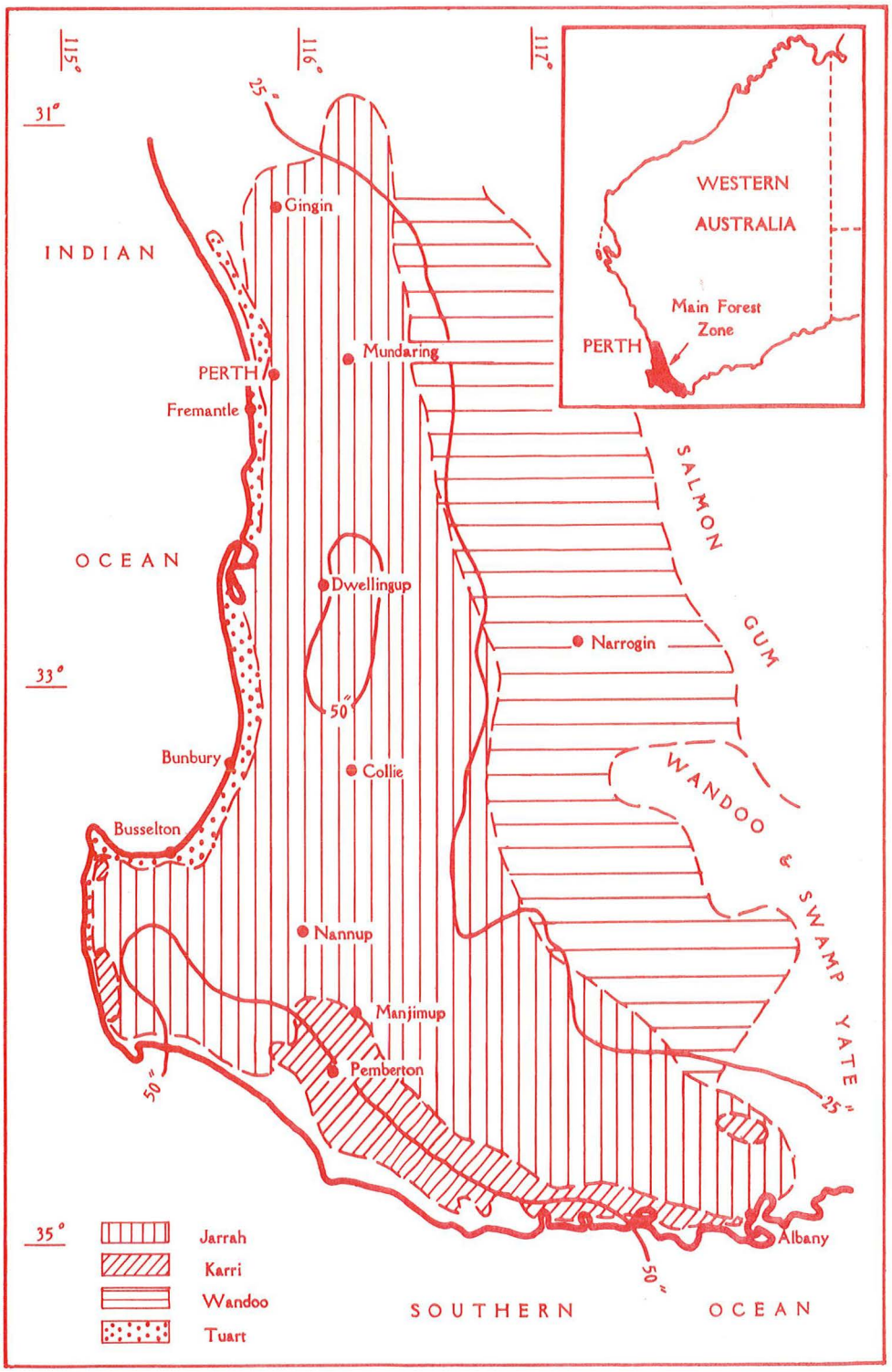
F.A.O. FIRE STUDY TOUR
AUSTRALIA 1970



Tour of Western Australia

18-23 JANUARY 1970

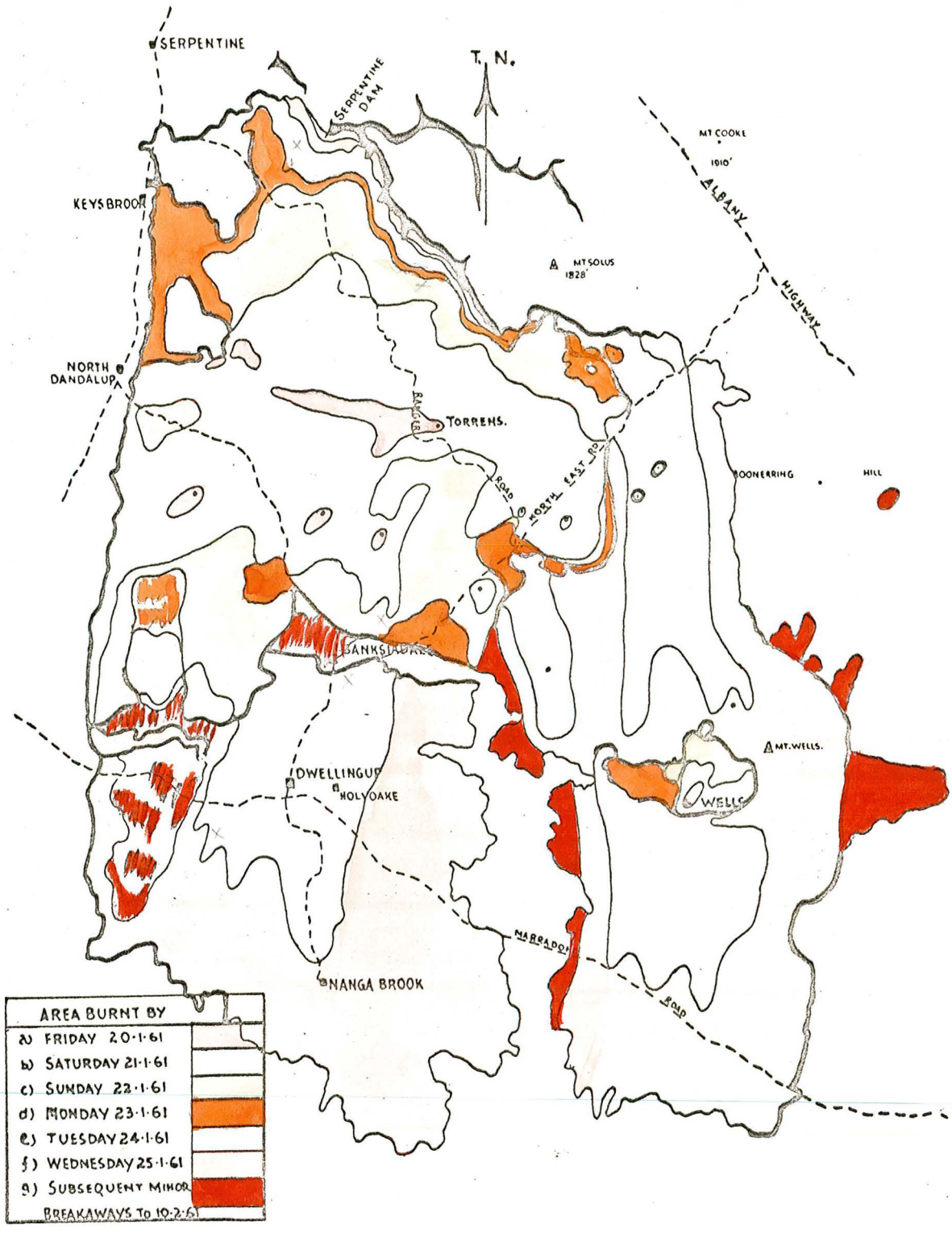
Compiled by

FORESTS DEPARTMENT *WESTERN AUSTRALIA*

THE DWELLINGUP FIRES - JAN. 19-25 1961.

PLAN SHOWING
FIRE PERIMETERS
AT
MIDNIGHT ON EACH DAY

0 2 4 6 8 10
SCALE: 4 MILES TO 1 INCH



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A. GENERAL NOTES ON FORESTRY IN WESTERN AUSTRALIA

B. TOUR NOTES

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 = 946,400. 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.

(5) The protection of the forest by controlling burning off and the lighting or use of fire on State Forests and Timber Reserves.

FOREST AREA

At 30th June, 1969, the forest area was as follows :

State Forests - 4,456,326 acres (1,804,180 ha)
Timber Reserves - 1,865,876 acres (752,850 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 and Wandoo (Mixed)	164	66
Jarrah and Karri (Mixed)	656	266
Karri	171	69
Karri and Tingle (Mixed)	14	6
Tingle	11	4
Tuart	6	2+
Mallet	57	23
Sandalwood	2	1-
Pine Planting Area	231	93

Botanical Names (for previous)

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

NOTES ON THE MAJOR FOREST SPECIES

Jarrah (Euc. marginata)

This is a stringy bark tree which grows to 150 feet in height. The timber is red brown, heavy and durable. In W.A. it 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.

Climate

The climate in which it grows 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 (10 cm) 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 (1 m) 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.

Karri (Euc. diversicolor)

This is a gum barked tree growing to 270 feet in height. It occurs only in the far south of this State and forms one of the most impressive Eucalypt forests.

Similar in appearance to jarrah, the 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.

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 de-foliation. 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.

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. 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 re-generation burning in the next seed year. The timing of the burn with respect to weather conditions and seed availability is critical.

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. Research is being carried out to establish the earliest time at which hazard reduction burning may be safely undertaken in karri regrowth.

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 (40 m) with breast height girths up to 30 feet (9 m) but more commonly 10-20 feet (3-6 m). 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 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.

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.

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.

TIMBER PRODUCTION AND DISTRIBUTION

Over the last few years the annual production of sawn timber has been approximately 200 million super feet (480,000 m^3). About 15 percent of the output is in the form of railway sleepers for both local use and particularly export. This State supplies over 80 percent of overseas exports of railway sleepers from Australia.

The production by species is approximately as follows :

Jarrah	72%
Karri	17%
Other Hardwoods	5%
Plantation Pine	6%

About 20 percent of total production is exported, two thirds goes 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 946,400 the present per capita consumption of sawlogs is about 38 cubic feet per annum and it is expected that the population will reach one million within 2 years. Currently some 12 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 66,000 acres (26,600 ha) of pine have been planted.

The rate at which planting can be carried out mainly rests on available finance, and until the last two years the average annual rate has been less than 3,000 ac. (1,200 ha.). However, this rate has doubled since special Federal loan funds have become available.

The following general rules are followed in all plantations :

Planting Stock	1/0 for both species.
Spacing	P. radiata and P. pinaster - 8' x 6' (2.4 m. x 1.8 m.)
Pruning	When 50 percent of the crop reaches a D.B.H. (o.b.) of $3\frac{1}{2}$ in. (8.8 cm.) all stems down to 2 in. D.B.H. (o.b.) - 5.1 cm. - are pruned to a height of 7 feet (2.1 m.).

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

In P. pinaster plantations the same practice holds.

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 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.

The aim is to reduce forest fuel quantities so that wildfires may be controlled when they occur during severe fire weather.

Approximately 1,000,000 acres (405,000 ha) are now being covered each year using hand and aircraft lighting techniques.

Each burn is applied to a predetermined area surrounded by tracks and at a predetermined intensity consistent with the silvicultural condition of the forest.

The scheme involves detailed planning and a thorough understanding of fire behaviour.

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.

Broadcast control burning was introduced into Western Australian forests in 1953 when it was found to be impractical to persist with a policy of fire exclusion which had been practised for 20 years.

Forest damage and wildfire size had increased dramatically in the heavy fuels and it was not until ten years later when fuels had been reduced over a sufficiently large proportion of forest that wildfire areas began a steady decline. (See Table 1 - Page 9).

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 trees.

On occasions of poor visibility dangerous fire hazard or extreme fire risk additional observation points and aircraft are used.

Many fires are reported by travellers.

Each tower is linked with Divisional or District Headquarters and adjacent towers by telephone and V.H.F. radio.

The towerman reports each smoke sighting to Headquarters giving its bearing, distance from him and a description of it. Once it is sighted from another tower, the two bearings are plotted on the co-ordination map to determine its precise position. (See Fig. 1 - Page 10).

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 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, 21 fixed stations and 153 "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.

The system used is Duplex, employing a "repeater", through which signals are re-transmitted to give added working range for mobile units. (See Fig. 2 - Page 11).

TABLE 1 :

Year	Area of State Forest	* Area Under Protection	Area of Controlled Burning	* Area Burnt Wild Fires	Comments On Fire Season
	000's ac (000's ha)	000's ac (000's ha)	000's ac (000's ha)	Acres Hectares	
1968-69	4,456 (1,803)	4,524 (1,831)	1,010 (409)	**32,432 (13,125)	Jarrah and Karri Regions - Above Average.
1967-68	4,451 (1,801)	4,524 (1,831)	1,096 (444)	4,774 (1,932)	Jarrah and Karri Regions - Generally Average.
1966-67	4,449 (1,800)	4,452 (1,802)	894 (362)	5,901 (2,388)	Jarrah and Karri Regions - Slightly Above Average.
1965-66	4,449 (1,800)	4,449 (1,800)	735 (298)	6,158 (2,492)	Jarrah and Karri Regions - Below Average.
1964-65	4,461 (1,805)	4,261 (1,724)	885 (358)	3,588 (1,452)	Jarrah and Karri Regions - Below Average.
1963-64	4,459 (1,805)	4,112 (1,664)	891 (360)	21,455 (8,682)	Jarrah and Karri Regions - Above Average.
1962-63	4,459 (1,805)	4,110 (1,663)	582 (236)	9,960 (4,030)	Jarrah and Karri Regions - Generally Average.
1961-62	4,348 (1,760)	4,108 (1,662)	1,200 (486)	66,689 (26,988)	Jarrah - Severe : Karri - Milder than normal for Low Duration.
1960-61	4,343 (1,758)	4,105 (1,661)	573 (232)	475,979 (192,626)	Jarrah Region - Extremely Severe : Karri - Severe.
1959-60	4,330 (1,752)	4,103 (1,660)	503 (204)	2,640 (1,068)	Jarrah and Karri Regions - Mild Conditions - Below Average.
1958-59	4,324 (1,750)	3,518 (1,424)	398 (161)	22,503 (9,106)	Jarrah and Karri Regions - Generally Average.
1957-58	4,169 (1,687)	3,402 (1,377)	395 (160)	33,617 (13,604)	Jarrah and Karri - Extremely Severe (Driest Summer on Record)
1956-57	3,990 (1,615)	3,348 (1,356)	456 (185)	11,522 (4,662)	Jarrah and Karri Regions - Average.
1955-56	3,892 (1,575)	2,412 (976)	385 (156)	18,685 (7,561)	Jarrah and Karri Regions - Above Average.
1954-55	3,834 (1,552)	2,319 (934)	362 (146)	11,618 (4,701)	Jarrah and Karri Regions - Mainly Below Average.
1953-54	3,462 (1,401)	2,312 (935)	417 (169)	12,500 (5,058)	Jarrah and Karri Regions - Mainly Below Average.
1952-53	3,460 (1,400)	2,111 (854)	164 (66)	8,692 (3,517)	Jarrah and Karri Regions - Mainly Below Average.
1951-52	3,442 (1,393)	1,955 (791)	228 (92)	52,468 (21,233)	Jarrah and Karri Regions - Above Average.

Column 5 * Refers only to Column 3 * No figures are available for areas burned outside of protected areas.
** 17,500 acres (7,082 hectares) occurred in one fire in an area of .5. M acres not subject to rotational controlled burning.

FIG. 1 :

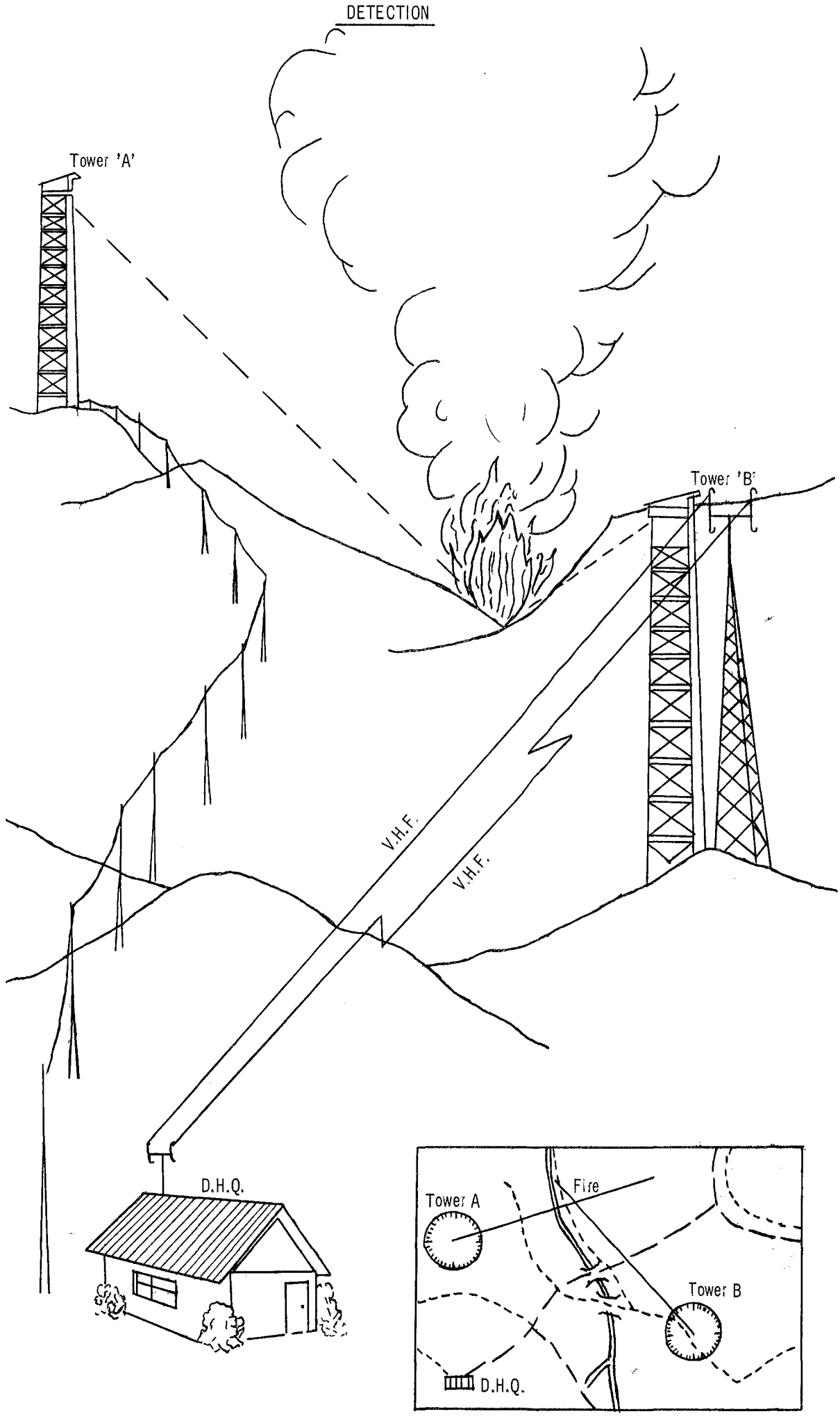
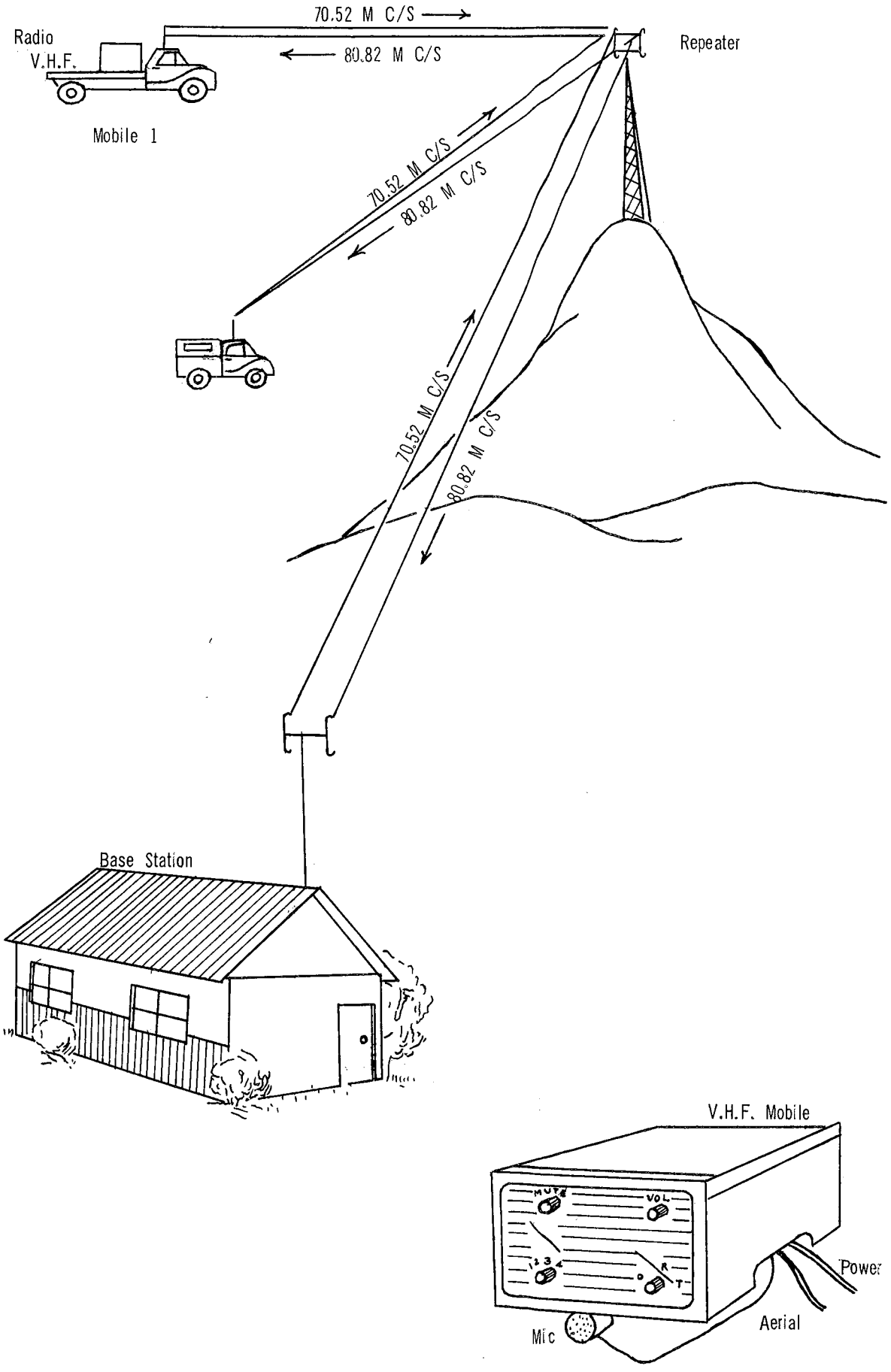


FIG. 2 :

COMMUNICATIONS



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 out-lying forest settlements for each region is no longer applicable. Changing times and social attitudes make it necessary to move people in out-lying 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 developed using 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. The vegetation maps are used together with fire history plans to estimate fuel quantity, for fire behaviour predictions.

REFORESTATION AND SILVICULTURE

Careful control is exercised on all saw-milling permits within State Forest to see that under the silivcultural 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.

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 deteriorated 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.

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 sizes 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 Phytophthora 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.

Areas Affected

Out of total of 1,851,000 acres (749,000 ha) mapped to date, from aerial photographs of the northern jarrah forests, just over 5 percent of the area has been affected by die-back.

In the forest south of Kirup airphoto mapping has proven more difficult and in this area the scope of the problem is not yet defined.

Rate of Spread

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

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.

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.

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

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 at $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.

Dwellingup Fire Weather - January 1961 :

Date	Maximum Temp. °F	°C	Minimum Relative Humidity	Windstrength Miles/hr.	Kilo./hr.
Jan. 19	104	40	15	5 - 15	8 - 24
Jan. 20	106	41.1	13	15	24
Jan. 21	103	39.4	20	5 - 15	8 - 24
Jan. 22	100	37.8	20	5 - 15	8 - 24
Jan. 23	100	37.8	32	7 - 15	11 - 24
Jan. 24	106	41.1	14	12 - 70	19 - 113
Jan. 25	98	36.7	26		

Heavy rain started to fall about 1400 hrs.

This fire showed very clearly the effect of fuel quantity on fire intensity. Approximately 10 percent of the Dwellingup Division had been control burned each year between 1953 and 1961. All areas in which the forest was defoliated had not been burned during the previous 5 years and carried in excess of 4 tons/acre (10,000 kilo/ha) of litter fuel.

Where crown fires ran into recently control burnt forest they rapidly came to ground making suppression possible.

The major fire effects were in defoliated forest.

A large salvage operation was necessary to utilise killed and damaged trees. Degrade due to cracking and insect attack caused considerable losses. Widespread areas of second growth aged up to 50 years was destroyed.

Extensive coppicing occurred. This will form the replacement crop and has had to be protected from all fire until the last two years when control burning has been reinstituted.

Dense thickets of Acacia species developed which have reproduced the heavy fuel condition in existence before 1961 and have presented special control burning problems. Selection of suitable weather to allow burning without damaging coppice is most difficult.

THINNING IN 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 ringbarking 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 widespread 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.

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

Recent Thinning

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 ring-barked 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.

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 widescale thinning . It was considered that standing dead stems would disintegrate slowly and not give any serious fire control problem under the prescribed burning rotation of three to four years. Thinning by this technique gave a vast reduction in the cost of the operation.

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 12,800 acres (5,200 ha) of pole stands have been treated and an annual programme covering 1,000 to 2,000 acres continues to operate. Where the operation borders main roads, felling and stump-poisoning unwanted stems still continues for aesthetic reasons.

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. Dairying 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 re-purchased 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 re-settle 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, in the immediate future.

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.

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 -

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. Beedelup National Park.

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.

Beedelup National Park

The Beedelup National Park, along with the Warren, 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 finance provided to the Board by the Government has been directed largely towards developing access for tourist use and fire control. More recently the need for limited fuel reduction in these Parks has been recognised by the Board and last year a large area of Beedelup was control burned. This and much of the roadwork is planned, directed and supervised by the Forests Department on behalf of the Board.

GANG TRAINING IN FIRE SUPPRESSION

The training programme is aimed at teaching and testing men in the various techniques required during fire suppression.

A competition between gangs is held each year in December which assists in developing and maintaining keenness and high morale.

Points are awarded for :

Dress, equipment and vehicle condition
Mapreading and reporting
Suppression method and technique
Quality and method of "mopping up"
Motivation of personnel
Safety
Use of various equipment including packsprays, saws, vehicles and pumpers
Hose running
Deviations from methods laid down for each section results in loss of points

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 1969 planting season 40,000 acres (16,200 ha) of the species had been established in Western Australia. Over half this area - 25,000 acres (10,100 ha) is located in the Wanneroo Division north of Perth, 3,000 acres (1,200 ha) being planted in 1969. Currently, it is envisaged that at least 70,000 acres (28,330 ha) of P. pinaster plantation will be established north of Perth.

An area of 2,200 acres (890 ha) of University endowment land south of Perth city is under Pinus pinaster and is administered from Wanneroo. It is known as Somerville plantation and has a peculiar fire problem to which further reference will be made later.

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 (^{o}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

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.

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.

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.

A second thinning is projected at stand age 30 to 40 years to leave 100 stems per acre standing.

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.

Fire Control

Under Western Australian conditions the rate of litter breakdown under P. pinaster is extremely slow. Large quantities of highly combustible needle fuel build up, even without the addition of pruning and thinning slash.

Where a high risk of ignition exists e.g. Somerville, fuel reduction by burning is applied throughout the plantation. As many as 30 fires are started each year by children and others from the surrounding suburban developments and hazard reduction is essential to ensure successful fire suppression.

Where the ignition risk is relatively low e.g. Gnangara, fuel reduction burning is carried out on buffer strips 10-20 chains wide, laid down on a grid pattern which divides the plantation in to areas of approximately 800 acres. Should initial attack fail, forces can fall back to these wide breaks.

Experience of fire in heavy P. pinaster fuels has proven the need for such policies.

TOUR NOTES

Sunday, 18th January, 1970 :

Depart Forrest House for Dwellingup 0900.

For the first 19 miles the route passes through Perth suburbs. The Darling Scarp is clearly visible for some 10 miles. The road traverses the coastal plain which is 20-30 miles wide and then rises abruptly about 1,000 feet on to the adjoining plateau. The scarp is an old geological fault running from about 100 miles north of Perth to 200 miles south. The major portion of State Forest occurs on the plateau.

17.0 miles : Kelmscott Divisional Forest Office and Commonwealth Forest Research Institute.

19-24 miles : The road, as it climbs to the plateau, is bordered by a narrow strip of orchards with State Forest occurring beyond them.

24.2 miles : From here the route passes through State Forest until passing back on to the coastal plain. The predominant species is Jarrah (E. marginata) with scattered Marri (E. calophylla). The understorey is mainly Banksia with low shrubs. There is a 1969 spring control burn on both sides of the road.

From here until Dwellingup is reached, the route passes continuously through water catchments serving Perth.

25.2 miles : To the right is a 1969 spring control burn which burnt too intensely as a result of an unexpected wind increase after the area was lit.

26.3 miles : On the right is the first of several trial areas planted with Eastern States Eucalypts where Jarrah (E. marginata) has been killed by the fungus P. cinnamomi, (see general notes on "die-back").

28.8 miles : P. pinaster on "die-back" sites. There are several similar planting trials over the next 4 miles. Areas on which die-back has necessitated the replacement of Jarrah with other species present particular fire control problems. The species used to replace Jarrah are relatively fire sensitive and many replanted sites are far from established suppression forces.

To reduce the risk of loss by fire, the surrounds of these rehabilitated sites are frequently control burned and in some of the older P. pinaster very low intensity burning has been carried out under the pines.

33.9 miles : Gleneagle plantation. This is an area of approximately 600 acres of P. pinaster planted between 1950 and 1957. The soils are laterite sands and gravels.

Until recently it was the site of a major Forests Department Divisional headquarters. However, in this and a number of other isolated field stations it has proven impossible to maintain a work force. Families will not forego the facilities which can only be provided economically in larger towns.

However, as a result of rotational control burning, faster vehicles and better roads it has been possible to meet the fire suppression requirement in hardwood forests from stations now established in larger towns.

To adequately protect the plantation it has been necessary to control burn most of it. There will be a brief inspection of the results.

36.1 to 41.5 miles : On the left is an extensive control burn of 44,000 acres carried out in one day using aircraft ignition.

49.5 miles : Turn right on to North East Road. This road was built by the Forests Department. Similar roads have been established throughout State Forest to provide access for fire control and timber cutting.

51.3 miles : 132,000 volt electricity mains. Part of a grid system servicing the Southwest of the State.

53.3 miles : Dwellingup fire area - refer to general notes for the history of this fire. The route traverses through the fire area until passing on to the coastal plain.

In the past few years extensive control burning has been carried out here in fuel and forest types which present many problems.

Divisional Forest Officer Robley, in charge of Dwellingup Division, will explain the results you see on the road verges.

65.8 miles : Recent logging.

66.8 miles : Typical die-back area.

72.5 miles : Thinning in Jarrah forest - refer general notes.

73.9 miles : Enter Dwellingup town. Note the large sawmill, operated by Hawker Siddeley Building Supplies.

74.3 miles : Dwellingup Divisional Forest Headquarters.

74.5 miles : Turn right on to Pinjarra road.

74.6 miles : Turn left on to Collie road.

78.3 miles : Clearing for establishment of Pinus radiata.

Stop for Lunch : 1300 hours.

Depart for Manjimup : 1400 hours.

The route continues for another 11 miles through the Dwellingup fire area and returns to the coastal plain. It then passes through the towns of Waroona, Harvey, Brunswick Junction, Dardanup and Boyanup, which serve the surrounding agricultural areas where dairying is the major industry.

Further south extensive apple and pear orchards will be seen as the tour passes Donnybrook, Mullalyup and Bridgetown. Tin is mined at Greenbushes. In these more southerly areas the farms are interspersed through State forest.

209 miles : Enter Manjimup : 1700 hours.

Monday, 19th January, 1970 :

Today's tour aims to illustrate the major forest and fuel types in the southern Jarrah (E. marginata) and Karri (E. diversicolor) forests, and to show the effects of past wild fires, recent control burning, and the use of fire for regeneration of Karri.

Depart Manjimup : 0845 hours.

0-30 miles : Stops will be made in the following forest types :

Jarrah (E. marginata)
Karri (E. diversicolor)
Mixed Species - Jarrah, Karri and Marri (E. calophylla)

Flats.

The route passes through extensive control burns carried out in spring 1969, using aerial ignition.

30-44 miles : Inspect Karri (E. diversicolor) regeneration burns, Westcliffe wildfire 1967, Boorara wildfire 1969 and further control burning.

44-54 miles : Examine tree defects caused by wildfire :

Dead trees
Hollow butts
Dry sides
Epicormic shoots
Utilisation problems caused by fire defects

54-64 miles : The results of regeneration burning in Karri will be inspected, together with the effect of repeated severe wildfire and control burning carried out by aerial ignition during the spring of 1968.

12.30 : Lunch at the Gardner River.

64-89 miles : Examples will be shown of the rehabilitation process in Karri forest severely damaged by wildfire.

89-104 miles : Inspect virgin Karri in Warren National Park and control burning under 35 year old Karri regrowth. The route passes through further areas control burned in spring 1969, using aerial ignition.

104-134 miles : The tour route provides further illustrations of the effects of control burning and returns through mixed forest and farmland to Manjimup. Arrive 1700.

Tuesday, 20th January, 1970 :

Manjimup Division Headquarters : 09.00

09.00 - 10.30 : Explanation of control burning in W.A. - aims, planning and techniques.

11.00 : Depart Manjimup and travel to experimental fire area in Karri forest.

12.00 - 13.00 : Explanation of fire behaviour tables prepared by Research Officer Peet for Jarrah forest and experimental techniques used in this research - refer "Forest Fire Danger Tables", "Controlled Burning in the Forests of Western Australia" and "A Fire Danger Rating and Controlled Burning Guide for the Northern Jarrah (E. marginata) Forest of Western Australia".

13.00 - 13.45 : Lunch

13.45 - 15.45 : Demonstration of an experimental fire and recording of it, followed by a discussion of the technique.

15.45 - 17.00 : Return to Manjimup via Diamond Tree Tower. There will be a brief stop at this lookout to explain the history of tree towers.

Wednesday, 21st. January, 1970 :

Manjimup Divisional Headquarters : 09.00

09.00 - 10.30 : Explanation and demonstration of :

Communications
Co-ordination
Detection process
Special equipment

11.00 - 13.00 : Demonstration Training methods in Fire Suppression - refer general notes.

13.00 : Lunch

14.00 - 17.00 : Continue demonstration of training methods.

Thursday, 22nd. January, 1970 :

09.00 : Depart Manjimup for the Mt. Folly Pine Plantation near Nannup.

For the first 10 miles the route passes through farming country. Originally the farms were part of the "Group Settlement" Schemes and cleared in the 1920's.

At 19 miles we pass Donnelly River Sawmill and a little further, on the right hand side, the small Forestry Settlement of Wheatley.

36 miles
10.00 hours : Stop at high point within Mt. Folly Plantation of the Nannup Division of the Forests Department. This Division covers some 350,000 acres (142,000 hectares) of Eucalypt forest and 6,500 acres (2,600 hectares) of Pinus radiata plantation.

This stop is to see how Plantation Fire Control problems are handled.

1. Prescribed burning of surrounding Eucalypt forest to achieve fuel reduction.

2. Implementation of "Parkland Clearing" concept, where dead trees are felled and burned. Living trees with dead crown sections are removed to promote young trees. Logs on ground are burned to facilitate prescribed burning of the area.

3. Provision of clean firebreaks adjoining farming properties achieved initially by grading and then subsequently maintained with chemical weedicides. See Diagram. Discussion. Depart 10.30.

10.30 : Leave Stop 1 and proceed to morning tea in Nannup Arboretum. On the way observe rapid growth of Pinus radiata on areas of re-purchased farm land.

Observe recent burning of Eucalypt forest to achieve fuel reduction.

Observe how farms are contiguous with forest operations.

10.45 : Morning Tea

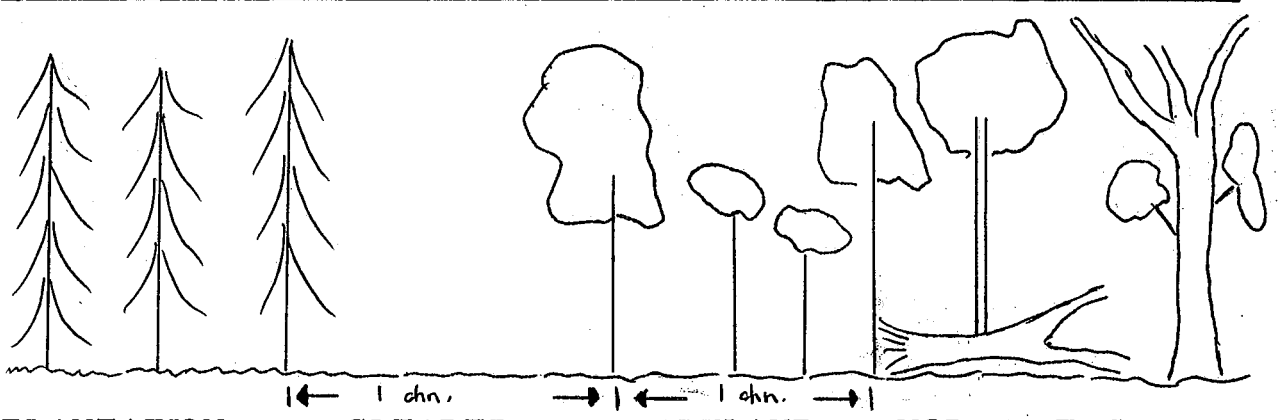
11.10 : Depart for Milward plantation to see further examples of :

1. Prescribed burning
2. Parkland clearing
3. Fire break maintenance

Arrive Milward Plantation.

11.30 : Depart for Ludlow.

The road now travels through an area of Eucalypt forest with Jarrah (E. marginata) and Marri (E. calophylla) the main species.



PLANTATION CONTROL BURNED

CLEARED FIREBREAK

Grass species removed by chemical methods.

PARKLAND CLEARING

Timber debris cleared and burned. Trees with dead crowns killed.

NORMAL EUCALYPT FOREST

Note : Timber debris on ground. Over-mature trees with dead crowns.

→| This hardwood forest is burned every three years.

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86 miles : Arrive town of Busselton - 12.15.

Busselton is a popular holiday resort with visitors coming from the drier inland farming areas. It is the centre of a farming and timber producing district with a population of 6,500.

96 miles : Arrive Ludlow Tuart Forest for picnic lunch. 12.35.

Tuart forest, (Eucalyptus gomphocephala) with dense understorey of Peppermint (Agonis flexuosa) regularly grazed to reduce fire hazard due to grass. Note where roadside has been chemically treated to reduce grass fire hazard.

101 miles : Ludlow departure : 13.30.

Mineral sands mining operation conducted by Western Titanium by water sluicing method. Minerals recovered include Illmenite, Zircon, Monazite, Rutile leucoxene. These minerals are exported.

120 miles : Bunbury : Coastal town of 15,000 exporting timber, wheat, mineral sands. Founded in 1837. For the first few miles the road runs alongside the Leschenault Inlet and passes Laporte Titanium (Aust.) Ltd., where illmenite sands are treated.

185 miles : Mandurah : 15.30.

Stop for 10 minute rest break.

215 miles : Kwinana : Industrial complex on the shores of Cockburn Sound. Industries located here include :

1. Major oil refinery.
2. Blast furnace producing pig iron (600,000 tons/annum).
3. Alumina production from Bauxite mined in Darling Range : current production 1,000,000 tons per annum.
4. Abbatoirs : Export meat preparation and packaging.

Arrive in Perth : 17.00 hours.

Friday, 23rd. January, 1970 :

08.30 hours : Assemble at bus and meet Mr. P. N. Hewett, Inspector in Charge of Kelmscott, Narrogin, Mundaring, Metropolitan and Wanneroo Division.

(Note Toyota Bus and 3 Cars)

08.35 : Depart for Somerville Plantation via Causeway and Canning Highway to Bateman Road.

09 miles : 09.00. N.E. corner of Somerville Plantation and inspect burning Cpt. 5B. P. pinaster planted 1932 last thinned 1965 and tops burned 1966, reburned 1967.

10.00 miles : Cpt. 7, (P. pinaster planted 1929). No tops, litter burned 1967.

10.5 miles : Cpt. 33, Planted 1936. Unburned tops at 10 tons per acre, (25,000 kilos/hectare).

10.6 miles : Cpt. 32, (planted 1936). Litter burnt 1968.

11.0 miles : Cpt. 37. Remains after large uncontrolled fire. Fire spread plan will be displayed.

11.00 a.m. : Depart for Wanneroo Division, via West Coast Highway.

44.0 miles : Gnangara Plantation.

Lunch 12.00.

45.2 miles : Gaskell Road, P. pinaster planted 1956. Needlebed burn, 1968.

47.0 miles : Pessoa Road, P. pinaster planted 1942.

47.5 miles : Machado Road, P. pinaster planted 1946.

(i) Green Slash Burnt, 1969.
(ii) Needlebed Burn, 1969.

49.5 miles : Dollar Road. P. pinaster planted 1951.

Travel for 1 mile through both burnt and non-burnt needlebed in good quality forest.

55.5 miles : Wetherell Road, via St. Patrick's Hall and lookout tower.

80.5 miles : Depart for Perth via West Swan Vineyards, Guildford. 15.30.

Arrive at Forrest House : 16.30.

The establishment of plantations of Pinus pinaster along the coastal dune systems near Perth began in 1927 and the discovery of a response to superphosphate in 1930 led to expansion of programmes at most coastal centres. Three of the areas started in 1927 were then in the outer metropolitan area and as urban development spread up to and around them the incidence of summer fire progressively increased and by 1967-68 the total of bush fires in Collier and Somerville plantations exceeded 20 per year. On one day in March 1957, separate fires were responsible for almost complete destruction of Scaddan plantation (North Perth) and of 103 acres in Collier.

The following tabular statement of annual fire totals in size categories shows the pattern over the past nine years.

TABLE 1 :

Year	0 - 1 acres	1 to 5 acres	Over 5 acres	Total
1960-61	17	-	3	20
61-62	36	-	6	42
62-63	22	8	3	33
63-64	30	3	4	37
64-65	11	3	3	17
65-66	N/A	-	-	N/A
66-67	30	5	2	37
67-68	30	2	-	32
68-69	23	2	-	25

It is apparent that although there is no real reduction in the incidence of fires in the Metropolitan plantations there is a strong trend since 1966-67 for the reduction in size of fires which do occur.

This reduction in size reflects the easier suppression of fires due to winter burning under the pine canopy. Burning of this kind started in Metropolitan and Wanneroo Divisions in winter 1965 following extensive experiments at Somerville in 1964, (refer general notes).

TABLE 2 : Progress of Pine Controlled Burning

Year	Wanneroo	Somerville	Collier
1965	500	193	-
1966	1115	579	-
1967	450	890	100
1968	528	605	520
1969	780	600	450
Proposed 1970	1000	750	450

The two most vital factors in the execution of safe controlled burning under pine canopy are fuel conditions and weather.

1. Fuel Conditions

If we consider the complete forest litter profile in plantation grown pines it is found that leaf, twig, cone and branch material varies in depth from a fraction of an inch to 9 or 10 inches dependant upon species, age of forest, pruning treatment, thinning history and soil micro-organisms.

It has been found necessary to delay initiation of controlled burning until the complete litter profile has been thoroughly wetted by winter rain and then begins to dry from the surface. If partial wetting only, has occurred e.g. after light rain, a thin zone of wetness exists within the litter profile, and there is a risk of "pot-holing" when the surface layer burns, dries out the wet zone and then ignites the dry base fuel. This condition was experienced frequently in deep litter beds during trials at Somerville in 1964.

2. Weather

Pine burning can be pursued only so long as damage to growing trees can be avoided. The needle litter is highly flammable and accumulates up to 10 tons of fuel per acre, so that the aim of burning is to work in relatively small sections attempting to remove $\frac{1}{4}$ to $\frac{1}{2}$ of the litter profile. Burning which removes litter down to mineral soil will cause stem damage and damage to feeder roots in the lower litter profile.

To achieve the desired class of burning activity must be confined with narrow limits of FIRE DANGER RATING viz between 0.2 and 0.6. In addition, areas must not be larger than 20 acres per fire to ensure completion before weather conditions change beyond the allowable Danger rating.

FOREST FIRE CONTROL STUDY TOUR.

1.	ABDUR REHMAN CHAUDHRY	PAKISTAN	C.P.
2.	MOHAMMED ZAHER AKBARI	AFGHANISTAN	C.P.
3.	ADJIS HERDJAN	INDONESIA	C.P.
4.	OU THOUK	CAMBODIA	C.P.
5.	BUM TAIK KYUN	KOREA	C.P.
6.	SS BUIT	INDIA	C.P.
7.	SRINIVASA RAO	INDIA	C.P:
8.	S.A. SHAH	INDIA	C.P.
9.	EWEN GREGOR	FIJI	A.S.P.T.A.P.
10.	OMER SAID MUSA	SUDAN	S.C.A.A.P.
11.	P. RASHIDI	MALAWI	S.C.A.A.P.
12.	SIKIRU AJANI KARIMU	NIGERIA	S.C.A.A.P.
13.	PATRICK A. ABUSOMWAN	NIGERIA	S.C.A.A.P.
14.	ALIYU MUHAMMADU	NIGERIA	S.C.A.A.P.
15.	MARI MADU MALGWI	NIGERIA	S.C.A.A.P.
16.	SHUMA.	KENYA	S.C.A.A.P.

C.P. COLOMBO PLAN.

A.S.P.T.A.P. The Australian-South Pacific Technical Assistance Programme.

S.C.A.A.P. The Special Commonwealth African Assistance Plan.

FAO STUDY TOUR ON FOREST FIRE CONTROL TO BE HELD IN AUSTRALIA, 13 JANUARY - 28 FEBRUARY 1970.

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