads may not be as effective as previously assumed.

Treatment of water points used in fire suppression and road construction and repair with fungistats, which suppress production of zoospores, has been found to be more valuable than previously supposed.

A matter of considerable moment raised during our discussions is the extent to which it might be possible for the timber harvesting industry to move closer to a strategy of dry season logging. Increased use of tactics such as stockpiling and light cable systems for harvest of thinnings might achieve significant improvements in hygiene.

The practice of contemporaneous harvesting of widely dispersed coupes with its attendant increase in the length of unsealed public road traversed needs reappraisal.

Recommendation

22. *Progressive refinement of hygiene strategies which will reduce risk of infestation in operations be undertaken.*

Resistance and disease-escape

Among the rare flora known to have a generally high level of susceptibility considerable numbers of individuals persist in long infested areas. These include *inter alia* *Andersonia pinaster* and two species of *Darwinia*. All are small, precocious and obligate seeders dependent on post fire regeneration for survival. Research on their resistance and biology in relation to fire may lead to development of fire management schedules essential to their survival in the presence of *Phytophthora*.

Recommendation

23. *That the role of fire in the management of those rare species which are threatened by* Phytophthora *root rot be further investigated.*

ORGANISATION OF RESEARCH

Cooperation and coordination

The Panel has previously examined the Cooperative Research Centre proposal for dieback research, and advised against it on the grounds of its organisational structure, which we saw as top heavy, and its inability to deliver results which would enable better management of the dieback problem. Neither do we favour a dieback institute, partly because of organisational problems, but mainly because the concentration of the wide range of scientific disciplines required in a single institution is impracticable.

Relevant research expertise, laboratory and other facilities located both centrally and regionally are situated mainly in CALM. This, together with its statutory responsibilities, should ensure CALM has a central and influential role in any structure proposed.

There are many other operators, both government agencies and industries, as well as CALM in the State's natural areas. Some, such as the mining and timber industries, run very substantial operations. They should contribute to both the determination of research priorities and its funding.

There appears to be no formal structure for the development of overall research strategies directed at the needs of planners and managers of operations, nor for its funding. The Panel concludes that such a structure involving both research scientists and managers is urgently needed. CALM should be an influential member, but the chairman should be independent, probably a scientist, and be directly responsible to the Minister for The Environment. Membership would need to include at least the following:

- CALM, both management and research aspects;
- forest and mining industries;
- public utilities, such as water supply, electricity, roads and communications; and
- two scientific members.

The Panel noted that several institutions in the forestry and mining areas of the private sector expressed interest in such a formal consultative arrangement.

Recommendation

24. *That the Minister for The Environment establish a Dieback Consultative Council DCC) reporting directly to him through an independent chairman;*

    That membership should:

    * *include representatives of CALM management and research, from relevant industries and utilities, and appropriate representation from the scientific community;*
    * *be constituted with a membership capable of providing independent advice to the Minister on the broader issues of policy and strategy that he might seek from time to time; and*
    * *include a secretariat provided by CALM's Dieback Coordination Unit.*

    The functions of the DCC should be:

    * *to establish close liaison between planners, managers and research scientists*
    * *to ensure that a high priority is given to research generated by management needs;*
    * *to publish reviews of research findings and their implications for both management and further research;*
    * *to recommend on acquisition and allocation of research funding according to its perceived priorities; and*
    * *to advise on appropriate institutions to carry out the work.*

The Panel considers that, within the broad framework of the DCC, input to the detailed setting of research projects is best left to the individual agencies and institutions

CALM Research

This section deals mainly with CALM's research and maintenance of its quality. It would not be appropriate for us to comment here on arrangements in universities and other research organisations, though such evaluations would be required of the proposed Dieback Consultative Council.

If CALM is to have the influential and responsible role indicated above, it is essential that it has a research scientist in the dieback field capable of providing strong leadership

within and outside its own organisation. There is not at the moment, however, a willing and appropriately qualified research leader identifiable within CALM.

Recommendation

25. *That CALM identify and recruit a senior scientist experienced in wildland plant pathology to provide urgently needed leadership in the dieback research program and to promote close collaboration with land managers through the Dieback Coordinator.*

Research emphasis

CALM's Science and Information Division employs scientists in a wide range of disciplines, yet even so it cannot hope to have the competence to cover all its research requirements, even in the dieback related field. The Panel believes that CALM's main emphasis should be on the applied research generated by its management needs. It will also identify more fundamental investigations and work, beyond its capacity, which should be contracted out to appropriate institutions.

Recommendation

26. *That CALM's research program give priority to applied projects related to management needs. Fundamental research and work beyond its competence should be contracted out.*

Departmental programs and research direction

Research scientists play a large part in research planning and identifying opportunities for profitable work. The process is outlined clearly in Science and Information Division's Guideline No 7. There are only 51 scientists, however, and their work is controlled by a Science and Information Council, consisting of senior staff of the Division most of whom are not qualified or experienced in dieback and who should presumably receive direction from the Corporate Executive. This process might be more effective if formal arrangements were made for management and senior policy input at this stage. The latter process appears to be less than fully effective, perhaps because of a need for clearer decision making by the Corporate Executive.

Research direction is generally achieved through a combination of discussion, persuasion and finally budgetary discipline. Some form of 'program budgeting' which relates objectives and programs to proposed expenditure is a useful means of providing it.

Recommendations

27. *That CALM consider adopting 'program budgeting' in allocating funds according to departmental programs and priorities.*

Research standards

The quality of research output is provided for in many research organisations by internal peer review, followed by submission of results for publication in scientific journals which arrange further evaluation by leading scientists in the appropriate field. The internal processes of review assess the techniques of measurement and observation, and the validity of conclusions reached. Editorial changes to improve presentation may be suggested, but not changes to scientifically valid conclusions.

Science and Information Division's Guideline No. 9 outlines a hierarchical and perhaps cumbrous system of review which has no formal provision for the use of practising scientists in the same or closely related fields. Because of the breadth of CALM's research effort there are in many areas too few scientists for fully effective peer review. CALM might look to wider and external review in its own publications.

Recommendation

28. *That CALM's Science and Information Division establish an internal Publications Review Panel consisting of research scientists. It should arrange review by practising scientists (in house or outside if necessary) of draft research papers in respect of the validity of scientific conclusions, and recommend accordingly to the Executive Director.*

Implications for policy

Research scientists may, and often do point out the implications of their findings for policy and decision making. But their advice is not to be taken as prescriptive in this area, since many other considerations (financial, social, political) then become involved. Nevertheless it is important to have research results publicly available as soon as possible, since they contribute to the information base on which informed discussion may take place.

Recommendation

29. *That strictly scientific papers recommended by the Publications Review Panel be published without delay.*

It is also important to distinguish between primary research papers reporting scientifically valid conclusions, and policy papers derived from them and other sources. The latter are often prepared by administrators rather than research scientists, and are not always subject to the same disciplined review.

Recommendation

30. *That CALM makes a clear distinction between primary research papers which report scientifically valid conclusions, and policy documents derived from them and other sources.*

FUNDING OF DIEBACK RESEARCH

At present funding levels available, other than for fixed salary, service and overheads, are low. For example, 94 per cent of CALM Consolidated Revenue funding for research is devoted to salaries leaving only six per cent for operations so that field work is limited. There is heavy dependence on external funding from Commonwealth and industry sources, leading to relatively small contributors having a major and disproportionate influence on priorities.

The Panel proposes that additional funding be sought from all industries using susceptible areas as a resource base and from public utilities affecting threatened areas. For the latter, budgetary provision might be made as a community service obligation.

Recommendations

31. *That the State investigate ways and means of applying the user pays principle to those public utilities whose activities contribute significantly to costs of dieback management and control.*

32. *That ways and means be sought which would enable charging of all industries, including tourism, beekeeping and wildflower harvesting which use natural areas, for their share of management and research costs.*

33. *That an identifiable proportion of royalties and other charges and payments levied be allocated to dieback related research.*

COMMENT ON RECOMMENDATIONS OF THE STRETCH REPORT

Where we generally agree but do not fully endorse we suggest caveats on the recommendations. Where we do not agree at all we comment on the reasons for our differences of opinion.

Stretch Committee Recommendation 1

The Committee generally supports the current quarantine measures taken by CALM to limit the spread of dieback disease by restricting access to critical areas.

No comment required.

Stretch Committee Recommendation 2

The Committee recommends that CALM in its role as the manager of most of Western Australia's public land, should use its discretion freely but reasonably to have its Minister quarantine areas under particular threat of dieback infection, or dieback spread within an infected area, without waiting for a full management plan; notwithstanding such a declaration, current bona fide commercial users of an area to be quarantined would be encouraged to negotiate access rights where this would not directly jeopardise dieback control measures being implemented. In addition a special effort needs to be taken to clearly and simply explain to local people the necessity for such action and an emergency budget made to fund this effort.

This recommendation is strongly related to recommendation 1 above and the Panel endorses the procedure outlined.

Stretch Committee Recommendation 3

That the Department of Conservation and Land management intensify its campaign to educate the public on the ways dieback is spread and the public role in limiting the proliferation of these killer fungi; and enlist the aid of supportive community groups whenever possible; the primary targets of this campaign should be touring groups, park users and school communities.

The Panel agrees with the need for education and community support. We suggest that the recommendation needs to be addressed in two parts:

a) the value and cost of intense programs of public education; and
b) the importance of enlistment of public interest groups through existing channels such as local government and 'Friends of the Park' type groups.

In that the majority of the public seldom go upon the conservation estate at such times and in such manner as is likely to contribute significantly to accelerated spread of the problem, the cost/benefit ratio of public education programs is likely to be very high. In our view such funding as is available should be directed primarily toward the development of training programs for employees of government agencies and industrial enterprises whose essential activities take them frequently, or at critical times, upon areas classified as combining the characteristics of being uninfested, valuable, and protectable.

Stretch Committee Recommendation 4

That a 'Dieback Pack' of information be developed by CALM and the RAC aimed at educating motorists and in particular 4WD vehicle users on preventative measures, and that the pack be supplied at a reasonable cost (if necessary) to motorists and also placed in the glove box of all 4WD vehicles offered for sale.

This recommendation relates to one specific subset of what is said more generally in recommendation 3 of the Stretch Committee's Report. This Panel recognises however, the importance of and difficulty in controlling off-road traffic.

Stretch Committee Recommendation 5

The Committee recommends the formation of 'Friends of the Park' type voluntary groups to provide advice and support for the management of national parks and reserve lands in their area and that a CALM officer have a key role with each of these voluntary groups to provide additional expert and scientific input. It also encourages the Government to consider giving such groups legislative support similar to that enjoyed by Land Conservation District Committees (LCDC's)

The Panel believes such groups can be very effective but believes their formation should be driven by demand from the 'friends' rather than CALM attempting to create the demand. The Panel also believes that such groups should be independent of CALM.

Stretch Committee Recommendation 6

That a simple clear and brief information pamphlet be distributed to all Shires, farmers and householders outlining the dangers and methods of spread of dieback and simple hygiene measures needed to limit its spread.

There are several adequate pamphlets available and these have been widely distributed in the south-west, although there has never been a direct mail out to all farmers. This should be tried and there is also a case for information, more cheaply packaged, directed at specific local problems and outlining what shires and groups of landholders and citizens have been able to achieve elsewhere in similar circumstances.

Stretch Committee Recommendation 7

The Committee recommends that as soon as practicable all road reserves in known or suspected dieback areas be tested for the presence of the dieback disease in order to establish a disease profile of each road, so that appropriate disease control measures can be implemented during reconstruction and maintenance work.

As a general rule all public works involving landscape modification should be evaluated for presence of the pathogen prior to that work rather than as a specific independent project. However, the Panel has discussed this issue in the chapter headed Management and has suggested classification of areas into those that are protectable and worth protecting and those that are not. In that regard it is considered that many of the public roads are likely to fall into the non protectable category and no longer worth practicing hygiene on their maintenance.

Stretch Committee Recommendation 8

The Committee recommends that the Government review relevant sections of the Act and the Mining Act with the object of making road-building materials available from public lands for the purpose of building better quality and relatively cheaper roads where the dieback-disease status of such material to be supplied is tested and found appropriate to the disease status of the road reserve being improved.

Agreed. Knowledge of the disease status of borrow pits for road construction and maintenance is fundamental to hygiene. Mechanisms for making gravel available at particular costs is outside the Panel's brief,

however we would expect that it is the type of issue which would be considered by the Regional groupings we have recommended.

Stretch Committee Recommendation 9

The Committee urges the Government to ensure that adequate funding is directed to the mapping and interpretation of dieback risk areas, where the spread of the disease is expected to be quickest and most damaging. A list of priority areas should be drawn up by a top-level Advisory group comprising CALM and Industry representatives including:

(i) Horticulture;
(ii) Apiarists;
(iii) Local Government;
(iv) Conservationists;
(v) Tour operators;
(vi) Foresters; and
(vii) miners.

This recommendation is strongly endorsed. The Panel believes the State objective should be on the one hand to identify significant protectable areas and increase the effort to minimise the spread of the pathogen into these areas. On the other hand it should decrease its efforts in areas which are no longer defensible.

It is apparent that outside of CALM there will be difficulty in achieving this and the Panel believes that CALM, having the responsibility for protecting the State's flora, should be taking the initiative with Government and non-government bodies to bring it about.

Stretch Committee Recommendation 10

The Committee recommends that very high priority be given to the development of quicker and cheaper diagnostic methods of detecting dieback pathogens, and that private research companies and individuals also be invited to contract for this development.

The Panel is concerned at the cost of processing an individual sample. However it sees little prospect that it can be reduced by new technology. Results from CALM and MERRIWA funded research indicate that the current diagnostic methods for *P. cinnamomi* used are the most cost efficient available. This work indicates also that, for the other species of *Phytophthora* of interest to wild land management in Western Australia, the most cost effective method is isolation into pure culture by traditional methods followed by electrophoretic typification in CALM's newly established isoenzyme laboratory.

Stretch Committee Recommendation 11

The Committee notes Western Australia's achievements in research and treatment of dieback diseases and recommends that all avenues of research should be coordinated as far as it is commercially appropriate, to achieve a greater and wider research base and speedier resolution of the problems of dieback diseases.

This matter is central to the Panel's recommendation number 24 which relates to the preferred structure and funding requirements and arrangements for dieback research in Western Australia.

Stretch Committee Recommendation 12

Research grants should be made wherever possible to local research companies, individuals and institutions so that Western Australia benefits economically from the technology developed in dieback disease control.

The Panel has no problem with this but believes the priority should be to determine the most promising and highest priority work, which should be commissioned to the group with the most expertise and capacity. All other things being equal the work should be done in Western Australia.

Stretch Committee Recommendation 13

The Committee urges the Government to ensure that CALM keeps close contact with the agricultural and horticultural industries and if possible with their research base and control practices.

Agreed.

Stretch Committee Recommendation 14

The Committee recommends that CALM and the new dieback research program at Murdoch University maintain a public 'running list' of minor and major research targets that could be taken up by tertiary graduates, private researchers and industries.

The Panel is of the view that such determination of priorities at the broadest level of strategy and policy should be set at Ministerial level on advice of the consultative council it has recommended at recommendation 24.

Stretch Committee Recommendation 15

The Committee recommends that following the election due in 1993, the Committee be reconstituted to further investigate the areas which were peripheral to the Committee's current Terms of Reference, as well as some additional issues that have arisen late in the Committee's deliberations and will require more time to investigate.

As this is a matter for the Minister and Parliament, direct comment by the Panel is outside its terms of reference.

Stretch Committee Recommendation 16

That the Government instruct CALM to make a very strenuous effort to discover and help local communities establish suitable short and medium stay camping areas near popular recreation spots where the risk of dieback spread is minimal or manageable, especially in the lower rainfall areas of Bremer Bay.

The Panel observes that in CALM's management plans prepared and issued since the release of the Stretch Committee's Report very detailed arrangements have been made to meet the intent of this recommendation.

Stretch Committee Recommendation 17

The Committee recommends that licences be issued from local District offices of CALM and that pickers can only be employed after they have been given instruction and accreditation by CALM on how to collect wildflowers without spreading Phytophthora and leaving unnecessary scars on plants thus allowing the entry of the Aerial Canker fungi which are now prevalent on the south coast areas particularly.

The Panel is aware that procedures have been put in place for the issue of licences from the local office from 1995. The matter of accreditation of pickers for their knowledge of dieback and its management, *inter alia* is an important issue for the protection of large areas of crown land on which picking takes place and the Panel believes it should be put in place. However this cannot be implemented without appropriate legislation.

Stretch Committee Recommendation 18

The Committee is confident that mining operations can proceed in or adjacent to dieback infected areas provided effective quarantine and hygiene practices are observed at all stages of exploration, mining and transport of materials. Such practices must continue to be observed strictly and monitored closely.

The Panel's experience is similar. We have been impressed with the spirit of cooperation in each of the exploration and extractive phases of the industry. The activities of the Northern Sand Plains Dieback Working

Party in particular is in our view a model for cooperative action at a regional and community wide level.

Stretch Committee Recommendation 19

The Committee believes that a large proportion of the registration fees obtained from the apiarists should be directed back into dieback research in these areas. The Committee urges the Government to ensure that every effort is made to allow beekeepers access to safe sites close to dieback areas so that bees can range over any honey-flow in such areas.

The Panel agrees and believes that there should be a principle of user pays in funding research into dieback. It has recommended along these lines in recommendations 31-33.

Stretch Committee Recommendation 20

The Committee recommends that a Dieback Research Foundation/Trust/Fund be established under legislation to receive contributions from public and corporate sources for funding research projects on dieback diseases. We recommend that tax deductible status be sought for donations to this fund.

This recommendation is dealt with in the Panel's discussion under Research Programs. We believe that such funds as are raised by any such initiative should not be dedicated to research alone, but should be directed in large part to practices necessary to provide on site protection of areas or species of particular value. The structure and membership of any foundation should be a matter for the Minister on advice from the Dieback Consultative Council.

Stretch Committee Recommendation 21

The Dieback Research Foundation should be administered by a high profile non-government council representing Industry, Academia, Independent Researchers and CALM with the Chairman being a senior officer of CALM.

This recommendation is related to Stretch recommendation 20 and has been dealt with in the chapter of our report entitled Research Programs. The recommendation of the Panel is similar but not identical to that above.

Stretch Committee Recommendation 22

The Committee recommends that the Government strongly oppose any proposal to move dieback research or research funds, away from Western Australia.

By actively promoting Western Australia's advanced level of dieback management and research, it should be possible to attract joint research projects to this State along with an appropriate share of the funding for such research.

The Panel's detailed advice is included in the chapter headed Research Programs.

Stretch Committee Recommendation 23

The Committee recommends that the Dieback Research Foundation actively seek out-of-state industries to conduct jointly funded research in Western Australia where so much advanced study and research is already taking place.

The Panel believes that all contributions to research are welcome and should be encouraged. It sees this as a function of the Dieback Consultative Council it has recommended.

APPENDIX 1 - TERMS OF REFERENCE

Provide an objective assessment of the importance and nature of problems which *Phytophthora cinnamomi* poses in Western Australia for the conservation of nature and the maintenance of sustainable natural plant productivity.

Assess the current status of research and identify those lines of investigation which show particular promise and warrant increased support.

Report on the preferred structure and funding requirements and arrangements for dieback research within Western Australian, in particular the development of novel approaches for disease control and management.

Evaluate the scientific basis and the efficacy of existing management strategies and practices and identify any need for modification.

Identify opportunities and constraints in the transfer of land management practice of recent and future advances in science and technology and any necessary structures to help maximise opportunities and minimise impediments.

Suggest organisational structures which might oversee the retention of intellectual rigour in research and maintenance of standards in land management practice.

Examine the findings of the Parliamentary Select Committee into dieback chaired by the Hon W Stretch MLC and provide advice on the implementation of the Committee's recommendations.