062209

HALF-YEARLY RESEARCH SUMMARY

JULY 1980.

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16 September 1980.

I. DIEBACK RESEARCH.

A. Jarrah Dieback Research - B. Shearer and S. Shea

General

Major progress has been made in the development of a rational model of the epidemiology of the disease. A research paper has been published in the Journal of Protection Ecology. A number of joint research programme's have been conducted in association with the Division of Forest Research - Kelmscott, W.A.I.T. and Murdoch University. A series of lectures have been given to Departmental staff, other Government agencies and Universities.

Epidemiology

An intensive sampling programme was undertaken in spring to gain a better understanding of the relationships between the soil physical environment and asexual reproduction and survival of P.cinnamomi . Soil population levels were determined by direct plating and asexual reproduction, by assessing sporangial production on mycelial disks inserted into the soil. In moisture gaining sites the fungus was consistantly recovered at high population levels throughout the year, even in summer. On freely drained sites the soil population levels were markedly seasonal with the greatest number of recoveries in spring and autumn. Significant number of sporangia were formed in relatively brief periods in spring and autumn, when there was a coincidence of high soil moisture and temperature. The periods of sporangial production coincided with the periods of greatest recovery of the fungus in random soil samples and soil samples taken around B. grandis stumps.

The Role of B.grandis

Studies in conjunction with D.Schild, Murdoch University, have shown that infected B.grandis is a major source of inoculum for P.cinnamomi and can act as a reservoir for the fungus during the dry summer months. The fungus totally invaded, except for the pith, recently dead Banksia. The degree of colonisation of infected B. grandis then declined with time from death.

The movement of P.cinnamomi from infected B.grandis stumps into the soil occurred in spring and autumn when soil temperature and moisture was conducive to development of the fungus. Movement from stumps tended to be localized but is increased by overland water flow.

Studies of survival of P.cinnamomi in B.grandis root pieces have shown that the fungus declines to low levels in dead infected tissue during the summer months but then has the capacity to reinvade dead tissue when the soil is rewetted. A research paper on this project is in preparation.

Jarrah Fine Feeder Root System.

Studies on the surface root system of Jarrah has shown that this root system is composed of pads ranging in size from 10cm. to 1-3 cm. in diameter and about 5 cm. thick. The pads are connected to horizontal roots which send vertical risers from the leached soil horizon into the A1 horizon where they divide extensively forming the surface root pads. The pads are composed of short roots 1-3 mm. long (which commonly form dense clusters around lateritic pebbles) which arise from small (n-1) order laterals 0.5 cm. - 1.5 cm. in length which are connected to (n-2) order laterals 2-5 cm. long and up to 7 mm. in diameter. Mycorrhizal roots were common throughout the surface root pads. During the summer drought the short lateral roots die but the main framework of the surface pads ie: (n-1), (n-2), (n-3).... lateral roots are perennial. Following rains or irrigation, new short lateral roots are rapidly formed from the framework of roots in the surface pads. Phytophthora cinnamomi was consistantly recovered from short lateral roots and the perennial roots which form the framework of the root pads, on a disease site where a high density of P.cinnamomi had been induced by summer irrigation.

Studies of the periodicity of growth of this root system have shown that growth only occurs when the soil is warm and wet. The periods at which growth occurs appear to coincide with the periods when P.cinnamomi forms sporangia in the soil. The presence of this specialized root system, its perennial nature and its susceptibility to P.cinnamomi could account

for the susceptibility of Jarrah. A research paper on this project has been submitted for publication.

Legumes and P.cinnamomi

1. In studies on the effect of a legume understorey on development and survival of P.cinnamomi, pieces of B.grandis stem inoculated with the fungus, were used to simulate infection similar to that developing from naturally infected Banksia. Development of the fungus in the soil around the infected pieces was supressed under a Acacia pulchella canopy at one site, but not at another. The poorest survival of the pathogen occurred in the infected pieces under A.pulchella and in the open with the greatest survival under B.grandis

2. A prelimary study suggested that legume roots when incorporated into the soil at rates varying from 10-75% by weight reduced survival and pathogenicity of P.cinnamomi. A comprehensive pot and field trial has been initiated to further test this observation. The study includes an assessment of the relative contribution of nitrogen by A.pulchella and A. lateritiicola to the jarrah forest ecosystem.

3. Studies on the effect of the chemical constituents of A. pulchella roots on P.cinnamomi has continued. Results suggest that the polyphenol constituents of the roots do surpass P.cinnamomi but the concentrations at which this occurs are unlikely to be present in the field.

Detection Service

In addition to research activities, the Dieback Lab. processed 640 samples for other sections of the Forests Department.

Origin of samples	No.
Working plans	505
Hamel	96
Dwellingup	29
Mundaring	6
Kunnenurra	4

A workshop was organized in conjunction with the Australian Plant Pathology Society meetings in May, with 2 one day tours. The workshop included a visit by Professor Lewis Roth, who reviewed the Jarrah Dieback Research Programme.

Trevor Boughton, Como Research.

1. PROJECT NAME - Factors affecting P. radiata susceptibility to P. cinnamomi : Glasshouse experiments.

OFFICER RESPONSIBLE: Trevor Boughton

(a) Nutrition and Waterlogging

In a pot experiment using 1-0 trees fertilisation with Agras N and P fertiliser increased the number of deaths in inoculated P. radiata. There were few deaths in unfertilised pots and none in continually waterlogged or superphosphate treatments. This experiment will be harvested and roots examined to determine mycorrhizal effects and the level of infection in live and dead plants.

(b) Tree genotype

Given an identical mycorrhizal inoculum, P. radiata trees of different seedlots form different numbers of mycorrhizas. This experiment confirmed the range of susceptibilities to P. cinnamomi observed by Trevor Butcher. Absolute tolerance to inoculation was not observed in any seedlot. Fewest deaths occurred in NZ7 seedlot trees. Abundant mycorrhiza formation did not prevent P. cinnamomi completely invading the root system and lower stem of the plants.

Some treatments of this experiment will be harvested to try to explain the high tolerance showed by NZ7 trees.

2. PROJECT NAME - Interactions between P. cinnamomi and clover.

OFFICER RESPONSIBLE: Trevor Boughton

In the glasshouse, subterranean clover has been shown to be a potential host for P. cinnamomi even though it does not usually show symptoms. Differences in intensity of root infection between clover cultivars have been observed. This project has been completed and has been written up as a Forests Department Research Paper.

3. PROJECT NAME - Sunklands mycorrhiza survey.

OFFICER RESPONSIBLE: Trevor Boughton

Over 40 mycorrhizal or potentially mycorrhizal fungi have been collected from the Sunklands and at the Nannup nursery. These are being tested for mycorrhiza forming ability. Mycorrhizas formed will be described and it is hoped that a key to mycorrhizal types will be developed.

The distribution of mycorrhizas and nutrient cycling through mycorrhizas is being studied on agroforestry and standard plantation areas at Jarrahwood. Mycorrhizas produce up to 5kg/ha of fruiting bodies each year in standard areas and up to 4 times this biomass in agroforestry areas. Quantities, and distribution of nutrients, biomass and mycorrhizas will be measured when the plots are harvested in September, 1980.

4. PROJECT NAME - Effect of mycorrhizas on infection of P. radiata.

OFFICER RESPONSIBLE: Trevor Boughton

Eight mycorrhizal isolates are being tested to measure their effect on infection of roots by P. cinnamomi. The trial is being established at present and should give results by March, 1981.

5. PROJECT NAME - Nannup nursery disease risk assessment.

OFFICER RESPONSIBLE: Trevor Boughton

P. cinnamomi and P. cryptogea are common pine nursery pathogens in eastern Australia and overseas. The Nannup nursery has been extensively sampled without recovery of either of these fungi. Quarantine measures have been suggested (but not implemented) to reduce the risk of these fungi being introduced. A pot experiment is underway to examine the effect of inoculations of P. cinnamomi and P. cryptogea on germination and survival of P. radiata in nursery soil. A fungicide control treatment will be tested in the same experiment.

6. PROJECT NAME - Mycorrhiza inoculation in the Nannup nursery.

OFFICER RESPONSIBLE: Trevor Boughton

This project is aimed to introduce the mycorrhizal fungi Pisolithus tinctorius and Cenococcum geophilum to the Nannup nursery. Overseas results show that these fungi should overcome existing problems of mycorrhiza formation on Pinus taeda and may help reduce nutritional and disease problems in Sunklands plantings.

PINE DEATH STUDIES

1. P. radiata death studies - H. Chevis

Continuing project

Annual monitoring of number and distribution of deaths in p. 74,75,76 P. radiata in Jarrahwood Plantation. This year monitoring was by 70 mm aerial photographs at a scale of 1:3,500. This method proved very satisfactory and should be used for any further monitoring.

Additionally, 80 ha of p. 77 P. P. radiata in the Jarrahwood Plantation, was ground surveyed. The results of this survey will provide further information relating deaths to site.

From previous surveys there appears to be a concentration of deaths on certain sites.

Data from the p. 71 P. radiata trial plots, standing at 1700 s.p.h., shows deaths decline to less than 1 death/ha/annum by age 7 (years).

2. Inoculation trial - H. Chevis and M. Stukely (Como)

New project W.P. 11/80

The project aims to determine whether the 'pepperpotted' distribution of deaths evident in the young Sunklands Plantation is primarily due to variable host tolerance or to the distribution of the (probable) causal agent, Phytophthora cinnamomi, in the soil. The experiment is being carried out on clovered and non-clovered p. 79 P. radiata in the Jarrahwood Plantation plots were also established in 28 year old P. radiata plantation (Willcox A) pine plugs, inoculated with P.C. were placed around the base of selected trees.

Preliminary results suggest a rapid decline in inoculum viability, in the 28 year old, compared to the 1 year old, plantation.

3. Water table/soil water in relation to P. radiata deaths - H. Chevis

New project W.P. 6/80

A perched water table is known to cause disease problems, especially if it undergoes marked seasonal fluctuations. This trial was set up in areas of 5 year of P. radiata exhibiting different rates of mortality. Ground water table is being measured through the establishment of shallow wells. Soil water is also being measured.

4. Soil moisture/temperature studies - H. Chevis

a) New project

Currently being established, this trial aims to investigate the effect of stand density upon growth and sporulation of P.C. p. 72 P. radiata plots, standing at 1700 s.p.h. are to be compared. Soil moisture and temperature are to be monitored and some assessment of inoculum viability is to be made.

b) Old project

Data from this experiment is being analysed.

PROJECT: Pinus radiata deaths in the Sunklands - Phytophthora isolations

OFFICERS RESPONSIBLE: Como - T/O M. Stukely and T/A C. Crane
Busselton - A.D.F.O. Chevis and T/A P. Jenkins

1. SAMPLING DEAD TREES FOR PHYTOPHTHORA INFECTIONS

The comprehensive sampling programme carried out during spring and summer 1979 indicated a strong link between P. radiata deaths and Phytophthora cinnamomi (P.c.) root infections, and also the presence of P.c. in the soil. Recently, attention has been focussed on Phytophthora collar-infections in established P. radiata.

Phytophthora species (sometimes P.c. and sometimes what is thought to be P. cryptogea, and sometimes both) have now been isolated from the collars of dying and recently-dead trees, and less frequently from trees dead for longer periods.

Infections have been shown to occur at various different positions in the collars of different trees - in the bark, the cambium and the central woody tissue, and from the base of the collar up to ground level and even above ground level. Most of the trees tested were 4 to 6 years old, and some 9-year-old trees have recently been found to be infected. It is planned to publish these results soon, when our identification of the fungal isolates has been confirmed.

Dead trees in P. radiata progeny trial RS8 at Jarrahwood (p 1974) have been sampled, and Phytophthora isolated from the collars and roots of several of them. However, due to the range of stages of decline among the trees sampled, it has not been possible to link Phytophthora infections to particular P. radiata lines.

At West Manjimup Seed Orchard, three P. radiata trees considered to be dying because of graft incompatibility were all found to have collar infections (probably P. cryptogea).

Collar sampling is now being used as a standard procedure for detection of Phytophthora infections, together with root and soil samples.

A high priority is being given to the isolation and identification of other species such as P. cryptogea, in addition to P.c.

During spring and summer it is planned to sample new dead trees as they are observed, and to compare their distribution with the mortalities which occurred previously. This should give some information on the spread of disease.

2. INOCULATION TRIAL

Soil beneath P. radiata at Jarrahwood (p 1979, clovered and non-clovered) and Willcocks A (p 1952, unthinned) has been artificially inoculated with P.c. in order to observe the distribution of infections and the survival of the inoculum in the soil. The trial was inaugurated in May.

So far, no deaths have occurred (as expected) and inoculum survival has been high (sampled July and August). These plots will be monitored and sampled until at least winter 1982, covering two spring periods of high P.c. activity and two summer-autumn periods of high water stress to the pines.

Deaths in the plantation have occurred in a "pepperpotted" fashion, spread among apparently healthy trees. It is hoped that this trial will provide some information on the question of whether the healthy trees are exhibiting tolerance to P.c. infection, or merely escaping infection due to a sparsely scattered inoculum.

It is planned, in 1981, to inoculate further plots in Willcocks A (p 1952) which were thinned during winter 1980, to gain additional information for these older stands.

3. SUB-CLINICAL INFECTIONS IN HEALTHY TREES

A preliminary examination of sub-clinical infections has been made. Whole root-systems of several apparently healthy 1-year-old trees adjacent to a dead one (with P.c. infection) were plated. Phytophthora infections of varying extent were found.

A lot more work is planned in this area, to include various tree ages, positions of the healthy trees in relation to dead ones, times of sampling (and corresponding degrees of stress on the trees), and fertilizer treatments applied.

Extensive sampling of the roots of two 5-year-old trees (one in the Agroforestry area, one outside it), to be excavated by T. Boughton for biomass measurements, will be done in September.

II HARDWOOD SILVICULTURE

1. Old Projects with action taken this period.
O.I.C. Ritson.

1a. Karri Plant spacement Trial R.W.P./71 Trial measured in April. Data not yet interpreted.

1b. Karri Establishment Fertiliser Trials R.W.P. 4/79
These trials were remeasured in May and early results suggest, fertiliser requirements on podzolic type soils are very similar to those of the red earths, for early karri seedlings establishment. Results are currently being written up by T. Annels. The show release fertiliser section of the trial has possibly had insufficient time for the full effect to be reflected and further measurements next year are required before a final report is made.

1c. A study of Genetic Variation in Karri R.W.P. 26/78
These trials were remeasured in June. To early for analysis.

1d. Broadcast Seeding in Karri R.W.P. 3/79
Trial has indicated that 35,000 seeds/ha should be sufficient. 45,000 is the original seeding rate used in operations.

2. New Projects O.I.C. O. Ritson

2a. Marri Provenance Trial R.W.P. 19/76
Provenance trial established using 96 families selected from high quality individuals over a wide geographical range. The aim is to see if it is feasible to significantly increase the quality of marri with respect to sawlog and chiplog.

2b. Karri Spot Sowing Trial R.W.P. 2/80
This trial has been established using shelters of various dimensions, opaque and transparent, with and without insect exclusion. It should increase our knowledge of the factors affecting germination and early survival of karri.

2c. Karri Thinning Site Damage Trial R.W.P. 12/80
Logging has now almost been completed. The aim is look at the effect on soil damage of machinery with high ground pressure (Forwarder) and compare this to the skidder which has a much lower ground pressure. In the long run we will try to determine the effect this soil damage has on the residual tree growth.

4. Apart from work on the above Research Working Plans considerable time and effort has been spent on establishing karri seed orchards.

Nineteen hectares at Poole 2, 10 hectares at the nursery and eight hectares in Brockman 14. Progeny trials have been established in parallel with these.

The current planting system being used is a 5 x 2 m spacing and using 10 trees per family block. The families being randomly placed in each replication. These 10 trees of a family occupy 20 m of a line and will eventually be thinned out to one tree thus given us a stocking of 100 S.P.Ha.

(B) *Rehabilitation Research - J. Bartle.*

Research on rehabilitation has been concentrated almost entirely on the selection and testing of tree species suitable for establishment in salt prone catchments. As a consequence of the allocation of this research primarily and because of staff shortages, very little research has been carried out on bauxite mining rehabilitation research. However, the results of previous research on bauxite pit rehabilitation are being collated in the form of a research paper. The absence of research on bauxite pits represents a major deficiency since it is evident that there are a large number of significant problems present and developing in the bauxite mine rehabilitation programme. It will not be possible to carry our research in this area unless research priorities are changed or additional staff are provided.

Trial Plot Establishment.

Arboreta consisting of 70 species planted in 1 hectare plots have been established at the following sites.

Del Park - Bauxite Mine Site - Salt free

Marrinup - Upland Dieback Effected Site - Salt free

George Block - Upland Site - Salt present

- lowland site - Salt present

Stenes Property - Agricultural property - Salt present

- Wellington Catchment.

Low level aerial colour photography has been carried out at the Del Park and Marrinup arboreta. Borefields have been established to assess the effect of the replanting on groundwater hydrology.

Tree Water Relations

A major objective of the rehabilitation programme is the selection of species which will have the same hydrological effect as Jarrah. That is, species used for rehabilitation of salt prone areas must maintain evapotranspiration rates comparable to jarrah if salt flow is to be prevented.

A technique involving the use of large ventilated chambers to determine the evapotranspiration rates of jarrah forest species and potential replacement species is being tested at Dwellingup.

Five large ventilated chambers were made operational and some data collected. This work revealed some important deficiencies in design of chambers and sample systems. Redesign and rebuilding to overcome these problems is in progress.

A data collection system for this work has been prepared.

MANJIMUP FIRE RESEARCH

Biannual Report. January 1980 - June 1980 (N. BURROWS & R. SMITH).

INTRODUCTION

During this period work has been almost entirely on the burning of test fires at Dwellingup and the summarization and preliminary analysis of the resulting data. Reports on the Lake Muir Wildfire study (W.P. 14/79) and Medium High Intensity Fires Harrington (W.P. 28/78) have been written.

CURRENT PROJECTS

W.P. 28/78 - Medium-High Intensity Fires - Dwellingup & Harrington

A progress report has been written on the fire behaviour, Banksia grandis kill and acacia germination results from the Harrington Block Fires. A follow-up report will be presented when multiple regression computations are completed.

Analysis of the data collected from the 18 fires burnt in Young Block, Dwellingtup during summer is proceeding at the moment.

In association with the work in Dwellingup on B. grandis fire kill further work is in progress to establish basic heat application rates required to kill different sized individuals.

W.P. 17/76

The Effect of Fire on Even-Aged Karri.

No further work has been carried out on this project due to commitments in jarrah burning.

W.P. 14/79

Lake Muir Wildfire Study.

A report outlining the results so far is being prepared for publication. Further monitoring of the area is envisaged.

P. radiata Establishment Trial - Peninsula Road, Lewana.

The height growth of these trees is being monitored annually. Preliminary measurements show the mulched and the burnt plots to be growing faster than the cleared plots. All treatments were fertilised at the same rate.

SOIL DRYNESS INDEX

After one season with the Soil Dryness Index in use it has been found the Index is not sensitive enough to respond sufficiently ro rain in summer. An improved model has been produced for further testing next summer.

V HYDROLOGY.

© *Hydrology - Peter Ritson.*

1. Yarragil project.

A major effort was put into assessment of a subcatchment of the Yarragil Catchment where a logging and cull felling treatment designed to enhance the growth of retained crop trees and increase water yield is planned for summer 1980/81. Logging slash is to be burnt in autumn 1981 in a fire designed to disfavour dieback disease.

Detailed measurements of crown cover are being tested to determine changes in water yield. Other measurements have been designed to show the effect of the treatment on growth rates of retained crop trees. Fire damage to crop trees is being assessed and measurements will be repeated after the burn. Understorey structure and composition is being monitored both from a conservation viewpoint and because of its importance to Jarrah Dieback. Included in the study is an assessment of the treatment's effect on nest holes in trees for arboreal mammals and birds. It appears that suitable nesting holes are mainly confined to veteran trees such as would be culled out if wood and water production were the only considerations.

Hydrologic calibration of other subcatchments in Yarragil Catchment has continued so that other silvicultural treatments may be tested in the future.

Dandalup Group of Catchments.

Monitoring of streamflow, stream salinity and rainfall in the Dandalup group of catchments continued in co-operation with the Public Works Dept. This is the fourth year of calibration. A "wet year" is required to establish a satisfactory calibration prior to testing thinning and reforestation treatments on these catchments.

Surface water sampling.

Data from water sampling in the Harvey Division and ~~long~~ the Darling Scarp are being analysed in preparation for publication.

South Dandalup Hydrology Study.

Monitoring of subcatchments in the South Dandalup catchment has been restricted to five western subcatchments being mined or likely to be mined in the near future. The object is to show the effect of mining on water quality and yield.

Data resulting from 5 years of monitoring of the South Dandalup catchment is being collected for publication.

Hunt Steering Committee Project 4.

Monitoring of bores along the Dwellingup Transect has been restricted to a few key bores.

HYDROLOGY - H. Chevis (SUNKLANDS PINE PROJECT)

Continuing projects

Monitoring of piezometers and weirs to investigate the effects of conversion of native forest to pine on the water balance is continuing.

HYDROLOGY - WOODCHIP LICENCE AREA. (D. WHITTLEY).

Routine measurements continued in the four study areas (Iffley, Crowea, Poole and Mooralup). In November 1979 Iffley and Mooralup were burnt. During the year a team from the Mines Department made detailed studies of the hydraulic conductivity of the groundwater output beneath the weir in each catchment.

A report covering the years 1979 and 80 was submitted to the Kelsall Steering Committee.

Section 3 - Hydrology of the coastal plain (T. BUTCHER)

The Gnangara Water Supply Reserve was proclaimed in April 1973. This includes all of the land area of State Forest 65. Proposals are to eventually pump 20% of Perths' water requirements from this reserve.

The Mirrabooka groundwater scheme, south of Gnangara plantation started pumping in 1971. The Wanneroo scheme which runs through the Gnangara plantation became operational in 1977. The Pinjar, Yeal and Barragoon ground water schemes are planned north of the Gnangara plantation, running through the Pinjar and Yanchep group plantations.

The Forest Department must manage it's land for water production as well as for sawlog timber. Fortunately there is no conflict. To meet objectives, our management strategy is to grow the pine plantations at a density approximating the water use of the native woodland.

A bulletin on the water relations of P.pinaster is now in preparation. Among others, it will also describe optimum management regimes for pine plantations.

For this report, discussion is limited to the topics -

1. Water balance
2. Water table levels
3. Rainfall distribution
4. Drought
5. Publications

1. Water balance

The water balance equation equates rainfall (R) with water losses caused by evaporation (E), changes in the soil moisture (S), deep drainage (D) and overland flow (O). On the coastal plain sands there is no overland flow such that this term can be ignored. The evaporation component is usually expanded to evapotranspiration (ET) when there is vegetation covering the soil surface. The equation is usually written as -

$$R = ET + S + D.$$

We have measured R and S and have estimated ET when D is zero. By extrpolation we are estimating the amount of deep drainage through the pine stands and native woodland.

A considerable part of my time in the past 6 months has been spent on the programming of our desk computer to analyse all of the neutron probe data from our Yanchep experiment. The program is now-running. This computes the soil water contents and variances and changes for increments of soil depth and a range of stand densities, as well as graphing the result.

Soil moisture monitoring is now at a low level, monitoring key plots in 27 year old pines and native woodland at Yanchep, and plots in 12 year old pines at the northern end of the SF.65. Recordings are taken in August, December and April.

.../2.

2. Water table levels

The department first recorded water table levels of the Gnangara mound in 1941, under both pine and woodland cover near Gnangara. The records are not continuous (1942-46(5), 1959-67(9) and 1976-79(4)) but linked with the more recent MWB recordings give valuable information on past levels. MWB established their first monitoring bores in 1964.

I am now writing on this topic for publication as a Research Paper. This covers the past fluctuations of the water table and the various effects caused by fire, conversion of woodland to pine plantation and pumping. A model to predict the level of the water table is discussed.

3. Rainfall distribution

Rainguages were positioned in 1956 along the east and northern boundaries of SF.65 to give information on rainfall. From 1965, these have been read on the first day of the month. The final rain guage run was made on January 1 1980.

This information was first sought to calculate length of growing season and to determine the potential for P.pinaster. The rainfall data is now very important as it allows the more accurate areal calculation of rainfall on the Gnangara mound. Present models use data from the single gauge at Gnangara as rainfall on the Gnangara mound.

Rainfall distribution and characteristics are being reviewed and will be published as a Research Paper.

4. Drought

Much time has been spent on writing programs to analyse climatic data. Particularly, I am looking at the decile distribution of rainfall and using this as an indicator of drought. This is being prepared for publication.

The study examines in detail the two most drastic drought death occurrences, the first in 1950 and the second in 1977. It also discusses the drought tolerance of P.radiata and P.pinaster species as well as the provenances of P.pinaster.

VI ECOLOGICAL STUDIES

Fire Ecology Research. (Owellingup)

Operational Medium Intensity Burn.

A 2000 hectare moderate intensity burn was carried out at Hakea Block in conjunction with Protection Branch. 45 plots were established throughout the area prior to burn and detailed assessments were made of legume presence, existing fire damage, fuel, associated shrub species and the B.grandis understorey. The burn was carried out within the range of intensity prescribed. Detailed post burn assessments are currently in progress. Preliminary results indicate that legume regneration has occurred over most of the burnt area. However, in contrast to previous burns where the dominant species were A.pulchella and A.lateriticola up to 10 different legume species have been recorded in the burn area.

Fire and B.grandis

Control of the B.grandis understorey cannot be achieved by single event treatments, for example high intensity fire or herbicides, because regrowth to pre-treatment densities occurrs within 10 to 20 years. Hence, the biology and population dynamics of the species have been studied in an attempt to devise a management regime which would maintain the density of the B.grandis understorey at a desireable level.

Growth rates of B.grandis in stands of different densities have been determined and a multiple regression equation developed to predict growth. The relationship between cone production and tree size, seed production per cone, seedling survival and the structure of the B.grandis understorey in jarrah forest stands with different burning and silvicultural treatments has been determined.

The effect of fire of different intensities on survival of B.grandis seedlings, lignotubers, and trees in 1 cm. size classes was determined from field plots which had been subjected to a range of fire intensities.

The data has been incorporated in an interactive Fortran stand computor model which is being calibrated by comparing simulated stand structures at different stages of development with comparible natural stands. The model has the capacity to simulate the effect of different burning regimes alone and in combination with other silvicultural treatments, on the density, structure and development of the

B.grandis understorey.

MANJIMUP RESEARCH January - June 1980

FLORA

W.P. 3/71 A study of the effects of fire on a plant community in which Crowea is a major constituent.

No further action

W.P. 4/71 A study of the effects of fire on an Acacia strigosa/ Crowea dentata community.

No further action

Harrington Block (W.P. 28/78) A further vegetation assessment has been done by ecology section in those plots prescribed burnt by Fire Research last summer. Results are being analysed by Fire Research section.

FAUNA

W.P. 25/71 Ecological effects of a hot karri fire

Trapping frequency in Warren Block has been increased from twice a year to four times a year. This will enable the increase in the mardo population to be more closely monitored. The population of bush rats showed normal seasonal fluctuation, with a number of juvenile animals being caught in February.

W.P. 4/78 Long term monitoring of forest fauna populations

Two daylight and two spotlight surveys were done in the Perup and Lake Muir areas. Population of grey kangaroo and brush wallaby were about normal, but there was a small increase in the numbers of brush possum.

W.P. 4/76 (Crowea Block Trapping)

Trapping was done in February and May. In the May session, two years since the area was burnt, several bush rats were trapped. This follows closely the pattern in Warren Block, an influx of mice (Mus musculus) following a burn, being replaced with a build-up of bush rats about 18 months later.

W.P. 5/78 A biological survey over 2 weeks was done in the Mitchell River area in April, following a proposal that this large area of crown land should become State Forest. Results of the survey have been written up as a report and is with the Conservator.

W.P. 8/78 Seeding the woylie (Bettongia penicillata) into an area from where it has recently disappeared.

Trapping continued in this area. The population of woylies remains comparatively low though some are still being trapped in the "new" territory occupied during the previous six months. Despite difficulties in monitoring the fox population during the winter months, indications are that it remains fairly stable.

VEGETATIVE COVER (Recovery following logging). D. WHITELEY.

Studies of scrub vegetation in the Woodchip Licence Area continued. Part of the programme deals with the recovery of vegetation on the recently logged catchments at Iffley, Crowea, Poole and Mooralup and each of these areas was assessed. Vegetation remaining after the burns at Iffley and Mooralup covered approximately 38% of the ground surface.

Studies are also being made to determine changes in scrub vegetation associated with woodchip logging operations. No work was undertaken during the year in eight study areas established in the karri forest and a progress report is in preparation. Assessments of vegetation were made in four representative areas in the jarrah forest scheduled for logged in the near future. Samples of the soil were taken at the same time to determine bulk density.

Studies have begun in the Lewin plots (Coronation Road) to determine the recovery of vegetation in jarrah forest logged and burnt 10 years ago.

Tuart Burning Trial - R.W. Moore

Lime Kiln Paddock.

New Project. (Originally planned by P. Kimber)

The overall objective of the trial is to determine the effect of reintroducing fire into the tuart forest after a virtual absence of 50 years. Grazing has also been stopped in the trial area. Plant and bird populations have been assessed to provide base data before burning treatments commence. The 200 hectare trial area has been divided into 16 plots each approximately 12 hectares in size. Four treatments will be applied.

1) No burning.
2) Annual burning.
3) 5 year burning interval.
4) 10 year burning interval.

It had been intended to burn the plots for the first time in Autumn 1980 but early winter rains caught us out. Preparation is now in progress to allow burning in late March 1981 before the rains arrive. Old stags are being burnt or felled down and buffers prepared. The extra time before burning has its good points. Further collection of base data is possible. The cadets will help to assess numbers of tuart seedlings in the plots in August 1980 and in September a group of students from WAITE plan to spend a few days collecting pasture samples and specimens of plants.

The trial aims to provide information about how to burn the tuart as a means of fire control and still maintain the conservation values of the forest.

2. Effect of Fire on Forest Soils (A.B. Hatch.)

In conjunction with Dr Abbott, some chemical analyses have been carried out on burnt and unburnt soil samples from the experimental plots in Young Block. Unfortunately, due to changes in the burning plan, only two complete sets of samples are available. Some preliminary results are shown below. The burnt plot is E1 and the area was burnt on 10.1.80.

	Plot C7		Plot E1	
	10.12.79	11.2.80	10.12.79	11.2.80
pH	5.13	5.52	5.61	6.89
T.S.S. %	.037	.040	.040	.062
O.C. %	3.91	4.64	5.75	5.30
N %	0.166	0.164	0.230	0.242
P (Bray) ppm	4.3	9.7	3.4	26.0
K (de Turk) m.e.%	0.22	0.25	0.34	0.49

The immediate result of the burn has been to increase pH, soluble salts, available phosphorus and potassium.

Further samples have been collected to study the variation in soil properties after the burn.

3. Soil Organic Matter Studies (A.B. Hatch.)

The range of jarrah forest soils were tested to measure the nitrogen availability index. The techniques recommended by Purvis and Leo, Waring, Standford and Jenkinson were tried and all gave a poor relationship to the total nitrogen in the soil.

Currently the programme is attempting to quantify the differences between the soil organic matter under banksia and jarrah stands.

VII PINE NUTRITION.

SECTION A: HARVEY COAST

1. Refertilisation on Grey Sands - R.W. Moore

McLarty Cpt 60.

Old Project.

Since refertilisation of 5 year old P. radiata with different rates of Super, Agras and Vigran in 1976, 4 years growth data is now available. Agras has produced the greatest increase in growth with 488 kg/ha giving a 28% increase in B.A. compared with the control.

2. Refertilisation of P. radiata on yellow sands - R.W. Moore

W.P. 13/78 Myalup Cpts 53, 42, 65 and 122.

Old Project.

The trial aims to determine the growth response of 8 year old P. radiata to different rates of NP fertiliser. Two years growth data is now available and shows that 800 kg/ha is about the optimum rate. The increase in B.A. produced by 800kg NP/ha is only 8% which is quite small.

SECTION B: COLLIE COAL BASIN

All fertiliser trials in the Collie Coal Basin have now been terminated.

A paper reporting the refertilisation trials on Preston Road is being written.

SECTION C: GRIMWADE

1. NP at Planting - R.W. Moore

Section 0.2 Grimwade.

Old Project.

Fertilisers tested included super, agran, ammonium sulphate, ammonium sulphate + super phosphate, urea + super phosphate and double phosphate at 4 application rates (25, 50, 100 and 200gms/tree).
Following the annual measurement of this trial recently all the data for the trial was coded and analysised by the CIBA computer in Perth. Previous analyses of the data showed no significant difference between treatments. However analysis by S.P.S.S. tells us that:-

(i) Whilst there is no significant difference between rates of fertiliser there are significant differences between types of fertiliser. Tree height in June 1980 (4 years after initial fertiliser) is significantly better for Agras compared with both double super and urea + super.

(ii) Superphosphate also resulted in significantly better growth than double super.

(iii) Height increments in the first year after fertilisation showed that Agras gave significantly better growth than all other fertilisers. This response was short lived though for the following year the height increment for Agras was significantly better than just two fertilisers - double super and NH_4SO_4.

It is unfortunate that the trial does not include a control. Until the growth is compared with unfertilised trees the value of applying fertiliser at all cannot be assessed. If possible trees surrounding the trial plots will be measured as a control at the final measurement in 1981.

SECTION D: SUNKLANDS

1. N & P Refertilisation of 3 year old P. taeda on Sunklands - R.W. Moore

W.P. 17/79 Cpt 3 Jarrahwood.

New Project - No data available yet.

The trial aims to determine the optimum rate of Agras 18:18 for refertilisation of P. taeda.

2. N & P Refertilisation of 3 year old P. pinaster on Sunklands - R.W. Moore

W.P. 18/79 Cpt 3 Jarrahwood.

New Project - No data available yet.

The trial aims to determine the optimum rate of Agras 18:18 for refertilisation of P. pinaster. A preliminary investigation of N requirements for P. pinaster on sunkland sites is also an objective of the trial.

5. NP Initial Fertiliser Trial - R.W. Moore

Cpt 3 Jarrahwood.

Old Project.

No action this period. Final measurement due November 1980. Data to date shows that the effect of Agras is short lived compared to the effect of Super. See Table 1 below.

Table 1:

Treatment	Height Increments (cm/yr)			
	1st	2nd	3rd	4th
200gm Agras/tree	29.5	60.2	84.9	154.1
200gm Super/tree	14.1	42.1	62.3	155.9

Pine fertilised with Agras had double the height increment in the first year compared with supered pine. However 3 years later the pines that had been given super were growing as fast as pine that had been given Agras.

These findings have been confirmed by a recent assessment of a large operational area planted in 1977. Table 2 shows that by age 3 years there is no significant difference in the size of ~~the~~ pine that received 100gms/tree Agras 18:18 and ~~the~~ pine that received 150gm/tree superphosphate 22%.

Table 2:

Initial Fertiliser Treatment	Height (m) (age 3 yrs)	Diameter (cm) (age 3 yrs)	Cost of Fertiliser	
			$/tonne	$/Ha.
Agras 18:18 (100gms/tree)	2.35 ± 0.09	2.39 ± 0.16	$225	$22.50
Superphosphate 22% (150gms/tree)	2.33 ± 0.09	2.45 ± 0.19	$84	$12.60

Cost data included in Table 2 shows that cost/hectare of applying Agras is almost double that of Super. These findings are further evidence of the likely benefits of growing pine on clover pasture for clover pasture should produce both an adequate and continuous supply of nitrogen.

8. Rosa 2 Fertiliser Trial - R.W. Moore

Jalbarragup Road P69.

Old Project.

Ten years since establishment the effects of the initial fertilisers are still clear.

(i) B.A. data for:-
56gm Super Cu Zn/tree is 16.98m^2/ha
224gm Super Cu Zn/tree is 23.01m^2/ha.

(ii) B.A. increment is also greater for the higher application rate.

The trial is to be maintained as an increment plot with annual measurements.

9. Atrazine Application Trial - R.W. Moore

Cpt 1 Jarrahwood P78.

Old project.

This pilot trial aims to determine whether atrazine stimulates P. radiata growth under Sunkland conditions. Two years growth data shows no positive response to atrazine. The trial should be terminated.

11. Inter-row Refertilising - R.W. Moore

Cpt 3 Jarrahwood P75.

Old Project.

Three rates of superphosphate were applied to the inter-row area when the pines were one year old. Table 3 below shows height data at 22/2/80.

Table 3:

Treatment	Height (cms) 1980
400kg Super/ha	317
800kg Super/ha	321
1600kg Super/ha	355

There is a clear growth response to increasing rates of superphosphate. The trial lacks a control which makes it difficult to assess the value of inter-row refertilising at age one year compared with not refertilising.

13. N & P Refertilisation of 6 year old P. radiata on the Sunklands - R.W. Moore

Old Project.

The project aims to determine the optimum rate of Agras 18:18 for refertilisation. Table 4 below presents a summary of growth data for all 4 sites and shows the average basal area for different rates of Agras 18:18.

Table 4:

Treatment	Basal age 7/80
Control	17.18
250kg/ha (Agras)	20.10
400 " "	21.3
550 " "	21.4
700 " "	23.4

16

700kg Agras has produced a 36% increase in basal area compared with the control. It appears that the growth response has not levelled off at 700kg/ha. A larger range of rates should have been tested to determine the optimum rate.

Annual measurements to continue.

17. 'Osmocote' Slow Release Fertiliser Trial - R.W. Moore

Cpt 6 Jarrahwood P79.

Height growth over the first six months since planting out shows that Agras gives far better growth.

See Table 5 below.

Table 5:

Treatment	Height Increment (7/79 - 2/80) (cm)
Osmocote 10gm/tree (12-14 month)	6.5
Osmocote 30gm/tree (12-14 month)	9.3
Agras 100gm/tree No. 1	32.2

This supports the findings of work with slow release fertilisers overseas which has shown them to be generally unsatisfactory compared with conventional fertilisers. Annual measurements of this pilot trial will continue.

18. Simulation of Mechanical Fertiliser Application in Mounds - R.W. Moore

W.P. 10/77 Cpt 1 Jarrahwood.

Old Project.

Growth data at 6/80 shows that line application of Agras 18:18 during mounding does increase the quantity of fertiliser required. It is only when (60gms or more/meter (400gm/tree) is applied) that there is a significant (P0.01) increase in growth compared to the standard spot application of 100gms. The trial is to be terminated.

19. Line Application of Fertiliser in Mounds - R.W. Moore

Cpt 3 Jarrahwood P76.

Old Project.

Data at 24/10/79 indicates that only at the very highest rate (1600kg/ha) is growth any better for line application of fertiliser compared with the spot application of 363gms/tree. See table 6 below.

Table 6:

Treatment	Height (cm) at 10/79
Line application of Super 22% @ 400kg/ha	312
Line application of Super 22% @ 800kg/ha	327
Line application of Super 22% @ 1600kg/ha	361
Spot application of Super 22% @ 363gm/tree (400kg/ha)	333

Clearly spot application is the superior method of applying fertiliser.
Trial is to be terminated.

20. Single Spot Initial Fertiliser (NP) Trial - P. radiata - R.W. Moore

W.P. 10/80 P80 Baudin.

New Project.

South Australian research has shown that to avoid damaging the pine roots it has been found beneficial to bury the fertiliser in a slot on one side of the tree only. In view of the overall mortality rate for P. radiata and P. pinaster in 1979 being 16% and 49% respectively this trial aims to answer the question does placement of NP fertiliser on one side of the tree result in better survival and as good a growth as placing the fertiliser on the surface on both sides.

21. Initial Fertiliser Trial P. pinaster, P. elliottii and P. taeda - R.W. Moore

Baudin P80.

New Project.

This trial aims to provide some preliminary information about the effect of fertiliser type, foliar sprays and clover on three pine species. Three fertiliser treatments (100gms Agras, 150gms Super 22% and 150gm Super Cu Zn) with and without foliar sprays will be tested. The trial has been replicated on and off clover.

SECTION E: PASTURED FORESTS - SUNKLANDS

1. Clover Shade Tolerance Experiment - R.W. Moore

W.P. 6/79 Ludlow Glasshouse.

Old Project.

The study aimed to test the shade tolerance of 8 clover cultivars to different shade intensities. A report dated 22nd April 1980 presents the findings of the trial. In summary, the results showed that none of the clover cultivars were any more tolerant of shade than any other in terms of biomass production. Growth of all cultivars declined with increasing shade. Trial has been terminated.

2. Site Preparation Methods for Clover Establishment - R.W. Moore

W.P. 12/79 Cpt 5 Jarrahwood.

Old Project.

The study aims to determine whether it is necessary to plough and mound when establishing pine with clover. 1980 treatments have been applied and sirvival counts made.

5. Nitrogen Build-up in the Soil by Clover Pasture under P. radiata - R.W. Moore

W.P. 17/80 Jarrahwood.

New Project.

This study aims to test the hypothesis that there has been a build up of nitrogen in the soils with clover pasture. Soil samples have been collected from on and off clover sites at:-

(i) Chapmans Lease.

(ii) No. 6 and No. 7 Road Agroforestry plots.

(iii) No. 9 Road Clover Cultivar Trial.

The samples will be analysed to quantify the N build up.

SECTION F: SECOND ROTATION TRIALS

1. Second Rotation Trial - Margaret River - R.W. Moore

New Project.

The trial aims to:-

(i) Investigate the effect of various site preparation treatments on site productivity.

(ii) Test a recently built crushing machine and determine the effect of not burning debris on site productivity.

The basic treatments are:-

(i) Crush debris - no burning.

(ii) Minimum distrubance treatments.
- heap only the very large logs and standing timber and then burn
- aim to leave as much of the duff layer undisturbed.

(iii) Broadscale treatment
- regrowth and all debris to be heaped and burnt
- area to be cleaned up to a high standard.

With and without clover treatments will be applied across all treatments. The trial area is located across the northern section of compartment 1 Margaret River plantation. The crushing treatments were applied in 1979. The remaining treatments will be applied in summer 1980.

2. Second Rotation Trial - Grimwade

Old Project.

The trial aims to test the effectiveness of a range of treatments for the second pine crop in terms of maintaining site productivity.

In May 1980 all measurement trees in the plots of section B were measured. Discs were cut from three trees per plot for sectional analysis data. Measurement of the discs has been completed but the data has not been analysised.

The trial requires a close look at the overall plan to clarify how treatments will be applied and what treatment the second crop of pine should be given. For example which sections require high pruning and should the clover be maintained with additions of fertiliser.

3. Second Rotation Trials - Harvey Coast Plantations

Old Projects.

a) Cpt 25 Nyalup

A very good crop of lupin was established in 1979. Three pre-planting treatments are being tested:-

(i) Heap all debris (including stumps) and plant lupins.
(ii) Heaping, leaving stumps, plant lupins.
(iii) Crushing plus lupins.

A large and good operational style trial currently managed by Harvey Division.

c) Cpt 85 McLarty

Area ploughed and sown with lupins in 1977. Half the area was fenced. Only a few lupins left in 1979 when P. radiata was planted. White lupins do not persist.

It is intended to re-establish lupins in the area in 1980.

It is a good operational trial. Soil sampling is required to monitor changes in N and organic matter levels.

PINE NUTRIENT STUDIES (A. B. Hatch).

a) Ecological Studies

Sixteen soil samples were analysed for SDFO McCutcheon and the data forwarded to Busselton.

b) Mundaring

Twenty three soil samples were analysed for Mr Batini (N, P, K and Organic C). Associated with these plots 23 foliar samples were analysed for N, P, K, Cu, Mn and Zn. The data has been forwarded to the above officer.

c) Busselton

A total of 205 foliar samples from Busselton pot culture trials were analysed for ADFO Moore.

d) A set of nine samples were analysed for B levels for Mr McGrath. The data showed that B levels were adequate in his samples. It is also good to report on the accuracy of the dianthrimide technique as Mrs Wong was able to report the theoretical value of B on the standard USDA orchard leaf sample.

PINE NUTRITION (WANNEROO – T. BUTCHER)

2.2. – Pine nutrition

2.2.1. WP.6/72 – Pinjar C1(P72), Pinus radiata.

This is a factorial design trial having two levels of applied superphosphate, four levels of manganese and is on four site types.

action in 1979 – plots were thinned to 500 spha.

2.2.2. WP7/72 – Pinjar C1(P72), Pinus radiata.

This looks at trace elements Zn, Mn, Cu and Mo on four yellow sand site types.

action in 1979 – plots were thinned to 500 spha.

2.2.3. WP 8/72 – Gnangara F21 (P66)

Aim is to determine the limits of fertilizer requirements for P.pinaster stands on Bassendean grey sands between the time of the early release thinning and the first commercial thinning.

action in 1979 – diameters and some heights were measured in July. Plots were thinned according to treatment, the work finishing in December.

2.2.4. WP23/73 – Yanchep E7(P65)

Aim is the same as for WP 8/72, but this is on Spearwood yellow sands.

action in 1979 – diameters were measured in July and fertilizer treatments applied in August.

2.2.5. YS35 and YS36(1972) – Gnangara J1, G100.

This is a rather complex series investigating the interaction of P.pinaster families with various fertilizer schedules on the range of grey sand soil types. Intention is to eventually publish this result in Silvae Genetica.

action in 1979 – fertilizer treatments applied as per prescription in August.

2.2.6. Starter fertilizer trial, Gnangara J1 (P77)

This looked at a range of commercial fertilizers, including osmocote, agriform tablets, Agras and IBDU pellets to see if the initial growth of P.pinaster could be improved.

some results – after 2 years the heights of seedlings were similar. Superphosphate at 50 gms/seedling was as good as the other treatments.

2.2.7. Gnangara J13 (P73)

This looks at the application of various combinations of P and N fertilizer at age 3, on Havel H type sands.

some results – after 2 years, fertilized plots are 1m taller ($p=0.001$). There was no apparent benefit from the application of N fertilizer.

2.2.8. Pinjar A (P55)

Various combinations of P and N fertilizer were applied to a 21 year old P.pinaster stand on yellow sands, that had been thinned either 1, 2 or 5 years before the fertilizer treatment.
some results - 2.5 years crop tree diameter increment

crop dbhob cm	Time from thinning treatment		
	1 yr.	2 yr.	5 yr.
P only	4.19	4.72	2.65
* P + 150 N	4.31	5.34	2.93
P + 300 N	4.04	5.34	3.51
P + 625 N	4.78	6.24	3.91

* P = 500 kgm superphosphate/ha, 150 N is 150 kgm urea/ha.

2.2.9 - Gnangara B26 (P51)

As for 2.2.8, but on a moist grey sand site in 25 year old P.pinaster thinned either 1 year or 3 years before fertilizer treatment.
some results - 2.5 year crop tree diameter increment (cm.).

~~crop dbhob~~ ~~cm~~	Time from thinning	
	1 year	3 years
P only	2.99	2.59
P + 150 N	3.03	2.96
P + 300 N	2.85	2.99
P + 625 N	2.94	2.70

2.2.10 - Gnangara E44 (P57

Idea is to impose a maximum fertilizer treatment on an area of P.pinaster recently (2 years) thinned to 250 spha. Significance is that the area is adjacent to pumping bores and the water table drawdown will be maximum. We want to follow the growth and particularly the health of the pine crop.

VIII. PINE SILVICULTURE (R. Fremlin, Busselton).

2. W.P. 21/79 - The effect of timing of application of various weedicides on survival and growth of P. radiata in the Nannup nursery - T/O R. Fremlin

Completed project.

Recommendations:
(i) Apply propazine or caragard within 14 days of sowing of pine seed.
(ii) Apply diphenamid 21 days after the sowing of pine seed.
(iii) Caragard to be applied immediately following the germination of barnyard millet, should this occur.

3. Spacing - T/O R. Fremlin

a) 1974 spacing trial - Jarrahwood Compt. 3

Old project.

Following a field trip by operations and research staff on 2nd July 1980 it was recommended that in view of the poor growth and unhealthy appearance, clover be established where practicable. One-way cultivation was achieved in plots planted at 2x3m and 2x4m spacings, whilst two-way cultivation was possible in 3x3m spacings. Clover has been sown and fertilised with a super copper zinc mixture. Measurements of plots prior to this work continue to show better growth on widely spaced plots.

4. Weed Control - T/O R. Fremlin

a) Weed control by cultivation, P77 - Jarrahwood Compt. 1

Old project.

A marked visual response is apparent following inter-row ploughing and the establishment of clover in 1979. Further "spot" weed control will be carried out in Spring. This is primarily aimed at Pultenea reticulata growing in the rows. As a result of this demonstration P.77 and P.78 areas not under clover are programmed for conversion this financial year.

b) W.P. 1/80, Use of Velpar as a means of controlling regrowth of Eucalyptus calophylla

Old project.

Although early indications looked promising, results of the first assessment (3 months after treatment) proved disappointing. 13% of the 0.5m-2.0m class were dead whilst 2% of the 2.5m-4.0m class were dead. However, this poor result may be due to the roots not coming in contact with the chemical because of its (the chemical) placement close to the stem. This theory is supported by deaths of untreated stems being recorded up to 5 metres from treated regrowth. In view of this, for the winter series, treatments were applied at a distance, away from the stem, equivalent to half the height of the plant. Although the effect of velpar on jarrah is not being studied, it appears that it is more susceptible than marri.

c) W.P. 2/78, Agroforestry demonstration area - T/O R. Fremlin

Old project.

D.B.H.O.B. measurements indicate that for selected crop trees in a stand of 200 s.p.h. growth was 60% greater than selected trees in a stand of 750 s.p.h. There was a 40% increase where trees are standing at 375 s.p.h.

d) W.P. 10/75, Grazing studies, Whicher scarp - T/O R. Fremlin

Old project.

No action other than routine fertilising.
Persistant epicormic shoots have developed on a high proportion of trees. This may be a feature of pines growing on clover because of the necessity to prune earlier. A study of ways to control adventitious shoots may be appropriate.

e) W.P. 4/80, Joint Forests Department/Department of Agriculture agroforestry trial - A.D.F.O. R. Moore

New project.

The prime objective is to obtain data on the effect of stand density and pasture fertilisation on tree and pasture growth.

Inter-row ploughing and sowing has been completed. Fencing and construction of the watering system is in progress. Scrub control will be commenced pending results from the velpar trials. Some revision of tree stocking treatments is contemplated. It is envisaged that initial stocking be increased overall to give three levels, vis: 500 s.p.h., 750 s.p.h. and 1000 s.p.h. This change is thought necessary for two reasons. Firstly, from experience, an initial stocking rate of 250 s.p.h. is too low because of poor selection and increased branch size. Secondly, pasture after 5 years under pines planted at 1,700 s.p.h. is still in good condition (No. 7 road). This is in spite of no fertiliser in the last two years.

f) W.I. 9/80, Strip planting of pines as a method of intergrating agriculture and forestry - T/O R. Fremlin

New project.

The hypothesis on which this trial is based relies on (1) close spacing, within the strip, to maintain acceptable form whilst not significantly altering overall stocking and,
(2) wide inter-strip area to allow pasture to persist adequately, more so than can be expected under a normal regime. Strips comprise four rows 3 metres apart with trees planted 2 metres apart within the rows. Inter-strip area is 16 metres. Four species, P. radiata, P. pinaster, P. taeda and P. elliottii have been included.

6. Pruning - T/O R. Fremlin

a) W.P. 16/75, Selective pruning/wide initial spacing

Old project.

A report covering this trial is in progress. The main points to come out of this are:

(i) Loss of dominance was the main factor responsible for reducing diameter growth on selectively pruned crop trees. This loss appears absolute.

(ii) Although diameter growth was initially reduced on crop trees in a stand where all trees were pruned, growth increased to a point, after four years, where standing basal area was equal to that of unpruned crop trees.

7. Thinning - T/O R. Fremlin

a) W.P. 7A/66, Thinning regimes in P.radiata

Old project.

Eight plots standing at 198 s.p.h. and four plots standing at 500 s.p.h. are measured annually. Mean standing basal area for select stems in June 1980 was 1.16m^2/ha for trees standing at 198 s.p.h. and 0.71m^2/ha for trees standing at 500 s.p.h.

8. Arboreta - T/O R. Fremlin

a) W.P. 25/67, Bussell arboretum

Old project.

Three plots were prepared and planted with P. halepensis and P. halepensis var. brutia in June 1980. One of these plots was established as a provenance trial.

An assessment of all coniferous species has been completed.

Pruning of certain species was carried out by Collie division.

b) W.P. 27/67, Asplin arboretum

Old project.

An assessment of all coniferous species has been completed.

c) W.P. 26/67, Meribup arboretum

Old project.

This area has received little silvicultural treatment since establishment. It is hoped to rectify this during the current financial year. Some species have failed whilst others have shown surprisingly good growth. An assessment similar to that carried out in the other arboreta is in progress.

Data from the above three arboreta will be collated into a progress report.

PINE SILVICULTURE (T. BUTCHER, WANNEROO)

2.1 Establishment

2.1.1. - Pinus radiata pilot plots (P72) Moore Rv. A4.

Investigation of thinning levels and P and N fertilizer on development of P.radiata at the northern end of SF.65. Facterial design.
action in 1979 - neutron probe measurement of soil moisture.

2.1.2. - WP16/69 Mt. Cooke (P69)

This looks at the establishment of pine species (P.radiata, P.pinaster, P.elliotti) on a former dieback site. Testing sites include a saline seep. Cultural treatments are mounding and ploughing and various combinations of N and P fertilizer. The interaction of species and fertilizer duration effect is significant. Sites are not dissimilar to the sunklands sites and results should be applicable.

M. Stukely is currently writing this for publication.

2.1.3. - Pedigree P.pinaster spacing (P74)

Investigation of the development (tree growth, form, branching) of P.pinaster and native shrub regeneration in pine stands at planting densities from 150 through to approx. 1400 spha. Trials are on a yellow sand at Yanchep and dry grey and moist grey sands at Gnangara.

2.1.4. WP18/73 Yanchep E6 (P65)

This study has been completed and results are being published in Australian Forestry (in press).

Title - The competitive effect of pine regrowth and woody weeds on the growth of Pinus pinaster.

abstract - Sixteen parent of usable wood volume was lost through competition, principally for a limited soil moisture resource. Regrowth from pine stumps following thinning to waste was the main form of competition. Removal of regrowth regulated the water use over a longer period and as a consequence, increased the tree growth. Woody weeds were not detrimental to the growth of P.pinaster.

2.3 Pine stand management

2.3.1. - WP48/66, large P.pinaster pilot plots.

A report on this has been published as AWRC technical paper 42 (1979).

Title - Management of Pinus pinaster plantation on the Swan coastal plain for timber and water yield. 60pp.

action in 1979 - the number of dead trees were recorded in September. There were only a few scattered new deaths at the north block while new deaths at the central and south blocks were extensive. In some cases more than 20% of the tree numbers in the unthinned treatment died in 1978-79.

2.3.4. - WP 20/65, Gnangara A69 (P46)

P.pinaster basal area thinning series on grey sands.

action in 1979 - plots were thinned to prescribed levels in April 1979. Fertilizer will be applied in 1980, the base level to be applied by aeroplane.

2.3.5. - WP 54/66 Yanchep A (P52)

P.pinaster basal area thinning series on yellow sands.

action in 1979 - plots were thinned in July to prescribed treatment levels. Fertilizer treatment was applied to appropriate plots in August.

Dendrometer bands on the 4 key plots were read at monthly intervals.

Needle moisture sampling (hourly over a 24 hour period) was carried out on single trees in plots 9 and 10 December. The same trees will again be sampled in February and April 1980.

2.3.6. - Pinjar (P71)

This looks at the height of low pruning and effect on tree increment.

some results - both height and diameter increment were similar 1.5 years after a 6 year old 4m tall P.pinaster stand was pruned to 1m, pruned to 2m or left unpruned.

2.5 Legume cover crops

Two trials were planted by Gordon Chester in 1979.

2.5.1. - Legume pasture on yellow sands

Five sub-clovers and 2 medics were planted under the thinned P69 area of the Mullaloo orchard. All clovers did well producing a dry weight biomass between 750-1200 kgm/ha. Medics were poor and had a biomass of less than 370 kgm/ha. Soil N levels were recorded.

2.5.2. - Lupins

New Zealand blue lupins were sown immediately prior to the planting of P.pinaster in the P79 Pinjar area. Several sowing rates were tried on a 2.4ha area.

Trials will be planted in 1980 in 3 year old pines, using several lupin varieties.

IX. CONSERVATION PROJECTS (O. W. Loneragan.)

W.P. 17/72 CONSERVATION OF FLORA AND FAUNA RESERVES (Under Forests Act) - O.W. LONERAGAN

1. *Publications - System 6 Maps and Forest Focus 22 have been published. The System 6 Atlas is at the Government Printer.*

2. *The Management Plan of Cocanarup Reserve has been revised and a control and (1985) review section added, by Regional Leader (Planning). Propagation of sandalwood will be considered as one of the alternative priorities in development of regulated utilisation of forest produce.*

3. *Dryandra (L.U.M.P.) is next on the list for outline of environmental features - climate, landform and soils, vegetation and hydrology.*

4. *Sandalwood research - Findings from raising and propagating sandalwood in all trials (1974-80) show that*

   (a) *satisfactory roots of host plants is critical for establishment and survival in the field;*

   (b) *funds for fundamental reserach is a first priority before operations will be understood and applied successfully;*

   (c) *concurrently, however, funds have been limited to raising nurse-host plants in the nursery and to extending small trials into the field at Narrogin (W.P. 21/74).*

5. *Sandwood Research and Management 1980 has been written; ready for editing and publication. The previous paper 'An Outline of the Sandalwood Industry, 1974' received restricted distribution and the author (yours truly) did not receive a copy. (The text could have been published in any event, simply by excluding tables 8, 10, page 16 and reducing the summary to the first 13 lines).*

6. *Sandalwood Survey 1980 - J. Williamson. From a pilot survey in April 14-18, techniques are being established (using air photos, Beard's vegetation maps, tally traverses and plot measurements) for assessment of sandalwood resources and regeneration areas on pastoral stations. Two assessors will work for 3 months on 20 stations. The assessors will be visited at Kalgoorlie in September (8-12) and liaison continued into November.*

RECOMMENDATIONS:

(1) Scientific MPAs

   (a) *Mundlinup Plots (between York Road BY63 and locs 455, 325, BT64);*

   (b) *Cobiac Fire-Protected Plot (BQ/BR69) have been recommended by Chief of Division, to be followed up by C of D Northern REgion.*

(2) Liaison with Museum Anthropology for protection of historical sites at Dryandra has been recommended by Superintendent to be followed up by the writer, O.I.C. Narrogin and F/R R. McAlinden.

W.P. 18/72 - GENETIC RESOURCES - O.W. LONERAGAN

2. Liaison is being maintained

   (a) with extension serivices, who continue to update field guides for Eucalypts;

   (b) with concerned authorities, who continue to locate and define rare species.

3. Funds and requirements for maintaining self-sufficiency in seed production of commercial rare species need discussion with O.I.C. Narrogin.

W.P. 5/77 - VARIABILITY OF W.A. EUCALYPTS - Liaison

1. The range of variability of species in the Yalanbee plot has been increased by C.S.I.R.O. Liaison on performance in controlling movement of water and salt in agricultural areas needs to be maintained.

2. Jarrah seedlings, raised at Hamel from seed collected from 12 provenances have been added in 1 plot of plantings by Mr John Bartle in George Block.

3. A field guide for describing and identifying eucalypt seedlings in the field requires to be developed.

W.P. 21/74 (NARROGIN) - SANDALWOOD SEEDLINGS RAISED THIS YEAR WITH JAM NURSE PLANTS at Narrogin have been planted out in 6 vegetation types in Dryandra. Treatments include fenced and unfenced; planting in lines, furrowed and not furrowed; also without fertiliser and with 50g Osmocote 3 weeks after planting. Surviving seedlings will be enumerated, before and after summer. (Previous years' results have been recorded in the Annual Report 25/6/80).

REGENERATION PLOTS (KALGOORLIE)

W.P. 17/74 Kambalda railway line borrow pits
W.P. 19/75 Eucalypts
W.P. 12/75 Mulga
W.P. 3/77, 4/77, 14/78 Sandalwood

Leaf flush, blossom and seedset, requires monitoring after recent rains. This was commenced as possible at Kalgoorlie, only for sandalwood (W.P. 14/78).

I TREE BREEDING AND SEED PRODUCTION.

(T. BUTCHER, WANNEROO).

1. River valleys of the Darling Scarp.

The Darling Scarp forms the South Western edge of the Precambian Western Shield. Rivers have cut steep sided valleys through the Scarp and fertile soils have developed on the freshly exposed granitic and basic rocks.

Early species trials at Mundaring and other small plots along the Darling Scarp to Pemberton showed P.radiata as the outstanding species. Later arboreta were established at Nannup (Asplins) and Collie (Bussells) over the period 1967-72 and looked at a wide range of coniferous species. Although we have several progeny trials of P.pinaster on the river valleys they are usually on sites considered marginal for P.radiata; most of the testing is concerned with the radiata species.

1.1 Pinus radiata

1.1.1 between provenance variation.

Pinus radiata has a very limited natural distribution and it is considered that most of the plantations originate from the centre of the range, at Monterey. As such only part of the variability existing in the natural stands is represented. In one of the few collections, planted by Forde in 1964 on a high quality site in New Zealand, little difference was found in growth rate between the three mainland populations (Burdon & Bannister 1973)

1.1.1.1 P72 - Asplins arboreta Nannup, area 0.8ha

objective - establish gene sources of P.radiata provenances from Ano Nuevo, Monterey, Cambria, Guadelupe Island and Cedros Island, on a high quality site.

Seed was collected from selected trees in the native stands by Prof. Libby in 1966.

some results - at age 5 years

provenance	n	%++	%+	height
Cedros Is.	124	38	88	6.37m
Ano Nuevo	170	38	88	6.27
Guadelupe Is.	371	32	82	6.84
Monterey	194	31	77	6.94
Cambria	431	26	81	6.47

n is the number of trees assessed and %++ is the percentage of trees with above average tree form and %+ is percentage of trees of average to above average tree form.

1.1.1.2. P72 - Bussells arboreta Collie, area 0.5ha

objective - establish gene sources of P.radiata provenances collected from native stands at Ano Nuevo, Monterey, Cambria and Guadelupe Island, on a marginal P.radiata site.

.../2.

1.1.1.2. (Cont.)

action in 1979 - plots were thinned in July to retain the best formed 60 trees/plot.

1.1.2. within provenance variation

Some of the older areas of our plantations have been searched for plus trees. These include the Mundaring (Greystones), Grimwade, Margaret River, Collie (Mungalup & Bussells), Harvey (Myalup and McLarty) and Pemberton (Pimelea). We have used a multi-trait selection. The selection intensity has been very high usually of the order of 1 plus tree per 30ha. The selection characters have been straightners and verticality of the tree bole, vigour (volume), and uniformity and balance of the tree crown.

Local
~~Loed~~ plus tree selections have been grafted and together with plus trees from the eastern states, planted in seed orchards at Gleneagle and West Manjimup to form this departments elite seed source. Progeny tests were also established to evaluate the parent trees in the orchard. Very little control crossing has been done; seed collected from parents in the orchard has been our testing strategy.

1.1.2.1. P69 - Bussells F9, area 1.4ha

objective 1) assessment of A.C.T. selections in the W.A. environment for rogueing of seed orchards.

2) study of genotype x environment interaction.

This is part of the 'A.C.T. co-operative progeny test' and has been planted in S.A., N.S.W., Vic., Qld., A.C.T., Uruguay, Chile and Venequala as well as in W.A.

some results - Certain families have been found to perform consistently over all of the environments while the performance of others has been variable. Parent 12038 is consistently good. In this test it was close to, and at times the best for bole straightness, branch angle, branch thickness and diameter growth.

This trial was extensively damaged by cyclone Alby in 1978.

action in 1979

Foliar samples were collected from 10 families in August 1979 and sent to Canberra for analysis as part of our role in the 'co-operative progeny test'.

1.1.2.2. P71 - Kirup B28, area 4.2ha.

objective - 1) assessment of A.C.T., S.A. and Victorian families on a high quality site.

2) investigation of genotype x environment interaction.

some results - Trees were measured for diameter and assessed for tree form, branch angle and branch thickness in 1978, at age 7 years. Some good parents were identified.

eg. 50015 - small flat angled branches, vigorous and average straightness;

.../3.

1.1.2.2. (Cont.)

50006 - very straight, medium flat angled branches and average vigour;
12038 - very straight, small medium angled branches and vigorous;
12187 - straight, small flat angled branches and average vigour;
30054 - small flat angled branches, straight and average vigour;
30007 - small flat angled branches, straight and average vigour.

action in 1979 - the 5 tree line plot was reduced to 2 trees and the retained trees high pruned to 4.5m. Work was completed in April.

1.1.2.3. P71 - Bussells F14, area 4.2ha
objective - assessment of A.C.T., S.A. and Victorian families on an average quality site and the investigation of g x e interaction.

action - this trial will be measured for diameter and form assessed in February 1980.

1.1.2.4. P72 - Kirup C.6, area 4.6ha
objective - 1) To test the major international selections of P.radiata on a high quality site.
2) To establish a broad base of genetic selection to provide parent material for a second stage orchard program.
3) To evaluate g x e interaction.
4) To utilize the progeny area as a seedling seed orchard.

some results - There are 250 families in this test so there can be no meaningful discussion in a paragraph. Some interesting comments are -
parent 60017 - particularly vigorous, is at or near the top for diameter growth in each of the 4 sub-trials of 72 families. Stem is straight but it has large branches at a moderate to high angle.
parent 50048 - a super tree from South Australia and doing very well here; very vigorous with moderate size flat angle branching and is straight.
parents 50015 and 50266 - show same characters as the P71 test.
parent 30011 - straight with good branch characters and average vigour.
parent 20055 - vigorous, straight and with average branch size and angle.

action in 1979 - the best tree in each of the 3 tree plots was high pruned to 5m. Thinning of all other trees is still proceeding.
Flowering has been prolific in these 7 year old pines and a heavy cone crop will mature in 1980. The stand will now be managed for seed production.

1.1.2.5. P72 - Grimwade S18, area 5.1ha
objective - The second part of the International gene pool project and is established on an average quality site.

.../4.

1.1.2.5. (Cont.)

action in 1979 - trial was aerially fertilized with Agras in May. Diameters and tree form are currently being measured.

Following analysis of data, this area will be thinned and then managed as a seedling seed orchard.

1.1.2.6. P74 - Kirup C7, area 1.7ha.
objective - evaluation of local plus tree and promising eastern states selections on the W.A. afforestation site types -
1) Blackwood Valley
2) Sunklands
3) Coastal plain.

This should give valuable information on g x e interaction and an index for culling of the Manjimup orchard.

action - This trial had severe attach by rabbits. Four blocks can be salvaged and trees will be measured in March 1980.

1.1.3.1. - P73, WP5/72(A) Kirup C7, 1.9ha
objective - to evaluate the potential of improved seed in the establishment and management of Pinus radiata plantations.

This is a factorial designed trial -

factor 1(2) - initial spacing
level 1 - planting of 1100 spha
2 - planting of 2000 spha
factor 2(4) - seed quality.
level 1 - orchard (Gleneagle) seed
2 - Grimwade seed production stand.
3 - crop tree (SN1899) Mungalup
4 - routine unselected, Mungalup 1749 and Bussells 3285.
factor 3(4) - replications
levels 1 to 4
factor 4(3) - location
level 1 - Kirup C7, blackwood valley, pasture site
2 - Grimwade S18, former forest site
3 - Yanchep C23, yellow sand

action in 1979 - October, all trees were diameter measured and subjectively assessed for tree and branching form. 150 spha were high pruned to 5m and plots were thinned (comm.) to retain 500 spha on plots. This is continuing.

some results

Age 6	orchard	stand	crop	routine
stem straightness - %+	52	42	50	50
" " %++	11	7	6	7
branch thickness - %+	87	87	85	88
" " %++	13	9	7	14
branch angle - %++	29	24	27	27
No. forks - %	6	9	8	10
dbhob cm (1100)	17.8	17.0	17.5	17.3
(2000)	15.2	14.6	15.2	14.7
baob m^2/ha (1100)	29.4	26.1	27.6	27.2
(2000)	33.6	34.6	36.6	32.9

Subjective ranking from 1 to 5 with 1 the best. %+ is class 1+2+3 trees and %++ is class 1+2 trees.

1.1.3.2. - P73, WP5/72(B) Grimwade S18, 1.9ha
action in 1979 - aerial spreading of 500 kgm Agras/ha in May 1979.
Trees to be measured for diameter in January 1980.

2. Donnybrook Sunklands

Plantings commenced in the early 70s, mainly with P.radiata and with some P.pinaster, P.taeda and P.elliottii. The change from trial scale to operational plantings came in 1977 and this could increase to an annual planting of 2000 ha in 1981.

The sunklands is a real problem site. The lateritic sands have a poor soil structure as well as being of poor fertility and strong nutrient fixing ability. In addition, watertables rise close to the surface and Phytophthora cinnamomi is prevalent in the area.

The first stage of an afforestation programme is species testing. It is equally important to run this test at least equivalent to the length of one third of the rotation. This gives a fair chance that changes in the climate (drought, flooding, wind), silvicultural treatment (thinning, fertilizer) and disease susceptibility are encountered during the test.

An arboretum was not established in the sunklands, but the arboretum planted between 1969-72 at Perup on very similar soils meets this requirement. This arboretum contains all of the probable pine species as well as some eucalypts. Ray Fremlin is currently establishing growth plots and will soon report on the 10 year growth of species.

Having selected the species, the next stage in a tree introduction program is to exploit the variation within a species and ultimately the variation within the provenance. Characters we will be looking at are tree and branch form, vigour or growth rate, stability on shallow soils, low nutrient demands, response to silvicultural treatment and tolerance to Phytophthora cinnamomi. Most of these characters require evaluation at the field site but glasshouse pot trials can help in the screening process. Examples of this are the studies of Dr. Hopkins and Frank Batini. Hopkins (1967) investigated the drought tolerance of P.pinaster provenances and P.radiata in a pot study and his results were substantiated after the 1976-77 drought. Batini (1978) used a pot trial to screen seedlings of P.pinaster for resistance to Phytophthora cinnamomi.

action in 1979

objective - screening of parents in the P.radiata breeding population for resistance to Phytophthora cinnamomi.

Eighteen parents were screened in the pot study. Treatment levels were inoculation with the dieback fungus and waterlogging. The experiment had a factorial design and used 4 replications. Pine seedlings were grown for 9 months before inoculation.

some results - Sixty days after inoculation, mortality ranged from 27% for parent 60017, 9% for parent 60001 to zero mortality on 5 parents. The average mortality rate of the affected parents was 6%. Recovery rate of the fungus when plating was 100% on each of the dead seedlings sampled. Height growth of the inoculated seedlings was significantly less than the control series. There were no deaths in the control series. (to be published in 1980 as a Research Paper)

Strategy is to repeat this pot trial in the field in 1981. Both healthy and dieback sites on the sunkland will be planted.

All parents in the breeding population will be screened by pot trials for resistance to Phytophthora cinnamomi.

.../2.

Species trials and arboretum inspection have narrowed the choice of species to Pinus radiata, P.pinaster, P.taeda and P.elliottii. We have been looking at variation in the first three mentioned species.

2.1 Pinus radiata

2.1.1. between provenance

We have two strong reasons against the development of a P.radiata monoculture for the sunklands. The first is the inhospitable site and regular attention needed to keep the P.radiata in a healthy condition and the second, is the very narrow gene base from which all plantations have originated. A solution to this is the choice of species to fit the particular site conditions; this is the departments' strategy.

Another solution, or extra insurance can be made by exploiting the total variability that is in natural populations of P.radiata. By increasing the genetic variability, the threat of serious outbreaks of diseases and pests is reduced.

2.1.1.1. P79 - Jarrahwood A6, area 2.9ha.

objective - 1) identify the best Californian sub-population.
2) provide a resource for selection of plus trees.
3) provide a long term and variable stock of genetic variation in many traits, particularly in possible resistance to diseases and pests.
4) compare the performance with stock from the West Manjimup orchard.

action in 1979 - This trial was planted in June 1979, it used 13 of the Californian mainland sub-populations collected by Ken Eldridge (CSIRO) in 1978. The trial design is a 14 x 6 randomized block with 25 trees per plot at a spacing of 3.5 x 3.5m.

2.1.2. within provenance

A limitation to the planting of P.radiata on the sunklands is the lack of a proven genetic seed source adapted to this environment. No large areas of P.radiata have been grown in W.A. on similar sites. This has made the task of providing an improved seed source more difficult. As there are no plantations from which to make the selection of adapted trees, it has been necessary to establish a base population from which adapted selections can be made. Our strategy is to establish a breeding population and seed production units concurrently. The breeding population is to find parents most suited to the sunkland environment leading to the establishment of orchards from these parents. In the interim, by heavy culling selection and fertilizer, seed with some adaption to the site will be collected from the seed production units. This will supplement our other sources of seed.

2.1.2.1. P74 - Jarrahwood A3, area 1.7ha.

objective 1) establish a breeding population.
2) evaluate some of the W.A. plus tree selections.
3) compare orchard and routine sources to calculate gains.
4) compare with adjacent P.pinaster progeny trial.
5) evaluate the genotype-environment interaction; similar trials were planted at Yanchep (Spearwood sand) and at Kirup (Blackwood Valley) in the same year.

2.1.2.1. (Cont.)

some results - Family differences in height at age of 3.5yrs were significant (p=0.01). The best family measured 4.7m while the smallest was 3.5m; both the orchard and routine seed were 3.8m tall and were ranked 26/28 and 27/28 respectively. The average height of the 25 pedigree families (collected from Gleneagle orchard) was 4.2m which is significantly above that of the orchard treatment; this could be a site effect as at Yanchep the mean height of the orchard treatment was 4.0m as compared with 3.9m for the average of the 14 pedigree families.

An interesting result was the good performance in height growth of some of the outstanding Australian parents.
eg. 50015, 80055, 30011, 12038, 30055.

Survival was 94% for the P.radiata and 99.5% for the P.pinaster.

action in 1979 - the P.radiata looked most unhealthy and on the point of collapse at an inspection in July 1979 while the pinaster trial looked a picture of health. This was despite the October 75 application of 300kg/ha rock phosphate plus 200kg/ha urea.

Heights and diameters of blocks 1 and 7 were measured in August 1979, prior to the aerial spreading of Agras fertilizer. Results are tabled under section 2.2.1., and show similar diameters and a converging difference in height growth for the two species.

2.1.2.2. P76 - Jarrahwood A3, area 5.3ha
objective - addition to the breeding population and evaluation of N.S.W. plus tree selections on the sunkland site.

Three trials were planted from pedigree seed provided by the N.S.W. Forests Commission. The N.S.W. selections, in the Manjimup orchard, have excellent tree and branch form and are of particular interest to us. A similar trial is planted on Spearwood sands at Pinjar.

action in 1979 - area was basal sprayed for scrub control and aerially spread with Agras fertilizer in September 1979. This series will be measured for height growth in February 1980. Interesting site differences in growth and species interactions are expected.

2.1.2.3. P77 - Jarrahwood A1, area 0.8ha
objective - enrichment of the sunkland breeding population by inclusion of control pollinated families from the Eastern Australian States.

2.1.2.4. P78 - Jarrahwood A2, area 1.4ha
objective - enrichment of the sunkland breeding population by the inclusion of control pollinated families from the A.C.T. and W.A.

.../4.

2.1.2.5. P79 - Jarrahwood A6, area 3.3ha
objective - addition to the breeding population by the planting of W.A. pedigree families.

action in 1979 - This randomized block trial containing 28 families replicated on 12 blocks was planted in June 1979 using o/r stock raised at the Wanneroo research nursery. Treatments include the Australian control seedlots as well as Manjimup orchard, Grimwade stand and SN 1899 seed.

2.1.2.6. P80 - Jarrahwood, area 2 ha
objective - addition to the breeding population and evaluation of families made from selections on low quality sites at Grimwade.

action in 1979 - the 30 families for this trial were sown in the Wanneroo research nursery in September 1979. Approx. 500 seed of each family were sown.

2.1.3. Sunkland seed production units

2.1.3.1. P74 - Jarrahwood A3, area 10ha
objective - to establish a seed production unit from seed collected from the Gleneagle orchard. Stand will be managed to optimize seed production.

action in 79 - seed area was pruned to 2m and thinned from 2500 to 420 spha. Agras fertilizer was aerially applied in September 1979. Flowering (5/tree) was noted in November so that a cone collection in 1981 is feasible.

2.1.3.2. P77 - Jarrahwood A1, area 35ha
objective - The establishment of seedling seed stands with wide genetic base by the use of bulk collections from P.radiata seed orchards. Stands will be managed to optimize seed production.

Seed sources used were W.A. - Manjimup orchard, W.A. - Gleneagle orchard, W.A. - Grimwade seed stand, S.A. - Southeast orchards, Vic. - Daylesford orchard, N.Z. - orchards, N.S.W. - Green Hills orchard, A.C.T. - Tallaganda orchard, Tas. - AFH orchard, and South Africa - Clonal mixture. Orchard block size is 3.5ha

2.1.3.3. P80 - Jarrahwood, area 15ha
objective - addition to the seedling seed stands by planting of seed sources from
a) Bussells clone bank - plus tree selections made in Victoria on a failed P.radiata site.
b) A.C.T. - Blue Range orchard
c) Vic. - Balook and Saxtons orchards.
Stands will be managed to optimize seed production.

action in 79 - seed sown at Gnangara and Nannup nurseries.

2.2. Pinus pinaster

2.2.1. between provenances

early plantings at Ludlow have demonstrated the superiority of the Leirian provenance. This has been statistically tested with the P74 intra and inter-provenance crossing trial.

2.2.1.1. P74 - Jarrahwood A3, area 1.3ha

objective - intra-provenance crossing of Leiria strain and inter-provenance crossing of Leiria with Landes and with Corsican strains. Aim is to evaluate the degree by which desirable characters are transmitted.

The same trial was established on grey sands at Gnangara and yellow sands at Yanchep. So far only height have been measured. It was interesting to note the vigour of the Leiria x Landes cross. French workers have been informed of this and they are now using some of our better parents to cross with their Landes for planting to evaluate for frost tolerance. Our interest is with the Leiria x Corsican crosses to see if the tree form and branching of the corsican strain is transmitted.

action in 1979 - Agras fertilizer was aerially spread in September 1979. All trees were then low pruned up to a height of 2m.

2.2.2. within provenances

Families from the breeding population have shown no genotype-environment interaction on W.A. sites planted in 1968 and 1969. Growth was relative regardless of site i.e. the best performing families were tops on good sites at Collie, Hamel and Yanchep and poor sites at Gnangara, Mundaring and Northcliffe.

2.2.2.1. P74 - Jarrahwood A3, area 3.6ha

objective - the establishment of a pinaster breeding population on the sunklands and to evaluate the potential of improved pinanster.

This trial contains 80 families and includes most of the parents used in the Joondalup orchard such that the average performance should be indicative of orchard growth. It also has routine and orchard pinaster treatments. The trial is planted alongside the P74 P.radiata progeny trial allowing comparisons between the species. A duplicate trial was also established on grey sands at Gnangara to examine environment effects.

some results -

height at age 3-5 yr (part data only)

Family	Sunkland			Gnangara		
	Rank	MRS	Height	Rank	MRS	Height
E50xE33	1	.01	3.83m	1	.01	4.10m
E50xE29	2	.03	3.63	4	.05	3.78
E40xE154	3	.04	3.62	15	.19	3.63
E45xE29	4	.05	3.58	36	.45	3.50
E47xE2	5	.06	3.49	27	.34	3.56
E19xE29	13	.16	3.30	2	.03	3.87
orchard	58	173	2.97	31	.39	3.53
routine	77	.96	2.72	80	1.00	2.99

.../6.

Data of top families is shown. In this trial the environment has some effect in the family performance at the two sites but it is not dominating. Good parents (E50, E29, E154, E33) are high in ranking at both sites while poor parents (E34, E28, E49, E2) are low in ranking. The difference between the orchard stock and routine was .3m (9%) at the sunkland and .5m (18%) at Gnangara. The mean height of all pedigree families was 3.1m at the sunkland and 3.5m at Gnangara; this is an increase over the routine seed source of 14% and 15% respectively.

Mean height of the adjacent P.radiata progeny trial was 4.2m.

action in 1979

The P.radiata progeny trees appeared chlorotic and generally unhealthy at an inspection in July 1979. Conversely the P.pinaster progeny looked strong, with long needles and a healthy colour and appearance. This striking difference prompted the measurement of adjacent blocks as they were scheduled for re-fertilization in September.

Data for blocks	P.radiata (1,7)	P.pinaster (5,10)
Height at 3-5yr	4.0m	2.9m
Height at 5yr (8/79)	6.2	4.8
increment	2.2	1.9
Diameter at 5yr	7.70cm	7.14cm

Both the pinaster and radiata trials were fertilized with Agras, from the air on September 1979 and then low pruned to a height of 2m.

2.2.2.2. P76 - Jarrahwood A3, area 1.0ha

objective - a) establishment of seedling seed orchards for provision of a high quality seed source.
b) establishment of a diverse, pedigree breeding population that will form the platform for the second generation programme.
c) estimation of g.c.a. and parental breeding value.
d) measure of gains by comparisom with standard crosses.
e) estimation of environment-genotype-interaction.

This seed was available from the random pair matings carried out in 1970-74. In brief, 124 parents in the breeding population were crossed at random creating a unit of 62 un-related families. This was repeated three times. These unrelated families have been planted in trials which are designed to form future seedling seed orchards.

action in 1979 - Trial area was basal sprayed to control eucalypt coppice and aerially fertilized with Agras in September 79. Trees will be measured for height growth in February 1980.

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2.2.2.3. P77 - Jarrahwood A1, area 0.6ha
objective - establishment of pedigree crosses of P.pinaster (South African plus tree selections) and evaluation with standard crosses of the W.A. program.

This trial has a special significance in light of the substantial gains found in the Gnangara P75 series. Height growth was up 17% on the W.A. standard families.

2.2.2.4. P78 - Jarrahwood A2, area 1.5ha
objective - extension of the breeding population of P.pinaster on the sunklands through the planting of random pair matings; this will form the basis for future generation breeding as well as being designed to form a seedling seed orchard.

2.3 Pinus taeda

This is another species having potential on the sunklands. It's growth compared to radiata pine is still impressive even where the radiata had received more fertilizer and silvécultural treatment.

Carlyle Franklin, an eminent forest geneticist from America, looked at the sunklands in 1978 during his stay in Australia. He was impressed with the taeda but felt there could be better provenances. He arranged the collection of taeda seed from a range of localities which he considered best suited our sunkland site. Pinus serotina seed was also collected from 4 localities covering the range of the species. Pond pine is closely related to loblolly and found under natural conditions on the very wettest of sites.

action in 1979 - 6 provenance lots of Pinus taeda and 4 Pinus serotina were sown into tubes in September 1979. Standard seed sources now used in planting of the sunklands were also included in the study viz. P.radiata - ex West Manjimup orchard, P.pinaster - ex Mullaloo orchard and P.taeda - ex Queensland orchard. 400 tubes were sown. Seedlings will be planted out in a randomized block design on a wet flat and slope above a flat, sites at the sunkland in June 1980.

2.4 Eucalyptus globutus

The Tasmanian blue gum is one of the most widely distributed plantation eucalypt species in the world. The wood of globulus is mainly used for production of paper pulp. Despite its commercial importance as a plantation species, as well as the very limited nature of original collections, no large scale provenance trials have ever been established.

The Tasmanian Forestry Commission collected from 20 provenances for Tasmania and the surrounding islands (Euc. globulus) and mainland Australia were collected for E.globulus (1), E.bicostata (3), E.pseudo globulus (2) and E.maidenii (4). A single E.globulus seed source was collected in Portugal.

Eucalyptus globulus has been extensively planted in W.A. in the past and there is potential for this species on some of our sites. Keith Orme has provided us with seed from his collections. Provenance and species trials will be planted out in 1980. Sites to be planted are -

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1. Sunkland
2. West Manjimup, adjacent to nursery
3. Bussells Arboretum
4. Wellington catchment

action in 1979 - approx. 1000 seed of each provenance were sown in seed trays at West Manjimup nursery in November 1979. Seedlings are to be pricked out into 500 jiffy pots/provenance in January 1980.

3. Coastal Plain

Quarternary deposits mantle much of the surface of the Perth Basin and are up to 75m thick in some areas. The most widespread deposits are laterite and associated eluvial sand, coastal limestone and associated dune sands, lake and swamp deposits, alluvium and colluvium.

The areas of afforestation concern are the dune and coastal limestone sands. Simply, the Spearwood dune sand is a covering of variable depth yellow-brown sands on limestone. Calcium has been removed from the profile by continued leaching and deposited as the underlying limestone. This series has a high relief and a water table usually 20-30m from the surface. Continued leaching has removed the iron from the profile and modified the surface relief. This series is referred to as the Bassendean dune sands; water tables are usually close to the surface.

Our planting is on the northern Swan coastal plain, based on the Wanneroo division and in the south based on the Harvey division.

Intensive early testing has shown P.pinaster as the most suitable species for the strongly leached sands of the Bassendean series. On the Spearwood dune sands and with fertilizer ammendment, P.radiata has been found more suitable in the south but the more severe climatic conditions in the north favour P.pinaster.

3.1 Pinus pinaster

Provenance trials have shown the Portuguese (Leirian) race as the most suitable. This race has superior volume growth, reasonable stem quality and branch characteristics, high basic density and tolerance to drought conditions.

A breeding programme for Leirian P.pinaster was implemented in 1957. The improvement of stem form was set as the major objective of the programme while the current level of vigour was to be maintained.

Plus trees were selected in local plantations and also in the native Portuguese stands. A multiple-trait selection index was used such that plus trees had to be outstanding for tree form, vigour and crown characters.

We have 81 statistically designed progeny tests covering an area of 135ha. These have been planted during the period 1965 to 1978 on a diverse range of sites. A range of genetic crossing designs have been used and the first generation breeding population we have established is of a particularly high standard.

Objectives of the program have been achieved. Substantial gains in tree straightness, finer branching and tree vigour have been reported. Further gains in branch character, tree vigour and stem straightness from a second generation are expected.

The total program is under review for publication. Based on results and calculated heritabilities of characters, future gains will be calculated to help form objectives and strategies for the next phaze.

3.2. - Pinus radiata

3.2.1. - within provenance

3.2.1.1. P74 - Yanchep C23, o.7ha

objective - evaluation of W.A. parents and some of the best Australian selections on yellow sands.

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some results - age 3.5yr, family heights ranged from 4.1m to 3.3m. The pedigree mean height was 3.9m; orchard treatment was 4.0m.

3.2.1.2. - P76 Pinjar B32, 3.5ha

objective - evaluation of N.S.W. selections on yellow sands.

action - measure height in February 1980.

4. Seed production and supply

The department is engaged in the large scale planting of three species. Planting in 1978 involved 2254ha of Pinus radiata, 556ha of P.pinaster and 1361ha of Eucalyptus diversicolor. In addition there were ha of P.radiata private plantation established. Our responsibility is to ensure a continuing supply of the highest genetic quality seed is available. Without going into broad detail, our strategies for the pine species are -

4.1 Pinus pinaster

4.1.1. pre-orchard (1944-1971)

All seed from uncontrolled collection in the forest of Leiria - Portugal with some supplemental local collections.

1 kgm seed gave planting stock for 5ha, requiring 200 kgm seed for a 1000ha planting program.

4.1.2. clonal seed orchard (1972 -

4.1.2.1. Joondalup orchard (10.5ha) was established in 1963-64 mainly using grafts of local selections. The first collection was in 1969 SN5008) and yielded 49 kgm, increasing to 70 kgm in 1970 (SN5020) and peaking to 257 kgms in 1971 (SN5047).

1 kgm seed gave planting stock for 9.5ha. During the 1000ha planting (1140 spha), the annual seed requirement was 105 kgms.

Seed quality was upgraded by the removal of the lower ranking parents in 1974-75. The last collection made in this orchard was in the year 1976.

1.2.2. Mullalloo orchard (11ha) established in 1969-72 with grafts of the best local and Portugal selections. First collection was in 1975 (SN5072) yielding 24 kgm, increasing to 77 kgm in 1976 (SN5084), 110 kgm in 1977 (SN5088) and 149 kgm from three quarters of the area in 1978 (SN5096).

Current management strategy is to plant 500ha per year at a stocking of approx. 625 spha. 1 kgm of seed is then required for the planting of 17ha. Annual seed requirement is about 30 kgm.

Cone collection every year is no longer warranted. We have built up a seed reserve because of present problems in the area. These are the rapid development of the Joondalup regional centre, and the total loss of the 1979 crop due to cockatoos.

The 1969 and 1970 planted area was thinned from 96 to 50 of the better clones in 1978. In 1979 various clover varieties were established under the thinned orchard to increase the site fertility; this is still under investigation.

1.3 post-orchard

Extensive seedling seed orchards have been established on both the coastal plain and sunklands over the 1976-78 period. This is the random pair matings series and ensures the maximum heterogeneity within our breeding population. Currently, they are being managed as progeny tests but they have been designed for use as orchards.

Second generation programs have been postponed awaiting breeding strategies and guidelines. This will necessitate the demonstration of likely future gains and the economic analysis of this.

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4.2. Pinus radiata

4.2.1. pre-orchard

4.2.1.1. period to 1968 - seed requirement was met by uncontrolled collection in South Australia and New Zealand. This was undesirable both as regards the quality of the seed and the reliability of supply.

4.2.1.2. period 1968 to 1977 - interim period between the establishment of our seed orchards and production. Seed was available from specially managed seed production areas.

The first of these was established in an old stand of exceptionally well formed trees in the Grimwade plantation. Cone collection was by felling of the seed trees. A single seed tree on the average has produced 80 cones yielding o.17 kgm of clean seed and sufficient seedlings to establish 3.5ha of plantation at 3.5 x 2.5m spacing. This source of seed is now largely eliminated.

Supplementary to the Grimwade seed stand, seed has been collected from second and third thinnings in better quality stands at Grimwade and Mungalup. In 1974 collection was mainly from this source, extending the life of the seed stand.

More recently, young seed production areas have been developed in SN1899 stands at Grimwade, Mungalup, Myalup, McLarty and Nannup. This strain has demonstrated exceptional form, branching habit and vigour on this range of W.A. sites.

4.2.2. orchard

4.2.2.1. Gleneagle orchard (4.4ha), planted 1965-66.

The first cone collection was made in 1971 yielding only 2 kgm seed. This was used in the tree improvement evaluation trial. Seed production was 0.5 kgm/ha of orchard area; at the same age the Tallaganda orchard was producing 5.3 kgm/ha.

Cones were collected in 1972 (SN.5062) and yielded 21 kgm of clean seed. The next collection in 1974 (SN.5069) produced only 14 kgm clean seed. Various fertilizer treatments had been applied in 1972 but this was found to have no effect on seed production.

Inspection in 1976 showed only a light cone crop which would be very difficult to collect. It was considered uneconomic to collect.

4.2.2.2. West Manjimup orchard (15.7ha), planted 1969-72

Orchard includes the best clones available from W.A. (33), S.A. (18), A.C.T. (10), N.S.W. (10), Vic. (17) and N.Z. (3). The seed orchard population of 91 clones was not included in each years planting, this varied according to the availability of ramets.

Details of cone collections -

1975 - SN.5082, 1 kgm seed.
1976 - SN.5087, 64 kgm seed, 10 kgm/ha orchard.
1977 - SN.5092, 73 kgm seed, 8 kgm/ha orchard.
1978 - SN.5099, 194 kgm seed, 18 kgm/ha orchard.

The P69 and P70 areas were pollarded at a height of 8-10m in 1978.

action in 1979 - collection of cones commenced in October. Pollarding was extended through the P71 and P72 areas.

Thinning in the P69-71 area commenced in December. Selection of the parents to remain in the orchard has been very intensive and is based on -

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a) performance in W.A. progeny trials.
b) performance in Australian progeny trials.
c) assessment of ramets in the orchard.

Selection favoured parents with good branch characters (angle and thickness), straightness of the tree bole and vigour in that order of priority. An overriding influence was the health of the parents; parents most likely to suffer from delayed graft incompatibility were removed. In summary 35 parents have been marked for removal from the orchard to leave 36 elite parents as the seed production population. This leaves a stocking of 155 spha.

As a consequence of the thinning and lopping operations, seed production will fall dramatically over the next few years. Probably less than 70 kgm seed can be expected from this source.

4.2.3. Post orchard

In addition to the seed production areas established in the SN.1899 stands, special seed production units have been established on the sunklands (60ha) and Blackwood Valley/Grimwade (18ha) sites. Together with the Manjimup orchard seed, this will provide our immediate future need of high genetic quality seed.

Another clonal seed orchard will be established from cuttings on a seed productive site. This will use super clones as defined from our local and Australian programme. This of course will not commence until the new selections from provenance, the recent N.Z. introductions and others have been screened for tolerance to Phytophthora cinnamomi.

4.2.4. Current

The annual departmental requirement of seed is 200 kgm and public sales are of the order of 100 kgm. Orchard seed now is filling a large part of the requirement and is supplemented by collection in the SN.1899 stands. However, both sources stocks have been significantly decreased, the orchard by thinning and lopping, and the loss of Grimwade SN.1899 stands caused by cyclone Alby.

Until the orchard again peaks in seed production and the specially developed seed units enter production our seed requirement is best supplemented by increased collection on the SN.1899 stands as well as the purchase of orchard seed from other States.