THE F.A.O. WORLD SYMPOSIUM ON MAN-MADE FORESTS AND ROW PLANTATIONS

AND

THE 3RD WORLD EUCALYPTUS CONFERENCE

TOUR OF WESTERN AUSTRALIA

28th APRIL, 1967 — 5th MAY, 1967

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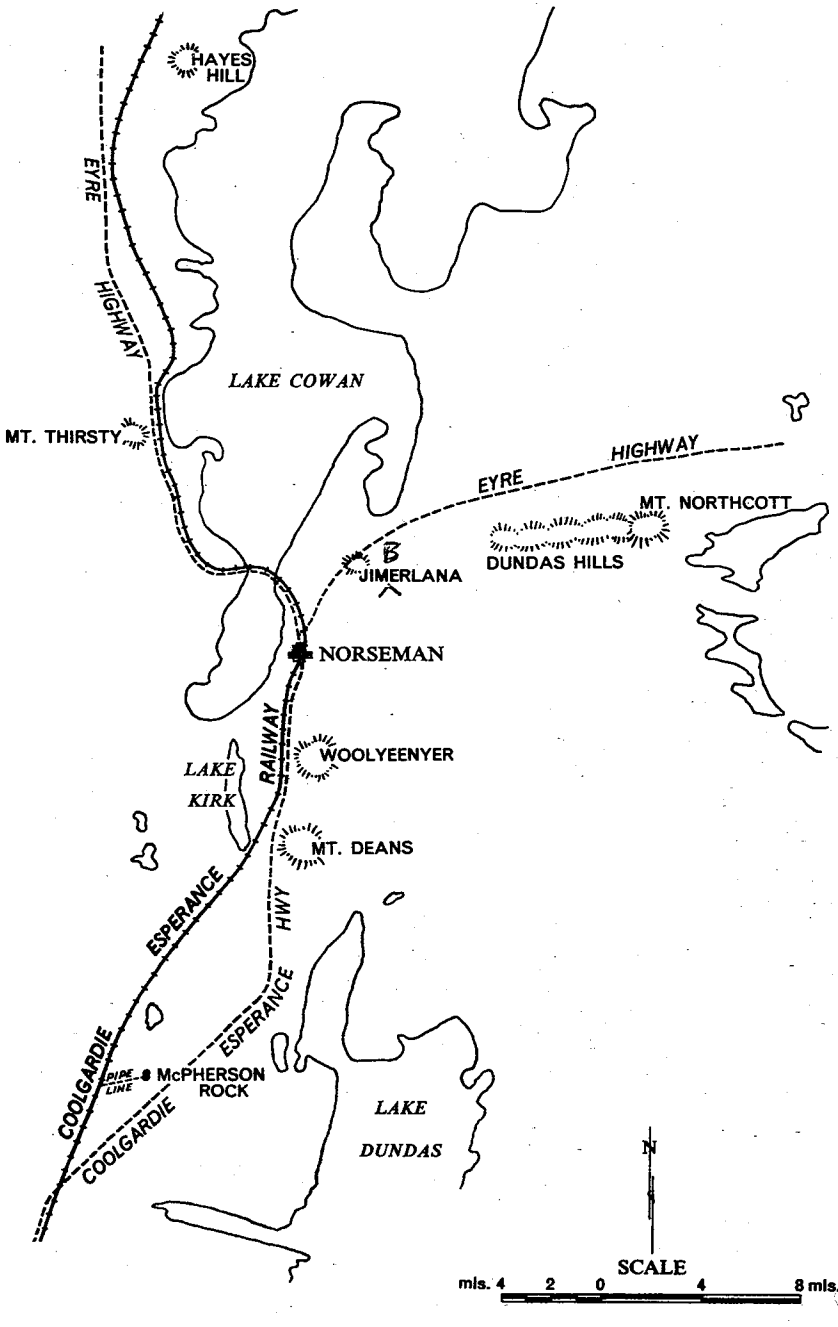

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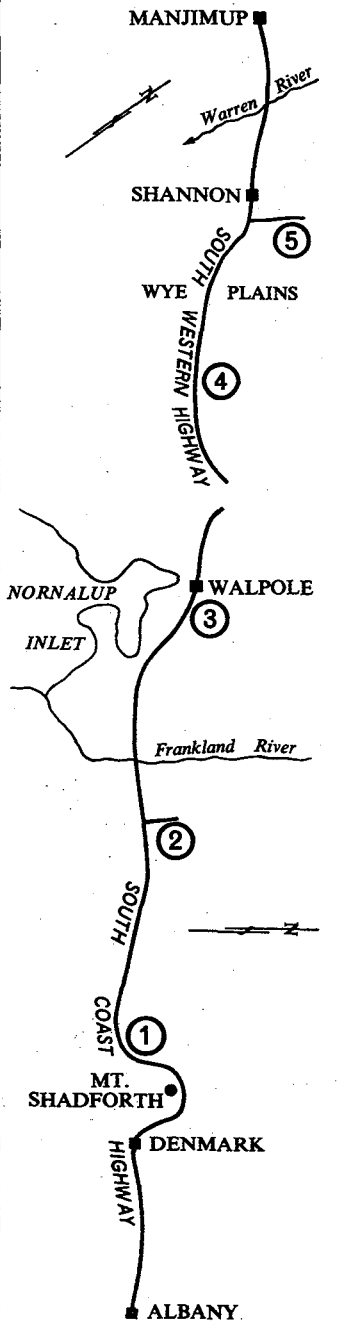

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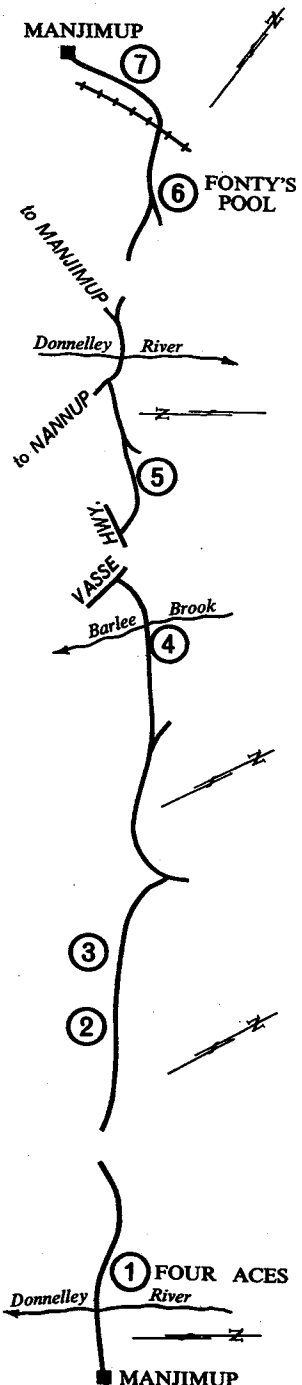

DAY 4. TUESDAY 2nd MAY

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59	Rejoin the South-Western Highway.
51	Lefroy Brook sample plot, a 90-year-old stand of naturally regenerated karri.
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24	PEMBERTON
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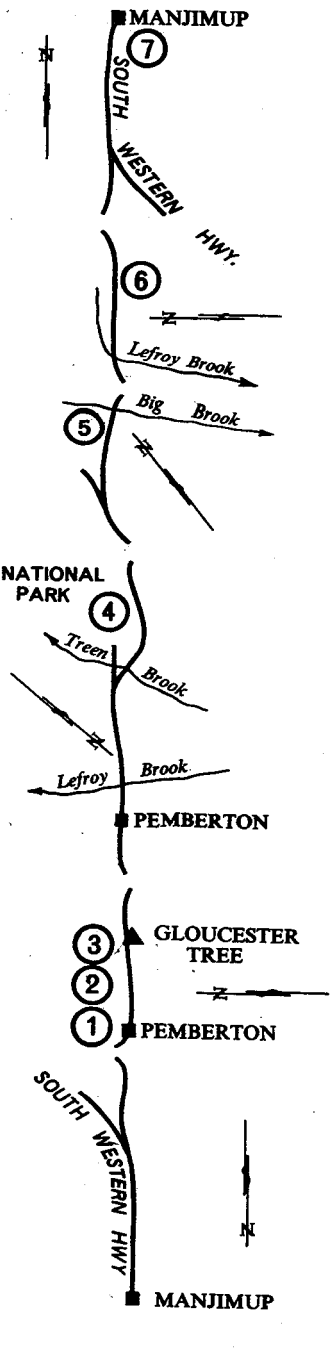
21	Pemberton Forest Headquarters.
20	Pemberton sawmill owned by Hawker Siddeley Building Supplies.
	PEMBERTON township is largely dependent on the sawmilling industry, but is also a well known tourist centre.
00	MANJIMUP



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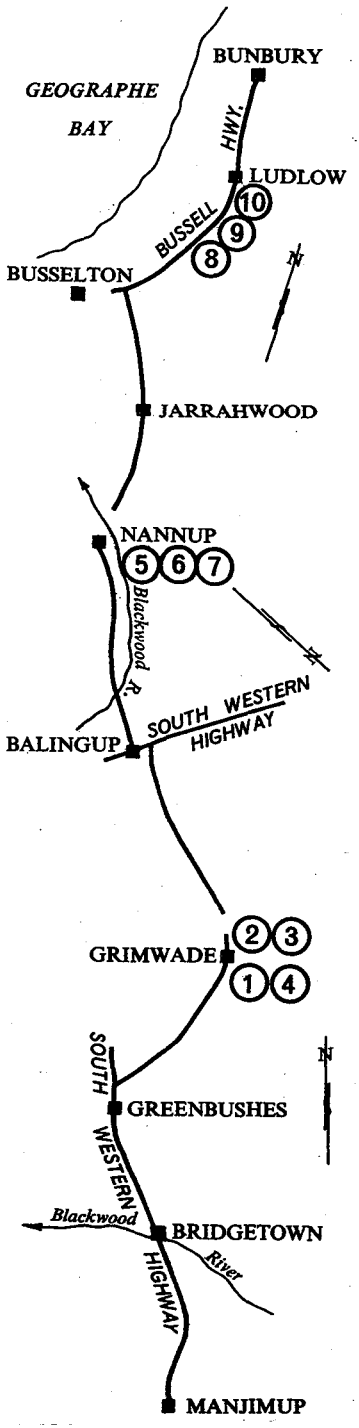

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	168
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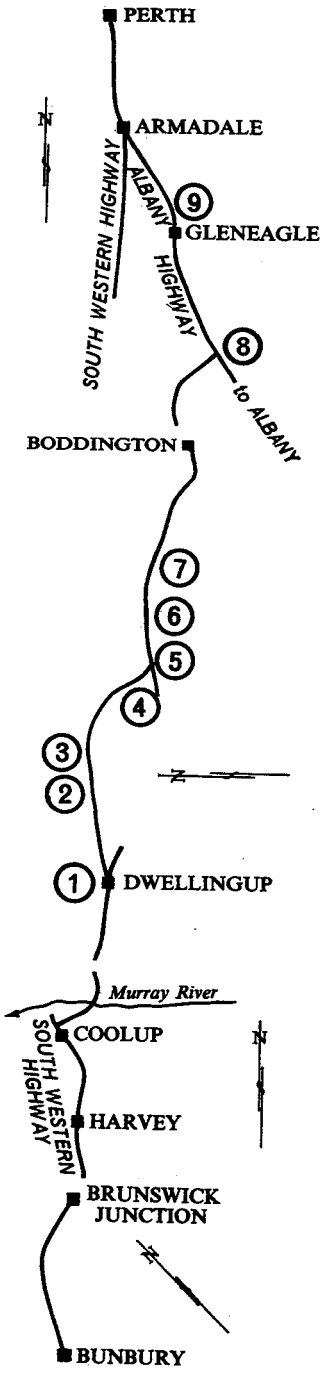
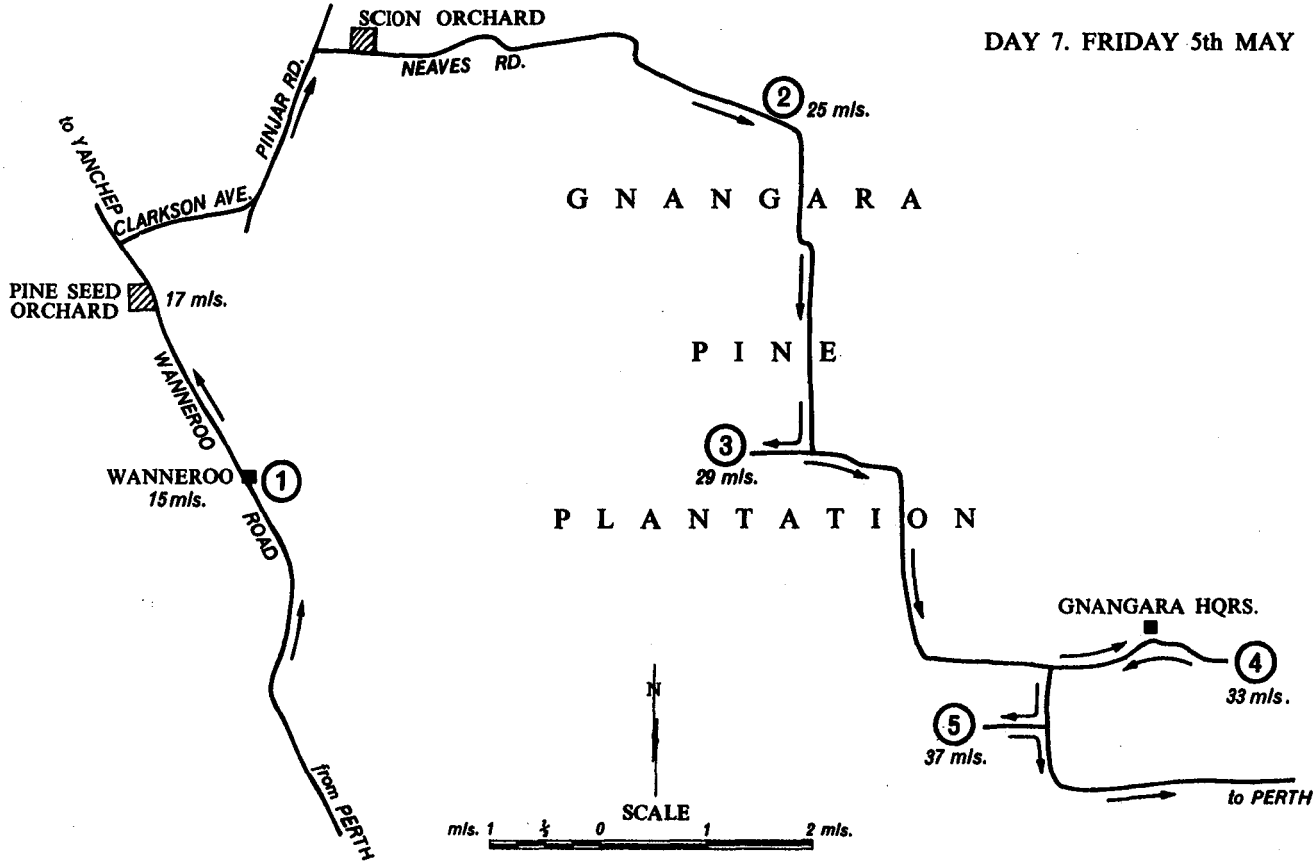


DAY 7. FRIDAY 5th MAY



SATURDAY, 29th APRIL, 1967

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	The day's tour consists of a charter flight to Norseman - 338 miles direct (544 Km.) - to inspect a variety of eucalypts growing in an area of low rainfall. The average annual rainfall in this region is about 11 inches (28 cms). The time of arrival at Norseman will depend on the type of aircraft chartered and this was unknown at the time of printing. It is expected that a minimum of four hours or a maximum of five hours will be spent in the dry area eucalypt forests. The party will then fly to Albany - 300 miles (483 km) and stay there overnight. For details on Norseman and notes on the semi-arid and arid eucalypt zone of South Western Australia see page 52 of General Notes.		

* * *

Saturday, 29th April, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	Prior to lunch at the Railway Hotel, the party will board a bus and inspect a variety of eucalypts in and around Norseman.		
	After lunch at 11.50 hrs the itinerary will be as follows :-		
	Travel 7½ miles south from Norseman	12.30	
STOP 1.	Inspect specimens of Dundas Mahogany (E. brockwayi), Dundas Blackbutt (E. dundasi), Merrit (E. flocktoniae) and Goldfields Blackbutt (E. le souefii).	12.45	7½
	Travel a further 3½ miles south noting regenerated areas of the species seen at Stop 1.	13.01	
STOP 2.	Inspect specimens of Blue Snap and Rattle (E. calycogona), Sand Salmon (E. leptophylla), Redwood (E. oleosa) and Boongul (E. oleosa var. glauca).	13.16	11

Saturday, 29th April, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	Travel a further 10 miles south noting regenerated areas of the species seen at Stop 2.	13.28	
STOP 3.	Inspect specimens of Salmon Gum (E. salmonophloia) and Gimlet (E. salubris).	13.50	21
	Return to Norseman airstrip a distance of 24 miles	14.02	
STOP 4.	Board aircraft.	14.47	45
STOP 5.	Depart for Albany airstrip Arrive Albany airstrip.	14.55 16.35	
	Board bus and travel 11 miles to the Albany Motel for overnight accommodation.		
	Day's tour ends.	17.05	

SUNDAY, 30th APRIL, 1967

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	09.00 - Depart by bus for Stop 1 on the Mt. Shadforth Road, seven miles past Denmark and 42 miles from the start point. Near the outskirts of Albany, the tour passes the woollen mills and superphosphate works, then follows the Elleker Road until it joins the South Coast Highway after 24 miles. The land form in this section consists mainly of high leached coastal sands with scattered peaty swamps and occasional outcropping rocky (granite or gneissic-granite) hills. After crossing the Hay River (28 miles) the granite outcrops are replaced by sandy, or ironstone knolls or hillocks, carrying stunted jarrah (E. marginata) and marri (E. calophylla). Sheoak (Casuarina fraseriana) is also present.	09.00	00

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	See page 55 of General Notes for the vegetation pattern of this region.		
	The first occurrence of karri (E. diversicolor) will be seen four miles from the start point. The factors, mostly edaphic, controlling the occurrence of this species and the problems associated with pasture development on karri soils are discussed in General Notes page 53.		
	Denmark (35 miles) marks the beginning of the main commercial karri forests. The township was an important sawmilling centre at the turn of the century but now only one medium-sized sawmill cutting jarrah and karri, exists. Further details on the Denmark district are given on page 55 of General Notes.		35
	At Denmark the route leaves the South Coast Highway and follows the		

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	Mt. Shadforth Road for seven miles to Stop 1.		
STOP 1.	Rest break of 10 minutes.	10.15	42
	Delegates will obtain a general view of karri clad hills, Wilson Inlet and the Southern Ocean.		
	Depart for the Red Tingle (E. jacksoni) forest - 27 miles.	10.25	
	The South Coast Highway is rejoined after ½ mile and the tour follows it for a further 25 miles to the turn-off at Giants Road.		
	Two points of interest on the way are fire-killed karri three miles along the Highway (See page 56 of General Notes), and pasture development on the Old Man Plains a further 14 miles onwards (See page 58 of General Notes).		
	After leaving the Highway at Giants Road the party travels 1½ miles		

Sunday, 30th April, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Mileage
	into the Red Tingle forest. (See page 58 of General Notes).		
STOP 2.	Inspect a 58 year old stand of Red Tingle (E. jacksoni).	11.15	69
	Return to South Coast Highway and proceed to Walpole township - 17 miles.	11.45	
	The tour leader will comment on the vegetation to be seen on the way, and also briefly discuss National Parks, Coalmine Beach and the township of Walpole. Notes covering these, as well as saw-milling activities in the Denmark-Walpole region, are given in some detail on page 57 of General Notes.		
STOP 3.	Lunch at Walpole Hotel.	12.20	86
	Leave Walpole and travel 12 miles along the South Western Highway (previously named the South Coast Highway).	13.20	

Sunday, 30th April, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
STOP 4.	Observe specimens of Yellow Tingle (E. guilfoylei). See General Notes page 61.	13.40	98
	Depart for Bevan Road plots - 30 miles.	13.55	
	After about four miles the Highway heads generally North-westerly away from the coast and continues in that general direction through to Manjimup.		
	The route crosses the Wye Plains (10-15 miles) where four separate tree establishment trials will be noted in passing. These trials are designed to study the feasibility of establishing a variety of eucalypts and conifers on poorly timbered sites (See page 61 of General Notes).		
	Half a mile past the first establishment plot the first example of "Jarrah Dieback" will be seen. Other examples of		109

Stop No.	PARTICULARS	Progressive Time	Mileage
	this disease will be seen as the tour progresses. For further information see page 63 of General Notes. After leaving Wye Plains the road rises into higher undulating country and passes through the first belt of good quality karri forest, part virgin and part logged. Four miles further the tour leaves the Highway and travels three miles along Bevan Road through virgin and cut-over jarrah forest to Stop 5.		
STOP 5.	Inspect establishment trials of eucalypts and pines on a treeless flat.	14.45	128
	Return to the South Western Highway and proceed to Manjimup - 38 miles. Shortly after rejoining the Highway the tour passes through the sawmilling township of Shannon River. The Shannon River sawmill, owned by a private company	15.25	132

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	has an average daily sawn output of approximately 1,800 cubic feet (51 m^3) and has over 90 employees on the payroll. About 60 per cent of the output is karri and the remainder, jarrah. (See page 66 of General Notes for further information). The Forests Department has a Divisional Headquarters in the settlement which controls forestry activities in the area. The tour continues 14 miles through State Forest until the first farm in the Manjimup region is reached. As the tour proceeds the area of farmland increases and the history and problems associated with farming development in this very large region are discussed in General Notes page 66. The Warren River, one of the major drainage channels of the region		150

Stop No.	PARTICULARS	Progressive Time	Mileage
	is crossed. It will be noticed that the proportion of large sized marri (E. calophylla) in the forest composition tends to increase in the 20 mile stretch approaching Manjimup. The presence of kino in the wood of this tree, and the ready availability, in the past, of the recognised timbers of jarrah and karri have led to this species being regarded by sawmillers as commercially unacceptable. However, its strength properties, ease of working, and pale coloured wood indicate that, under proper management and silvicultural control, it will in the future no longer be considered as a "scrub species". It is of interest that one sawmill close to Manjimup is now milling the timber and it is estimated that some 225 million cubic feet (6.3 million m^3) of		

Sunday, 30th April, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	acceptable sawlogs are available south of the Blackwood River (20 miles north of Manjimup).		
	A general discussion on the silvicultural and management problems of marri are given in General Notes page 69.		
	The day's tour ends at Bonnebeth Motel Manjimup.	16.30	166
	Evening free.		

MONDAY, 1st. MAY, 1967

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	09.00 hrs.: Depart by bus for the "Four Aces".	09.00	00
	For the first 13 miles the route passes through typical "Group Settlement" farming country established over 40 years ago.		
	On reaching the Donnelly River (13		

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	miles) delegates will observe natural regeneration of Tasmanian Blue Gum (E. globulus) which came from a tree planted on a nearby farm many years ago. In 1905 the Donnelly River was "bridged" by felling a karri tree across the stream and fastening bearers and decking to it. For many years this crude bridge served the graphite mine workings to the west of the river and gave more direct access to the port of Busselton. The bridge was washed away several years ago.		
STOP 1.	Inspect the "Four Aces" - a group of four large karri trees situated in a Scenic Reserve.	09.30	14
	Depart for Stop 2, karri logging operations - nine miles. The logging road to be followed passes through several areas of karri	09.50	

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	forest recently logged and regenerated.		
STOP 2.	(a) Morning tea will be served. (b) Inspect all aspects of logging in virgin karri forest.	10.10	23
	Depart for the karri clear-felling trial area- three miles.	11.10	
STOP 3.	Observe a 120 acre (48 ha) trial area of karri clear-felled except for seed trees (See page 73 of General Notes).	11.20	26
	Depart for the lunch stop at Barlee Brook - 17 miles. After rejoining the logging road, the tour continues in a northerly direction for six miles then heads generally north-westerly and westerly. The forest type traversed is mostly mixed jarrah-marri with patches of	11.50	

Monday, 1st. May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	karri in the gullies. The forest was logged from 1956-1958.		
STOP 4.	Picnic lunch at Barlee Brook.	12.30	43
	Continue one mile to the Vasse Highway, travel one mile south, then turn east along Dickson Road, and continue three miles to a stand of virgin jarrah.	13.30	
STOP 5.	Inspect a stand of good quality virgin jarrah (See page 75 of General Notes).	13.45	48
	Continue in a general easterly direction returning past the "Four Aces" and over the Donnelly River. After travelling 17 miles, the route heads south and continues for another five miles to "Fontys Pool".	14.15	
	The pool, popularly known as "Fonty's Pool" was built, and the attractive surroundings		

Monday, 1st. May, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	developed by Mr. A. Fontanini.		
STOP 6.	The party meets Mr. A. Fontanini and has afternoon tea.	15.10	70
	Depart for the seasoning yard and processing plant of Hawker Siddeley Building Supplies five miles.	15.45	
STOP 7.	Meet Mr. J. J. Honniball of Hawker Siddeley Building Supplies and inspect air and kiln seasoning and subsequent processing of jarrah and karri.	15.55	75
	Depart for Bonnebeth Motel - two miles.	16.35	
	Day's tour ends.	16.40	77

TUESDAY, 2nd. MAY, 1967

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	09.00 hrs.: Depart for Pemberton - 20 miles.	09.00	00
STOP 1.	Inspect Hawker Siddeley Building Supplies sawmill and high pressure preservation plant.	09.30	20
	Depart for the Pemberton Divisional Forest Headquarters - one mile.	10.20	
STOP 2.	Party has morning tea.	10.25	21
	Depart for Gloucester Tree fire lookout - one mile.	10.45	
STOP 3.	Inspect Gloucester Tree with its cabin built in the branches some 200 feet (61m.) above ground level.	10.50	22
	Return through the Pemberton township and proceed eight miles in a general southerly direction to Warren National Park. (See page 79 of General Notes for comments on national Parks).	11.10	

Tuesday, 2nd. May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
STOP 4.	Inspect virgin karri forest in Warren National Park.	11.30	30
	Leave the Warren National Park and after seven miles enter the Treen Brook karri forest. This forest has resulted from regeneration burns following logging operations - without tree-marking - some 27 to 37 years ago. Continue through to Big Brook forest. (See page 80 of General Notes).	11.50	
STOP 5.	Picnic Lunch in Big Brook forest. Following lunch Mr. G. B. Peet, Research Officer, will discuss controlled burning technique and research. The party will then inspect :- (a) An arboretum of conifers and eucalypts.	12.30	43

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	(b) Thinning trials in a 37 year old stand of karri.		
	Proceed through Big Brook forest to the Lefroy Brook sample plot - eight miles.	15.00	
STOP 6.	Inspect a 90 year old stand of karri (See page 82 of General Notes).	15.25	51
	Leave the Lefroy Brook sample plot and travel 14 miles to the Forests Dept. Regional Headquarters at Manjimup.	15.55	
STOP 7.	Inspect the arboretum of eucalypts and conifers at Manjimup Forest Headquarters.	16.25	65
	Depart for Bonnebeth Motel.	16.55	
	Day's tour ends.	17.00	66

WEDNESDAY, 3rd. MAY, 1967

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	08.00 hrs.: Assemble at the bus and meet Mr. D. R. Lejeune, Inspector in charge of the Kirup, Nannup and Busselton Forest Divisions.	08.00	00
	08.05 hrs.: Depart for Grimwade Plantation via the towns of Bridgetown and Greenbushes. Bridgetown, which is noted for its apple orchards, is situated on the Blackwood River, the longest river in the south-west of the State. Greenbushes, once a thriving town, was the centre for the tin mining and sleeper hewing industries. However, tin mining ceased many years ago and has only recently been revived, while the sleeper cutters have long since disappeared.		23 33
STOP 1.	Grimwade Forest Settlement. During morning tea in the Grimwade Hall, meet	09.25	46

Wednesday, 3rd. May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	Mr. E. A. Jenkins, Divisional Forest Officer in charge of the Kirup Division, who will give a brief introductory talk on the Grimwade plantation. (See page 83 of General Notes).		
	Depart for the plantation - one mile.	09.45	
STOP 2.	Inspect :- (1) 33 year old P. radiata stand thinned to 100 stems per acre (247/ha). (2) 33 year old P. pinaster (Landes), unthinned. (3) A "plus" tree of P. radiata.	09.48	47
	Proceed through the plantation, observing the result of controlled burning under pine in 1966. The route passes through a 26 year old stand of P. radiata thinned to 200 stems per acre (494 ha).	10.13	

Wednesday, 3rd. May, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
STOP 3.	Observe a disorder causing death in P. radiata planted in 1941.	10.16	48
	Proceed through the plantation to an 18 year old stand of P. radiata thinned to 300 stems per acre (741/ha).	10.36	
STOP 4.	Observe :- (1) The effect of zinc deficiency. (2) The response to zinc from an old wire netting fence and from spraying with Z_nSO4.	10.41	50
	Return three miles through the plantation and travel 34 miles via Balingup and along the Blackwood River valley to Nannup. Note good jarrah forest, agricultural development and the Lewana Pine Plantation on the way.	11.01	61
STOP 5.	Lunch at Nannup Hotel.	12.20	87

Wednesday, 3rd. May, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	Travel one mile to Mt. Folly plantation.	13.10	
STOP 6.	Meet Mr. A. R. Hill, Divisional Forest Officer in charge of the Nannup Division, who will give a brief talk on the establishment of P. radiata plantations in the Blackwood Valley. See page 84 of General Notes. Inspect :- (1) Thinning and trial logging plot in 10 year old P. radiata. (2) High pruning to 30 feet (9m).	13.15	88
	Continue two miles through plantation.	13.35	
STOP 7.	See :- (1) Steep terrain in 1960 planting. (2) Trial area of P. canariensis. Discuss fire control problems.	13.40	90

Wednesday, 3rd. May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	Depart for tuart forest at Wonnerup (near Busselton) - 45 miles - via Nannup and Jarrahwood, noting on the way :- (1) Jarrah forest logged at various times since 1920. (2) Patches of "Die-back" in jarrah - (see page 63 of General Notes). (3) Eucalypt and P. pinaster plots in "Die-back" areas.	14.05	
STOP 8.	Meet Mr. J. K. Smart, Officer in Charge of the Busselton Division. Inspect tuart (E. gomphocephala) forest on either side of Bussell Highway (See page 87 of General Notes).	15.20	135
	Proceed one mile along Bussell Highway.	15.45	
STOP 9.	Inspect a 10 acre (4 ha) trial plot of tuart planted in July 1965.	15.48	136

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	Observe P. pinaster growing on tuart sands and treated P. pinaster posts in a fence line.		
	Continue to Ludlow Forest Settlement - 1½ miles - where the first Forestry School in Western Australia was established in 1921.	16.08	
STOP 10.	Inspect :- (1) 42 year old Tuart and other species planted by the students. (2) Tuart timber cut at the Forests Department sawmill.	16.11	138
	Depart for Bunbury - 23 miles. Note the mining of ilmenite sands on the way.	16.30	
	Arrive at Ocean Drive Motel where the party will stay overnight.	17.05	161

THURSDAY, 4th MAY, 1967

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	08.00 hrs. : Assemble at bus and meet Mr. J. B. Campbell, Acting Superintendent of the northern forest region.	08.00	00
	08.05 hrs. : Depart for for Dwellingup - 70 miles.	08.05	
	The tour will parallel the Leschenault Inlet to Australind and join the South-West Highway at Brunswick Junction. At Australind will be seen Laporte Titanium (Aust.) Ltd. plant which treats the ilmenite sands from nearby coastal deposits.		
	From Brunswick Junction through to the foothills approaching Dwellingup the route through farming country, much of it irrigated, where dairying, the raising of beef cattle and potato growing are the main agricultural pursuits. In the last 7 miles the road climbs into the Darling Range to reach Dwellingup - elevation 883 ft. above sea level.		

Thursday, 4th May, 1967 cont.

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
STOP 1.	Forests Department Trainee School. Morning tea will be served in the school and during that period Mr. D. Spriggins, Divisional Forest Officer in charge of Dwellingup, will give a brief introductory talk on the jarrah forests of the Division (See page 90 of General Notes).	10.00	70
	Depart for Stop 2 - six miles. (Refer to page 93 of General Notes - Thinning in the Jarrah Forest).	10.25	
STOP 2.	Inspect a thinned 50 year old jarrah pole stand where two techniques using hormone poison have been employed to kill unwanted stems. (1) On the south side of the road, unwanted stems were felled and the freshly cut stumps treated with 2% 2,4,5-T in water.	10.40	76

Stop No.	PARTICULARS	Progressive Time	Mileage
	This was the earliest (1959) thinning trial using hormone poison and the technique is still employed where aesthetics are important. (2) On the north side of the road, unwanted stems were ringbarked in 1963 and the wounds sprayed with 2% 2,4,5-T in water.		
	Depart for Stop 3 - 1½ miles.	11.00	
STOP 3.	Inspect a further two thinning trials which demonstrate :- (1) The heavy accumulation of combustible material resulting from felling stems and poisoning stumps. In this area, thinned in March 1965, fallen stems average 250/ac. (618/ha) having a	11.05	78

Stop No.	PARTICULARS	Progressive Time	Mileage
	total volume to 4" diameter underbark (10cm) of 550 cubic feet (38m^3/ha). It is estimated that the extra accumulation of fuel exceeds 12 tons per acre (29 metric tons/ha) (2) An area thinned in 1964 by basal frilling with an axe and spraying the frill with 2% 2,4,5-T in diesel oil. This technique superseded the ringbarking method seen at the previous stop.		
	Depart for Stop 4 - five miles	11.20	
STOP 4.	Inspect a 45 year old jarrah pole stand with three plots thinned to basal areas of 40, 60 and 90 square ft. per acre (9, 15 and 21 m^2/ha)	11.35	83
	Travel one mile to Stop 5 - Inglehope.	11.55	

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
STOP 5.	PICNIC LUNCH	12.00	84
	Inglehope, in the 1920's was a large sleeper cutters' camp. Subsequently, a small settlement was established to accommodate Railway and Forests Department employees. However the settlement was partially destroyed by the Plavins fire in 1950 and has since been abandoned.		
	The railway line which once served a number of sawmills now serves only the Marradong and Boddington farming districts some 20 miles to the east.		
	The fenced arboretum was established in 1928 and the larger pines originate from that date. Natural regeneration, mainly from P. pinaster, accounts for the range of size classes.		
	More interesting species are :-		

Stop No.	PARTICULARS	Progressive Time	Progressive Mileage
	P. canariensis - Canary Island Pine P. laricio - Corsican Pine P. muricata - Bishop's Pine P. pinaster - Maritime Pine P. radiata - Monterey or Radiata Pine P. taeda - Loblolly Pine Some additional plantings were made after 1928 and in 1965-66 the arboretum was extended by the planting of a wide range of conifers and eucalypts.		
	Depart for Stop 6 - 2½ miles along the Marradong Road to Amphion 6.	12.55	
STOP 6.	Demonstration of a pole stand which has been protected from fire for 35 years compared with a stand of similar age, adjoining the main road which has been subjected to regular controlled burning over the same period.	13.00	86

Thursday, 4th May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	Depart for Stop 7 - 2½ miles.	13.20	
STOP 7.	Observe a 43 year old pole crop thinned to 140 stems per acre (346/ha) in August 1965, by injecting "Tordon" into notches cut into the stems of unwanted trees. The technique used here is the one employed today.	13.25	88
	Continue along the Marradong Road through the township of Boddington to the 65 mile peg on Albany Highway - 32 miles.	13.40	
STOP 8.	Inspect a stand of Wandoo (E. wandoo, syn. redunca var. elata).	14.30	120
	Depart for Gleneagle Forest Settlement - 32 miles along the Albany Highway. As the tour approaches Gleneagle note the establishment of	14.50	

Thursday, 4th May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	P. pinaster on areas where jarrah has died out.		
STOP 9.	Inspect trial plots of eucalypts.	15.40	152
	Depart for Perth - 34 miles.	16.00	
	Arrive Hotel.	17.00	186
	EVENING FREE.		

FRIDAY, 5th MAY, 1967

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
09.	09.00 hrs. : Depart Perth hotel for Wanneroo Forest Headquarters - 15 miles. (Refer to page 106 of General Notes on P. pinaster).	09.00	00
STOP 1.	Introduction to day's tour (P. pinaster plantations). Inspect pine tree-breeding station.	09.30	15
	Morning tea.		

Friday, 5th May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	Depart for Gnangara plantation - 10 miles with brief stops (don't de-bus) to note the Wanneroo Seed Orchard and Neave's Road scion orchard.	10.20	
STOP 2.	Demonstrate establishment of P. pinaster. See new clearing, ploughing, furrow lining and recent planting.	10.45	25
	Continue four miles through the plantation.	11.15	
STOP 3.	Observe superphosphate response in a 14 year old stand of P. pinaster.	11.35	29
	Depart for the Old Gnangara Sawmill - four miles.	11.55	
STOP 4.	Picnic Lunch - in a 35 year old stand of P. pinaster (Landes).	12.10	33
	Travel four miles through plantation.	13.10	
STOP 5.	Inspect thinning trials in a 25 year old stand	13.30	37

Friday, 5th May, 1967 cont.

Stop No.	PARTICULARS	Progressive	
		Time	Mileage
	(Leiria).		
	Depart for a tour of Perth and environs, via Swan Valley vineyards, Perth City, King's Park (stop 30 minutes), University and ocean beaches.	14.10	
	Return to hotel.	16.40	Approx. 87

GENERAL NOTES ON FORESTRY IN WESTERN AUSTRALIA.

These very brief notes are intended to give an outline only of major aspects of forestry in Western Australia.

WESTERN AUSTRALIA

Land Area = 625 million acres (253 million hectares).

Population = 835,000. Over 50% in the Perth Metropolitan Area.

FOREST POLICY

Although the "Swan River Colony" was founded in 1829, it was not until the passing of the Forests Act and Regulations in 1918 that uncontrolled exploitation of the native hardwood forests was checked.

The Forests Act and Regulations (1918-1954) provides for :-

(1) The dedication of State Forests which can be alienated only by agreement of both Houses of Parliament.

(2) Nine-tenths of the nett forest revenue to be available for forest replacement and improvement.

(3) The formation of a Forests Department and the appointment of a Conservator of Forests who shall be a fully qualified forester. The Conservator has wide powers in applying policy.

(4) The preparation and enforcement of Forest Working Plans, which shall be

revised at periods not exceeding 10 years.

FOREST AREA

At 30th June, 1966, the forest area was as follows :-

State Forests - 4,448,827 acs.(1,800,416 ha)
Timber Reserves - 1,859,538 acs.(752,541 ha)

State Forests

These cover less than one per cent of the total area of the State and are confined almost entirely to the south-west corner in the region having an annual rainfall of over 25 in. (63 cm.).

Distribution of the main forest types is as follows :-

	Thousand Acres.	Thousand Hectares
Jarrah.....	3,190	1,291
Jarrah& Wandoo(Mixed)..	164	66
Jarrah & Karri(Mixed)..	656	266
Karri.....	171	69
Karri & Tingle(Mixed)..	14	6
Tingle.....	11	4
Tuart.....	6	2+
Mallet.....	57	23
Sandalwood.....	2	1-
Pine Planting Area.....	178	72

Botanical Names (for previous)

Jarrah	-	Euc. marginata
Wandoo	-	" wandoo, Syn.redunca var. elata
Karri	-	" diversicolor
Tingle (Red)	-	" jacksoni
Tingle (Yellow)	-	" guilfoylei
Tuart	-	" gomphocephala
Brown Mallet	-	" astringens
Blue "	-	" gardneri
White "	-	" falcata
Sandalwood	-	Santalum spicatum

Timber Reserves

Most of these are located in the inland areas and provide mining timber and firewood for goldmining centres such as Kalgoorlie and Norseman. A wide variety of eucalypts are found in these inland areas.

THE MAJOR TIMBERS AND THEIR USES

Jarrah (Euc. marginata)

In W.A. this durable, attractive red-brown timber is used for a great variety of purposes, including many for which softwoods are considered essential in other countries.

It is used in house building for stumps, joists, framing, siding, flooring, window frames, doors, mantelpieces and panelling. In large buildings it makes excellent beams, columns and rafters.

It is famous as a railway sleeper timber and is used in the construction of bridges, wharves,

piers and jetties. Small ships have been made of it and it is commonly used for telephone and transmission poles.

Karri. (Euc. diversicolor)

Similar in appearance to jarrah, this timber is not durable in the ground, but its strength and stiffness combined with the extraordinarily long, clean lengths which may be obtained, render it unsurpassable for superstructional work. It is favoured for mine guides in the goldmines of this State and in South Africa, and large quantities are used locally for coach, wagon and motor body building as well as for house framing, particularly roof trusses, fruit cases and, in the past, wine vats and casks, wooden pipes and flumes.

Treated with pentachlorphenol in oil under very high pressure it is prized for transmission and telephone cross-arms. Other uses include veneer for multi-ply waterproof sheets used in concrete formwork, and being good bending timber, has been used in the construction of laminated bowstring trusses. It is on Lloyd's list of shipbuilding timbers and has been pulped successfully on an experimental scale.

Wandoo. (Euc. wandoo, Syn. redunca var. elata)

The light brown wood is heavy, hard, strong, tough and highly durable. It is recognised as one of Australia's best railway sleeper timbers and is particularly suitable for flooring subject to heavy wear. It is used in railway wagon construction, particularly in top planks in wagon sidings where it is subject to heavy service conditions.

A remarkable feature of the wood is that it does not corrode steel even after 20 years or more contact with it. The wood contains a high per-

centage of tannin and one factory produces a commercial extract from the chipped wood.

W.A. Blackbutt. (Euc. patens)

This tree was not listed in the forest types previously given. It occurs in small patches in the gullies and pockets of alluvial soil through the prime jarrah forest, and mixed with jarrah in some parts of the karri forest.

The timber is similar to jarrah in weight, strength and durability, but is pale yellow in colour. It is used for much the same purposes as jarrah, including railway sleepers, and its attractive colour makes it popular for flooring and panelling.

Tuart. (Euc. gomphocephala)

The pale yellow timber with its interlocked grain is particularly strong, but only moderately durable in the ground. Only small quantities are available and at present its main use is in railway wagon construction. It makes an excellent floor and attractive panelling.

TIMBER PRODUCTION AND DISTRIBUTION

Over the last few years the annual production of sawn timber ranged from 200 to 210 million super feet (480,000 to 500,000 m^3). About 25 percent of the output is in the form of railway sleepers for both local use and particularly export. This State supplies over 90 percent of overseas exports of railway sleepers from Australia.

The production by species is approximately as follows :-

Jarrah	-	70%
Karri	-	20%
Other Hardwoods	-	6%
Plantation Pine	-	4%

About 30 percent of total production is exported, a little more than half going to the Eastern States of Australia and the remainder overseas. South Australia, which takes large quantities of karri for home building, is by far the most important Australian market. South Africa, New Zealand and the United Kingdom are the largest overseas buyers.

Imports of veneer logs and sawn timber represent about nine percent of local consumption. Veneer logs and sawn light hardwoods from Malaysia form the bulk of the imports.

AFFORESTATION

Western Australia has no indigenous softwoods and it is estimated that our native hardwood State Forests, on present standards of utilization can provide, under sustained yield, little more than 40 million cubic feet (1,130,000 m^3) of timber per annum.

With a population of 835,000 the present per capita consumption of sawlogs is about 45 cubic feet per annum and it is expected that the population will reach one million in about 10 years time. Currently some 20 percent of log timber comes from private property, but it is recognised that supplies from this source will be considerably reduced within the next few years. It is obvious therefore that to meet future requirements, plantations of exotics will be necessary.

This situation was appreciated many years ago and extensive trials of the establishment of over 30 exotics have been carried out. These trials have shown that two species of pine, P. radiata and P. pinaster, are best suited to our conditions. The latter, with the aid of fertilizers, has been successfully established on the poor coastal sands from north of Perth, south to Busselton. P. radiata, however, requires better class soils and these have largely been taken up for agriculture. Shortage of suitable soils for this species is a problem in this State.

Western Australia aims to establish 200,000 acres of pine plantation.

To date some 49,000 acres (20,000 ha.) of pine have been planted.

The rate at which planting can be carried out mainly rests on available finance, and over the last six years the average annual rate has been less than 3,000 acres (1,200 ha.). However, it is expected that this rate will be doubled when special Federal loan funds become available.

The following general rules are followed in all plantations :-

Planting Stock - 1/0 for both species.

Spacing - P. radiata - 8' x 8' (2.4m x 2.4m)
- P. pinasta - 8' x 6' (2.4m x 1.8m)

Pruning - When 50 percent of the crop reaches a D.B.H. (o.b.) of 3½ in. (8.8cm) all stems down to 2 in. D.B.H. (o.b.) - 5.1cm - are pruned to a height of 7 feet (2.1m).

In P. radiata plantations 100-120 vigorous stems are selected and pruned first to 15 feet (3.8m) and subsequently to 22 feet (5.6m).

In P. pinaster plantations the same practice holds except that a decision on pruning above 15 feet has yet to be reached.

First pruning is done with light axes, second and subsequent prunings with pole saws.

PINE UTILIZATION

For the year ended 30th June, 1966 the total round-wood production from departmental plantations, mainly in the form of thinnings, was 1,875,750 cubic feet U.B. (53,122 m^3). Of this total, nearly 60 percent was P. pinaster and the remainder P. radiata.

About 68 percent of the P. pinaster was produced as sawlogs, mostly case logs with crown diameters U.B. of 4"-9". Thirty percent went to a chipboard factory near Perth, in log sizes ranging from 2½"-4" crown diameter U.B. The remainder was sold for fence posts, woodwool logs and poles.

Nearly 90 percent of the P. radiata was obtained as sawlogs for both case and board production. Peeler logs accounted for the remainder.

The Forests Department has four small board mills based on plantations 90 miles (145 km) and more from the Perth market. These four mills at present supply most of the board requirements of the Perth market. In addition a small case mill at Ludlow (near Busselton) produces cases for fruit growers in nearby districts.

FIRE PROTECTION

One of the most important functions of the Department is the protection of State Forests from fire.

The climate in the south-west corner of the State consists of cool, wet winters and hot, dry summers. In general, about 80 percent of the rainfall occurs in the six months, May to October inclusive.

The subject of fire control will be dealt with in some detail during the tour, but the following notes give a broad outline of prevention methods employed.

Hazard Reduction

Rotational controlled burning is practised with the object of covering the whole of the forest area in five years.

For the jarrah forest, fire danger ratings and a controlled burning guide have been prepared and tested in practice. They have proved valuable aids to the planning and execution of rotational controlled burning. Investigations along similar lines are being carried out in the karri forest region.

Detection

Fire-spotting is done from a network of 36 look-out towers spaced at intervals of 10-15 miles (16-24 km), or more rarely, 20 miles (32 km), throughout the forest. Actually, several of the "towers" are karri trees with their branches lopped and cabins built in the upper branches. The cabins may be from 170-200 feet (52-61 m) above ground level. Gloucester Tree is an example. The highest constructed wooden tower is 140 feet (43 m).

Fires are usually pin-pointed by cross-bearings from two or more towers.

Communications (Telephone)

Look-out towers, divisional and district headquarters are interconnected with a single wire earth-return telephone system covering some 1700 miles (2,700 km). In addition, P.M.G. telephone lines link the various headquarters.

Communications (Radio)

Very High Frequency (V.H.F.) radio now forms the main supplementary means of communication, but is supported by H.F. radio for the transmission of weather reports, etc. At present the V.H.F. system consists of 18 repeater stations, 18 fixed stations and 143 "mobile" sets. These give a radio coverage of the whole of the State Forest except for a relatively small area in the extreme south-east.

FOREST MANAGEMENT

The general management of State Forests is governed by Working Plans and estimates covering a Scheme of Expenditure are placed before Parliament each year.

The practice of management is carried on within a framework of 15 Divisions under the management of Divisional Officers responsible to Superintendents.

Forest Engineering

The need to provide adequate access to the forests for the purpose of protection and management has resulted over the years in a network of some 16,000 miles (26,000 km) of roads tracks and firelines being constructed and

maintained. The Department provides and maintains the plant and equipment necessary to carry out this work. Other equipment includes stationary engines, power pumpers, power saws and agricultural implements.

Buildings

Wherever possible, the Department provides housing for its employees, the total number of houses at present being 474. The old system of having a divisional headquarters with small outlying forest settlements for each region is no longer applicable. Changing times and social attitudes make it necessary to move people in outlying settlements to centres of larger population. Better road systems and faster transport make it possible to cover larger forest areas from central locations.

Apart from offices and research buildings the Department also has five small pine mills and two small hardwood mills.

Mapping and Inventory

The Department prepares all its own topographical and vegetation maps using photogrammetric procedures which have been greatly improved by the recent acquisition of a Wild B8 stereo plotter for base plan preparation. The mapping programme covers about 1.8 million acres (0.73 million ha) per year.

Systems of continuous inventory have been introduced into the hardwood forest using air-photo stratification. Since 1954 all State Forests have been covered by detailed inventory and re-inventory is now proceeding at a rate of about 0.5 million acres per year. Continuous inventory using height-age relationships for site classification is now being introduced into the

plantations, where the former system of inventory based upon subjective site classification and yield tables has been abandoned because of basic mensurational problems and variability of site and stand conditions.

REFORESTATION AND SILVICULTURE

Careful control is exercised on all sawmilling permits within State Forest to see that under the silvicultural system in operation, the correct trees are removed in such a way as to protect the remaining growing stock and encourage regeneration. This control is achieved by the actual branding by a forestry officer of every tree which is to be felled. After felling, a top disposal and burning operation assists to protect the immature growth and provide both a seed bed and fire protection for the young crop.

In the northern cut-over jarrah forests, surplus stems in the form of useless trees and veterans of marginal quality, as well as competing stems in sapling and pole stands are still occupying valuable growing space. To bring these forests to a condition of maximum production, a stand improvement programme is proceeding which involves normal logging, salvage cutting, thinning and the removal of useless trees.

More detailed information on the silviculture of the jarrah and karri are discussed later on in these Notes.

FOREST RESEARCH

Very briefly the current research programme involves investigations into the following (not in order of importance) :-

1. NATIVE HARDWOOD FORESTS

A. Jarrah

(i) Thinning regimes in sapling and pole stands in prime forest.

(ii) Inducement of dynamic growth in natural regeneration.

(iii) Achieving satisfactory stocking where regeneration is inadequate.

(iv) Rehabilitate detiorated sites where jarrah has died out.

(v) Stem analysis to measure the response to treatments.

B. Karri

(i) Ensuring adequate stocking of karri or other introduced hardwood species.

(ii) Thinning regimes in sapling and pole stands of second growth karri.

C. General

The life cycle and possible control measure for forest insect pests such as jarrah leaf miner.

2. SOFTWOOD PLANTATIONS

A. P. pinaster

(i) Tree improvement.

(ii) Site potential of available planting land.

(iii) Thinning regimes.

(iv) Periodicity of growth in relation to environment.

(v) The cause of a shoot disorder.

(vi) Other planting sites further south.

B. P. radiata

(i) Methods of ground preparation for best establishment results.

(ii) Control of scrub after planting.

(iii) Thinning regimes.

(iv) Testing the South Australian regional volume table for P. radiata under W.A. conditions.

3. FIRE RESEARCH

A. Native Hardwood Forests

(i) Fire danger rating and controlled burning guide for the southern jarrah and karri forest region.

(ii) Fire damage in jarrah.

B. Softwood Plantations (P. pinaster and P. radiata)

(i) Safe limits for controlled burning under pine canopy.

(ii) Prediction of fire behaviour in uncontrolled fires in plantations.

4. MANAGEMENT RESEARCH

(i) Pine mensuration.
(ii) Pine growth.
(iii) Sampling for Inventory (Hardwood-Pine).
(iv) Yield calculations.
(v) Economics of forest operations.
(vi) Development of A.D.P. systems.

5. UTILIZATION RESEARCH

A. Forests Department

(i) Comparison of strengths of round and split mine props in the Collie coal mines.

(ii) The life of commercially preservative treated karri and marri railway sleepers.

B. Forests Dept. in conjunction with Division of Forest Products

(i) Marine borer tests of treated pine and hardwood at Kwinana and Port Hedland.

(ii) The life of treated and untreated timbers in cooling towers.

(iii) The life of preservative treated marri, karri and jarrah railway sleepers.

GENERAL NOTES ON ITEMS OF INTEREST DURING THE TOUR.

NORSEMAN

With a population of 2,500, Norseman is the major gold mining centre outside Kalgoorlie, some 100,000 ounces of gold being recovered annually, practically all from the Central Norseman Goldmine. A second mine, the Norseman, once produced gold but now mines iron pyrites.

A feature of the surrounding country is the presence of extensive hardwood forests of low to medium height which provide a ready supply of mining timber and firewood. Large quantities of fence posts, mainly Boree (Melaleuca pauperiflora), are available for the fencing requirements of local pastoralists and farmers on the Esperance Plains some 100 miles to the South. These forests are remarkable for their development in an area with an average annual rainfall of barely 11 inches (28 cm).

Further notes are given in the pamphlet entitled "The Semi-Arid and Arid Eucalypt Zone of South Western Australia."

ALBANY

Albany is one of the major townships and regional centres in Western Australia outside the Perth metropolitan area. Its fine natural harbour provides an outlet for the produce of the lower southern agricultural areas. The Albany zone covers about 22,000 square miles (57,000 Km.^{2}) and supports a population of over 50,000 of which 12,000 reside in the township of Albany.

The main exports from the port are wheat, apples, oats, barley, wool, frozen meat and whale oil. Imports include rock phosphate, crude sulphur, petroleum products and jute goods. The rapid development of the hinterland in recent times has resulted in the total trade being quadrupled in the last 10 years.

Local industries in Albany include woollen mills, meatworks, butter factory, pea processing factory, freezing works and superphosphate works. Albany is the centre for the one remaining whaling enterprise in Western Australia and also supports a fish canning industry.

Historically the town is of interest as it was the first place settled in Western Australia. Discovered by Captain George Vancouver in 1791 a settlement was established in 1826, three years before the settlement on the Swan River, now Perth. Until 1831, Albany, or Frederickstown as it was then called, was an outpost of New South Wales.

THE NATURAL OCCURRENCE OF KARRI (E. diversicolor)

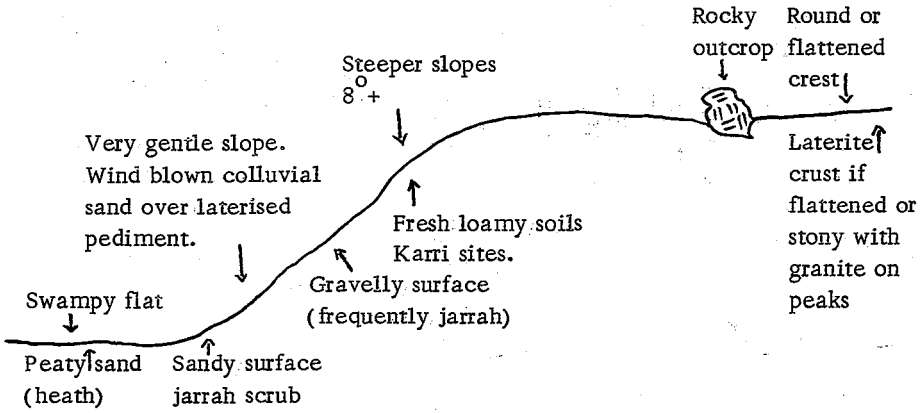
The leaflet on karri, provided at the start of the tour, gives information on the habit and distribution of the species. However its occurrence, apart from rainfall, is largely controlled by the edaphic factor. Only deep, relatively freshly produced soils are able to support high forest growth. The soils have resulted from the erosional stripping of fossil soils (laterite caps and sands) thus exposing the parent rock, usually gneissic in character. A characteristic of most karri soils is the formation in them of ironstone gravels which are retained as part of the deep colluvial mantle.

PASTURE ESTABLISHMENT ON KARRI SOILS

The conversion of karri sites to pasture presented many problems to the early settlers. The problems included the removal of massive trees and the prevention of karri regrowth development or invading scrub species, especially bracken. The soils are naturally too infertile to support the establishment of grass, and applied fertilizers were rapidly lost by leaching. Trace element deficiencies also retarded development. However, once a sward of deep rooted persistent species (e.g. Kikuyu grass) is established, grazing is successful.

COMMON SOIL PATTERN - COASTAL AREAS

Associated with the large rises there is a typical catenary sequence in the soil pattern, as indicated by the following diagram.



JARRAH FOREST VEGETATION (HAY RIVER-DENMARK)

The following is typical of the vegetation to be seen between the Hay River and Denmark.

Trees	(Jarrah - E. marginata
	(Marri - E. calophylla
	(Sheoak - Casuarina fraseriana
Understorey	(Ti-Tree - Agonis parviceps
	(Wattle - Acacia myrtifolia
	(Spearwood - Kunzea sericea
Undergrowth	(Emu Bush - Podocarpus drouyiniana
	(Green Kangaroo Paw - Anigozanthus flavida
	(Sedges - (Restionaceae)

DENMARK

The Denmark River, along with its good stands of karri, was known early in the history of the State. In 1829, the same year that the Swan River settlement was established, Dr. Braidwood Wilson led a small exploration party out from Albany. Two of the results were the naming of the river and the report of good stands of timber.

The township of Denmark had its beginning in 1895 when Millar Brothers (now Millars' Timber and Trading Co.) established a timber mill. By the end of 1896 three mills were operating, producing 7,500 cubic feet (210m^3) of sawn timber daily, and employing 700 men. Timber produced was exported and supplied building needs for the rapid development of the Eastern Goldfields (Kalgoorlie, Coolgardie etc.). Their life was not long. They closed down in the early 1900's.

The next impetus was the extension of the Group Settlement Scheme in the 1920's. Of the

400 settlers allocated farming lots, only 100 remained by 1936. Most of the farms were located in the karri areas cut over by the mills at the turn of the century. This venture at land settlement was economically disastrous to the State and to the majority of the settlers. However, by amalgamation of farms for surviving Group Settlers, and for later settlers, the farming community now exists. Then as now, the main source of income is dairying, though beef cattle and sheep numbers in recent years have been increasing. Orchards and potatoes are grown but are of minor significance. There is some professional fishing.

The population of the Shire is about 2,000, but this would increase significantly during the summer when the mild climate, scenic coastline and inlet attracts many visitors.

A Government sponsored Agricultural Junior High School was established on the outskirts of the town in 1942. This provides a course of 2 years for a total of 40 students ages 15 or more. It specializes in animal husbandry and pasture establishment.

FIRE DAMAGE IN KARRI

Karri, while not a lignotuberous species, depends upon a strong ability to produce epicormic shoots to re-establish a crown or sapling stem.

The species is fairly fire-resistant and will recover after complete defoliation. However, repeated hot fires cause degeneration of the crown, thinning of the bark, and finally death. Whether or not regeneration results after a hot fire depends on the availability of seed in the crown at that time.

Karri saplings, once established for a few years, are not killed outright by fire but shoot

again from the stem or base of the stem. The critical diameter for death of a stem appears to be three inches. The bark thickness of stems with larger diameters appears to be sufficient to protect the cambial layer. Thus, regrowth stands damaged by past fires often have kinks corresponding to the periodic fire occurrence. Such damage can result in the development of heart rot. "Brown wood", apparently containing incipient rot, is a feature of regrowth stands in the Denmark area.

SAWMILLING ACTIVITY IN THE DENMARK-WALPOLE AREA

There are no major sawmills (daily log intake over 2,500 cubic feet - 70 mβ) in this area at present. However, a considerable forest resource of both jarrah and karri exists north of the settled areas through which runs the South Coast Highway. This applies particularly to the Walpole or western end. As demand increases so will sawmilling activity be introduced into these areas.

Existing mills cut timber mainly on land alienated in the past for agricultural development, or on areas set aside for future farming operations. Cutting in State Forest is limited to areas requiring urgent salvage treatment - e.g. fire damaged stands etc.

Mills operating are :-

Mill Owner	Location	Daily Log Intake Cu. Ft.	Cu. Metres
Whittakers	Denmark	2,300	64
Hawker Siddeley Building Supplies	Kent River	1,250	35
Bunning Bros.	Walpole	2,000	56

PASTURE DEVELOPMENT ON FLATS

In the vicinity of the south coast, considerable areas of flats exist. These are treeless for the most part, comprised of peaty sand which is waterlogged in winter, often dry in summer and usually very acid. An impervious hardpan development at varying depth is frequently found.

That these soils can be developed for pasture is illustrated by the "Old Man" plains. A heavy application of lime - at least one ton per acre - to correct acidity is necessary, as well as a heavy application of superphosphate. Various trace elements may also be needed. It is important not to disturb the topsoil to any great depth, otherwise the bared subsoil takes years to bring into an arable condition. It takes some time for the heavy root-mat of scrub to die and break down sufficiently to allow grass to develop.

Although presenting problems of establishment which are expensive to tackle, the trend is now towards pasture establishment on these treeless flats and lightly forested soils, as clearing and developing land carrying heavy forest is even more expensive.

RED TINGLE (E. jacksoni)

Red tingle grows to a very large tree, usually 140' to 160' (43m-49m) in height and four to seven feet (1.2m to 2.1m) in diameter breast high, but it can attain 200' (61m) in height and 15' (4.6m) in diameter.

Its occurrence is restricted to about 100 square miles (259 $Km.^2$) along the lower reaches of the Deep, Frankland and Bow Rivers. It grows in situations up to 600 feet (183m) above sea level.

The climate is temperate, perhaps the most temperate in the State. Temperatures rarely fall below freezing point or exceed 95°F. in the shade. The annual rainfall ranges from 50 to 60 inches (127 to 152 cm), falling mostly in winter with many days of light rain. Summer rainfall - 13 inches (33 cm) - though light, is greater than most areas in the southern part of the State. The growing season of 10 months is the longest recorded in the State.

Red tingle is one of the more shade tolerant eucalypts being able to regenerate in small gaps in the forest. Its crown is denser than other local eucalypts and in overall appearance it bears a resemblance to jarrah.

The timber is red-brown in colour, resembling jarrah, but is lighter in weight. Although having a high shrinkage with drying, and a tendency to collapse, its lightness, strength and appearance make it one of the best timbers in Western Australia. Only its restricted occurrence prevents its wider use.

RED FLOWERING GUM (E. ficifolia)

There are several restricted pockets of this species growing within a few miles of the red tingle forest. In its natural state it forms a straggling much-branched tree, growing on low sandy rises near the coast.

The brilliantly coloured flowers (orange-pink-scarlet) have been the reason for the wide horticultural planting of this tree in Australia and overseas.

NATIONAL PARKS

In Western Australia, national parks vary in their status and administration. They may be

broadly classified as :-

(a) Those vested in the National Parks Board - e.g. Nornalup National Park. A paid managing secretary and a staff of rangers are responsible for their maintenance and development. Finance comes from Government grants and revenue from users.

(b) Those vested in local bodies - e.g. Warren National Park. These are discussed more fully later on in these Notes - see page 79.

The Forests Department has little direct responsibility for them, but as many occur within or adjacent to State Forest, their protection is often linked with that of State Forest. Some access roading and controlled burning is done by the Forests Department, with part of the cost in some instances being recoupable from the administering authority.

WALPOLE

Walpole had its beginnings in the 1920's as a small outpost township to serve the surrounding Group Settlement. Agriculture did not prosper due to the high cost of development and many other factors. Although improvements have been made progress has been slow.

The township has received some impetus as a seaside tourist resort, having a mild climate and good natural boating and fishing facilities. Since World War II a sawmill has been established along with a small Forests Department settlement. It is likely that in the future it could become a much bigger sawmilling and forest administration centre.

YELLOW TINGLE (E. guilfoylei)

The geographic occurrence of yellow tingle is restricted, like red tingle, to the lower reaches of the Deep, Frankland and Bow Rivers, but extends further inland and along the coast. It grows in association with karri, red tingle, jarrah and marri.

The tree bears an external resemblance to both red tingle and jarrah, but its size is typically less than red tingle and equivalent to jarrah.

The wood is yellow, hard and straight-grained. It has the same durability rating as jarrah and is accepted for railway sleepers under the same specification. Only its limited occurrence precludes its wider use as an all-purpose timber.

ESTABLISHMENT TRIALS - EXOTIC EUCALYPTS AND CONIFERS

State Forest, particularly approaching the south coast, includes a high proportion of non-forested plains and low quality jarrah forest. In this vicinity the proportion is as high as 40 percent.

Also the timbers of the native eucalypt forests of W.A. are mostly reddish coloured (jarrah and karri). Lighter coloured woods exist (tuart, blackbutt, yellow tingle) but their natural occurrence is restricted. A demand exists for light coloured joinery and furniture woods, which must be supplied largely from imported species. Lighter coloured timbers are also favoured for the production of pulp for paper products.

To gather information on the possible

establishment of exotic species on unproductive areas, and to correct the deficiency of light coloured woods in W.A. a programme of establishment trials has been instituted to cover a complete range of sites and includes a range of exotic eucalypts and conifers.

The experimental design is based on a unit of five trees of any one species, replicated at random at least three times, preferably 5. A number of species, both eucalypts and conifers, forms a unit block. Treatments include varying site preparation, ploughing, fallow periods, drainage, time of planting, and the application of fertilizers at time of planting. On any one site the aim is to repeat the whole experiment three times in different years.

At this stage the aim is to obtain information on establishment only. Later when the adaptability of species can be confidently compared, plots of the more promising species will be established to obtain information on growth.

So far it is apparent that drainage and the application of complete fertilizer is of definite benefit to the establishment and early growth of all eucalypts. With conifers (pines) the position is not so clear.

In higher quality karri sites E. muelleriana (yellow stringy bark) is known to grow vigorously and with splendid form, better than natural karri in the younger stages. This has a light coloured durable wood, which would satisfy a demand for durable poles, and for lighter coloured sawn timber. Tasmanian blackwood (Acacia melanoxylon), a valuable cabinet timber, grows well and regenerates freely in gullies in the karri forest.

Economics of establishment and distance from

market precludes the establishment of any significant amount of such plantation this far south at this time. However, the time will come when demand for timber and competition for land will make such establishment possible. Meanwhile the basic knowledge is being obtained.

JARRAH DIE-BACK

Description

The term "Die-back" has been applied to mortality occurring in patches of the forest. It is, perhaps, a little misleading, implying partial rather than the actual, rapid and complete death of some of the trees and other plants in the areas concerned.

Small isolated areas of die-back have been observed and reported over the years since the early 1920's but until relatively recently were not recognised as a problem of significant proportions.

The early symptoms are the chlorosis ("yellowing") and fairly rapid death of certain understorey and shrub species. Usually the most susceptible are members of the family Proteaceae. Banksia and Persoonia are the first of the tree species affected and as such are used as the chief indicators of the disorder.

In the case of jarrah, death may be sudden from an apparently healthy condition, but in most cases there is a gradual deterioration in crown vigour. This deterioration is marked by thinning and yellowing of the primary crown, reduction in leaf size, death of branchlets and replacement of crown by epicormic shoots. Epicormic crowns display the same symptoms of poor health and there may be third and fourth order epicormic replacements before death. The

process may take a few or many years and temporary recovery may occur.

All size and age classes of jarrah are affected. Advance growth appears, however, to be more resistant, but eventually succumbs.

Die-back has reached its major development in average to lower quality forest, but does also occur in high quality forest. It is most commonly found in cut-over areas but can also appear in virgin forest.

Distribution

Die-back patches have now been located throughout the entire geographic range of the merchantable jarrah forest. That is, from Walpole and Margaret River districts in the South to Mundaring and the coastal sand plain country of the Wanneroo district in the North.

The highest incidence is along the Western edge of the main forest zone close to the edge of the Darling ranges North of Harvey.

It occurs most commonly at the heads of shallow gullies but has been found on ridge tops, steep slopes and, in fact, in every topographical situation.

Cause

In October 1964 the pathogen Phythophthora cinnamomi was isolated from roots of jarrah seedlings in the diseased soil series. Soil moisture and temperature requirements for a rapid build up of this fungus are met, at least in part, in every spring and autumn. The death of the rootshoots in this period followed by a hot dry summer can lead to rapid loss of vigour and sometimes death.

An alarming feature of this fungus is that it is easily transported from place to place by such

common activities as logging and the removal of gravel for roadworks etc.

Area Affected

Out of total of 433,600 acres (175,500 ha) mapped to date, from aerial photographs of the western portions of the northern jarrah forests, just over 14 percent of the area has been affected by die-back.

Mapping is continuing in areas further south and, present indications are that a further 70,000 acres (28,300 ha) are affected bringing the total to some 130,000 acres (52,600 ha).

Rate of Spread

Die-back is estimated to be increasing at an overall rate of 4 percent of the present affected area per year.

At present the aim is to fully utilize all merchantable timber on affected areas.

Investigations

These come under two main headings of "control" and "replacement".

1. Control

Affected areas are clear felled and
(a) the perimeter either trenched, or
(b) the major host species in the perimeter - e.g. banksia - eliminated by various means.

2. Replacement

Various introduced commercial species are being tried. So far tallowwood (E. microcorys) has shown promise, and P. pinaster has been successfully grown on die-back areas for up to 10 years.

SHANNON RIVER SETTLEMENT

This settlement houses the employees of one large sawmill and of the Shannon River Divisional Forest Headquarters. Over 90 employees are on the sawmill payroll and over 30 are occupied in forest administration.

The sawmill, which commenced operations in 1949, has a daily log intake of some 5,000 cubic feet (140m^3) and the sawn product is transported by road 34 miles to the railhead at Manjimup. In an isolated settlement such as this, lack of amenities such as higher grade schooling and better class amenities make the procuring and holding of suitable labour a difficult problem. The trend is to locate such sawmills closer to bigger townships such as Manjimup. It is considered that the increased cost of a longer log haul would be offset by having no housing construction and maintenance costs, and a more stable source of skilled labour would result.

AGRICULTURAL DEVELOPMENT - MANJIMUP REGION

The first settlers arrived in the Manjimup-Pemberton area in the mid-late nineteenth century.

Exploration and consequent development came both westwards from Albany and southwards from Perth, Bunbury and Busselton. Cattle raising was the main source of income, though other avenues were attempted, e.g. wheat at Channybearup, fruit trees, mainly for homestead use etc. Generally settlers placed themselves astride the main permanent streams in the area - Warren, Donnelly, Perup Rivers - Wilgarup, Lefroy Brooks.

Early in the 20th century the timber industry began operating in the area, and with it came population, railways and further farming development. The 1920's and 1930's, following World War I, saw the Group Settlement Scheme. This was an attempt to settle immigrant farmers in groups for the purpose of mutual help. Government assistance was given in the form of housing, limited clearing, fencing, stocking advice and supervision. The work in the first years was to be done by the settler with payment by the Government. When the property was viable the debt thus far incurred would be taken over by the settler along with his farm. Diarying was the basic land use.

The scheme, grandiose in concept, was largely a failure. Costs of clearing were much greater than anticipated, basic knowledge of soil deficiencies and corrective measures was lacking, and the depression reduced returns to subsistence levels. Most of the settlers left their farms, leaving in their wake thousands of acres of devastated forest. Evidence of dead trees on Group Settlement land, ringbarked by relief labour during the depression, can be seen throughout the area.

Since then, the land so abandoned has been taken up by the remaining Group Settlers, other settlers, and later farmers possessing more capital and increased knowledge. Some land, particularly that which regenerated to karri, has been repurchased by or has reverted to the Forests Department. In some areas, e.g. Northcliffe, large areas still remain vacant.

Following World War II a Soldier Settlement scheme attempted to resettle some of this land by growing tobacco and by dairying. This also failed here, though a few settlers still remain. Tobacco growing failed completely.

The existing farming community is well established and economically sound, though not opulent, by comparison with other areas further inland.

Three factors have combined to make agriculture in the region more prosperous.

1. Irrigation

Though not in unlimited supply, water availability is greater here than elsewhere in the southern half of the State.

Its use in spray irrigation has doubled the production per acre of horticultural crops, e.g. potatoes and orchards. Water is conserved during winter months by gully and catchment dams, from which it is pumped during the dry summer months for irrigation purposes. Some permanent streams are used without the need for storage.

Manjimup has a great potential for growing further horticultural crops, with irrigation, for canning and freezing processing. Peas, pears and peaches have been grown successfully in the past few years. A larger industry awaits the establishment of canning and freezing works, with more assured and stabilized marketing conditions.

2. The Bulldozer

Clearing costs have always been high in the heavy forest region. The bulldozer, though not making clearing cheap, has speeded up the process, allowing earlier returns on capital invested in clearing and development.

3. Fertilizers, Minor Elements

All soils require heavy dressing of superphosphate in the early stages. The discovery

of minor elements deficiencies (copper, molybdenum, zinc) has enabled a much greater carrying capacity for stock on improved pasture.

The trends are towards intensification of all agricultural industries, with greater production sought from cleared areas. Further clearing is on a limited scale and governed, after sore experience, to what can be handled by the farmer. Small holdings are becoming amalgamated into bigger units of better economic potential.

Dairying for butterfat production (a heavily subsidised industry) is decreasing, though with the same trend towards intensification. Sheep raising for meat and wool is increasing, particularly in the last few years. Beef cattle are increasing. Pig raising is static. Orchards (apples and stone fruits) are increasing, and it can be expected that peas and other fruits for canning and freezing will increase. Potatoes are strictly controlled by the Potato Board, each grower being restricted by licence to a certain acreage for each crop (2 annually). Yields per acre however have increased. Some of the heaviest yielding crops in the State are grown here - up to 27 tons/acre. Irrigation of pasture has begun and is expected to increase, particularly where the farmer already irrigates horticultural crops.

The expanding use of water has pointed out the need for the control of water conservation, which so far has been left to the individual farmer.

UTILIZATION OF MARRI (E. calophylla)

Marri has a wider occurrence than both karri and jarrah. It occurs as a mixture with both species and as a pure stand in limited areas in the karri forest region. It is associated with a

wide variety of soils. Its best development is in association with karri and in pure stands in the southern extremity of its range.

Marri can often be the predominating species (in numbers) in mixture, particularly in the more southern regions where its standing volume assumes vast proportions. It is estimated that within 10 miles of Pemberton alone there is a resource of 45 million cubic feet (1.26 million m^3) potentially marketable.

Due to the prevalence of concentric shakes (termed water shakes) and kino, often associated together, marri has been avoided as a commercial species. Apart from the vast resource, the desirability of utilizing this species is enhanced by its tendency to dominate the mixture further with the removal of other more desired species.

Recent tests have indicated that in the better areas of its development (with karri), up to 50%, but more generally about 20% of the standing marri volume has high enough quality to permit economic sawmilling. A licence has been issued to one milling concern for its utilization over a wide area. It is expected that gradually more and more will be sawn.

The sawn product, provided that kino and water shake is not excessive, is satisfactory for general building purposes. The timber is creamy brown in colour, with good strength properties and with durability midway between jarrah and karri. As the sapwood is prone to lyctus attack, anti-lyctus treatment in the form of low pressure preservative treatment is desirable. Occasional defect-free logs are obtained capable of producing high quality boards and joinery.

One of the chief problems associated with its

utilization is the difficulty experienced in selection of the better quality log in the forest, both in the standing tree and when fallen with the ends exposed. Experience has shown that trees with good vigorous crowns and straight stems contain utilizable logs. Lack of vigour, heavy lean, bends, kinks, overgrowth and visible kino indicate faults. Even so it is usually necessary to fell more trees than are required so that a selection can be made. Mounting experience tends to make selection of the fallen logs more certain.

Properties of strength, and the ability of the sapwood to dry out to 20% M.C. without excessive checking have made marri poles desirable for pressure preservative treatments and use by the P.M.G. in telephone lines. Considerable numbers are treated at Picton near Bunbury.

Samples have been pulped experimentally by the C.S.I.R.O. and pulp manufacturers in the Eastern States. Although not rated highly as a pulping species, its eventual utilization for pulp is not impossible. As yet there is no pulping industry in W.A.

Its annual seeding habit, its vigour in colonizing openings and its resistance to such diseases as leaf miner and dieback, though highly desirable in themselves, make it a problem species when it occurs in competition with the economically more desirable species of karri and jarrah. Given time, further developments in utilization could enhance the economic value of marri - at which time its silvicultural characteristics would be less of a problem. With this possibility in mind, any action to remove marri to waste as an undesirable species, so as to maintain or improve the balance in favour of karri and jarrah must be considered with caution.

At present the removal of marri to waste by poisoning or felling is confined to defective stems in good quality karri forest. This is done following the selection felling of karri and prior to the regeneration burn, which is designed and timed to favour karri regeneration.

EARLY THINNING AND FERTILIZER TRIALS IN NATURAL KARRI REGENERATION

Successful natural karri regeneration produces up to 30,000 seedlings per acre. Competition sets in almost immediately, and consequent deaths steadily reduce the number per acre from year to year. Although karri establishes dominance quickly and permanently, competition in an unthinned stand must take its toll of growth of dominant or crop trees. It seems likely then that early thinnings to reduce this competition could have a beneficial result on the growth of crop trees.

Experiments examined two avenues :-

(a) Thinning young regrowth (ages 1 and 2 years), by using a foliar spray on unwanted stems and
(b) Use of various fertilizers to promote growth in both thinned and unthinned stands.

It is too early to assess fully the results of these investigations, but it has already been shown that spraying must be done during the spring following germination, i.e. at age 6 - 8 months. At this age both karri seedlings and scrub are at a height of 6-12 inches. No significant response to fertilizers has been noted in the thinned and unthinned regrowth, but where used in planting holes for artificially planted karri seedlings, growth has increased 1½ to 2 times.

SILVICULTURAL SYSTEMS IN KARRI

The system currently in use is a selection system, termed "Australian Group Selection". This allows the removal of single trees, e.g. in the thinning of a young group, to virtual clear falling with retention of seed trees in limited areas of grossly overmature and fire damaged bush. Thus the proportion removed is governed by the condition of the stand. Where the proportion of vigorous growing stock is high, the proportion removed is low, - where growing stock is deficient in fire damaged and overmature stands, the proportion is high. The average removal rate is 50-60% of the virgin stand.

Time, with changes in market conditions and further experience have changed the picture somewhat. There are factors which detract from a selection system viz.:

1. Use of Fire

The cheapest and most effective means of obtaining regeneration is to burn logging slash and scrub at a time when seed supply is adequate in trees left standing. Ash bed so created, along with removal of competition, favours the germination and growth of the new karri crop. The greater the intensity of the burn the better is the resultant regeneration in both stocking and early vigour, - but the greater also is the damage done to residual growing stock. The desirable compromise in fire intensity, between favouring the growing stock at the expense of regeneration on the low scale, and favouring regeneration at the expense of growing stock on the high, is difficult to obtain. The periodic flowering and seeding habit of karri (four years at least) means that the area of cut-over forest requiring regeneration

accumulates steadily from the last seed year, often presenting a large and fragmented area for regeneration burning in the next seed year. The timing of the burn with respect to weather conditions and seed availability is critical. Success therefore depends upon the fine and brave judgement of the officer responsible.

The prospect of regeneration burning in second and subsequent cutting cycles, when areas will be greater due to reduced volume per acre available, when protection of a younger age class will be involved, is not enviable.

Apart from regeneration, fire is also used to protect both karri and jarrah forest by means of controlled burning. The problem of prescribing times and techniques for controlled burning in stands of mixed age is greater than for even aged stands with uniform fuel conditions.

Young karri up to at least age 10 years is susceptible to fire damage even at low intensity. Complete protection must therefore be afforded during this period. The area under complete protection will be greater under a selection system. This is balanced by the fact that a selection stand in which the regeneration has failed due to wildfire, mistiming of the regeneration burn or other factors, can be revitalized much easier than a young stand of uniform age which may contain no trees of sufficient age to produce seed.

2. Falling and Extraction Damage

Karri is a large tree both in height and volume. Heavy equipment is required for its extraction. Damage to younger members of a selection stand required for growing stock must occur in the felling and hauling operations. Although experience has indicated that this can be kept to a minimum it is a factor which is largely

avoided in an even-aged system.

Costs of extraction and supervision and ease of management favour an even-aged system.

NOTES ON THE JARRAH FOREST

After lunch on Monday, 1st. May, the party will see an example of a virgin jarrah (E. marginata) stand in the southern forest belt. Although this is a good quality forest, it is not quite typical of virgin stands in the prime jarrah forest north of the Blackwood River as it contains a much higher proportion of marri. Only small areas of uncut jarrah forest remain in the north and it is regretted that time would not permit the party to visit one of these rather isolated areas on Thursday, 4th May.

The party will have received prior to the commencement of the tour, a leaflet on jarrah dealing in some detail with its habit, distribution and description of the wood and its uses. The following brief notes are intended to provide further information on the most important commercial forest tree in Western Australia.

Climate

The climate is typically Mediterranean with a reliable, well defined winter rainfall and a very dry summer. At Dwellingup which may be taken as representing the typical prime jarrah belt, the average annual rainfall is 51 inches (130 cm).

Average temperatures range from a maximum of 84°F in February to a minimum of 41°F in July. In summer, rainless periods of up to 40 days can be experienced and temperatures over 100°F are usually recorded for a few days each summer. During winter, frosts are common and ground temperatures may fall as low as 25°F.

The following table shows the monthly average rainfall and temperature recordings for Dwellingup.

Month	Rainfall		Max. Temp. °F	Min. Temp. °F
	Points	Mms.		
January	30	8	83	56
February	86	22	84	56
March	85	22	80	54
April	264	67	72	49
May	659	167	64	45
June	1039	264	60	43
July	996	253	58	41
August	834	212	60	44
September	469	119	63	43
October	341	87	66	45
November	177	45	73	49
December	89	23	79	53

Topography

Jarrah does grow on the coastal plain where the boles are usually short and the crowns umbrageous. It reaches its best development in the higher rainfall areas of the Darling Range, a gently undulating plateau ranging from 400 feet (122 m) to 1600 feet (488 m) above sea level. The average altitude of the forested plateau would be about 900 feet (274 m).

Regeneration

Jarrah is a lignotuberous species and does not depend solely on seedfall for replacement. In a seed year, once every four to six years, germination takes place after the first general rains in autumn. The surviving seedlings then proceed to develop a lignotuber and normally do

not throw out a dynamic shoot until the lignotuber is some four inches (10cm) in diameter. This may take 15 years or more and during that period the young jarrah develops a low bushy habit up to three feet (1m) in height. This "advance growth" as it is known, is commonly distributed throughout the virgin or fully stocked forest. In this stage it is virtually indestructible by fire. When there is a reduction in competition, dynamic development of saplings occurs particularly following the logging of the forest.

Coppicing

This aspect as it affects the thinning of jarrah pole stands is discussed in some detail on page 93 of General Notes.

PEMBERTON

Pemberton is a timber milling, farming and tourist township within the Shire of Manjimup.

The first settler, Edward Revely Brockman, arrived in 1861 and settled on the Warren River. He was followed by Pemberton Walcott in 1862 who settled on what is now the northern outskirts of the town. Further development was slow until 1913 when a mill was established to cut karri sleepers for the transcontinental line. A township was formed which was called Pemberton after Pemberton Walcott.

The 1920's and 1930's saw Group Settlement bring an influx of settlers to the district, with the formation of Northcliffe further south. Group Settlement had much the same unfortunate history here as elsewhere. Time, with amalgamation of farms for survivors and other settlers has seen the development of a stable farming community. The pattern of Agricultural land usage is similar to Manjimup - i.e. irrigated orchards, potatoes

and other horticultural crops, dairy and beef cattle, and sheep of recent years. Irrigated pastures, both annual and perennial, are making their appearance. One notable crop, grown nowhere else in the State is hops. One appreciable plantation exists and prospers on the Beedelup Brook, some 10 miles west of Pemberton.

Being the centre of the karri forest area, and possessing permanent streams containing marron and introduced trout, Pemberton has become a tourist centre of some significance.

Sawmilling has however been the major source of income for residents of the town, and has continued, not always with steady prosperity, from 1913 to the present day. It is a Divisional centre of the Forests Department.

The new timber mill has been constructed by Hawker Siddeley Building Supplies to replace both the old mill which is still standing, and another mill which was burnt down in 1961. Formerly these were part of the State Buildings Supplies, a Government owned organization which was sold to Hawker Siddeley interests in 1962.

The new mill uses a band saw for breaking down and sizing, and a stub edger for its major production bench. Although not new to sawmilling in W.A. they are departures from the usual pattern of karri and jarrah sawmilling. An inspection of the mill will be conducted by the management of Hawker Siddeley Building Supplies.

Permissible Intake	- 2,502,000 cu. ft. ($70,056\ m^3$)p.a.
Actual Intake (one old mill)	- 1,250,000 cu. ft. ($35,000\ m^3$)p.a.
Expected Intake (one new mill)	- 2,500,000 cu. ft. ($70,000\ m^3$)p.a.
Expected No. Employees	- 115

WARREN NATIONAL PARK

The Warren National Park, along with the Beedelup, Brockman, Vasse Road, and Pemberton town reserve total 8,140 acres (2,010 ha). All contain virgin karri of high quality.

All are under the control of the Pemberton National Parks Board, consisting of some six local residents, appointed by the Minister for Lands under the Parks and Reserves Act of 1895. This body was constituted in 1928 at the instigation of local residents. Their first concern was the Townsite reserve, the others being added at later dates.

No finance was available to the Board, even from local sources until 1956, when it started receiving Government support, commencing with $1,000 towards approved capital development, and this has been increased progressively to $4,300 which it is receiving today.

The Board's policy over the years has been broadly to keep such reserves as Warren and Beedelup in a virgin condition, (providing access only) while the recreational reserve in town contains local and tourist facilities (swimming pool, caravan park, youth hostel, trout breeding ponds, nature trails).

All except the townsite reserve border on large areas of State Forest. Fire protection of State Forest must therefore take cognisance of these parks. The Warren National Park for instance, sits on the northern boundary of the Warren Block, which in the next decade will be cut-over and regenerated. The park, if maintained in a virgin and unburnt state will create dangerous fire hazards to itself and regenerated State Forest in a fire sensitive state. Already some 100 acres or so of the Park have been

severely fire damaged on the south side of the Warren River.

The Board is not necessarily opposed to controlled burning, but has insufficient funds or men to undertake any such work. In recent years some Government funds were made available to the Forests Department for further roading and maintenance. There was insufficient however to carry out burning as well.

THE FORESTS OF TREEN BROOK AND BIG BROOK

These two forests of karri are notable in that they result from natural regeneration following clear felling of all stems considered millable at that time. Nowadays such a system would mean the removal of far more stems per unit area.

Following logging, marri was ringbarked, casuarinas were felled, and unmerchantable karri stems were left to provide seed. In the case of Treen Brook, cut over from 1930-1940, regeneration burns were applied when seed was present in the remaining karri. However, in Big Brook cut over a decade earlier, from 1920-1930, a regeneration burn was programmed for 1930 but a wildfire completed the job before lighting began. The age of the regeneration in Big Brook is therefore 37 years and that in Treen Brook an average 10 years younger.

The dense regeneration obtained in Big Brook is illustrated by the following figures :-

1930 - 30 to 50,000 seedlings per acre germinated (74-123,000/ha)
1933 - stems reduced to 8,000 per acre (20,000/ha)
1950 - " " " 850 " " (2,100/ha) of which 300 stems were below 9 inches (23 cm) G.B.H.O.B.
1955 - stems reduced to 545 per acre (1346/ha)

At age 25 years (in 1955) fifteen 1/10th acre plots gave the following average figures :-

No stems per acre	- 545 (1346/ha)
B.A.U.B. per acre	- 174 sq.ft.($16m^2$)
Bole Height to 3" U.B. diam.	- 90 ft. (27m)
Vol. U.B. per acre to 3" U.B. diam.	- 4,200 cu. ft. ($290m^3$/ha)
M.A.I. per acre	- 168 cu.ft.($4.7m^3$)

At this stage five plots thinned to varying intensities and an unthinned control were established to obtain information for a thinning prescription.

These plots were remeasured 10 years later in 1965 and the results are summarised below :-

PARTICULARS	PLOT NO.					
	1	2	3	4	5	Control
BEFORE THINNING (1955)						
Stems/Acre						
Over 12" G.B.H.O.B.(No)	294	443	575	506	500	464
" 36" " "	60	53	45	63	89	62
Vol. U.B. to 3" U.B. diam. (cu. ft.)	3640	4180	4220	4580	5530	4430
M.A.I. (cu. ft.)	146	167	169	183	221	177
Vol. U.B. to 3" U.B. diam. in stems 36" + G.B.H.O.B. (cu. ft.)	2515	1865	1470	2180	3330	
M.A.I. in stems 36" + G.B.H.O.B.	100	75	59	84	132	

PARTICULARS	PLOT NO.					
	1	2	3	4	5	Control
AFTER THINNING (1955)						
Thinned to-stems/acre	20	40	59	79	59	
Thinned from	below	below	below	below	above	
B. A. U. B. -sq. ft. per acre	21.35	28.33	34.12	44,82	36.17	41.63
AFTER 10 YEARS (1965)						
B. A. U. B. -sq. ft per acre	35.05	47.55	53.32	65.75	51.27	56.23
INCREMENTS OVER 10 YEARS						
B. A. U. B. - sq. ft./annum	1.37	1.92	1.92	2.09	1.51	1.46
- Rate %	6.4	6.8	5.8	4.7	4.2	3.5
G. B. H. U. B. - Inches per annum	1.24	1.05	0.81	0.69	0.64	0.52

From the above it was deduced that it was safe to thin down to a minimum of 28 sq. ft. underbark per acre ($6.4m^2$/ha), or 35 sq. ft. overbark per acre ($8.0m^2$/ha).

Thinnings from such stands are expected to provide long poles for treatment and use in transmission lines, logs for small dimension sawn material such as tile battens and pulpwood when the need arises.

LEFROY BROOK SAMPLE PLOT (KARRI)

This 23 acres (9.3 ha) stand of second growth karri is estimated as being 92 years old and regenerated on what was once a wheat farm.

The area on which this karri now grows was leased to Mr. G. de Courcey Lefroy in 1861, who cleared 23 acres. It was known to have grown a

wheat crop in 1865. In December, 1869 it was acquired by a Mr. Giblett who abandoned it soon after and no further agricultural activity took place. The Forests Department bought the land in 1916.

If agricultural activity ceased in 1869 it is likely that some four to five years elapsed before sufficient fuel accumulated to carry a fire. As fire in those days were fairly frequent it is assumed the area was burnt as soon as it was capable of carrying a fire. Regeneration would probably date from this burn which is assumed to be 1875. On this assumption the stand age would be 92 years.

In 1928 one plot was laid down and a thinning by removing dominated and suppressed stems was carried out. A second plot was established in 1949 and remains unthinned.

Both plots were remeasured in 1954 and again in 1967. Growth details are given on the signboard.

Current thought favours a rotation age of 100-120 years so this area is now approaching rotation age.

KIRUP - NANNUP - BUSSELTON GROUP OF DIVISIONS

The total area of State Forest in these three divisions is 966,000 acres (391,000 ha). Jarrah forest covers almost the entire area except for 6,000 acres (2430 ha) of karri south of Nannup and at Karridale south of Busselton, 6,000 acres (2430 ha) of tuart on the coastal sands between Wonnerup and Capel, and 13,600 acres (5,500 ha) of pine plantation.

The distribution of the pine plantations is approximately as follows :-

Division	P. radiata		P. pinaster	
	Acs.	Ha.	Acs.	Ha.
Kirup (Grimwade)	4,700	1,900	200	80
Nannup	4,700	1,900	-	-
Busselton	1,200	485	2,800	1,130

Most of the P. pinaster is grown in the coastal sands near Ludlow.

The best development of jarrah occurs on the Darling Range plateau with an average elevation of 900 feet (274 m) and an annual rainfall of some 40 inches (100 cms). The quality of the forest falls away to the west and south-west of Nannup.

The whole of the better class jarrah forest has been logged at least once, but virgin areas of lower quality forest still occur to the west and south-west of Nannup. At present 50 hardwood mills are removing annually some 7,600,000 cubic feet (213,000 m^3) of sawlogs from crown lands and 1,150,000 cubic feet (32,000 m^3) from private property.

Small sawlogs from thinnings are also being extracted from Departmental pine plantations. Three small Departmental sawmills and one private sawmill obtain annually some 630,000 cubic feet underbark (17,600 m^3) of logs.

THE BLACKWOOD VALLEY PLANTATIONS

These are located on either side of the Blackwood River with Nannup township (population 1500) as its centre.

Plantation establishment commenced in 1956 and to date some 4,700 acres of P. radiata have been planted.

Soils

It is recognised that plantation establishment of P. radiata is satisfactory in soils of igneous origin giving rise to red brown and brown sandy loams as opposed to the generally occurring soils of lateritic origin. These suitable soils occur in isolated areas; in the Nannup Forest Division some 12,000 acres only are available. Soil surveys are carried out to locate boundaries of suitable and non suitable soil, on physical characteristics initially; finally chemical analyses are made; 250 ppm of P205 is considered to be the lower limit which indicates suitable soil types.

Establishment

The aim is to establish 500 acres (202 ha) per annum.

The following are comments on the various operations invalued.

Nursery Stock

Some 2 million plants of 1/0 open-rooted P. radiata and P. pinaster are raised in the local nursery annually. These supply the normal requirements of the Nannup and three other Divisions.

The seed is pre-treated with a fungicide (Ceresan) and is sown in September in drills 10 inches (25 cms) apart to produce 10 plants per foot (33/metre). Five drill lines comprise a bed suitable for straddling by a tractor. Damping off (Phytophthera sp. and Pithium sp.) is checked with an application of Cheshunt mixture. Water is applied as sparingly as possible; never to the P. radiata and ½" at 3 weekly intervals to P. pinaster, commencing in December.

All stems are root-pruned following the opening rains in April.

Weed control is effected by a pre-emergence treatment with Simazine at the rate of 3/4 lb. of active ingredient per acre (0.84 kg/ha). This accounts for 90 percent of the weeds, the remainder being controlled with applications of mineral oil (kerosene) at rates of 20-60 gallons per acre (225 - 674 litres/ha).

Planting is done by hand using a planting spear. Contractors are employed on this work and the successful strike is about 90 percent. Rabbits account for most of the losses.

Tending in the form of control of eucalypt coppice is achieved with 2,4,5-T either as a 0.4 percent application in water or as a basal spray in dieseline.

Establishment Costs

Average establishment costs for P. radiata plantations are :-

Nursery costs	-	$6/1000 plants
Ground preparation	-	$60/acre ($148/ha)
Planting	-	$10/acre ($25/ha)
Refilling	-	$4/acre ($10/ha)
Road and Tracks	-	$16/acre ($40/ha)

Pruning

This had been discussed on page 43 of General Notes. At Nannup both low and high pruning are done under contract.

Average costs for pruning P. radiata plantations are :-

Low pruning	-	$20/acre($50/ha)
High pruning	-	$11/acre($27/ha)
		$31/acre($77/ha)

Firebreaks

Firebreaks are kept free of annual herbaceous growth with the aid of chemical weedicides in particular "Vorox" at 2 lb/acre (22kg/ha), the active constituents of which are Atrazine and Amitrole.

THE TUART FOREST

Tuart (E. gomphocephala) is confined to the limestone formation and on this formation it stretches in scattered lines from the Sabina River, some three miles east of Busselton to Lake Pinjar some 30 miles north of Perth - a total distance of about 150 miles. Curiously enough, it is not found elsewhere in the State, although limestone occurs all round the coast line.

The tuart belt is separated from the seaboard by the extensive system of sand dunes, and from the Darling Range (which runs parallel to and at an average distance of 20 miles from the coast) by the lateritic foothills which claim jarrah as their principal tree.

A feature of the prime tuart forest, as represented by the stand to be seen approaching Ludlow, is the presence of native grasses. This is the only forest formation in the south-west of the State to have a ground covering partially of grass, a factor typical of savannah formations generally. The main understorey species is Peppermint (Agonis flexuosa).

Under optimum conditions tuart attains a height of 130 feet (40m) with breast height girths up to 30 feet (9m) but more commonly 10-20 feet (3-6m). Its form varies considerably from long straight boles to heavily branched short boles of poor form. The bark is persistent, rough and light grey in colour, typical of the "Box" group of

eucalypts more common in the Eastern States.

The timber and its uses have been described on page 41 of these Notes.

The climate is temperate, the winter usually frost-free and the summer heat moderated by cool afternoon sea breezes.

The average climatic recordings for Busselton are given below :-

Month	Mean Rainfall		Mean Temperature (°F)	
	Ins.	Mm.	Max.	Min.
January	0.41	10	82.5	56.2
February	0.46	12	82.3	56.2
March	0.86	22	78.5	53.8
April	1.37	35	73.2	50.6
May	4.71	120	66.2	48.2
June	6.51	165	62.4	46.0
July	6.43	163	60.6	44.6
August	4.53	115	61.6	45.2
September	3.05	77	63.9	46.9
October	2.30	58	67.4	48.4
November	0.88	22	74.0	51.3
December	0.52	13	79.3	53.9
	32.03	813		

The tuart forest is highly regarded as a tourist asset and strong representations have been made for its retention for that purpose.

Past History

Some cutting was carried out during the last century - some pit-sawing took place - and again early this century, but a high volume of standing timber remained.

Following the passing of the Forests Act in

1918, some 6,000 acres of private land carrying tuart forest were purchased and became State Forests No. 1 and No. 2. At the same time, 1920, dissatisfaction with the wasteful cutting by private operators led to the Forests Department erecting its own sawmill at Wonnerup, about six miles from Busselton. The mill operated until 1930 when orders ceased during the depression years. The sawn timber was used mainly for the requirement of the Government Railways. It was not until some 10 years ago that further supplies of tuart were milled. In the last few years a steady supply of sawn timber produced at the Department's mill at Ludlow has been forwarded to the Government Railways.

Regeneration

Natural regeneration of tuart presents a problem. The buds are subject to attack by a weevil (Haplonyx tibialis), but even when good flowering years occur, natural regeneration survives only on ashbeds. In addition, the weaker stems may then be attacked by a number of insects including leaf-hoppers (Cercopidae), leaf-rollers (Tortricidae) and the larvae of a Cerambycid beetle (Phorocantha sp.). Earlier trials of spot-sowing seed on natural ashbeds and sites on which wood ash had been spread met the same fate.

In 1955 various sites were totally cleared and ploughed to remove grass, and a variety of fertilizer trials initiated. These indicated that there was a positive response of planted one year old tray stock to the removal of grass and the addition of nitrogen in the form of ammonium sulphate. Growth after three years gave a codominant height of 20 feet (6m). However, the cost of such establishment was extremely high.

The latest trial area of 10 acres in which planting stock was raised in jiffy pots, will be discussed at Stop 9 on Wednesday, 3rd. May.

BUNBURY

Situated 115 miles south of Perth, Bunbury was one of the State's earliest settlements. It was founded in 1837 and named after Lieutenant Bunbury.

The town is solidly based and is growing both in size and importance as a natural outlet for the timber industry of the South-West, as a centre of many new industries and the port for the rich hinterland producing wheat, potatoes, fruit and other agricultural products. It is also the nearest port for the coalfields at Collie and for the export of ilmenite and titanium.

With a population of 15,000, its mild climate, ocean beaches and sporting facilities make it a popular tourist resort. It is also reasonably accessible to such scenic features as the underground caves further south.

DWELLINGUP FOREST DIVISION

The Dwellingup Division is situated in the Darling Range in the heart of the jarrah forest belt and covers over 400,000 acres (162,000 ha).

The commercial forest area is bounded on the west by the Darling Scarp and some 20 miles to the east by farming country. The Serpentine and Murray Rivers form the northern and southern boundaries respectively.

The adult male population of the small township of Dwellingup, totals about 250 comprised of Forests Department employees, sawmill workers and a small number of orchardists. Dependants total approximately 600.

Topography

The greater part of the area is on the gently undulating plateau of the Darling Range. Some steep river valleys - e.g. Murray River, North and South Dandalup Rivers - occur where the rivers cut through the Darling Scarp.

The elevation of the plateau ranges from 400-1600 feet (122-488 m) averaging about 900 feet (274 m) above sea level.

Climate

This has been discussed on page 75 of these Notes.

Soils

The majority of the jarrah forest soils are low in plant nutrients and have been developed from the weathering of a lateritic cap up to four feet thick which once covered the plateau.

Jarrah reaches its best development in the deep gravels of the middle and lower slopes. Where streams have exposed underlying basic rock, soils richer in nutrients have developed, and in the moist gullies good stands of W.A. Blackbutt (E. patens) often occur.

Forest Types

The main forest formation is of jarrah with marri scattered throughout. In the moister gullies W.A. Blackbutt, Bullich (E. megacarpa) and Flooded Gum (E. rudis) are commonly found.

Understorey species consist of Sheoak (Casuarina fraseriana), Bull Banksia (Banksia grandis) and Emu Bush (Persoonia longifolia). Below this understorey Blackboy (Xanthorrhoea preisii) and Xanthorrhoea gracilis are often found.

On the eastern edge of the jarrah belt near

the 25 inch (63 cm) isohyet, jarrah gives way to an open type woodland of which Wandoo (E. wandoo Syn. redunca var. elata) is the principle species.

History of Cutting

The first sawmilling and hewing operations commenced in the western part of the Division about 1910. Cutting was very heavy in the prime virgin stands, and often approached a clear-felling operation. Hewers selected mainly the prime, easily split small veterans to produce railway sleepers and a considerable amount of wood was wasted.

Following the passing of the Forests Act in 1918, restrictions on cutting were gradually introduced. A girth limit of 90 inches (229 cm) was placed on sawlog trees and later treemarking, as practised today, was introduced. Restrictions on hewing steadily increased and by 1939 the hewing of railway sleepers had virtually ceased throughout the State.

Peak periods of production were just prior to the First World War and again in 1927-28 prior to the depression. During the depression several large mills closed down and did not re-open. At present, two large mills obtain approximately 13,000 cubic feet (364 m^3) daily from the region.

Thinning in the Jarrah Forest

For a detailed description of the development of thinning of jarrah pole see page 93 of these notes.

Dwellingup Fire- January 1961

This fire, the most serious ever in the jarrah forest, developed from at least 19 lightning strikes in two separate electrical storms within 24 hours. Extreme heat conditions for the next six successive days made suppression almost impossible.

By the end of the second day 72,000 acres (29,000 ha) of forest land had been burnt. On the third and fourth days the fire was gradually being brought under control. On the fifth day, however, a cyclonic windstorm whipped the fire through the townships of Dwellingup, Holyoake and Nanga Brook and caused great destruction estimated $1,000,000. On the sixth day cooler conditions developed and rain falling in the afternoon allowed the running fire to be stopped.

The total area of forest burnt was 361,000 acres (146,000 ha) of which 65,000 acres (26,000 ha) were completely defoliated, 190,000 acres (77,000 ha) were badly scorched and the remainder only slightly damaged. It was estimated at the time that the damage to the forest was of the order of $2,000,000.

THINNING IN THE JARRAH FOREST

Introduction

Any reference to thinning in regrowth jarrah would be incomplete without some explanation of the origin of these stands which form an appreciable percentage of the northern part of the jarrah forest.

All of the relatively even aged pole stands of this area arose from a similar sequence of events: heavy fellings in the virgin crop, severe and often uncontrolled fire through the felling debris, and the subsequent growth of saplings from the lignotuberous advance growth, already present on the ground in bushy form when felling was carried out. It will be already obvious that lignotuberous advance growth of jarrah is resistant to fire; indeed, present day regeneration methods include the use of this medium to stimulate the formation of saplings from advance growth.

This resistance to fire is retained by jarrah in varying degrees throughout its life. The only really vulnerable period is the first four or five years after germination when seedlings will be killed by all but very light fires. A similar vulnerable period also occurs during the first five or six years of sapling life. However, damage from fire at this stage results in the death of the sapling shoot only; the root-stock is not killed and will shoot again. The implications of fire damage at this growth stage are serious as far as producing a crop of good form is concerned. A fire damaged sapling which does not die will be seriously malformed. This type of damage was not infrequent in the 1920 era when the Forests Department was in its infancy and the relationship of fire to the forest was imperfectly understood.

Towards the end of the 1920 decade a start was made on silviculturally cleaning up the sapling stands. At this time these consisted of dense jarrah (with a few marri) saplings among which were interspersed overmature and generally fire damaged jarrah, and a few marri of all sizes but particularly veterans.

Regeneration Treatment

The first silvicultural treatment afforded the sapling stands was termed a regeneration treatment and comprised three operations. Malformed saplings were felled to encourage the formation of coppice shoots of good form. Useless, mature jarrah were ringbarked both where they were overtopping jarrah saplings and where no saplings existed. In the latter case the object was to create gaps in which advance growth would develop sapling shoots. Marri of all sizes were ringbarked toward the same objective.

The success of the treatment in eliminating

saplings of bad form was widespread. The ring-barking operation gave very variable results due to the resistance of both jarrah and marri to this treatment. Sometimes it was completely successful; on other occasions the ringbarked trees failed to die.

Early Thinning

During the period 1928 to 1936 a widescale thinning programme was followed. Felled stems were unsaleable and left lying on the ground. The prescription allowed for the freeing of individual selected stems by felling competing stems; it was specified that crowns of the residual crop should have at least two feet gap between them. This prescription resulted in about 200 stems/acre being selected for retention in a 15 year old stand and an approximate reduction of basal area by 50%.

The success of the thinning varied widely. In many cases, particularly in the younger crops, the thinning effect was nullified in a few years by the formation of coppice shoots from the stumps of the felled stems. These shoots frequently re-entered the upper canopy and sometimes became dominant members of the crop. Evidence of this exists in some stands today. A typical example of the increase in stem numbers due to coppicing is available from a thinning experiment established in 1928 when the crop was reduced to 206 stems to the acre. At a reassessment in 1959 there were 550 stems to the acre.

In the late 1930's a light, second thinning is reported to have been given to restricted areas.

Recent Thinning

The re-assessment of a long term thinning trial in 1956 aroused a new interest in thinning pole stands. The original trial was laid down in

1928 in a 53 year old pole crop exceeding 70 feet dominant height. In this case the number of stems to the acre increased by only 8% in the thinned area, which carried two and one half times the volume of merchantable timber that the unthinned area did. It was also at this time that the hormone-type arboricides became more readily available and gave the first sound promise of coppice control. The use of arsenic salts had never reached any large-scale application due to their human toxicity.

By 1960 it had been established that the ester of 2,4,5-T gave very satisfactory coppice control, particularly when the unwanted stem was ringbarked near ground level and the arboricide applied to the wound. Treatment of the stumps of felled stems was only moderately successful on a field scale and still poses some problems.

The initial spate of recent thinning, started in 1961, was confined to a narrow strip bordering main roads. Here, for aesthetic reasons, it was necessary to fell unwanted trees and to treat the stumps with 2,4,5-T to prevent coppicing. The prescription stated that the residual crop should be at approximately 15 foot spacing. The poles treated had a dominant height of between 50 and 60 feet and by present day standards were grossly underthinned.

This type of thinning ceased in late 1962 and a reappraisal of thinning technique was considered necessary; the cost of between $30 and $60 per acre was excessive and would not justify widescale thinning away from roads. A major part of the cost arose from the necessity to clear felling debris from around residual crop trees to avoid damage to them when burning operations were carried out.

An earlier reluctance to leaving dead stems

standing in the forest, due to fire control problems, was overcome and the technique of ringbarking with 2,4,5-T application was adopted for wide-scale thinning. It was considered that standing dead stems would disintegrate slowly and not give any serious fire control problem under the prescribed burning totation of three to four years. Thinning by this technique continued during the first few months of 1963 and a vast reduction in the cost of the operation was noted. Costs varied depending on the density of the crop being thinned but averaged $15 per acre.

A further reduction to $11 average per acre was achieved during the period December 1963 to June 1965 by again changing the technique. The 2,4,5-T, previously mixed with water to reach the desired concentration of 2%, was now mixed with diesel oil and the concentration raised to 4%. This mixture was sprayed into a basal frill cut in unwanted stems. The technique is basically effective but, compared with previous techniques, it allowed some operator error. If the frill was incomplete, the tree failed to die. Due to this fact occasional areas were thinned with only marginal success.

By mid 1965 research workers had established the fact that injections of some arboricides were over 90% effective in killing jarrah. Concurrent with this work were trials on the new arboricide picloram (trade name 'Tordon'), which was found to be more effective in far smaller doses than 2,4,5-T. Thus developed our current thinning technique. Trees to be killed are notched at five inch intervals round the stem, approximately 3½ feet above ground, using a narrow bladed hatchet. 2.5cc of a 1:4 dilution of Tordon 50D with water is injected into each notch using a sheep-drencher. (Tordon 50D is a mixture of 5% Tordon and 20% 2,4-D, both as amines.) When trees of over 40"

girth at breast height are to be killed, 5cc of the mixture is injected into each notch.

Since the introduction of this technique considerable increases have taken place in wages, hence the operation costs are better given by man days. A costing study was made comparing notching and Tordon with frilling and 2,4,5-T when the former technique was introduced. In the trial area the ratio notching method cost to that of frilling was 2:3.

The current thinning operation is performed by a working gang consisting of 1 overseer, 1 chain sawyer, and 3 notchers. The production per gang day is 11-14 acres. A breakdown of costs per acre is as follows :-

Wages	$3.50
Plant	1.00
Materials	2.00
Overhead	1.50
Total	$8.00

This gives a wages cost of less than 50% of the total which illustrates the simplicity of the technique.

Thinning Prescription

The prescription under which the first of the recent thinnings was carried out resulted in a residual crop approaching 100 square feet/acre basal area. At this level thinning will become necessary again in under 10 years - before the crop has reached a merchantable size. At present, and for the forseeable future, any stem below 40" girth at breast height remains unsaleable. The current cost of thinning precludes a second unmerchantable thinning on economic grounds. All amendments of the initial prescription have taken this fact into account and crops are now reduced to between 60 and

70 square feet basal area to the acre (between approximately 100 and 140 stems/acre depending on mean girth.) It is anticipated that a second thinning will be necessary in 20 to 25 years time when most of the produce from the thinning will exceed 40" girth at breast height.

The current prescription is detailed enough to ensure uniformity in pole thinning irrespective of the proportion of old mature jarrah trees in the stand; to favour jarrah over the relatively inexperienced in hardwood thinning. A copy of the prescription appears in Appendix A.

Extending the Operation

Until the introduction of the notching technique for killing unwanted stems, thinnings had been confined to areas where pole-sized stems formed a large proportion of the stand. The much reduced cost of notching allowed the thinning operation to be extended into stands where the early fellings had been much lighter. Here the pole sized crop members stand in groups interspersed with groups of mature trees. It was decided that at least one third of the stand, in terms of area, should consist of poles to warrant thinning. The problem of selecting areas for thinning, particularly where the pole-sized stand members approached the critical level of one third of the stand, soon became apparent.

Selection of Areas for Thinning

Initial selection of areas for thinning has always been made from crop-type maps prepared from aerial photographs. However, the division of crop types on these maps proved too unprecise where poles formed less than approximately 50% of the stand by area. To overcome this problem an assessment on the ground was obviously necessary. A rapid and cheap system of sequential

sampling was developed with the help of the C.S.I.R.O. (mathematical Statistics Section). Using this method two men can sample an area of between 600 and 800 acres a day, to assess its suitablility for thinning.

Relation of Thinning to Other Operations

Where possible thinning follows a trade-cutting operation. Rather more important, however, is the tying in of controlled burning with thinning. The cost of thinning a recently burnt stand, where there is little ground vegetation to hinder movement, is far below that of thinning a stand that has not been burnt for 3 years. Burning plans are therefore adjusted as far as possible to fit in with the annual thinning programme.

To date over 8,000 acres of pole stands have been treated and an annual programme covering 2,500 acres continues to operate. Where the operation borders main roads, felling and stump-poisoning unwanted stems still continues for aesthetic reasons.

APPENDIX A

PRESCRIPTION FOR THINNING JARRAH POLE CROPS

Introduction

The aim of silviculture is to grow the maximum amount of useable timber in the minimum time and at the lowest possible cost. As much of our best forest carries too many stems to achieve these aims, we need to thin.

The achievement of these aims will be affected by all procedures from selection of stands to thin, to selection of trees to retain, marking and gang procedure.

1. Selection of Stands to Thin

(a) The initial selection shall be made from A.P.I. and from cutting plans. Stands coded as JA or JA+, P types with less than 30% upper strata and 60% or more total density can normally be assumed to be in need of thinning. Only stands cut before 1940 will be considered for thinning. Potentially thinnable stands in the above terms will then be checked by field inspection.

(b) The stand must be obviously overstocked, ideal stocking being regarded as 65 sq. ft. b.a.o.b. per acre in even aged stand.

(c) There must be a reasonable proportion of trees with good form.

(d) The stand must not be severely fire damaged.

(e) No stand should be selected for thinning within 10 chains of active dieback.

2. Background to marking

Marking will involve :-

(a) Selection of crop trees
(b) Marking for retention of saleable trees.

A. Definition of Crop Trees

For the purpose of this prescription a crop tree is defined as :-

(a) A tree of minimum 20" g.b.h. and a maximum 50" g.b.h., which occurs in or above the general level of the canopy, having a crown width twelve times its bole diameter at breast height. An exception may be made for trees lower than the general canopy level only when they meet the crown width and all other crop tree requirements.

and

(b) A tree having at least 20 ft. of bole, straight and defect free. A tree with stump scarring is acceptable provided that there is a 20 ft. straight and defect free length higher in the bole. Exceptionally, a tree having two separate 10 ft. lengths of straight, defect-free bole is also acceptable.

B. Definition of Saleable Trees

A tree is to be retained as saleable in the following cases :-

(a) If it has a bole length of at least 30 ft., a crown diameter inside bark of at least 7", and the necessary attributes to meet S.E.C. pole standards. G.B.H.34".

(b) If it has a bole length of at least 8 ft., a crown diameter inside bark of at least 11" and the necessary attributes to meet Mill Log quality. G.B.H. 40".

C. Thinning Aims

The aim of thinning described in the introduction may be fully expressed as :-

(a) To increase the rate of growth per acre to the maximum, and to place this growth on the best trees in the stand.

(b) To increase the rate of growth to a maximum on each tree selected as a crop tree.

(c) To increase the area available for growing useful timber by killing useless trees occupying growing space.

D. Crop Tree Selection

Crop trees will be selected to give a stocking of about 110 stems of approximately 30"

g.b.h. per acre, corresponding to an approximate 20' x 20' spacing, or a number of smaller or larger stems equivalent to a basal area stocking of approximately 65 sq. ft. per acre. The thinning marker will be guided by Table A in considering the distance between crop trees, bearing in mind that spacing is secondary to both dominance and form. It is much better to retain two crop trees of first class dominance and form even though they may stand at close spacing, than to retain poor trees at exact spacing. A tree should not be selected as a crop tree if it will inevitably be damaged by the falling of (useless) veterans (A3). A crop tree may be selected from two or three such poles. Where a stand consists mainly of clumps of poles of coppice origin it shall be regarded as unsuitable for thinning. (No crop tree selection will be made within 30 feet of a retained useful jarrah veteran.)

Selection of Marri Poles

Marri poles with a minimum straight clear bole of 30 ft. will be freed :-

(a) Where a choice between Marri and Jarrah exists and the Jarrah is inferior in both form and size.
(b) Where there is no Jarrah.

Crop Tree Freeing

Crop trees will be freed from competition by poisoning all woody species within the distance specified in Table B. Exceptions to this rule are:

(a) Eucalyptus stems under 2" diameter at notching height will not be killed.
(b) Banksia stems under 1" diameter at notching height will not be killed.
(c) Persoonia and Native Pear will not be killed.

Note

Useless Marri should be poisoned wherever they occur in the area selected for thinning.

Marking Code

(a) Trees selected as crop trees and therefore requiring freeing - one horizontal paint mark at breast height.

(b) Non crop trees retained within freeing distance of a crop tree - two horizontal paint marks approximately 4" apart at breast height. This category will include trees having girths of over 50" g.b.h. unless they fall under category 'c'. These trees are not to be freed.

(c) Unwanted and unsaleable veterans to be poisoned - a paint ring.

Normal Thinning Procedure

Organisation - This will require the full time attention of an officer - usually of Forest Guard rank - whose time, over a fortnight, should be directed as follows :-

Future thinning inspection	-	3 days (this will also cover C.B. inspection)
Thinning marking	-	6 days
Measuring and recording thinning	-	1 day

The thinning programme will assume that two gangs will be engaged for approximately 9 months of the year, each gang to consist of :-

Overseer	-	Marking for thinning, inspection of gangs work, chain saw efficiency.
3 Notchers		
1 Chainsaw operator		

Notching and Poisoning Procedure

Notching shall be by hatchet (or tomahawk) with blade ground to 1¼" width. Notches shall be at a height convenient to the operator and at a spacing of 5" around the girth of the tree. The notch should penetrate the sapwood at an angle of about 45°. Both from the efficiency and safety angles, hatchets should be kept as sharp as possible, each operator using his own hatchet and not interchanging.

Poison shall be 1 part of Tordon to 4 to 6 parts water and applied at the rate of 2.5 ccs. per notch, using Phillips Mk III, 10 cc auto sheep drencher. The drencher should be washed in clean water each night and a few drops of castor oil applied to the felt-pad. The drencher should be calibrated at least three times daily against a known measure.

Chain Saw Operators

Shall cut down the unmarked stems of any coppice clump where a pole has been marked for freeing.

He shall cut and remove debris within 3 feet of crop trees, except heavy logs.

TABLE A

Guide for Markers

Girth of Stem	Distance between Stems
20" - 35"	20 feet
35" - 50"	25 feet

TABLE B

Guide for Notchers

1. No tree larger than 50" g.b.h. is to be poisoned unless it has a silver paint circle marked on it.

2. Trees with a single paint strip on them will have trees standing round them poisoned within the following distances :-

Size of Marked Trees	Poison all Surrounding Trees for a Distance of :
20" - 35"	20 feet
35" - 50"	25 feet

3. The following stems will not be poisoned :-

Banksia under 1" diameter
Jarrah and Marri under 2" diameter
Native Pear (Xylomelum occidentale)
Persoonia sp.

AFFORESTATION WITH PINUS PINASTER AIT IN THE WANNEROO DIVISION

Introduction

Pinus pinaster Ait., the maritime pine of southern and south-eastern Europe was first introduced into Western Australia in 1896. The objective of this introduction was to establish a softwood resource on undeveloped sandy soils in the south-west of the State. Extensive species trials over the past 40 years have now proven that Pinus pinaster is the only softwood that can be seriously considered for commercial planting on the sandy soils of the Swan Coastal Plain.

By the end of the 1966 planting season, 25,800 acres (10,440 ha) of the species had been established in Western Australia. Over half this area - 14,000 acres (5,666 ha) is located in the Wanneroo Division north of Perth, 2,000 acres (809ha) being planted in 1966. It is planned to increase the annual planting rate to 3,000 acres (1,214 ha) within the next three years. Currently, it is

envisaged that at least 70,000 acres (28,330 ha) of P. pinaster plantation will be established north of Perth.

Climate

The plantable country in the Wanneroo Division lies within 20 miles of the sea in a coastal strip between Perth and the Moore River.

Published figures for Perth may be used to indicate the general climate of the region. This climate is typically of the "Mediterranean" type with cool winters, a reliable winter rainfall, and warm dry summers.

AVERAGE CLIMATIC RECORD FOR PERTH

Month	Mean Rainfall		Mean Evaporation	
	ins.	mm.	ins.	mm.
January	0.31	8	10.37	263
February	0.45	11	8.63	219
March	0.80	20	7.52	191
April	1.81	46	4.62	117
May	5.06	129	2.80	71
June	7.31	180	1.82	46
July	6.79	172	1.76	45
August	5.66	144	2.37	60
September	3.25	83	3.44	87
October	2.18	55	5.38	137
November	0.84	21	7.65	194
December	0.59	15	9.69	246
Annual	35.05	890	66.05	1678

Month	Mean Temperature (°F)	
	Max.	Min.
January	84.6	63.2
February	85.3	63.6
March	81.8	61.4
April	76.3	57.3
May	69.0	52.6
June	64.4	49.7
July	62.9	48.0
August	64.0	48.3
September	66.7	50.1
October	69.6	52.4
November	75.9	56.7
December	81.2	60.5
Annual	73.5	55.3

The major planting within the Division has been at Gnangara, some 19 miles from Perth. Future extension to the north involves planting up to 60 miles from the city. Rainfall figures for this latter area are slightly lower (4 inches per annum) than the values stated for Perth.

Frosts pose no problem to establishment within the region.

Soils

Plantable country is part of a dune complex consisting basically of coarse sands. The younger dune system on the western margin of the Swan Coastal Plain has a limestone influence. The older, heavily leached dunes further inland have no trace of limestone.

Fertility is highest on the soils overlying limestone. However, planting is restricted on these yellow to brown sands, to those phases with a suitable depth to limestone. Drought deaths are usual on the shallower phases of the series.

Favourable planting sites on the older dune series (grey sands) are related to the presence of a depositional or "coffee rock" horizon within 10 feet of the surface. Such sites also have a water table influence within 10 to 20 feet of the soil surface.

Even on Australian standards the sands are very infertile. Deficiencies in phosphorous, nitrogen, copper and zinc have been recorded. Typical chemical analyses for the two soil systems are as follows :-

	Younger Dune System (Yellow Sand)	Old Dune System (Grey Sand)
	%	%
Loss on Ignition	1.0	0.1
N	0.008	0.005
P	0.002	0.0004
K	0.009	0.002
Fe	0.500	0.006

Natural Vegetation

In the natural state the better sites carry a scattered crop of eucalypts of little commercial value. The major cover is of low Banksia species. Although virtually worthless commercially the sparse nature of the natural plant cover leads to very cheap clearing and is a major factor favouring the economics of plantation establishment on such poor sites.

Seed Provenance

Trials with Pinus pinaster seed from the Landes and Esterel regions in France, Italy, Corsica and Portugal were established prior to 1935. The Portuguese provenance has proved superior to all others tested extensively and since 1942 all plantings of the species in this State have been with seed obtained directly from Portugal.

Arrangements have been made to collect all future seed requirements from 25 year old plus stands at Gnangara and the seed orchard at Wanneroo.

Tree Improvement

The best plus phenotypes of Pinus pinaster from both Western Australian plantations (50 clones) and the Forest of Leiria in Portugal (84 clones) are incorporated in a tree improvement programme for the species. A 30 acre seed orchard containing local clones was completed in 1963 and a further 30 acre orchard containing both local and Portuguese clones will be established in 1968-1969.

Site Preparation

Planting sites are cleared by bulldozer and chain, broadcast burnt, and the remaining debris stacked and burnt to completely clear the area. Prior to planting, the sites are extensively ploughed to a depth of 8 inches and furrow lined. Both ploughing and furrow lining have been found essential to survival and sound establishment.

Planting

All planting is carried out with machines. One year old nursery stock is used at a spacing of 8 x 6 feet: 8 feet between rows to allow tractor access. Two ounces of superphosphate is applied at the base of each plant immediately after planting.

Survivals exceed 90 percent and a general idea of costs involved may be obtained from the following data :-

Establishment costs (dollars Australian)

Chaining and pushing (clearing)	$1	per acre
Burning and clearing up	$4-$5	per acre
Ploughing and furrow lining	$3-$4	per acre
Planting	$3	per acre
Cost of plants	$3	per acre
Fertilizer	$3-$4	per acre

Tending

Within the first three years in the field, two cultivations are made with a tractor and disc cultivator between the rows. Approximate operation cost is $2/acre for each treatment.

Subsequent Fertilizing

At age 7 to 10 years a further fertilizer application broadcast at the rate of 4 cwt. superphosphate per acre is given. Approximate cost of the operation is $6/acre. Further fertilizer applications later in the rotation may be necessary.

Pruning

All stands are pruned to a height of 7 feet at age 6 to 10 years. This is primarily a fire protection measure although useless stems are culled during the operation.

The best 100 stems per acre are pruned further to 15 feet with a pole saw at age 10 to 15 years. Further pruning on these stems to a height of 22 feet, aiming to maintain a 4 inch diameter knotty core is projected.

Thinning

A first merchantable thinning is carried out at age 15 to 18 years to leave 200 stems per acre (494 ha). Produce is removed in logs 7 feet in length. Size classes 4-7 inch end diameter are used as case logs. Other material down to 2.5 inch top diameter is taken by particle board operators. Thinning returns follow the trend tabulated.

Removals in cubic feet underbark volume at first thinning:

Thinning to 200 Stems per acre	SQII		SQIII		SQIV	
	Logs	Pulp	Logs	Pulp	Logs	Pulp
15-18 years	700	875	350	875	-	-
20 years					175	525

A second thinning is projected at stand age 30 to 40 years to leave 100 stems per acre standing. Removals at this stage are estimated at 1225 cubic feet underbark.

Currently, rotation age is estimated as 60 years.

Production is estimated as 160 and 105 cubic feet underbark per acre per annum for maximum and average yields respectively. These figures include both mill and pulp volumes.

General

The economics of the venture are favoured by:

1. Location of planting sites close to the key market.
2. Minimal clearing and establishment costs.
3. The need to use otherwise valueless land.
4. Low tending costs due to the relatively flat topography.
5. The high performance of the Portuguese provenance of the species on the sites.

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