MR BARTLE
DWELLINGUP RESEARCH

1982 RESEARCH CONFERENCE

You are invited to attend the 1982 Forests Department Research Conference, to be held at the Como State Headquarters Training Centre on July 19/20.

The first day will be devoted to a review of research in progress in the Forests Department and by other organisations in the forest. A number of persons from organisations such as Alcoa, CSIRO, P.W.D. and tertiary institutions will attend on that day. Each speaker will be allotted 10 minutes in which to outline the objectives of his research and the means of attacking his problems. There will be no time to present any results other than in very general terms. It would be useful if you would prepare a written summary for distribution along the lines of that attached.

The second day will be occupied mainly by an internal search-type review of our research problems with the objective of defining areas where greater or less effort is required, or where we might be omitting significant areas of research. One or two hours will also be devoted to administrative matters within research branch.

The Date Again:	July 19 and 20
The Place:	Como SHQ Training Centre
Times:	0900-1630 both days

F.H. McKINNELL
A/C.O.D. RESEARCH

FHMcK/kc
Como Research
17/6/82

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Dr Tippett, Kelmscott C.S.I.R.O.
Dr Siemon, Mr Chevis, Mr Moore.
Miss de Braganca
Mr Butcher, Dr Abbott, Mr Stukely, Mr Ward, Mr Loneragan, Mr McGrath.
Mr Underwood, Mr Smart, Mr Edwards, Mr Havel.

1982 RESEARCH CONFERENCE COMO 19-20 JULY 1982

For review of research in progress, projects summarised by O. Loneragan are -

1. Kalgoorlie regeneration plots for Eucalypts, Mulga and residual Sandalwood.

2. Sandalwood establishment and management:
    1. natural regeneration in Kalgoorlie plots;
    2. artificial regeneration, Narrogin and tertiary institutions.

3. Genetic resources and variability of eucalypts (with other authorities).

4. Conservation of Flora and Fauna Reserves under the Forests Act (liaison with other authorities).

5. Ecology and Silviculture of Jarrah (with Dr Abbott).

6. Permanent Field Plots and Archives (with Dr Abbott).

DISTRIBUTION:

C.C. Como
Wanneroo
Dwellingup
Busselton
Manjimup
Mr Underwood
Mr Smart
Mr Edwards
Mr Havel

PROJECT NAME: Kalgoorlie Regeneration Plots

Research liaison with Kalgoorlie Division.

PROJECT DESCRIPTION: Frequency-abundance of leaf flush, budding, blossom and seed set studies of the local species, prescriptions for regeneration and measurement of growth rate processes and habitat factors, and validation of responses.

PROBLEM: A 1979 report to the State Cabinet on the present and future pastoral industry has been made available for public comment. It points out that the pastoral land has been degraded and makes recommendations for restoration. Resources are limited for improving trends, either for short term or long term benefits.

Lines of Research for Eucalypts, Mulga and Residual Sandalwood:

Eucalyptus species

WP 17/74 - Kambalda railway line, regeneration in 10 barrow pits cleared of the vegetation and topsoil in 1973 was described and photographed by Mr Richmond in January 1974, 1975 and 1978. Large scale aerial photographs were taken by Mr Morrissey, W.A. Dept. of Agriculture in Dec. 1978. As well as weeds and grasses, 4 eucalypts were present (E. salmonophloia, E. oleosa, E. griffithsii and E. lesoneffii) but not in all plots.

WP 19/75 - Fire effects on Eucalyptus sp and regeneration in Lakeside Sandalwood Reserve (and Goongarrie Mulga National Park), injury and recovery in 30 Salmon Gum trees were recorded following the 1975 wildfire. Seed was absent at the time of the fire and regeneration has not been recorded.

Mulga (Kalgoorlie liaison with W.A.I.T., Dr Fox)

WP 17/75 - Effects of the 1975 wildfire and regeneration in a small plot of Goongarrie NP is being monitored at regular intervals. Seven years after the fire, the tallest mulga reached 1 m in height and the number of seedlings was 2000 ha^{-1}.

Residual Sandalwood

WP 20/73 - Some progress has been made in elucidating the effects of various factors (fencing, grazing, site preparation, seed supply and climate) on regeneration in two pastoral stations and two sandalwood reserves (and of fire on sandalwood in the Lakeside Reserve). Survival was better in fenced areas on stations than unfenced. Ploughing was harmful to survival by destroying the fine roots of the host plants.

WP 20/74 - For germination and survival of sandalwood, the untreated control was equally as good as any of the treatments - removing the seedcoat, soaking the seed, sowing the seed in peat and irrigating at 5 l and 10 l m^{-2} per week in these tests. The importance of the proximity of the host roots was shown for the survivals which were 2.6 m (Bulloch Holes Reserve) and 1.3 m (Jeedamya Station), compared with the dead seedlings at 3.8 m and 2.3 m respectively, from the nearest host plants.

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WP 4/77 - At Wyo Well, Yowie Paddock, Hampton Hill, Kalgoorlie six airphotos of sandalwood regeneration with mulga have been taken by Department of Agriculture, John Morrissey in December, 1978.

WP 3/77 - Yerilla Station, 145 km north of Kalgoorlie has 30 ha of natural regeneration with a patch of 60 trees/ha of which 16 are mature and 44 immature, about 15 years old. The aim is to compare the influence of grazing on growth rates in the unfenced area, in one 7 ha plot fenced and in 6 small plots in 4 ha, replicating in 2 plots each, 3 treatments at random:

1. stock-proof fence to exclude large animals;
2. rabbit-proof fence;
3. unfenced.

The outstanding feature of the surviving sandalwood is its position protected from grazing, invariably in the centre of the host bush.

WP 14/78 - The frequency of leaf flush, blossom and seedset is being recorded in 2 sandalwood reserves, Bulloch Holes and Calooli (c 45 km NE and SW from Kalgoorlie).

PROGNOSIS: Continuation as necessary, subject to resource allocation. Monitor blossom and seed production in relation to break of drought for observed species in all plots, give prescribed treatments for regeneration and measure response. Liaison with W.A.I.T. is being continued. Publish bulletin on Sandalwood in W.A.

PROJECT NAME: Sandalwood establishment and management:
1. natural regeneration - Kalgoorlie regeneration plots;
2. artificial regeneration - Narrogin and tertiary institutions.

PROJECT DESCRIPTION: 1. Seed production, factors affecting natural regeneration of sandalwood in the arid zone of W.A.
2. Artificial regeneration, host-parasite interactions.

STATEMENT OF PROBLEM: Sandalwood procurement is an economically significant industry in W.A. yet the very basis of the industry, the sandalwood tree, has grave problems in establishment and management. Successful natural regeneration has been observed in very few instances in the last 100 years. In the long term this situation alone would threaten the viability of the industry. Regeneration is affected by such factors as run of seasonal rainfall, seed supply, browsing by sheep, rabbits and goats, availability of suitable hosts (sandalwood is an obligate root parasite). Once regeneration is obtained the young plants face such problems as adverse seasons in early years, grazing by sheep (most sandalwood occurs in pastoral leases) and vermin, drought and insect damage.

LINES OF RESEARCH IN PROGRESS:

(1) Growth rate of sandalwood in different rainfall zones.

(2) Efficiency of different host plants (at tertiary institutions, W.A.I.T).

(3) Evolution of reliable nursery handling techniques (Narrogin, ~~see over~~)

(4) Establishment of suitable seed production areas (Dryandra-Highbury).

* The main findings at 3 and 9 months after planting show that sowing 4 germinants per spot can be expected to produce the number of surviving seedlings equal to or greater than 100 percent survival, for planting out from the nursery, one seedling per spot in the field.

PROGNOSIS FOR PROJECT:

The W.A. Sandalwood Company has recently made funds available for research into some aspects of sandalwood establishment. The next 5 years should see significant progress in that area, but real problems in managing sandalwood in pastoral zones remain. The possibility of using sandalwood in the wheat-belt should be considered, as part of the basic work program:

1. regular provision in the estimates for annual seed collection;
2. regular supply of seed-germinants from May to July. When seed is available for orders, raise germinants by the Narrogin method, starting six weeks before planting out:
   - crack the seedcoat in chainsaw breaker or with band saw;
   - sterilise the seed for 30 minutes in 10 percent household bleach and dust with fungicide;
   - prepare vermiculite germination mixture in seed trays;
   - place seed in vermiculite in seed tray with bottom heat at 20°C in hot house; (is 5cm;
   - remove germinants and supply orders from as soon as germination starts (&before radicle//
3. approve suitability of woodlot and its protection from grazing, before endorsing orders;
4. donate seed-germinants to those who provide approved woodlots;
5. provide for sale of seed and seed-germinants to others as necessary.

O. Loneragan
COMO 16/7/82

PROJECT NAME: Genetic Resources and Variability of Eucalypts

Research liaison with Extension Service and other authorities (CSIRO, W.A.W.L.A., W.A. Herbarium, National Parks).

PROJECT DESCRIPTION: Field guides for describing and identifying Eucalyptus species and distribution of seed sources and seedlings in reserves and experimental plots. Requirements for being self-sufficient in seed production of valuable species.

PROBLEM: Development restricted.

LINES OF RESEARCH:

WP 18/72 - Genetic resources, W.A. Eucalyptus spp. mini herbarium for the SW and inland areas, and pocket guide for northern species support literature references for use in the field.

WP 5/77 - Variability of W.A. Eucalypts, CSIRO has introduced a range of W.A. eucalypts in Yalanbee plot for controlling movement of water and salt in paddock (Bakers Hill). Seedlings from 12 provenances of the weeping form of jarrah have been added in one plot of plantings in eastern ridge laterite, George Block (East of Dwellingup).

PROGNOSIS: Continuation as necessary, subject to resource allocation for further research and development, refer to T. Butcher.

PROJECT NAME: Conservation of Flora and Fauna Reserves (Under Forests Act) WP 17/72

PROJECT DESCRIPTION
AND PROGNOSIS: Evaluate conservation potential of native woodland and arid zone species and maintain liaison with other authorities on ecological matters, historical and scientific values of management priority areas.

PROJECT NAME AND
PROGNOSIS: Ecology and Silviculture of Jarrah - Silvicultural practice in high quality forest (I.M.Us) was discontinued, while strategies of zoning for multiple use forest forest policy (L.U.M.P.) were being developed. The first priority in this work was the conservation of flora and fauna (above). As the lack of demand for jarrah trees of small and intermediate sizes began to change due to shortage of large sized trees, priority has returned now to allocation of staff and employment into ecology and silviculture of jarrah.
'Second Growth Jarrah' (1971) Bound Report)
Stocktaking in the Jarrah Forest (1934-38) maps, inventories and other records are being checked in the northern region and updated as a joint project in association with Dr Ian Abbott.

Project Name - Pine silviculture

Project Description

Establishment, nutrition, weed control, pruning, thinning, spacing and wind stability of pine species.

Statement of Problem

The softwood afforestation programme being carried out by the Forests Department has until recently been concentrated in the Blackwood Valley and the coastal plains near Harvey and Wanneroo. Now the major plantings are in the Donnybrook Sunkland. The Sunkland is characterised by infertile soils of sand to sandy loam texture. Some areas are subject to periodic waterlogging. There are challenges in defining establishment, nutrition and tending regimes for pine grown on these sites. P. radiata is the main species being grown with some areas of P. pinaster, P. taeda and P. elliottii also being established.

Lines of research in progress

1. Site Preparation

   Considerable site preparation is required to successfully establish pine in the Sunkland. Techniques being investigated are ploughing, mounding and ripping of the planting lines on the sites with 'heavier' soil texture.

2. Nutrition

   Initially P. radiata on the Sunkland was fertilised with 'Agras No. 1', an inorganic nitrogen and phosphorus fertiliser. Observations of pine in several plots established with clover and fertilised with 'Super' in the Sunkland suggested their vigour and health to be superior to the pine fertilised with 'Agras'. This had lead to the adoption of the clover/'Super' regime in the plantation.

   Research is now being concentrated on refining this regime. Rates and times of application of phosphate, levels of nitrogen input and the need for minor element (zinc and copper) sprays are the main lines of investigation.

3. Weed Control

   Both scrub and coppice (Eucalyptus spp.) require control in all recently established plantations on sites cleared of native forest. Scrub control methods being investigated are interrow cultivation, mulching and broad-cast sprays of herbicide (hexazinone). Establishment of a heavy clover sward, and grazing by sheep, also may have potential for scrub control.

   Alternative chemicals to 245-T and 24-D for coppice control are being tested. Promising techniques are:-

   (i) Line drench with hexazinone.

   (ii) Foliar spray, cut stump and stem injection with glyphosate.

   (iii) Foliar spray and stem injection with dicamba.

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4. Silvicultural Regimes

The use of clover to provide nitrogen to the pine and potential instability following thinning has lead to alternative silvicultural regimes being investigated for the Sunkland plantations.

Strip planting techniques and early thinning are being investigated as a means of maintaining clover longer in the plantation than would be possible under the current silvicultural schedules.

Thinning methods which may improve stability are early heavy thinning or regular light thinnings.

5. Pruning

Branching habit of pine at various stand densities is being investigated. Assessments of epicormic occurrence and severity have been carried out over the established plantations.

6. Second Rotation Studies

A comparison of several site preparation methods for second rotation planting is being made. Crushing and hand planting was a cheaper method than heaping and burning the debris. Effective crushing machinery is required to introduce this technique on a broad scale.

Hugh Chevis

Proposed project name: Seasonal periodicity of nutrient absorption, nutrient distribution and growth in pine species in a mediterranean climate.

Project Description: Determine the annual pattern of nutrient uptake and utilisation and relate this to growth and concentration of nutrients in various parts of the trees.

Statement of Problem: Diagnosis of nutrient deficiencies in pine species is a very empirical science. Virtually nothing is known about the factors outlined above - although some studies have looked at one aspect of the overall problem but always in isolation - Foliar sampling for the diagnosis of nutrient deficiencies is typically done in late Autumn when tree growth rates are lowest in a mediterranean climate. The justification for this sampling time is "that the statistical variation" in the nutrient concentrations between trees is lowest in this season - as would be expected when trees are dormant.

Lines of Research: Investigate the seasonal periodicity of nutrient absorption.

: Examine patterns of nutrient distribution in trees.

: Accurately determine the seasonal periodicity of tree growth, both stem and crown growth (and maybe root growth).

: Confine study to the nutrients known to be deficient on the Sunkland (N,P,Zn,Cu).

: Determine the effect of the nutrient status of trees on the above factors.

Prognosis for project: ? Project has not yet been submitted for comment.

Project Name: Diagnosis of zinc deficiency in young P. radiata.

Project Description: Zinc deficiency in young P. radiata was examined to determine if it is possible to accurately diagnose the deficiency by analysing needle tissue. The effect of NP and Cu on the occurrence of zinc deficiency on Sunkland soils was investigated. Distribution patterns of zinc in seedlings and the mechanism of transport of zinc through seedlings were also examined.

Statement of Problem: Zinc deficiency in P. radiata occurs in young trees growing on some Donnybrook Sunkland soils. The deficiency can be diagnosed by the symptoms it causes, however, by the time characteristic symptoms are apparent the growth of the affected trees is severely retarded. An accurate method of diagnosing the deficiency before symptoms occur could prevent loss of production. The relationship between the concentration of zinc in needles, and tree growth has never been examined adequately.

Lines of Research - completed

(i) Relationship between growth and zinc supply was defined.

(ii) Relationship between the concentration of zinc in needles and growth has been defined.

(iii) Most suitable tissue (young growth) to determine the zinc status of plants has been determined.

(iv) Mobility of zinc in young plants has been examined - it is largely immobile.

(v) Distribution and mechanism of zinc movement in tracheids has been examined.

(vi) Limited testing of results in the field.

Further research

(i) More exhaustive testing of results in field.

(ii) Relationship between zinc mobility and senescence of old needles needs examining.

Prognosis for project:

Needs some field work to determine how applicable the controlled environmental data are to the field. This can probably be incorporated into a general pine nutrition programme. The mobility of zinc out of senescing needles also needs examining.

PROBLEM SOLVING IN RESEARCH - USING BOTH MINDS

1. The left and right hemispheres of the human brain process information in different modes - one in serial, the other in parallel mode.

2. Research is a series of questions and answers. Questions can be answered in two ways - by intuition or by logic. Intuition is a valuable thing - most advances in science have started from an intuitive flash. However, intuition can at times by wildly wrong. Remember the cost of shoeing a horse?

3. Use intuition and imagination, but check your answer with cool logic. This usually involves counting or measuring followed by statistical analysis.

4. Use both sides of your brain - otherwise you'll only be half a researcher.

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PROJECT NAME: Ventilated Chamber Project.

PROJECT DESCRIPTION: Development and application of the ventilated chamber technique of transpiration measurement to evaluate rehabilitation methods.

STATEMENT OF PROBLEM: Potential rehabilitation methods for jarrah forest water catchments must be tested for their hydrologic impact. This is especially important in the saline forest zone where the chosen rehabilitation method must prevent stream salinity. There are several variables in rehabilitation which combine to give a wide range of possible methods, the suitability of which may vary from site to site. With so many possibilities for rehabilitation one approach to evaluation is to set up simple empirical trials and rank methods with respect to an appropriate hydrologic parameter. Transpiration was selected as the appropriate parameter since it could be measured on a short time scale on plots of managable size. Furthermore, a suitable technique for its measurement, the ventilated chamber, was available from C.S.I.R.O. A major difficulty which was only partly foreseen was that quite small differences in transpiration may have a large effect on stream salinity i.e. a high order or resolution of differences would be required of the ventilated chamber technique.

LINES OF RESEARCH IN PROGRESS:

1) Refinement of the ventilated chamber system to obtain the highest order of resolution practically possible.

2) Estimation of transpiration on an area basis from the measurements of individual trees.

3) Investigation of the stomatal control of transpiration for whole trees, especially to define the relationship between stomatal conductance, vapour pressure deficit and leaf water potential.

PROGNOSIS FOR THE PROJECT:

The technique has been refined as far as is practical but still does not have sufficient resolution. It is now clear from studies of the hydrologic impact of conversion of native forest to pasture, that the annual rate of ground water accummulation which is equivalent to the decrement in evapotranspiration, can be as little as 5% of rainfall. No method of direct measurement of transpiration presently available can detect differences this small. Therefore, any attempt at empirical evaluation of rehabilitation methods by measurement of transpiration is not sound.

Two alternatives remain for evaluation of rehabilitation:-

(i) long term methods which allow the small differences in current evapotranspiration to accummulate until measurable differences in soil water storage or stream flow eventuate.

(ii) develop a water balance model suitable for predicting the success of rehabilitation methods.

The ventilated chamber project is well suited to provide input data for alternative (ii). This line of research has taken over as the major objective of the project.

J. BARTLE

Project Name: Rehabilitation arboreta.

Project Description: Screening of species for suitability for reforestation of disturbed areas in the Northern Jarrah Forest.

Statement of the Problem: Much of the Northern Jarrah Forest has been or may be subject to vegetation disturbance or removal. The major types of disturbance are agricultural development, infection with Phytophthora cinnamomi and bauxite mining. These cause permanent alteration to the native environment such that successful revegetation may not be a simple matter of replacement of the native species. The major use of the forest is water catchment and so the hydrologic impact of vegetation is important, especially given the potential salinity problem. The identification of tree species able to meet the hydrologic objectives as well as provide other benefits is a major research task. There are few existing plantings from which to gauge species suitability and so it was necessary to establish a comprehensive set of arboreta for this purpose.

Lines of Research in Progress.

1) Inference of species performance for any site in the Northern Jarrah Forest.

2) Importance of provenance variation.

3) Response to caprock cracking (by blasting) on upland sites.

Prognosis for the Project:

It is a long term project, the full benefit of which might not be available for 10 - 20 years. The continuing uncertain performance of most species in bauxite mined areas supports the systematic and comprehensive approach adopted.

J. BARTLE

Project Name: Water handling systems in bauxite pit rehabilitation.

Project Description: Practical development of surface drainage systems for rehabilitated bauxite pits.

Statement of the Problem:

The present pit rehabilitation method aims to prevent any discharge of surface water from the pit. The pit floor is ripped and given a coarse surface finish to favour infiltration. Holding banks and sumps are constructed to contain any runoff generated when rainfall exceeds the infiltration rate of the pit profile. There are several unsatisfactory aspects of this method:-

- the finished pit relief.
- generation of surface ponds in the pit and discharge swamps below pits causing dieback intensification.
- water is less directly routed to water supply reservoirs.
- it may be an inappropriate method for the saline zone.
- risk of exceeding storage capacity in major storm events.
- cost.

The solution is to equip pits with a surface drainage system, but this raises other difficulties such as channel and discharge point stability, turbidity of discharge water and effect on peak stream flow of many such pits in a catchment.

Lines of Research in Progress:

1) Quantity + quality of discharge
2) Channel and discharge point design, stability and longevity.
3) Manipulation of ripping and surface finish to favour discharge.

Prognosis for Project.

The present work is a practical method development exercise which is necessary to lay a foundation for more detailed 'process' study of pit hydrology.

J. BARTLE

PROJECT NAME: Histopathology of *Eucalyptus marginata* and *Banksia grandis* invaded by *Phytophthora cinnamomi*.

PROJECT DESCRIPTION: The histology of interactions between *P. cinnamomi* and various other plants of varying susceptibility to the fungus is being studied. Reasons for host susceptibility or basis for resistance, are sought. Behaviour of the fungus in the various hosts from infection through to sporulation is also being described.

STATEMENT OF PROBLEM: Little was known about disease development in jarrah and understorey species in terms of fungal activity within their tissues. Now there has been a shift in research emphasis as it has been recognised that an understanding of the host-pathogen interactions is a necessary basis for understanding the epidemiology of the disease in the forest. Environmental and seasonal effects on the interaction rather than on the fungus alone, also have to be considered.

LINES OF RESEARCH IN PROGRESS:

(1) The infection and invasion of jarrah. Lesion development and host resistance. The reasons why resistance breaks down or is inaffective at certain times of the year are sought.

(2) Study of exit and sporulation of the fungus from secondary phloem lesions, particularly in *Banksia grandis*.

(3) Seasonal effects on establishment of the fungus in secondary phloem of large roots after fine root infection.

(4) Reasons for varying susceptibility of eucalypts. Appreciation of the non-specific nature of resistance in all eucalypts against *P. cinnamomi*.

PROGNOSIS FOR PROJECT:

An understanding of both the epidemiology of jarrah dieback and the etiology of symptom development in infected trees.

DR. J.T.TIPPETT

Project Name:	Effect of a single high intensity fire on litter and soil fauna.
Project Description:	Changes in abundance and/or frequency of occurrence of termites, spiders, earthworms, ants, beetles, crickets and earwigs; Biomass of larger soil animals. Changes in soil chemistry and physics following fire.
The Problem:	How long does it take for the above kinds of animals to overcome the effects of a single summer fire?
Lines of Research:	Sampling every ±8 weeks in Young block since December 1979 (Coile samples and pitfall traps).
Prognosis:	To finish December 1982.

Project Name:	Ecology of Mangite, Banksia grandis Willd.
Project Description and Problem:	Mangite is abundant in the jarrah forest and is a significant factor in the ecology of Dieback fungus. The F.D. would like to attempt to reduce the numbers of Mangite as a way of controlling disease in the forest. In order to achieve this, a thorough knowledge of the population biology of Mangite is required.
Lines of Research in progress:	(1) Factors affecting germination. (2) Growth rate (height, diameter). (3) Recruitment and Mortality. (4) Flowering and Fruiting in relation to age, and factors affecting seed abundance. (5) Effect of logging on germination and growth. (6) Effect of past logging on abundance. (7) Effect of soil moisture and light intensity on growth.
Prognosis:	To be completed early 1983.

Project Name:	Ecology of Jarrah (jointly with Owen Loneragan).
Project Description and Problem:	Analysis of a wealth of data hitherto neglected in the F.D. Research Archives. Mainly remeasurement of assessment lines established in 1930s-1950s.
Lines of Research:	(1) Effect of low- and high- intensity fires on the growth rate of jarrah. (2) Growth rate of jarrah in terms of Havelian site/vegetation types, using I & P growth data. (3) Coppice growth in relation to time since cutting and Havelian types. (4) Effect of thinning on growth rates. (5) Jarrah forest dynamics - particularly the spatial relationships between overstorey and understorey (Mangite) in both virgin and cut-over forest.
Prognosis:	Most fieldwork completed. Writing-up begun.

Project Name:	Effect of heavy cutting, cull felling, Mangite removal and autumn burn on bird, earthworm and lizard populations.
Project Description:	Abundance and frequency of occurrence of birds, earthworms, lizards. Biomass of earthworms. Litter data. Soil chemical data. Vegetation cover data. Yarragil 4L sub-catchment.
Problem:	Will the above treatment be detrimental to the conservation-value of the jarrah forest? Time, staff limitations and inclination of the investigator permit a study of only 3 groups (birds, lizards, earthworms).
Lines of Research:	(1) Census of bird populations each Spring (transect method) in control area and area to be treated (Spring 1982). (2) Hand-sorting of soil quadrats for earthworms in control area and area to be treated (each winter). (3) Pitfall trapping of skinks each Summer in control area and area to be treated. In all cases, features of the environment likely to be important in the ecology of each group are measured.
Prognosis:	There should be good short-term returns from this work, as our fundamental knowledge of each group in the jarrah forest is weak.

Note: Further information about some of these projects is to be had from the displays in the Museum, Como Research.

IAN ABBOTT
23rd June, 1982.

Project - Genetic improvement of Pines.

Officer in charge - T.B. Butcher

Description - The Forests Department is involved with the planting of two pine species - Pinus pinaster and Pinus radiata.

Tree improvement programmes for both species commenced in 1957. Extensive progeny tests have been planted for both species. Seed orchards are established and provide all of the Department's seed requirements.

Lines of research in progress

1. Assessment of progeny trials, and their maintenance.
2. Evaluation of progeny trial data; calculation of heritabilities and classification of superior genotypes,
3. Breeding of Pinus radiata for resistance to Phytophthora cinnamomi.
4. Investigation of genotype x cultural treatment interactions.
5. Vegetative propagation by cuttings.
6. Controlled pollination to create genotypes with specified characteristics.
7. W.A. role in the Australian Pinus radiata co-operative programme.
8. Establishment and management of seed orchards.
9. Provision of elite seed source for departmental planting.

Project - Tree improvement of indigenous eucalypts

Officer in charge - T.B. Butcher

Description - Re-afforestation with eucalypts is approaching the scale of the pine planting programme in Western Australia. Currently there are three categories of planting: a) woodchip area - planting of Eucalyptus diversicolor; b) Wellington catchment area - planting of E. wandoo, E. calophylla, E. accedens, E. rudis; c) bauxite pits - planting of E. wandoo, E. accedens, E. patens, E. calophylla.

The karri programme was initiated in 1972 by Mr B. White and is actively continuing.

Intensive investigation of E. wandoo was commenced in 1980. Principal objectives are to determine the best wandoo seed sources for planting on bauxite pits, and for planting on catchment areas.

Lines of research in progress

Eucalyptus wandoo

1. Mass selection for elite and seed trees from the natural range.
2. Establishment of field provenance/family trials, in 1981 and 1982 on the Wellington catchment; parent trees were mainly selected on valley flats/lower slopes in the main range of wandoo.
3. Establishment of field provenance/family trials, in 1982 and 1983 on bauxite mine sites; parent trees in the main were selected on ridges/upper slopes.
4. Glasshouse screening trials to examine variability of salt tolerance; field trial to validify glasshouse screening; tissue culturing of salt tolerant seedlings by Murdoch University; provenance screening by University of Melbourne.
5. Natural variation studies of leaf, capsules, seed; Murdoch University are investigating the variation in essential oils.

Eucalyptus accedens

1. Mass selection for elite and seed trees from the natural range.

Project - Management of *Pinus pinaster* plantations.

Officer in charge - T.B. Butcher

Description - The Department has some 20 000 ha of *Pinus pinaster* plantations and the majority are located on the Swan Coastal plain. The same area was proclaimed as the Gnangara Water Reserve in 1973. Principal objectives of the area are the production of large size sawlogs from plantations and the production of water for the Perth metropolis from the Gnangara Mound aquifer.

Lines of research in progress

1. Silvicultural investigations; establishment, pruning and tending regimes, thinning and stand density regulation.
2. Fertilizer prescriptions for bassendean, spearwood and marginal site types.
3. *Pinus pinaster*, growth model.
4. *Pinus pinaster*, mature growth studies.
5. *Pinus radiata*, other alternative species.
6. Hydrological investigations
   - 6.1 monitoring rainfall variation on the coastal plain, water level of the Gnangara mound, soil moisture profiles under various densities of pine forest.
   - 6.2 data analysis of a comprehensive time and pine stand density series of soil moisture profiles.

Project Name: Utilisation of pines in W.A.

Project Description:

Research into utilisation of pines in W.A. is concerned with the following aspects:

(i) Wood quality of Pinus radiata and P. pinaster in different geographic areas, and the effect of various silvicultural techniques on wood density

(ii) Effect of silvicultural systems on sawn graded recoveries of both species

(iii) Schedules for high temperature drying of both species, including C.C.A.-preservative-treated timber

(iv) Stress grading of dressed pine, comparing proofgrading with visual stress grading

(v) Strength properties

(vi) General utilisation e.g. treated pine sleepers, transmission poles, finger jointing, glue-laminated timber, timber finishes.

Lines of Research in Progress:

(i) Wood quality assessment will commence next month. The initial sampling will be in the oldest available material in the Sunklands

(ii) A mill study assessing sawn graded recoveries from the "Silviculture 70" treated stands will be arranged when the Harvey sawmill recommences cutting

(iii) A stud stability trial comparing high temperature dried and low temperature dried P. pinaster has been completed. The R.P.A.A. is offering the Department a contract to research high temperature drying of C.C.A.-preservative treated P. radiata. Modified seasoning schedules are being tested.

(iv) The proofgrader is now used for commercial production at Harvey. Quality assurance tests of the pine are made at W.A.I.T., and these data will be analysed continually

(v) Strength testing of P. pinaster has indicated a strength grouping of SD6 which is used in visual stress grading and engineering design. Retesting will be required in several years when pedigreed stock is older and comprises a higher proportion of the plantation area

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(vi) Westrail are testing dowelled creosote-treated sleepers. Strength tests of these are being planned. Co-operative studies of defects in transmission poles are made with the S.E.C.

Prognosis for Projects:

Considerable research into utilisation is required as the pine industry is still in the developing stages in W.A. The Harvey Sawmill is essential for most research to be efficiently carried out. At present research is supplementary to commercial production.

Involvement with outside organisations is increasing e.g. R.P.A.A., W.A.I.T., W.A. timber industry, Westrail, S.E.C.

One problem is the present high cost of strength testing.

PROJECT NAME: Epidemiology of Phytophthora cinnamomi.

PROJECT DESCRIPTION: Effect of Environmental factors and influence of susceptible host tissue on reproduction and survival, site factors affecting reproduction and dispersal with depth, infection of jarrah by P.cinnamomi, factors affecting expression of resistance.

STATEMENT OF PROBLEM. Phytophthora cinnamomi has caused extensive mortality of jarrah and shrub and understorey components of the jarrah forest. Rapid decline and death of jarrah has occurred primarily in the period from 1945-65 although disease extension, as measured by death of understorey, has occurred in many areas of forest since that period. It has been assumed that P.cinnamomi attacks the fine feeder root system of susceptible Eucalyptus spp. However, we have been unable to explain how this pathogen can cause rapid and extensive mortality of jarrah by fine feeder root attrition alone since the distribution of inoculum in surface soil is limited in time and space. We have shown that P.cinnamomi can invade the secondary roots of jarrah but the absence of extensive and rapid mortality of jarrah in areas of infected forest since 1965 and the rates of lesion extension observed in wound inoculation studies indicate that jarrah normally resists invasion of the major root system.

RECENT FINDINGS:

1. A third site category has now been identified. Upland sites that impede water penetration (eg. layer of concreted laterite in surface horizons) have been shown to be highly conducive to intensification and spread of P.cinnamomi. On these sites:

   i. Inoculum of the pathogen can occur at a very high density above the layer at depths up to 75cm.

   ii. The pathogen can reproduce at the surface of this layer and in root channels within the layer.

   iii. Zoospores are transmitted in water running over the surface of the layer.

2. Detailed excavations of 12 affected trees down to the caprock layer revealed extensive infection of the vertical root systems. The roots were infected at the surface of the layer and within root channels. The presence of Banksia grandis roots and the fact that the root channels form depressions in the lateritic layer allowing accumulation of water, causes zoospores to be concentrated around the vertical roots of jarrah in the channels and ensures almost total infection of these roots.

3. Xylem potential measurements of trees in affected areas indicates that they were under severe stress. We conclude that the death of jarrah results primarily from destruction of the vertical root system and/or the extensive invasion of horizontal roots and the stump by P.cinnamomi which prevents uptake of water from depth in the soil profile and dessication of the tree.

4. Preliminary results from extensive studies using wound inoculation indicate that lesion extension in jarrah secondary tissue is markedly seasonal. Maximum rates of extension occur in summer and temperature has a marked affect on lesion extension rates. Site and vigour do not appear to affect lesion extension rates. Jarrah is normally resistant to invasion by P.cinnamomi in free draining sites.

LINES OF RESEARCH IN PROGRESS:

1. Definition of the processes that permit reproduction and lateral transmission of P.cinnamomi at depth in the soil profile.

a) Comparisons between 'deep' and 'shallow' sites.

b) Identification of site characteristics, other than concreted laterite, that affect movement of water in the soil profile, e.g. sand over clay or gravel.

c) Interaction between soil stimulation, temperature and moisture at depth on sporulation.

d) Effect of soil profile and texture on water infiltration lateral flow and distribution of the fungus.

e) Distribution of inoculum with depth in association with infected B.grandis roots.

f) Identification of host species that grow into root channels and provide a source of inoculum similar to B.grandis.

g) Identification of management practices that create water impedence and lateral flow on 'deep' sites.

2. Host response to infection.

a) Need to confirm or refute our hypothesis that, under free draining conditions, jarrah is resistant to P.cinnamomi invasion.

b) Identify the factors that predispose jarrah to invasion by P.cinnamomi, to permit extrapolation of our results in time.

i. Effect of vigour on ability of jarrah to contain infection in subsequent years.

ii. Effect of stress on infection and invasion

PROGNOSIS FOR PROJECT:

Our recent research suggests that large areas of jarrah forest are less susceptible to P.cinnamomi than has previously been assumed. However, further research is required to define the sites where reproduction and transmission of the fungus at depths in the profile occurs and to determine if jarrah's apparent resistance to the pathogen can be overcome by factors other than those we have described. Even on sites where the specific profile characteristics whith permit reproduction and transmission at depths are not present the pathogen may cause significant damage unless management procedures which reduce spread of P.cinnamomi such as forest hygiene and B.grandis understorey reduction are practiced.

DWELLINGUP RESEARCH

FIRE ECOLOGY

NOTES FOR ANNUAL RESEARCH CONFERENCE 19&20th JULY 1982

SUMMARY OF MAJOR WORK AREAS

1. ECOLOGICAL EFFECTS OF MEDIUM INTENSITY FIRES

Most of the Northern Jarrah forest is currently subject to a regime of low intensity spring fires on a 5-7 year rotation. The primary objective of this burning is to reduce litter fuel accumulation. Some consideration has been given to the inclusion of higher intensity prescribed fires within the management burning regime. Higher intensity fires could be used to manipulate the balance of understorey species so as to disfavour the soil-borne pathogen Phytopthora cinnamomi, and would introduce a degree of diversity into the fire regime.

An operational scale medium intensity burn (2200Ha) was conducted under dry conditions in March 1980 at Hakea Block, south-east of Dwellingup. The aim of the trial was to determine whether changes in understorey composition observed in small-plot fire experiments could be achieved over a large area.

Following the burn full crown scorch was observed over most of the area apart from the perimeter where partial scorch occurred. Several small patches of defoliation occurred, mainly in forest of lower canopy height.

Investigation into the effects of the fire has concentrated on -

1) germination and subsequent growth of legume species
2) reduction of the Banksia grandis component of the understorey
3) bole damage to Jarrah

The assessment is based on a series of permanent sample plots and transect lines established prior to the burn.

Available results indicate :

legume regeneration	-germination has been widespread -survival and growth of germinants has been good
fire damage	-mortality of Jarrah growing stock has been negligible -incidence of damage is inversely related to D.B.H.O.B. -most injuries (drysides, scars) are small in area and confined to the butt and lower bole.

Assessment is continuing.

Fire is a valuable and flexible tool for forest management, and an ecological factor which cannot be ignored in the forests of W.A. Greater knowledge of the effects of different intensity fires will allow the use of fire as an active management tool for purposes in addittion to fuel reduction.

2. The effect of bole injury on wood quality of Jarrah

Bole injury to standing trees can occur through fire or mechanical means. Injury may cause direct physical damage to the wood, and may allow destructive insects and decay organisms to enter the tree.

Current work deals with fire injuries, particularly scars and drysides. The objective is to determine whether the incidence and severity of injury caused by medium intensity fires will lead to a significant loss of wood quality or volume over the rotation.

Data from several experimental fires have been gathered on:

- incidence of damage for a range of size classes
- type of injury
- location of injury
- severity of injury
- factors predisposing the tree to damage.

Injury data is being used in the selection of trees for a dissection programme. Trees with wounds of known age, obtained from wildfire records and confirmed by ring counting, are being felled and sectioned.

Observations are being made on:

- extent of visible injury
- extent of original injury
- spread of discolouration and decay in the stem
- insect attack
- other stem defects.

An estimate of volume loss and quality degrade is being made for each tree, and this will be related to original wound size.

A high background level of fire damage exists throughout much of the Northern Jarrah forest due to intense wildfires in the past. The dissection studies should indicate the extent of degrade already existing in regrowth stands as a result of these fires.

3. F.I.R.S. monitoring

The Forest Improvement and Rehabilitation Scheme (FIRS) is a joint project involving the Forests Department and Alcoa. The stated objective of the FIRS operation is to improve the capacity of the forest for long term production of water, timber, recreation, conservation and other forest valves. The majority of forest treated under the scheme is adjacent to areas mined for bauxite.

Treatments vary between forest types, and may be modified to suit the dominant land use of the area. Monitoring has concentrated on the higher quality forest where treatment generally involves
- pushdown of native Banksia grandis
- thinning of Jarrah with crop tree retention and
- tops disposal.
- autumn burning
- legume seeding

Investigation is being undertaken into the:
- effectiveness of treatments in controlling Banksia understorey and
- fire and mechanical damage to crop trees.

PROJECT NAME: Fuel Reduction Burning in Young, Even-Aged Karri Regrowth.

PROJECT DESCRIPTION: Interaction between site and stand development, stand heterogeniety, fuel build-up (pre-burn and post burn), relationship between fire intensity and tree size and damage.

SUMMARY OF PROBLEM: Young karri regrowth stands comprise a significant and quickly increasing proportion of forest area in the Southern Region. They constitute a very valuable resource for which protection must have a high priority. This is even more important if these areas are not to have an adverse effect on protection plans for the forest as a whole.

However current prescribed burning techniques cannot be used in young karri regrowth at this stage. The trees are thin-barked and fire susceptible. At the same time fuel build-up is heavy and, though inflammable for only a short period in a normal season, presents a potentially severe hazard during that time. The possibility of achieving a successful, mild fuel reduction burn without inflicting unacceptable damage is further complicated by the variation within the stand and fuel complex, the narrow range of fuel moisture conditions suitable for such fires, and logging debris remaining after the regeneration burn. All these problems must be overcome before protection of regrowth areas becomes operational on a large scale.

LINES OF RESEARCH TO BE UNDERTAKEN:

a) Heterogeniety of crop and of fuel complex in relation to site and stocking.

b) Effect of vegetation type on fuel accumulation and inflammability.

c) Relationship between tree size and fire tolerance.

d) Tree damage and hazard amelioration resulting from mild fire.

e) Effect of fire on stand structure and vegetation development.

PROGNOSIS FOR PROJECT: Past research in this area has indicated the numerous problems involved in burning young karri but it has also shown that good results can be achieved under the right conditions. A detailed and concerted research effort aimed at identifying the ideal physiological age for burning and at gaining the knowledge required to accurately prescribe fires in these fuels should see protection burning operational in sufficient time to protect regrowth, most of which is currently in earlier stages of development.

PROJECT NAME: Karri Silviculture Research

PROJECT DESCRIPTION: To investigate alternative methods of regenerating karri, and to determine the effect of various tending operations on established regeneration.

STATEMENT OF THE PROBLEM: The Forests Department is currently clear falling over 2 000 hectares of mainly mixed karri forest every year. The establishment of dense, vigorous regeneration is the major priority of the Forests Department. The use of seed trees for regeneration is limited due to the lack of seed in the stands. Hand planting of nursery raised open-rooted seedlings is currently favoured because the method uses very little seed and gives the Forests Department control over stocking and spacing. It is however a very expensive operation and there is evidence of root deformities in some of the plantings. As a result alternatives are being studied.

The large areas of even aged regeneration established since clear felling was re-introduced in 1967 forms a very valuable resource. Tending of this resource will vary according to the management objectives of the day and long term planning objectives. It is important that we know the effects of various tending operations before they are carried out on a large scale.

Karri seed is extremely costly to collect (> $1000/kg) and will become even more scarce as the area of virgin karri forest decreases. As a result the Forests Department has so far established 65 hectares of karri seed orchards and seed production areas. It is aimed to maintain 80 hectares which would ensure an adequate long term supply of high quality seed.

LINES OF RESEARCH IN PROGRESS:

(1) The Shelter Spot Sowing Technique

(2) Spacing Trials

(3) Thinning and fertilizing trials

(4) Improving seed production in karri seed orchards.

PROGNOSIS FOR PROJECT: Continuing trials with shelter spot sowing may soon see this technique being used on an operational scale. The results of the spacing, thinning and fertilizing trials will not be available for many years but should lead to a more varied management system of what will then be a huge area of even-aged regeneration. Study of factors affecting seed production of karri may result in seed orchards being planted well "off-site" in the future.

HYDROLOGY

Yarragil Project.

The Yarragil catchment is a major forested catchment of the Murray River. It is some 72.5 km^2 in area and all 30 subcatchments have been monitored for streamflow and salinity since 1975. The objective is to quantify water and salt cycles, to relate these to physical and vegetation characteristics, and to carry out treatments to test vegetation management options. The Yarragil catchment was selected for this work because of its intermediate position between the salt and non-salt zones of the Northern Jarrah Forest, and for its wide landform range. It presents in microcosm the full range of forest types to be managed on jarrah forest catchments.

Yarragil 4L Project.

The Yarragil 4L subcatchment was chosen for treatment because it is a low salt catchment, and at that stage there didn't appear to be any problems with its hydrologic calibration. However, the lack of a good hydrologic calibration due to the exceptional series of dry years (the probability of getting a sequence of five years as dry as the 1975-1979 period is less than 2%) and the unusual response of 4L to rainfall events has resulted in the treatment of 4L being postponed for each of the last three summers. It is now intended to treat 4L in the summer of 1982-83.

The treatment will be a 'best bet' composite treatment for a low salt jarrah forest catchment. It will consist of:-

(i) thinning of the overstorey,
(ii) Banksia grandis pushdown, and/or felling and poisoning,
(iii) a fire regime to encourage a legume understorey and banksia and overstorey regrowth suppression, and
(iv) follow-up treatments to restrain regrowth of overstorey species.

Detailed assessments of the structure and composition of the vegetation are underway so that the treatment can be planned and its impact followed over time. The vegetation characteristics being subject to study include:-

(i) crown cover/density,
(ii) understorey density, regrowth and composition
(iii) total and merchantable wood volumes,
(iv) a simulation of the effects of different intensities of thinning on the composition and structure of the residual stand and the economic viability of the operation
(v) impact of the treatment on wood quality
(vi) changes to fauna habitat
(vii) Banksia grandis/leguminous species balance and its interaction with Phytophthora cinnamomi,
(viii) The effectiveness of hygiene during treatment in reducing spread of Phytophthora, and
(ix) The effect of the treatment on the spread of Armillaria.

Little Dandalup Project

In the high rainfall (up to 1300 mm p.a.) non-saline western zone of the Northern Jarrah Forest large increases in stream yield may be possible by forest reduction. This zone is already extensively infected by Phytophthora, and it is projected that up to 20% (or 500 km^2) may be mined for bauxite over the next few decades. Seven catchments of about 100 ha have been monitored for streamflow, salinity, suspended sediment and rainfall since 1977. The objective is to relate streamflow to physical and vegetation characteristics especially to the existing extent of dieback. Treatments such as mining and rehabilitation, the F.I.R.S. treatment of dieback degraded areas (i.e. partial reforestation) and the F.I.R.S. treatment of largely intact forest (i.e. as for Yarragil) will be tested.

1982 RESEARCH CONFERENCE

Como State Headquarters - Training Centre - July 19/20

Project Name Agroforestry

Project Description

The main reason for the agroforestry research program stems from problems in rural areas such as land and stream salinity, soil erosion and high lambing losses. At a recent seminar in Esperance, which reviewed these problems, many farmers took part in a questionnaire and listed their ideas on solutions. The most common solution (24%) involved the use of trees.

As a term, "agroforestry" is being used in a very broad sense and covers a wide spectrum of approaches to integrating trees with farming. The appropriate form of agroforestry, or the way in which trees are used, will depend on the type of farming and nature of the problem to be overcome.

The objective of the Department's program is to investigate various systems of agroforestry and to determine benefits, production levels and practical problems. The program is very much a co-operative venture with the Department of Agriculture, the P.W.D. and farmers.

Lines of Research in Progress

1. Agroforestry for salinity control

The problem to be overcome is clearly illustrated in the reforestation scheme of the Collie River Catchment. The scheme has social and economic problems; farmers are put off the land and land is very expensive for government to acquire. A better scheme would involve farmers in planting and managing the trees. For farmers to be interested in doing that there would have to be financial incentives. The aim of agroforestry research in this area is to develop viable systems of trees integrated with farming for salinity control.

The research work is being carried out east of Mundaring in the Helena River Catchment in conjunction with Geoff Anderson of the C.S.I.R.O. and in the Collie River Catchment. These trials aim to answer such questions as:-

(i) When can grazing commence amongst young trees? How much agricultural production is possible?

(ii) What is the impact of different species and densities of trees on the water table level?

(iii) What is the value of timber production under agroforestry in this rainfall zone?

(iv) What are the practical problems of combining grazing with tree growing?

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To adequately tackle the problem a wide range of agroforestry systems need to be tested. Future work would look at such aspects as:

(i) Management of parkland native forest with grazing.

(ii) The strip system of agroforestry using a range of trees with the potential to provide returns for farmers.

2. Agroforestry for protection of soil, stock and crops

Along the south coast region, around places such as Jerramungup and Esperance the combination of light soils and strong winds has caused much soil erosion.

The Department is involved in a joint agroforestry trial at Esperance with the Department of Agriculture. The trial aims to assess timber production of P. radiata and P. pinaster, the protection benefits provided by the trees and the agricultural production of the system. Most farmers want to continue cropping, and this involves the use of wide machinery. Therefore the concept of strips of trees with areas in between for cropping has appeal and is a major part of the trial.

3. Agroforestry for timber production and grazing

There is also interest in agroforestry in the high rainfall areas of the South-West where salt and wind erosion are not problems. Increasing numbers of farmers see trees as a possible way of improving the production of their farms. Research is being concentrated on the combination of widely spaced pine and grazing. Most of the trials are on the Sunkland. The objectives of this type of agroforestry are twofold:-

(i) To produce high quality sawlogs.

(ii) To produce substantial amounts of pasture throughout the rotation.

The two main problems to overcome are:-

(i) How to prune above 5 metres?

(ii) How to deal with the thinning and pruning debris?

Good progress has been made in solving these problems in recent months. A modified version of the "Squirrell" orchard pruner has been built which allows pruning to 10 metres. A tractor mounted mulcher has also been tested recently and proved capable of mulching up most pine debris under agroforestry conditions. Future work will concentrate on assessing forestry and agricultural production to enable economic analysis.

RWM:GS

Richard Moore
July 1982

1982 RESEARCH CONFERENCE

Project Name: Second rotation studies

Project Description: To investigate if a decline in productivity with the second rotation is existent, and if so, the means of preventing this decline.

Statement of Problem: Decline in productivity with successive rotations of pine plantations has been a serious problem. Recent studies show that this decline is mainly due to the methods of disposal of the logging debris by burning. Such burnings cause organic matter and nutrient losses; if crushing of the debris is practised instead better second rotation growth is achieved. This is due to the mulch layer created which not only preserves the organic matter and nutrients but also conserves the moisture and suppresses weed competition.

Lines of Research in Progress:

(1) Possibility of decline in productivity with the second rotation.

(2) Efficiency of cultural treatments on second rotation growth.

Prognosis for Project:

Evidence of decline in productivity (if existent) is possible through a study of the growth of a stand in which the height growth was recorded. The stand was destroyed by a fire and replanted in 1964. By means of stem analysis of the now 18 year old second rotation stand a comparison of growth is possible.

Since a serious re-establishment problem was evident, investigations of the allelopathic effects of the previous crop on the growth of the young seedlings were initiated in conjunction with the Botany Department, U.W.A., under the supervision of Dr David Bell. Also mycorrhizae studies were conducted through CSIRO - Dr N. Malacjuk.

L. de Bragança
A.D.F.O. Research

FORESTS DEPARTMENT RESEARCH CONFERENCE 1982

Project Name: Phytophthora and pine deaths in the Donnybrook Sunkland plantations.

Officer Responsible: Mike Stukely, Research Officer, Como.

Project Description: Pathological investigations into the cause(s) of deaths of pines. Related studies of host-pathogen interactions and disease spread, host physiology, and the biology of potential pathogens with particular reference to conditions in the Sunkland.

Statement of Problem: The Sunkland pine afforestation scheme involves the progressive conversion of 60 000 ha of jarrah forest (much of it severely affected by dieback disease) to pine plantations. After the initial planting losses, scattered sudden deaths of Pinus radiata have occurred up to about age 8 years, mainly in summer and autumn. Preliminary sampling had shown that the roots of several of these trees were infected by Phytophthora cinnamomi. The initial questions to be answered were:

1) What are the pine mortality rates, and how are the deaths distributed?
2) Is P. cinnamomi causing the deaths of established trees?
3) If so, is there evidence of resistance in the pines?
4) In view of the reported increase in susceptibility of Pinus radiata to Phytophthora after the age of about 20 years, is there a risk of high mortalities in final crop trees, and if so what can be done to minimise it?

Progress to date: Mortality surveys by Hugh Chevis have shown that the distribution of mortalities is random rather than in distinct patches. But more pines die on sites where the native forest was known to be affected by jarrah dieback disease. Mortality rates fall to zero by about age 8; however, a resurgence of deaths has occurred after pruning and culling of 6-year-old stands.

We found that the roots of dying and recently-killed Pinus radiata were often extensively infected by Phytophthora spp., most commonly P. cinnamomi, but sometimes P. cryptogea, P. megasperma var. sojae, or P. citricola. 64% of these trees were infected - this is considered to be a relatively high recovery rate for Phytophthora.

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Of 38 recently-killed trees aged 4-8 years which were examined for collar-infections, 88% were found to be infected by P. cinnamomi and/or P. cryptogea. This is the first record of such an infection in established pines, although it is common in young seedlings.

The pathogenicity of a Sunkland isolate of P. cinnamomi to young Pinus radiata has been verified in pot and field tests conducted by Trevor Butcher. The sudden wilt symptoms were reproduced, and we reisolated P. cinnamomi from most of the affected seedlings. This satisfies Koch's postulates to some extent, although it cannot be claimed that Phytophthora is the sole cause of pine mortality.

Seven Pythium spp., including several plant pathogens, have also been isolated, but these do not seem to be associated with any visible symptoms in the pines.

A small number of outwardly healthy-looking trees were found to have Phytophthora infections in a few of their smaller roots; these trees have remained healthy for over 12 months.

Trevor Butcher has found that there is genetically controlled resistance to P. cinnamomi in some pedigree lines of young P. radiata. The results of glasshouse tests have been reproduced in the field.

Lines of Current Research:

1) Monitoring of pine mortalities is to continue. The Nannup nursery is also to be checked regularly for Phytophthora infections.

2) Studies of the resistance of P. radiata to Phytophthora (with T. Butcher). Emphasis on broadening the spectrum of P. cinnamomi isolates as well as Phytophthora spp. tested.

3) Investigations to test the likely stability of the resistance of pines to Phytophthora through the 30 year rotation period (with T. Butcher).

4) Studies of the infection process, host physiology, the significance of sub-lethal infections in "healthy" trees, and the persistence and activity of Phytophthora inoculum in maturing plantations.

5) The use of the Shigometer (electrical resistance meter) to monitor the health of trees, and possibly detect infections before crown symptoms are visible.

6) Species identification of new Phytophthora isolates.

Prognosis for Project:

Due to the limitations of manpower (one Technical Assistant) a strict order of priority must be applied in tackling problems which are of most urgency to management.

In addition to the above lines of research, we need to find out whether other potential pathogens as well as Phytophthora are present.

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This must be known before the cause of mortality can be attributed. Other likely contributing factors such as soil conditions and nutrition need to be examined. We should also look into the distribution and relative importance, both to pines and native vegetation, of the Phytophthora spp. other than P. cinnamomi which are present in the Sunkland.

Since most of the present knowledge on jarrah dieback and Phytophthora in W.A. forests has come from studies in the northern jarrah forest, there are many other possible avenues for useful research on Phytophthora in the Sunkland.

M. STUKELY, RESEARCH OFFICER

FOREST RESEARCH PROJECTS AT MURDOCH UNIVERSITY

19 July 1982

1. Growth of tree roots in lateritic soils
2. Tree fertility and root growth in relation to dieback
3. Eucalypt nutrition
4. Development of lignotuber in jarrah
5. Anatomy of sandalwood wood
6. Asexual propagation of sandalwood
7. Development of salt tolerant clones in E. wandoo
8. Micropropagation of jarrah and use of tissue culture in producing lines resistant to dieback

Project Name	:	GROWTH OF TREE ROOTS IN LATERITIC SOILS
Project Description	:	Root occupation of jarrah forest subsoils in relation to clay parent material. Distribution abundance and properties of root channels.
Statement of Problem:		The jarrah forest stands on deep lateritic profiles. Penetration of these layers (which may be acidic and have high bulk densities) by tree roots is likely to be essential for the long term success of tree plantations, e.g. after dieback, in bauxite pits. A knowledge of how the indigenous species exploit the pallid zone is necessary as a basis for the selection of suitable rooting characteristics of exotic species.
Lines of Research in Progress	:	(1) Distribution of roots and root channels with depth in bauxite pits and forest cuttings. (2) Physical and chemical properties of pallid clays in relation to rooting frequency.
Prognosis of Project:		The project has been funded by ARGS and is likely to continue for another 3 years. Information is available on root occupation of the pallid zone by indigenous species and this needs to be extended to exotic species.
Personnel	:	Dr. B. Dell Collaborative studies with John Bartle (Forests Department) and Warren Tacey/Ian Colquhuon (Alcoa).

Project Name : TREE FERTILITY AND ROOT GROWTH IN RELATION TO DIEBACK.

Project Description : Root growth, soil fertility, small and large root infection by *Phytophthora cinnamomi*.

Statement of Problem : *Phytophthora cinnamomi* is a serious pathogen of jarrah yet the susceptibility of jarrah varies with site. Soil fertility is an important factor in determining the vigour of jarrah and this is likely to affect the interaction between the pathogen and its host.

Lines of Research in Progress :

1. Periodicity of root growth in jarrah
2. Development and anatomy of jarrah roots
3. Effect of soil fertility on root development in jarrah
4. Effect of soil fertility on infection of jarrah roots by *Phytophthora cinnamomi*.
5. Susceptibility of large roots to infection by *Phytophthora cinnamomi*.
6. Factors affecting spread of *P.c.* from fine roots into large roots.

Prognosis : The research has been supported by the Jarrah Dieback Foundation. Considerable progress has been made with respect to 1-4 above and work is continuing on 4-6 above.

Personnel :

Dr. B. Dell
Mr. I. Wallace (Graduate Res. Assistant)
Ms J. Wymer (Research Assistant)

Project Name	:	ANATOMY OF SANDALWOOD WOOD
Project Description	:	Wood anatomy in relation to oil yield and grading of wood for export market.
Statement of Problem	:	A sound scientific basis is needed for the grading of sandalwood for export. The identification of wood characters to support current grading practices would also serve in identifying Grade 1 plants for propagation in the future.
Lines of Research in Progress	:	1. Scanning electron and light microscopy of a range to wood blocks 2. Distribution of oil in woody tissues
Prognosis for Project:		The W.A. Sandalwood Company has recently made a small contribution to cover microscopy costs. Results of this initial survey will be available December 1982.
Personnel	:	Dr. B. Dell.

Project Name : EUCALYPT NUTRITION

Project Description: Behaviour of nutrients in eucalypts, nutrient response, nutrient uptake by mycorrhizal roots.

Statement of Problem: Little definitive information is available on the nutrition of eucalypts in relation to diagnosis of deficiencies and toxicities. Disorders are apparent in eucalypt plantations in bauxite pits. Much basic experimentation is required to understand the behaviour of particular nutrients in eucalypts before suitable diagnostic tests can be developed.

Lines of Research in Progress :

1. Response of eucalypt seedlings to N & P fertilizer
2. Response of jarrah seedlings to trace elements
3. Growth of eucalypt seedlings in pallid zone clay in relation to lime and phosphorus levels.
4. Mycorrhizal roots of jarrah (Hons. Project Dell/Malajczuk)

Prognosis for Project :

The project is proceeding at a low level mainly through Honours or similar activities. However, available expertise and facilities could support a much larger activity if the necessary funds could be found.

Personnel : Professor J.F. Loneragan
Dr. B. Dell

Project name	:	DEVELOPMENT OF LIGNOTUBER IN JARRAH
Project Description:		Role of soil fertility in development of lignotubers.
Statement of Problem	:	The lignotuberous phase of jarrah may be very long (e.g. up to 50 years) when grown on infertile soils or transitory when grown in plantations with adequate fertilization.
Lines of Research in Progress	:	1. Effect of soil type on lignotuber development in jarrah seedlings 2. Effect of P and N fertilization on nutrient composition of the lignotuber 3. Distribution of P in the lignotuber 4. P content of lignotubers in the field in relation to plant age.
Prognosis for Project	:	The project has been funded by ARGS and is expected to be completed in 1983.
Personnel	:	Dr. B. Dell Mrs Jones (Graduate Research Assistant, P/T)

FORESTS DEPARTMENT RESEARCH CONFERENCE

July 19 1982

Project

Asexual propagation of sandalwood

Problem

If planting sandalwood to replace exhausted natural stands is to be undertaken, clonal propagation from trees with high wood/oil quality should bring eventual economic benefit.

Lines of research

1. Cuttings are being taken from 30 year old trees in Dryandra to test for rooting ability. Sampling is being done each three months and different auxins and treatments applied. (Reports in the literature on other sandalwood species led us to believe that it will not be possible to sterilize these cuttings.)

2. The methods for initiation of shoot tip cultures and a suitable shoot multiplication medium have been developed and we are now testing rooting media. We aim to establish for comparison cultures of seedling and adult material from both the narrow leafed and broad leafed forms.

3. Callus cultures are also being established from seedlings, mature tree nodes and cambuin to develop methods for plant regeneration from callus.

Short term objectives

1. Establish whether or not cuttings will strike.

2. Establish a micropropagation method from nodes of mature trees.

Long term objectives

1. Find out if tissue cultured plants will form haustoria.

2. Examine the environmental and genetic effects on wood/oil quality using clones and seed families from poor and high quality trees, and planting material at various localities from Perth eastwards.

Personnel

Dr. Jen McComb
Ms. Lynda Chilvers (honours student)
(Help received from Forestry Dept. staff at Narrogin and Como is much appreciated.)

Project

Development of salt tolerant clones of *E. wandoo*.

Problem

Salt tolerant eucalypts could help delay salt encroachment. CSIRO research has shown that a combination of screening of seedlings against salt followed by tissue culture propagation of the survivors results in fast build up of salt tolerant lines in *E. rudis* and *E. camaldulensis*. We feel that *E. wandoo* has the potential of being at least as good as these species and has the advantage that acceptable timber might eventually be produced.

Lines of research

1. We have been able to recently set up cultures from seedlings surviving the highest salt treatments in trials conducted by Dr. T. Butcher. We aim to screen, then culture, more seedlings and eventually test all the tissue cultured lines for tolerance of salt.

2. Work with herbaceous plants has shown that the relative growth of callus in media with various levels of NaCl reflects the performance of whole plants in aqueous aerated cultures supplemented with salt. We wish to discover if this also applies to woody plants by using wandoo. A preliminary trial with callus has been done and will be repeated.

Short term objectives

1. Finalize details of micropropagation methods for wandoo.
2. Test clonal lines for improved growth in the presence of salt (glasshouse trials).
3. Discover whether callus growth does or does not reflect whole plant growth in presence of salt.

Long term objectives

1. Plant out salt tolerant lines and examine field performance.

Personnel

Dr. Jen McComb
Mr. Ian Bennett (Ph.D. student)
Ms Margaret Shaw (hons. student as from August 1982)

Dr. T. Butcher has been collaborating in this work.

Project

Micropropagation of jarrah and use of tissue culture in producing lines resistant to dieback.

Problem

1. It is not known whether jarrah trees surviving in graveyard areas are disease escapes or are resistant to *Phytophthora cinnamomi*, any other pathogens, and changed environmental conditions present in these areas. We aim to clone from surviving jarrah trees and test their resistance to *P.c.* in the glasshouse and the field.

2. We are also cloning from trees resistant to leaf miner as we feel that any improvement plan for jarrah must incorporate resistance to this insect.

Lines of research

1. Clones are being established from trees surviving in dieback areas (five successful to date) and leaf miner resistant trees (five), and for comparative purposes two fast growing trees not selected for resistance to either pest. There are two main difficulties in establishing cultures; firstly material is difficult to sterilize and secondly when in culture it may not begin to multiply shoots for 6-10 months and an acceptable level of rooting may not be achieved until 12-17 months in culture.

2. Experiments are being conducted to examine the root morphology and anatomy of tissue cultured plants and seedlings and the early stages of infection by *P. c.* zoospores in both types of plant before and after infection. This work has the dual purpose of acting as the basic information for work on the 'resistant' tissue cultured plants, and also relates to the work with callus discussed under 3.

3. Callus cultures have been established and we aim to compare the early stages of infection of callus cells with those of root cells. It is possible that resistance in whole plants might be reflected in the behaviour of the callus/zoospores and if this were so it would provide a screening method for selection of superior trees from quarantine areas. (I plan to visit Nagoya in July to discuss the techniques used there in similar work with *Phytophthora infestans* and potato callus and protoplasts.)

Short term objectives

1. To develop micropropagation methods for jarrah (largely achieved - it seems genotypic differences between trees will continue to cause problems).

2. To discover whether tissue cultured trees revert to juvenile leaf morphology, if they show plagiotropic growth, develop normal tap roots and lignotubers.

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3. Establish at what age the roots of tissue cultured plants are comparable to those of normally raised seedlings, and thus are suitable for testing with P.c. zoospores.

4. To describe the early infection stages of P.c. zoospores on seedling roots, roots of tissue cultured 'control' and 'dieback resistant' plants and callus.

5. To establish whether resistance to leaf miner is expressed after passage through tissue culture (and if the typical leaf anatomy is maintained).

Long term objectives

1. To set up field trials with the lines produced in the above research.

Personnel

Dr. Jen McComb
Mr. Ian Bennett (Ph.D. student)
Dr. Elaine Davison (D.C.E.)
Ms. C. Tonkin
(Assistance from Forestry Dept. staff from Como and Dwellingup is gratefully acknowledged.)