DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

PROTECTION AND PRODUCTION RESEARCH BRANCH

SUMMARY OF RESEARCH

1984 - 1985

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CONTENTS

PREFACE

Communicating with Regional and District Managers is one of our major tasks and responsibilities. We tackle it in several ways - for example:

- in discussion at meetings and conferences;
- at field days;
- in collaborative preparation of management plans and job prescriptions;
- through publications; and
- in Research Reports, such as this one.

Part of our aim in this process is the rapid and effective transfer of research findings into practice. But we are also interested in the reverse flow - i.e., the views of those outside the Branch about research priorities and direction.

This booklet contains brief summaries of research studies carried out over the last 12 months by staff from Protection and Production Research and indicates likely emphasis in the year ahead. Comments on any aspect will be welcome.

Please note:

1. This is not a publication and is not to be cited.
2. Reports are grouped by Research Station, not by discipline.
3. Results are not presented exhaustively. If further details about programmes are needed, please contact the Research Officer involved.

Thanks to Luisa de Braganga who compiled this booklet, and to research staff for preparation of their reports.

P Christensen
MANAGER
PROTECTION & PROTECTION RESEARCH

November 1985

PROTECTION AND PRODUCTION RESEARCH BRANCH 1985

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Narrogin:
- P. Brown

Ian Abbott, Como Research

The past

Between July 1984 and August 1985 an additional eight research working plans were approved. These dealt with the impact of leafminer, skeletonizer, and other insect herbivores in the southern jarrah forest. In November 1984 20 stands were selected with a 40km radius of Manjimup and 30 new season's leaves on jarrah ground coppice were tagged in each stand. (Leaves 11m above ground level were also tagged in 12 of these stands). In February, May and August these leaves on the ground coppice were traced to determine which kinds of insects graze leaves and when most damage occurs. Many potentially relevant environmental features (including logging and fire history, and crown cover) have been determined. It is hoped to discover which of these factors correlates with the extent of insect damage because this knowledge would simplify the planning of future experiments.

Experimental studies have been complementary. In a simulated defoliation experiment, 0, 25, 50, 75 and 100% of each leaf present on jarrah ground coppice was manually removed. The response of the plant in terms of sprouting of new leaves and the survival of the leaves that were tampered with is under study. In another experiment, the diameter growth of sapling jarrahs sprayed and not sprayed with insecticide is being studied.

Comparison of two methods of sampling insects has shown that 'branchlet - removal' is superior to 'sweeping'.

The future

Research into the ecology of the karri borer Tryphocaria acanthocera commenced in November 1985. Initially, the aim is to discover the relationship between signs of external damage to the tree and the internal density of larval galleries. If a good one can be found, then it is hoped to survey in 1986 stands of regenerated karri differing in factors like basal area, fire history, silvicultural history, stand area, proportion of marri and site quality. This will indicate which of these factors is worthy of experimental manipulation.

The study of leaf herbivory in the southern jarrah forest will continue in 1986 in order to evaluate the importance of annual variability. Comparisons will be made with the northern jarrah forest and with the seven other eucalypt species present around Manjimup.

TREE BREEDING, PINE SILVICULTURE

Trevor Butcher (Como, Wanneroo Research)

Major work, July 1984 to August 1985:

1. A long term plan for the breeding of radiata pine in Western Australia was prepared. The plan reviews the progress and advances of the first 20 years of the programme and outlines the future development of the species to continue the cumulative improvements already achieved and to maintain the genetic diversity.
2. A new Pinus radiata seed orchard containing second generation selections was planted at Manjimup in early August 1985. It has been designed as a hedged artificial pollinated seed orchard (HAPSO) requiring intensive management. The concept is radical, there are no other orchards of this type in the world.
3. (G. Chester) Investigations on the handling and striking of woody and fascicle shoots of radiata pine continued at Wanneroo. Technical support was given to the setting up of misted cutting beds at Manjimup and the setting of 55,000 cuttings in May 1985. Development of the cutting hedges of superior families of Pinus pinaster continued with their planting as clonal hedge rows at Gnangara nursery and multiplication from fascicle shoots.
4. (C. Sanders) Grafting of the best WA second generation selections of P. radiata for HAPSO planting continued at Wanneroo. Additional elite second generation selections from the Victorian and South Australian programmes were imported and grafted in our quarantine glasshouse at Kelmscott. Outstanding second generation selections of P. pinaster were grafted for new orchard establishment.
5. (J. Ipsen) "Search 85" located 521 plus trees of P. radiata in the Nannup, Harvey Weir, Margaret River and Ludlow plantations. Classification, scion and cone collection is proceeding.
6. (J. Stritof) Best tree selections were made in all of the "op ex Portugal ortet" families for the next generation breeding population of P. pinaster. Principal criteria were straight and vigorous stems with an emphasis on small branch development.
7. After evaluation of progeny trial information, the Mullaloo orchard was culled to retain high performance clones, at a stocking of 140 stems/ha. Encroachment of the Joondalup Regional Centre into the orchard area is creating many management problems.

8. Phytophthora cinnamomi resistance screening tests have indicated a valuable gene source in the South African radiata breeding population; 15 of 26 elite families were classified as tolerant to P.c. in the current tests. Conversely only 1 of 22 elite families from the South Australian population was tolerant. Field progeny trials and genetic resource stands of seedlings and cuttings of P.c. tolerant radiata provenances were planted in the Sunklands.
9. (G. Chester) Family/provenance trials of Eucalyptus globulus were planted at Huntley bauxite mine sites (collaboration with Alcoa) and at Boddington (collaboration with WACAP); provenance trials of E. camaldulensis were planted at Jarrahdale and Huntley mine sites and in the Wellington Catchment.
10. (J. Stritof) Seed collections from all of the E. accedens plus trees was completed; These will be planted at the Hamel nursery in December 1985.
11. (G. Calvert) Ten year old trees in trials planted with a range of densities from 150 to 1,200 seedlings/ha and on three site types were intensively measured to provide plantation density information for the P. pinaster management model.

Proposed work, 1985/86:

1. HAPSO development, pollen orchard planting, pollen collection and application studies.
2. (G. Chester) P. radiata cutting development as outlined in the task force report leading to continuous annual production of one million cuttings. Import elite Australasian families from South Australia as cuttings and set in Agriculture Department quarantine glasshouse.
3. (C. Sanders) Import and graft in quarantine glasshouse at Kelmscott second generation selections of P. radiata from the APM (Victoria) breeding population. Grafting of second generation selections of P. radiata and P. pinaster for orchards and clone banks.
4. (J. Ipsen) Cone collection from each of the "Search 85" plus trees, continue with evaluation and scion collection. Assessment of Sunkland progeny trials.
5. (G. Calvert) Plant the P. radiata diallels and the P. radiata / P.c. yield trial. Sow the "Search 85" seedlots at Gnangara nursery.
6. (J. Stritof) Selection and development of the second generation population of full sib P. pinaster, scion collection for clone banks.
7. (G. Calvert) Maintenance of silvicultural experiments.

FOREST ECOPHYSIOLOGY AND JARRAH DIEBACK

D. Stuart Crombie, Research - Como

Progress

Work commenced in March 1983. A preliminary project with Dr J. Tippett established the relationships between the water potential of jarrah phloem and both phloem water content and the growth of P. cinnamomi in the phloem. The work is reported in the manuscript "The effect of phloem water relations on the growth of Phytophthora cinnamomi in Eucalyptus marginata", by J. Tippett, D. S. Crombie and T. C. Hill.

Current objectives

(i) To test the usefulness of selected water relations parameters of understorey species as indicators of soil water status and site susceptibility to dieback.

Experimental sites have been established in high and low rainfall zones along the Brookton Highway. Understorey species for study were selected on the basis of their wide distribution in the jarrah forest and their rooting patterns (determined by excavation). Pre-dawn and daytime water potentials and stomatal conductances of the selected species are being measured at intervals over the summer.

Measurement of plant water status may alleviate the need for soil sampling or neutron scattering to assess soil water content. As soil and plant water status are two of the factors affecting the spread of dieback and its impact, the technique has potential in predicting levels of risk in different areas and at different times.

(ii) To assess the effect of infection by P. cinnamomi on jarrah water relations (with J. Tippett).

Water potentials and stomatal conductances of jarrah on each side of active dieback boundaries are to be compared at intervals during the summer. Sites which have trees with a range of symptoms have been selected. Roots of trees in the dieback - affected area will be tested for the presence of P. cinnamomi at the end of the study. Roots of selected small healthy trees will be cut to simulate the effect of root loss to P. cinnamomi. The effects of root cutting on crown water relations will be assessed.

At present the effects of infection by P. cinnamomi on jarrah vigour on low to moderate impact sites are poorly understood although changes in uptake of both water and nutrients have been suggested. This work will provide information on the degree to which root loss adversely affects water uptake.

(iii) To compare water relations of overstorey and understorey species on sites of similar topography but different stocking rates.

TREE NUTRITION/PHYSIOLOGY

John McGrath - Como Research

Pinus radiata Nutrition:

Shoot growth in young *P. radiata* continues throughout the year with maximum growth occurring in spring and early summer. Nutrient absorption shows a distinct seasonal pattern with no nutrient absorption during the summer drought and rapid nutrient uptake in autumn and winter. The disparity between seasonal growth and nutrient absorption cycles leads to a rapid decline of nutrient concentrations in needles, bark and wood during late spring and summer. Maximum nutrient concentrations occur in midwinter and minimum concentrations immediately prior to the first rains. Preliminary results indicate that there is a relationship between current (monthly) nitrogen concentrations and current increments. A similar trend occurs for phosphorus. The critical concentrations of nitrogen and phosphorus predicted by this technique are higher than previously reported for *P. radiata*.

Jarrah Physiology:

Seasonal trends in concentrations of soluble sugars, polyphenols Ca, P, N in jarrah bark have been determined. Increases in soluble sugars during summer coincided with decreased relative water content in phloem. There was minimal seasonal change in the other properties.

Current/Future Programme

1. Continue nutrient deficiency prediction project for at least one more year (growth cycle).
2. Evaluate the post thinning response to nitrogen and phosphorus fertilizer by *P. radiata* growing on loam soils in Hills plantations (initiated May 85).
3. Examine effect of timing of fertilizer application on growth response by *P. radiata*.
   (a) Timing during the year (i.e. Autumn or Spring)
   (b) Timing relative to thinning
4. Determine whether the level of soil calcium affects the susceptibility

RESISTANCE TO PHYTOPHTHORA IN PINE AND JARRAH

Mike Stukely, Como Research (Pathology)

MAJOR RESEARCH JULY 1984 - AUGUST 1985:-

1. Screening Pinus radiata for tolerance to Phytophthora cinnamomi (P.c.):

The final major screening trial (No. 7) was completed in 1984-85, with T Butcher. This included the remaining 56 elite South African, New Zealand and South Australian families for which growth data are available.

From a total of 294 families screened so far, 127 have been classified as tolerant or moderately tolerant to P.c. on a new 5 - point scale.

In field trials in the Sunkland (planted 1980, 1981), deaths caused by P.c. collar infections were again consistently from susceptible families. The high correlation of field with glasshouse mortality data has now been maintained to age 5yr. The growth depression of surviving trees of susceptible families associated with P.c. in the field is becoming steadily greater; tolerant families still show little depression.

2. Testing jarrah for genetic resistance to P.c.:

A new project has been initiated to demonstrate whether genetically controlled resistance to P.c. is present in jarrah. Seed was collected from selected individual trees on a variety of sites, some of which have been severely affected by dieback.

The half-sib progeny of these trees are now being tested in a series of glasshouse and field trials. Several inoculation methods are being used, and a number of different variables will be measured and compared.

3. Dieback Detection Service:

Regular batches of cultures are now being received at Como for identification. Apart from P. cinnamomi, P. citricola has so far been the most frequently isolated Phytophthora. This is causing some concern.

PROPOSED RESEARCH 1985-86:-

1. Resistance of jarrah to P.c. - The main glasshouse trials will be completed in mid 1986. The field trials will continue for several years.
2. Screening Pinus radiata - Two small glasshouse trials are planned for the 1986-87 season, to test (1) additional families from New Zealand and South Africa; and (2) full-sib seedlots from crossings of parents of known tolerance or susceptibility. (With T Butcher).
3. Dieback Detection Service - This service is expected to continue, in co-operation with Dwellingup. A great deal of work is needed here, particularly in National Parks.

DIEBACK : HOST STUDIES 1984-85

Joanna Tippett, Research - Como

PROGRESS

The susceptibility of jarrah to invasion by P. cinnamomi is dependent on the water status of the trees during summer. Trees on "dry" sites are less susceptible than trees with an adequate water supply during summer. Growth of P. cinnamomi was monitored in trees at 16 sites from January to May and it was found that the fungus was inhibited when phloem relative water contents (RWC) dropped below 85%. At such sites pre-dawn leaf water potentials were as low as -2.63MPa. Trees growing at an infertile P site type, off Kinsella Road, have been shown consistently to be the most susceptible of those compared. (Site also affects the susceptibility of Banksia grandis to invasion).

Monitoring of seasonal changes in the levels of polyphenols, Ca, P, N and RWC's in pole sized trees at 4 sites (with John McGrath) is nearing completion. Although the slowest growing trees (low rainfall zone) have the highest concentrations of polyphenols in the phloem, this does not explain observed seasonal changes in the susceptibility of trees to invasion.

PAPERS (prepared for submission to journals)

"The effect of phloem water relations on the growth of P. cinnamomi in Eucalyptus marginata" by J.T. Tippett, D.S. Crombie and T.C. Hill.
"Detection and mapping of stem lesions with the Plant Impedance Ratio Meter" by J.C. Barclay, J.T. Tippett and T.C. Hill.
"Formation and fate of kino veins in Eucalyptus L'Her." by J.T. Tippett.

CURRENT OBJECTIVES

1. To check that jarrah at a number of P sites are similar to those studied at the P site off Kinsella Road.

2. To determine whether the level of soil calcium affects the susceptibility of trees to P. cinnamomi (with J. F. McGrath).

3. By comparing the water status of trees at dieback and non-dieback sites try to develop a method of assessing levels of infection or root damage, (with D. S. Crombie).

4. Dieback in National Parks. To help in the establishment of a comprehensive list of the species susceptible to P. cinnamomi. Work aimed at defining the extent of the high disease risk area of the south - west is planned.

7 October 1985
Loc. 4/2 JTT:DP

Rehabilitation Research

John Bartle, CALM Research Station, Dwellingup (forest water relations)

The objective of water relations research is to design and test rehabilitation systems able to meet hydrologic objectives, particularly to reverse or prevent stream salinity. The two major aspects of this work are:-

- to probe the water relations of many eucalypt species as a guide to species selection,

- to provide input parameters for modelling water balances of whole rehabilitation systems over small areas (1-100ha).

The ventilated chamber method has been used to define the water relations characteristics of jarrah. The measurement of leaf conductance derived from the chamber has been shown to be comparable with that measured independently using a hand held porometer. This not only provides an independent check but also demonstrates that individual leaf conductance can be simply added to give whole canopy conductance, a previously contentious point. Observations of water relations of some twenty species in the Bingham River Arboretum continue and have identified several more promising species.

Two leaf area measuring methods are being developed. Competent measurement of leaf area is a major difficulty in providing areal estimates of transpiration for water balance modelling.

Future Work

- improve the jarrah conductance data by observations from a wider selection of trees,

- complete the development of a jarrah conductance model as an input (with other physiological and meteorological data) to the Penman-Monteith equation for prediction of transpiration,

- predict transpiration on the Del Park hillslope,

- continue screening research arboreta for species with promising water relations characteristics.

REHABILITATION ECOLOGY RESEARCH
(Alan Davey, Research Officer, Dwellingup)

Arboretum Assessment

Measurements in Bingham River, Marrinup, George Upland, George Lowland and Del Park arboreta have been completed. For each arboretum, species have been ranked according to tree performance (height, diameter, vigour, form and survival).

These results have been overlain on information concerning site and climate of origin (of introduced species), utilization potential and commercial value to produce a short-list of 10 species which warrant further investigation as rehabilitation species for the Western, high rainfall zone of the Northern Jarrah Forest. Transpiration / canopy conductance results from John Bartle were also overlain on the arboretum assessment to produce a short-list of species for the intermediate rainfall zone.

Based on the above data, Alcoa has funded the C.S.I.R.O. Division of Forest Research's Seed Section to collect seed from between 5 and 15 provenances (depending on distribution) of each of these short-listed species. This seed will be made available for Provenance Testing by Richard Mazanec.

Arboretum results are being prepared for publication as a C.A.L.M. Technical Paper (Davey and Bartle).

In September 1985, data on borer and termite damage were collected for each of the 590 arboretum plots. A publication is being prepared (Davey and Mason).

Electro-dendrometer Bands

Calibration of the this instrument (developed by Dwellingup Research) continued last Summer/Autumn. Interim results indicate promising correlation between seasonal change in diurnal dendrometer response and seasonal change in transpiration for a number of both high and low water consumers.

Bands previously read manually and only twice daily (pre-dawn and mid afternoon), will be read automatically every hour by automated data-logger in the coming season.

Slash-Burn Factorial Trial

A 2 hectare slashed area and a corresponding unslashed area (both rehabilitated bauxite pits at Jarrahdale) were burnt in April 1985. Understorey and tree recovery shall be monitored over the next 24 months to give forest managers some insight into the effect and/or role of fire in rehabilitation management.

High Productivity Rehabilitation

A trial to be planted in June 1986 is aimed at determining the productive potential of a number of intensively managed rehabilitation forest systems. As well as testing a number of high-productivity eastern states species, this study will include a trial replanting of selected mined areas back to an intensively managed Jarrah Forest.

Eucalypt Genetics

R. Mazanec, CALM Research Station, Dwellingup

1. Major Work: January 1985 to August 1985

Since joining the Department in January 1985 a literature review on eucalypt breeding has been completed. To date very little in terms of actual tree breeding has been done in Australia. The species with the most advanced programme is karri, for which seed orchards have been established. Some problems in this area have been experienced.

Breeding programmes for other species of importance to W.A. such as E.wandoo, E.resinifera, E.globulus and E.camaldulensis are presently at the provenance trial stage. Trials of other species are planned for the future. In the long term, seed orchards of select parents will be used to produce seed for each species. The seed in turn will be used in the rehabilitation of problem areas such as bauxite pits, with a view to meeting ecological aesthetic and production objectives.

2. Future Work

2.1 Owing to the widespread flowering of jarrah in 1984 a comprehensive collection of jarrah seed will be made during the 1985/86 summer. Collections will be concentrated in the northern half of the jarrah forest. Sampling in the southern areas will be less intensive.

2.2 Establish a family/provenance trial of E.accedens.

2.3 Look at early detection of selfed or inbred karri seedlings in the nursery to enable culling prior to planting.

Phytophthora cinnamomi Research

B.L. Shearer, Research Station, Dwellingup (Plant Pathology)

1. PROGRESS

In order to investigate the relationship between site indicators and impact of Phytophthora cinnamomi, we have surveyed over 300 sites throughout the north and central jarrah forest. We found marked differences between impact types in the distribution of the Havel vegetation site types. For the subtle and moderate impact types the site type is skewed towards the S vegetation type, while for the high impact sites, the P vegetation type is the major site type. The distribution of subtle sites is skewed towards lower slopes, while those for moderate and high impact sites are skewed towards upper position in the landscape. Subtle impact sites were mainly concave areas, moderate sites were mainly convex, while the curvature of high impact sites were mainly concave or parallel. Some vegetation species are associated with high impact and their occurrence can be used to predict potential impact. However in two thirds of the high impact sites, no vegetation indicators are yet apparent.

In studies on hydrologic responses of sites in relation to disease development most of the effort has been in the development of 'in situ' techniques to measure the physical environment and pathogen behaviour at depth in the soil profile. Recently we have been able to quantify subsurface lateral flow of water in relation to rainfall event.

Techniques have been developed for tree excavation and quantification of root damage in live jarrah growing in infected moderate impact sites. From quadrant samples and plating onto selective agar, P.cinnamomi has been recovered from fine jarrah roots in half of the sites assessed. The pathogen has been isolated from the major roots of eleven of the seventeen trees excavated.

2. FUTURE WORK

2.1 Survey and analyse a representative number of sites in the intermediate and low rainfall zone,

2.2 Determine a 'short list' of indicators to predict impact,

2.3 Validate conclusions from 2.2.

2.4 Determine the relationship between site, climatic and subsurface flow of water that influence disease behaviour,

2.5 Continue tree excavation work to relate root damage following infection to site characteristics.

JARRAH FOREST HYDROLOGY AND SILVICULTURE

G.L. STONEMAN, CALM RESEARCH STATION, DWELLINGUP

Progress

The Yarragil 4L catchment (an area of 120ha, 1120mm rainfall, 4.3mm streamflow, 200mg/l groundwater salinity) was thinned early in 1983 from a basal area of 35m^2/ha to 11m^2/ha. In the first two years following the treatment streamflow only increased marginally in stark contrast to other similar catchment experiments around the world where the biggest increase in streamflow has been found in the first year following treatment. The difference is thought to be due to the very deep soil profiles and large soil water storage capacity of the Darling Range. The effect of the thinning on groundwater level has been pronounced with rises of 1m/yr over the two and a half years since thinning.

Another small experimental catchment (Warren) which was badly dieback affected has been rehabilitated in a study to determine the effect of rehabilitation on streamflow and groundwater quality and quantity, and the success of the rehabilitation in relation to site-vegetation-type.

The effect of thinning on the growth of sapling and pole sized jarrah stands has been studied. Analysis shows that thinning pole stands to a basal area of 10m^2/ha does not reduce stand increment whilst doubling the growth rate of the crop trees. A study of the characteristics of the trees that respond most to thinning shows that trees should be selected for retetion on the basis of the depth and width of their crown. In sapling stands thinning below 1500 stems/ha reduces the stand increment, whilst thinning to 200 stems/ha increases the growth rate of the crop trees by 45%.

Experiments to develop methods of non-commercially thinning jarrah have resulted in prescriptions now being used operationally.

Future Work

Identify those factors that are important in determining the water salt yields in the intermediate rainfall zone.

Determine the seasonal growth patterns of jarrah in a range of thinning intensities and time since thinning.

Continue the development of methods and determine herbicide doses for killing unwanted trees in thinning operations.

Initiate a long term experiment on the effect of thinning and fertilising on the growth of pole sized jarrah.

Determine the effect of stand density on throughfall of rainfall.

Log and thin Hansens catchment in the high rainfall zone to determine the effect on streamflow and groundwater.

HARDWOOD UTILISATION/SILVICULTURE

Gary Brennan - Busselton Research
(located in Bunbury)

1. Major Work Between July 1984 and August 1985.

A literature review titled "The Economic Utilisation of Thinnings from the Jarrah Forest", has been submitted to the Publications Section for publication as a Technical Paper.

A Pilot survey was conducted on copper chrome arsenic (C.C.A) treated jarrah regrowth posts, to determine the difference between the depth of sapwood and depth of preservative penetration. Two methods of measuring sapwood depth (a visual and starch test) were used and both gave a significant difference between sapwood depth and depth of preservative penetration. The mean difference between the visual method of measuring sapwood/depth of preservative penetration and starch test method of measuring sapwood/depth of preservation penetration were 1.2mm and 0.7mm respectively. From a practical viewpoint this difference is very small.

A number of joint trials with industry, utilisation branch and C.S.I.R.O. have been started and are on-going from this point. These include:

1) Seasoning of mature jarrah in a tunnel kiln,
2) Seasoning of regrowth hardwoods in a tunnel kiln,
3) W.A. Sheoak seasoning/utilisation,
4) Lyctus spp. attack in W.A. Sheoak and karri,
5) Stockpiling treatments for regrowth hardwoods,
6) Sawmilling of regrowth hardwoods,
7) Mechanical debarking of hardwood posts,
8) Durability studies of in-service hardwood posts, and
9) Harvesting of small hardwood sawlogs using different systems and machinery.

2. Future Work:

The above projects are on-going. Progress/final reports will be written when experiments have been completed.

SECOND ROTATION STUDIES

by Luisa de Bragança (Busselton Research)

MAJOR WORK:

- A study was initiated at Myalup to test different methods of treating first rotation (1R) logging slash (crushing, burning, raking) on second rotation (2R) sites. Clover and fertilization were also included in this trial. Pinus radiata seedlings were treated with a plastic film on the foliage to reduce moisture losses at establishment. An adjunct trial to assess the effect of furrowlining on the survival and first year growth of P. radiata seedlings was established.

- A study of simultaneous growth of adjacent 1R and 2R P. pinaster stands at Yanchep is in progress. This experiment was possible through the use of old pine pilot plots as 2R sites and the adjoining native bush was cleared to provide the first rotation areas. Eight paired plots were planted in 1984 covering a range of sites (marginal to good yellow sand).

- W.P. 29/71. This experiment was initiated to anticipate the 2R problem and find the means of correcting it. The treatments implemented were aimed at favourably changing the microenvironment of a stand in the last 5 years of the rotation to benefit the next crop. The treatments consisted of thinning the stand, crushing or burning the debris, establishing a nitrogen fixing crop and fertilizing, monitoring the growth response of the mature crop, and then clearfelling the stand. Due to a delay in clear-felling the stand (the effect of the treatments was dissipated by then), it was decided to reapply the treatments (1984 and 1985), monitor the growth response for another 5 years, then clearfell.

PROPOSED WORK:

- A study to compare growth of 2R planted stands and natural regeneration of the same age, on steep sites.

..../2

- Continue to monitor existing projects.

PUBLISHING:

- Experiments on establishment of P. pinaster on northern coastal sands - draft completed.

- Mt. Cooke experiment - draft completed.

PINE SILVICULTURE

Ray Fremlin, Busselton Research

1. Major Areas of Research

   i) Establishment of conifers on farms

   ii) Preparation for establishment of P. radiata plantations

   iii) Weed control

   iv) Pruning and thinning

   v) Coniferous arboreta

   vi) Development of mechanical pruning devices

2. Main Aspects and Findings

   i) Techniques have been developed to improve the survival of P. pinaster on farms in medium rainfall areas. Trials have been established to test prescriptions on a range of sites.

   ii) Prescriptions have been prepared that improve weed control in the establishment phase of P. radiata plantations in high rainfall areas.

   iii) Trials are continuing in order to develop methods to control woody weeds (mainly Acacia spp) in established plantations.

   iv) Current pruning trials are designed to give information that will enable clear-wood production to be increased in wide spaced plantations.

   v) Established thinning trials will provide data that will be used to improve management procedures in plantations.

   vi) Continuing management of coniferous arboreta provides comparative data on species performance.

   vii) Demonstration of a feasible method of high pruning in high risk fuel reduced buffers is expected with the development of a new mechanical pruning platform.

3. Future Proposals

   i) Continue studies of ways to improve the establishment of P. pinaster on pastured sites.

   ii) Develop methods to control weed competition in established pine plantations.

   iii) Screen alternative conifer species for planting on farms in medium rainfall areas.

iv) Evaluate the new mechanical pruning platform in fuel reduced buffers.

4. Reports and papers in the past year include:-

Fremlin, R.R.A. (1985). The use of herbicides in Western Australian forests. Paper presented to Research Working Group 5, Albany, March 1985.

Weed research report. Australian Weeds Committee meeting, Launceston, July 1985.

Fremlin, R.R.A. , Kruger, J.W., Hingston, R.A. (1985). Growth and potential of coniferous species in the South West of W.A. Forests Department Tech. Paper No. 14.

Techniques to improve the establishment of trees. Internal report, January 1985.

AGROFORESTRY

Richard Moore, Research Station, Busselton

Major Areas of Research

(1) Widely-spaced P. radiata for sawlogs with pasture for grazing.

(2) Other tree arrangements (e.g. strips of trees - with areas for agricultural production in between) and other tree species (e.g. Eucalyptus and Populus spp.)

Main Aspects Being Studied and Some Major Findings

(1) Growth rates of P. radiata were monitored and the likely timber yields were estimated. The value of 20 year old trees should range from $20-60 per tree, while the value of 30 year old trees should range from $70-200 per tree. The estimates apply to P. radiata at 100 sph, on well drained soils (but not deep white sand) which are pastured, fertilized annually and receive an average rainfall of 700mm or more per year.

(2) Costs of tending widely-spaced pine were determined. They totalled $8-10 per tree over the rotation and included planting, culling and pruning.

(3) Ways of improving the management of pine agroforestry were investigated. Techniques studied included very early culling to reduce the amount of debris, and pruning with a new "Squirrel" (Mark 2).

(4) Collaboration with other researchers (Department of Agriculture and C.S.I.R.O.) and with farmers continued. The extension of pine agroforestry was increased with the aim of finding several farmers who wish to try it.

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Proposed Research

(1) A new pine agroforestry trial is planned for the Manjimup area. As its prime purpose is to obtain data on agricultural aspects, the trial involves a large commitment from the Department of Agriculture. The trial is also important because cuttings of well-formed P. radiata will be used.

(2) Surveys of pine windbreaks near Esperance are required to determine growth rates, timber yields and the limits of rainfall and soil type for P. radiata. A wide range of tending techniques such as fan pruning and lift pruning of selected trees need to be evaluated on farmers plantings to determine options for management.

(3) The proposals to improve P. radiata planting stock, through such techniques as cuttings and intensively managed orchards, are important developments for pine agroforestry.

Reports

(1) Research Planned for Tree Use in Land Management (Paper for Ag. Dept. Conference) - February 1985

(2) A Review of 'Trees on Farms' Work, Esperance - September 1985

(3) Summary of Agroforestry Research - October 1985

PINE UTILIZATION/SILVICULTURE

Graeme Siemon, Busselton Research

MAJOR AREAS OF RESEARCH:

Relationships between silvicultural practices, wood quality and timber utilization.

General timber utilization.

MAIN ASPECTS BEING STUDIED:

The Department has a Wood Utilization Research Centre at Harvey, where the major research programme is in sawmilling and seasoning of regrowth hardwoods, particularly jarrah, karri and marri. The research programme was implemented when modifications to the sawmill, and construction of research seasoning facilities were completed.

In pine utilization, the major field of research is productivity of fast grown pines from agroforestry stands or fuel reduced buffer areas. A study compared 'heart-in' pine dried by dehumidifying with similar material seasoned by high temperature drying, with mature wood used as a control. This trial was in co-operation with Wesfi Pine Pty Ltd at Dardanup, under contract from the Radiata Pine Research Institute. Stability testing was organized by the RPRI. Results indicated that dehumidification of 'heart-in' pine is less effective than high temperature drying, while results from mature wood were similar.

Sawn graded recoveries were assessed of timber milled from radiata pine logs from different thinning treatments. The study demonstrated the advantages of heavy non-commercial thinning in producing fast-grown sawlogs.

FUTURE RESEARCH:

A major study of the effect of rate of growth on graded recovery, hence marketability of finished products, is planned to assess whether sawlog sized trees younger than 18 years could be used

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satisfactorily. Agroforestry stands will be included.

Studies of moisture content variation in pine, from standing trees to sawn seasoned timber, are also planned.

Research into utilization of pine eg. transmission poles, sleepers, will continue.

PAPERS AND REPORTS INCLUDE:-

Siemon, G.R. and Donnelly, D.J. (1985). Sawn graded recoveries of timber milled from radiata pine logs from different thinning treatments. Submitted for publication by Dept. of C.A.L.M.

Siemon, G.R. (1985). Using pine timber grown in agroforestry stands. Submitted for publication by Dept. of C.A.L.M.

Siemon, G.R. (1985). Stability of dehumidified 'heart-in' radiata pine. Report prepared for Radiata Pine Research Institute Inc.

"KARRI SILVICULTURE RESEARCH"

by

Richard Breidahl
MANJIMUP W.A. 6258

The major areas of work over the past year have been;

1. TREEN BROOK THINNING TRIAL

A large thinning trial was established in a 50 year old karri regrowth stand in Treen Brook. The trial consists of fire treatments, unthinned ($43m^2$/ha), $30m^2$/ha, $20m^2$/ha, $15m^2$/ha and $10m^2$/ha. The 50 year old regrowth stands in Treen Brook and Big Brook are due to be clearfelled when karri sawlog supply is very low. This trial will provide data to enable these stands to be managed for maximum sawlog production. The trial will also provide further silvicultural data for a proposed karri growth model.

2. OPERATIONAL THINNING TRIAL IN YOUNG REGROWTH

An operational thinning trial was conducted in 1972 regrowth in Warren Block to complement a research thinning trial established last year in the same regrowth. The trial has indicated that early commercial thinning may be a viable means of increasing sawlog production from karri regrowth stands.

3. KARRI SEED PRODUCTION AND IMPROVEMENT PROGRAMME

A 5 hectare karri seed orchard consisting of families collected from the Gardner, Weld and Deep Rivers was established. A 10 hectare seed production area was established at Huntley mine site (Dwellingup). These areas along with other S.O.'s and S.P.A.'s will ensure a long term supply of high quality, inexpensive karri seed.

4. REGENERATION PROGRAMME

A fertiliser trial established in winter 1984 has lead to a change in the fertiliser treatment for open rooted karri seedlings. The new treatment 25g/plant of D.A.P. is 50% cheaper than the previous treatment, 65g/plant of Agras.

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The major research proposals for the coming year are;

1. Monitor existing thinning trials.
2. Determine the effect of early operational thinning on prescribed burning.
3. Recommence the karri cuttings research initiated in 1984.
4. Establish a selection cutting trial.

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"JARRAH FOREST FIRE RESEARCH SUMMARY"

by

Neil Burrows
MANJIMUP RESEARCH STATION

SUMMARY OF MAJOR PROJECTS - JULY 1984 to NOVEMBER 1985

1. Jarrah forest fire behaviour

We are continuing to analyse fire behaviour data from infra-red scanning imagery gathered near Nannup in 1982. Computer Mapping Branch have developed a unique technique using computer systems at the Remote Sensing Applications Centre and the Intergraph system (CALM). This has streamlined the interpretation of infra-red imagery. We expect to complete the study in 2 - 3 years.

2. Fuel Models

A study of a range of fuel types from Banksia woodlands north of Wanneroo to south coast flats is aimed at describing fuels in other than upland jarrah and karri forests. Expect to complete this in 1 - 2 years.

3. Biological Reference Areas

Reference areas have been established in six major vegetation types in the southern and central forest regions to examine the long term effects of different fire regimes on plants.

4. Forest Surveys

Both fire and ecology researchers have jointly surveyed Dryandra Forest to gather relevant fuels and biological data to help formulate a fire management plan for the area. A report, including our recommendations, has been submitted to managers. We intend to follow-up our recommendations by working closely with the Narrogin District staff.

5. Publications

- Predicting Blow-up Fire in the Jarrah Forest - Technical Paper.
- Describing Forest Fires in Western Australia - Technical Paper.
- Fire; An Old Tool With A New Use. - Scope Proc.
- Planning Fire Regimes for Native Conservation Forests in South Western Australia - Fire Symposium Proc.
- Reducing the Abundance of Banksia grandis in the Jarrah Forest by the Use of Controlled Fire - Australian Forestry.

Future Work

- Continued analysis and model formulation of jarrah forest fires and fuels in non forested areas.

- Continued burning and monitoring of biological reference areas.

In the next twelve months, I do not see us taking on any new projects. We aim to consolidate current projects.

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"FUEL REDUCTION BURNING IN KARRI REGROWTH"

by

Lachlan McCaw

Dept. Conservation and Land Management
MANJIMUP W.A. 6258

Fire is excluded from regenerated karri forest until the young trees have developed sufficient height and bark thickness to withstand an initial burn of low intensity. Current research aims to;

1. define the level of stand development at which prescribed burning could commence,

2. determine conditions and techniques appropriate for burning of young stands.

Regrowth aged 12 and 15 years (mean basal area 20m^2/ha) was burnt operationally during February 1985 using guidelines developed from small plot trials. Wide ignition spacing and stable evening weather conditions resulted in low fire intensities (<300 kW/m) and crown scorch heights below 20 metres. However, higher fire intensities rapidly developed when slope, wind, and close ignition spacing interacted. Intensities above 600 kW/m fully scorched co-dominant trees and caused localised defoliation. Current indications are that 200 - 400 stems/ha of 15cm d.b.h. or greater will remain undamaged and a further 50 - 100 stems will have only minor damage (<100cm^2 in area).

Investigations of regrowth stand dynamics have shown that the dominance status of most trees does not change markedly from age 10 to 20. Stands on good sites have a greater proportion of basal area on large trees than those on poor sites where much of the stand may consist of subdominant trees.

MAJOR PROJECTS FOR NEXT YEAR

Expand the programme of operational burning to evaluate and improve the current prescription, with emphasis on lighting techniques for irregular shaped coupes and steep country.

Examine fuel and stand characteristics of marri/karri sites, Walpole sites and planted regeneration.

Assist Ian Abbott with studies of insect borers in regrowth.

MAJOR REPORTS DURING 1985

Prescribed burning to manipulate the understorey composition of jarrah forest - a large scale trial (submitted to Australian Forestry).

Behaviour and short term effects of two fires in regenerated karri forest (submitted to C.A.L.M. as Technical Paper).

"JARRAH SILVICULTURE"

by

Greg J. Strelein

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MANJIMUP W.A. 6258

SITE CLASSIFICATION

Measurement and assessment was completed on over 400 plots to provide data for the classification of the southern jarrah forests into management types. Measurements included vegetation abundance, stand structure measurements, soil descriptions and analysis, regeneration assessments, disease ratings, geology and landform and general site descriptions.

Data analysis has been carried out based mainly on Principle Component Analysis with other programs used to aid interpretation of the data. Models were constructed of the data based on species/plot relationships to determine natural groupings and interpret the environmental factors governing the variation. This enabled determination of types which had management significance and the description of those types in terms of their characteristics - vegetation, soils, drainage, fertility etc.

Some summarising and correlation of data is still to be done to also describe the other parameters of the types such as B.A. and other structural data, regeneration prospects, dieback susceptibility, silvicultural potential etc. While this is being done the writing up of the project has also commenced.

This study will provide managers and planners with the basis of categorising areas of land which they need to make decisions on. It will provide information for those categories to assist in their decisions on land use and management.

Since the classification is based on vegetation, soils and landform it is possible to map categories from aerial photos to give managers a planning tool for considering options for new areas or broadscale planning considerations without the need for extensive fieldwork.

REGENERATION TRIALS

One of the components of the above project was the consideration of the regeneration potential of types. Regeneration can be a problem in some types where natural regeneration is inadequate.

Trials of different seeding, planting, fertilising and spacing treatments were established to provide solutions for artificial regeneration in such cases.

These trials have been remeasured and data coded ready for analysis. It does appear that the solutions will differ on some types as described above. Since the trials were set up to look at site differences also, the results can be included in the prescriptions for the different forest types.

"ECOLOGICAL EFFECTS OF FOREST OPERATIONS"

by

Grant Wardell-Johnston
MANJIMUP W.A. 6258

EFFECTS OF LOGGING AND BURNING ON THE KARRI FOREST

The main thrust of our work in the karri forest has been in determining the composition site fidelity and foraging ecology of bird communities in relation to forest operations in the karri forest. This study was set up in 1982 in four coupes in Gray forest Block in the Donnelly River system. The first two years of study was designed to determine differences and similarities between sites in vegetation structure and floristics and in bird community composition.

Other long term studies being undertaken in the karri forest include;

1. The effects of a hot fire on small mammal populations. This study was set up in 1971 and burning carried out in two of the three sites in 1972, The most important aspect to emerge from the study was that long term population fluctuations in the bush rat populations occur over and above the effects of a single fire event. A succession of the three most common species of small mammmals in the area (i.e. mice, bush rat and mardo) was observed following the fires. The intention is to encourage division to continue to monitor the populations on a quarterly basis as part of their brief in reserve management.
2. The effects of logging on hollow resting animal species. This study commenced in 1982 in areas of a variety of cutting history. Populations are being monitored by the use of nest boxes. The breeding pattern of the mardo was studied in an area of 14 year old regeneration, where all 36 nest boxes were occupied as breeding sites by this species. The six other sites being monitored have had less use though six species have been observed using the boxes (Owlet nightjar, Rufous treecreeper, Western Rosella, Mardo and two species of bats).
3. Effects of fire regimes on understorey plant species composition. This study was set up in 1970 in an attempt to change the floristics of the understorey by the use of different fire regimes. Plots burnt on a three year cycle have now been burnt five times since the study began though no strong pattern or change has been observed in the plots.

Other studies being carried out in the karri forest include surveys in co-operation with fire research and a study with the School of Zoology, U.W.A. on frog ecology and speciation in the genus Geocrinia.

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Other institutions and interested people are also encouraged to have involvement in ecological research in the karri forest.

FIRE MANAGEMENT IN RESERVES

The main thrust of our work in this area has been in the monitoring of fauna populations in the Perup M.P.A. Emphasis is currently directed in using fire to regenerate thickets suitable as habitat for the Tammar wallaby.

A major emphasis of future work will be directed towards using survey to determine the role of fire in reserve management. This has and will continue to be a co-operative research effort with ecology and fire research and emphasis will in future be placed towards an encouragement of division in monitoring work associated with these surveys.

The running of several field ecology courses at Perup is a major part of our works programme. Our continued involvement in these courses will be necessary although a greater involvement of information branch is being encouraged.

Other institutions and interested people are encouraged to have involvement in ecological research in the Perup. The field station at Perup is an advantage in this regard.

MAJOR REPORTS DURING 1985

"The composition and foraging ecology of a bird community in karri forest in south western Australia" dissertation as part of requirements of a M.Sc in "Forestry and its relation to land management" at Oxford University.

SCHEDULED REPORTS FOR 1986 will include;

1. "Effects of fire regimes on understorey plant species composition".
2. "The effects of a hot fire on small mammal populations in the karri forest".
3. "The distribution and ecology of four species of Geocrinia in south western Australia.
4. "Birds and fire in south western forests".
5. Survey report on fire and fauna in Dryandra forest.

The above include reports with other officers and institutions.

FARM TREE RESEARCH IN THE WHEATBELT

Paul H. Brown
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NARROGIN 6312 (Phone 098 811 011).

MAJOR WORK 1984/85 1. The Farm Tree Research Centre was established in late 1984 to study 'Tree Research in the Wheatbelt' and is jointly administered by C.A.L.M. (previously by the Forests Department) and the W.A. Department of Agriculture.

2. Review Since December 1984, my main research responsibility has been to thoroughly review what is known about farm trees in the 600 - 300 mm annual rainfall zone of the W.A. Wheatbelt, and to identify problems requiring research input. Very little reliable scientific information is currently available on tree research in the Wheatbelt, with most available literature and advice to farmers based on practical experience rather than systematic research data. The report identified the following project areas to be of high priority:

- cheap broadscale revegetation techniques, particularly natural regeneration and direct seeding
- interaction of herbicides and trees
- the systematic diagnosis of tree decline based on the description of specific symptoms
- the role of vegetation in soil erosion problems on the south and west coasts
- the multiple use of trees and shrubs on farms.

3. P. pinaster establishment Assisted R. Fremlin (Busselton Research) in trials aimed at overcoming poor establishment problems of Pinus pinaster on established pastureland using mechanical site preparation techniques and by improving weed control using herbicides. To be completed April 1986.

Research Proposals The research review was completed in October 1985 and is currently being disseminated to interested scientists, farmers and advisers before an agreed Research Working Plan for the Centre is implemented.