

ANNUAL REPORT 1981



Cover:

Part of the new 1-3 million map
(Vegetation of Western Australia)
Compiled by Dr. J. S. Beard and produced by
The Forests Department Mapping Branch.

*Forests Department
COMO, W.A. 6152*

TO THE HON. D. J. WORDSWORTH, M.L.C.

MINISTER FOR FORESTS

In accordance with Section 42 of the Forests Act, I have the honour to submit the Annual Report of the operations of the Department for the year ended 30 June 1981.

*B. J. BEGGS,
Conservator of Forests*

Common and botanical names of vegetation species mentioned in this report.

Jam	.....	Acacia acuminata
Prickly Moses	.....	Acacia pulchella
W.A. Peppermint	.....	Agonis flexuosa
Bull banksia	.....	Banksia grandis
W.A. sheoak	.....	Casuarina fraserana
Powder bark wandoo	.....	Eucalyptus accedens
Brown mallet	.....	Eucalyptus astringens
Dundas mahogany	.....	Eucalyptus brockwayi
Marri	.....	Eucalyptus calophylla
Silver gimlet	.....	Eucalyptus campaspe
Cleland's blackbutt	.....	Eucalyptus clelandii
Karri	.....	Eucalyptus diversicolor
Dundas blackbutt	.....	Eucalyptus dundasii
Tasmanian blue gum	.....	Eucalyptus globulus
Tuart	.....	Eucalyptus gomphocephala
Yellow tingle	.....	Eucalyptus guilfoylei
Red tingle	.....	Eucalyptus jacksonii
Spotted gum	.....	Eucalyptus maculata
Jarra	.....	Eucalyptus marginata
Bullich	.....	Eucalyptus megacarpa
Yellow stringy bark	.....	Eucalyptus muellerana
Yarri or W.A. blackbutt	.....	Eucalyptus patens
Red mahogany	.....	Eucalyptus resinifera
Sydney blue gum	.....	Eucalyptus saligna
Albany blackbutt	.....	Eucalyptus staerii
Wandoo	.....	Eucalyptus wandoo
Heartleaf	.....	Gastrolobium bilobum
Maritime pine	.....	Pinus pinaster
Monterey pine	.....	Pinus radiata
Pond pine	.....	Pinus serotina
Loblolly pine	.....	Pinus taeda
Sandalwood	.....	Santalum spicatum
Hazel	.....	Trymalium spathulatum

Common and zoological names of faunal species mentioned in this report.

Mardo	.....	Antechinus flavipes
Native cat	.....	Dasyurus geoffroii
Little brown snake	.....	Elopognathus minor
Red-eared firetail finch	.....	Emblemata oculata
Bandicoot	.....	Isoodon obesulus
Numbat	.....	Myrmecobius fasciatus
Golden whistler	.....	Pachycephala pectoralis
Ringtail possum	.....	Pseudocheirus peregrinus
Bush rat	.....	Rattus fuscipes
Mueller's snake	.....	Rhinoplocephalus bicolor
Grey fantail	.....	Rhipidura fuliginosa
Quokka	.....	Setonix brachyurus
Dunnart	.....	Sminthopsis murina
Honey possum	Tarsipes spencerae
Brush-tailed possum	Trichosurus vulpecula

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PRINCIPAL OFFICERS*

Conservator of Forests	B. J. Beggs, B.Sc. (For.), Dip. For. (Canb.)
Deputy Conservator of Forests	P. J. McNamara, M.A. (Oxon.)
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Chief of Division	J. B. Campbell, B.Sc. (For.), Dip. For. (Canb.)
Chief of Division	E. R. Hopkins, Ph.D. (Melb.), B.Sc., Dip. For. (Canb.)
Chief of Division	....	....	....	....	J. J. Havel, M.Sc. (For.) (Qld.), Dip. For. (Canb.), Dip. Ed.
Chief of Division	....	....	....	....	D. E. Grace, B.Sc. (For.), Dip. For. (Canb.)
Chief of Division	....	....	....	....	P. N. Hewett, B.A., B.Sc. (Adel.), Dip. For. (Canb.)
Chief of Division	....	....	....	....	A. C. van Noort, B.Sc. (For.), Dip. For. (Canb.)
Superintendent	....	....	....	....	C. J. Edwards, B.Sc. (For.), Dip. For. (Canb.)
Superintendent	....	....	....	....	J. K. Smart, B.Sc. (For.) (Aber.)
Superintendent	....	....	....	....	F. H. McKinnell, Ph.D. (A.N.U.), B.Sc. (For.), Dip. For. (Canb.)
Superintendent	....	....	....	....	G. B. Peet, M.Sc. (For.) (Melb.), B.Sc. (For.), Dip. For. (Canb.)
Superintendent	....	....	....	....	A. J. Williamson, M.For. (Mich.), B.Sc. (Melb.), Dip.For. (Canb.)
Superintendent	....	....	....	....	R. J. Underwood, M.For. (Wash.), B.Sc. (For.), Dip. For. (Canb.)
Superintendent	....	....	....	....	A. R. Hill, B.Sc. (For.), Dip.For. (Canb.)
Chief Draftsman	....	....	....	....	D. B. Johnston, Dip.Cart., F.A.I.C., Grad. Dip. S.M.
Secretary	....	....	....	....	K. G. Hide, B.A., Dip. Pers. Mgt.
Accountant (Acting)	....	....	....	....	B. J. Hodge, Dip.Pub.Admin., A.A.S.A.

*As at 30 June, 1981

STATISTICAL SUMMARY OF MAJOR OPERATIONS

Sawn Wood Production

Total Production of Sawn Timber 353 817 m³

Trends in Production and Consumption

Year ended 30 June	Sawn Production (m ³)				Total Export	Local Avail- ability	Number of Sawmills	Monthly Average No. of Employees
	Hardwood	Softwood	Hewn Hardwood	Total				
1938	331 928	.....	72 883	404 811	213 695	191 116	134	3 112
1946	251 194	.....	398	251 592	95 524	156 068	128	2 876
1951	356 029	.....	33	356 062	66 339	289 723	256	4 047
1956	544 134	.....	150	544 284	129 367	414 917	274	5 804
1960	470 833	.....	.....	470 833	174 643	296 180	265	5 037
1965	460 246	22 667	.....	482 913	133 565	349 348	206	3 615
1966	475 642	16 499	.....	492 141	68 885	423 256	203	3 518
1967	461 176	17 085	.....	478 261	138 723	339 537	202	3 173
1968	469 818	16 531	.....	486 349	84 569	401 779	188	3 209
1969	413 666	19 643	.....	433 309	86 455	346 854	191	3 233
1970	425 295	16 893	.....	442 188	96 275	345 914	163	2 869
1971	420 777	21 595	.....	442 372	79 437	362 935	150	2 401
1972	379 006	21 733	.....	400 739	101 191	299 548	154	2 533
1973	375 135	23 283	.....	398 418	111 547	286 871	145	2 825
1974	374 899	26 534	.....	401 433	98 200	303 233	140	2 215
1975	368 844	27 086	.....	395 930	100 127	295 803	129	2 228
1976	383 010	16 258	.....	399 268	94 136	305 132	129	2 211
1977	369 151	16 685	.....	385 836	77 352	308 484	136	2 242
1978	347 111	18 669	.....	365 780	58 833	306 947	139	2 170
1979	331 135	18 145	.....	349 280	66 420	282 860	133	2 033
1980	331 411	21 400	.....	352 811	N/A	N/A	133	2 088
1981	330 863	22 954	.....	353 817	N/A	N/A	137	2 136

Log Production* (m³)

	Crown Land	Private Property
Saw Logs Hardwood	876 885	99 995
Saw Logs Softwood	64 074	2 988
Other Logs Hardwood	515 075	58 983
Other Logs Softwood	137 478	N/A

* Includes sawlogs and logs for plywood, veneer and reconstituted wood (particle board etc.) and chipwood.

Forest Area

Total area of State forest	1 867 833 ha
Additions to State forest	1 103 ha
Excisions from State forest	140 ha
Land purchased for pine planting	NIL ha

Pine Establishment

Areas planted with pines 1980	2 595 ha
<i>Pinus radiata</i>	1 617 ha
<i>Pinus pinaster</i> and other species	978 ha
Total area of pine plantation established at 31 December 1980	50 356 ha
<i>Pinus radiata</i>	25 584 ha
<i>Pinus pinaster</i> and other species	24 772 ha

Management

Area covered by hardwood assessment	88 000 ha
Engineering, new works—	
Roads and tracks	398 km
Houses	2

Protection

Area of prescribed burning	264 550 ha
Fire outbreaks—	
Number of fires	178
Area burnt	7 407 ha

Nurseries

Produced for private buyers (Hamel and Narrogin)	266 875 trees
Produced for Forests Department (Hamel, Narrogin and Manjimup)	2 791 134 trees

Sandalwood									1 652·5 t
Quantity exported	....	....	....	....	....	....	....	....
Chiplogs (hardwood)									515 075 m ³
Quantity produced	....	....	....	....	....	....	....	....

THE FOREST AREA

State Forests (Forests Act 1918-1976)

The area of State forest at 30 June 1981 was 1 867 833 ha, an increase of 963 ha compared with the area at 30 June 1980.

Timber Reserves (Forests Act 1918-1976)

The area held under Timber Reserves at 30 June 1981 was 118 772 ha, an increase of 124 ha compared with the area at 30 June 1980.

Freehold land held at 30 June 1981 in the name of the Conservator of Forests totalled 26 367 ha, a decrease of one hectare for the year.

These areas may be classified into the following forest types (to the nearest 1 000 ha).

Type	Area (ha)
Jarrah	1 450 000
Karri	149 000
Wandoo	106 000
Mallet	10 000
Tuart	3 000
Goldfields species	30 000
<i>Pinus radiata</i>	26 000
<i>Pinus pinaster</i>	25 000
Very open areas	214 000
	<hr/>
	2 013 000

Jarrah type includes: pure jarrah; jarrah with marri, W.A. blackbutt, wandoo, sheoak and bullich as minor species; stands dominated by marri with jarrah as the minor species; stands dominated by W.A. blackbutt with jarrah or marri as the minor species; stands dominated by bullich with jarrah or marri as the minor species.

Karri type includes: pure karri; karri with marri and/or jarrah and the tingles as the major or minor species.

Wandoo type includes: pure wandoo; pure powderbark wandoo; wandoo and powderbark with jarrah, marri and mallet as the minor species.

Mallet type includes: plantation mallet (8 300 ha); mallet with wandoo as the minor species.

Tuart type includes: pure stands of tuart. These are mainly in the Ludlow area.

Goldfields species include: pure stands of salmon gum, Dundas mahogany, Dundas blackbutt, Cleland's blackbutt, silver gimlet, sandalwood, jam and many others; or any of these species in combination.

Pinus radiata type includes: pure stands in plantations only.

Pinus pinaster type includes: pure stands plus a very small area of other species in experimental plots, in plantations only.

Very open areas include: swampy and rock areas; areas with sparse tree canopy; areas cleared for mining, power lines and dams.

Land Alienation and Leases

There were 51 applications for alienations involving 13 054 ha, and 20 applications for forest leases involving 426 ha.

During the year the Department agreed to the following:

(a) Alienations	Number	Area (ha)
Timber Zone—		
State forest	1	250
Crown land	9	11 591
Outside timber zone	1	2

(b) *Leases*

Timber zone—									
State forest	....	....	....	....	....	....	....	7	184
Crown land	....	....	....	....	....	....	....	5	263
Outside timber zone	....	....	....	....	....	....	....

LAND MANAGEMENT

System 6 Participation

After the completion and publication of vegetation maps for the System 6 area, the Forests Department's contribution was limited to assisting the Department of Conservation and the Environment with the preparation of the System 6 Study Report.

The report has now been completed, published and distributed for public response. The Forests Department's response to the report is being prepared.

Land Use and Management Plans

Draft land use management plans for the Central and Southern Regions, Wanneroo and the Swan coastal plain and Dryandra have been prepared. Standards have been set and a composite plan for the whole State forest area is in preparation.

A draft framework plan for recreation in the Northern Region was prepared and circulated to other organizations for comment. This exercise has greatly assisted in outlining the future requirements for recreational development in the northern jarrah forest. Recreation plans for the Mundaring and Wanneroo Divisions are in preparation and will indicate the detail required in regional planning.

Terminology and procedures for land use planning have been extensively reviewed for the new General Working Plan.

THE ESTABLISHMENT AND TENDING OF FORESTS

Jarrah Forest

The Forest Improvement and Rehabilitation Scheme continued in 1980/81, the operation being financed by Alcoa of Australia. The Department carried out improvement work in areas of the northern jarrah forest adjacent to bauxite mining. A total of 672 ha at Jarrahdale, 1 030 ha at Huntly-Del Park and 415 ha at Willowdale were treated to favour water production, timber production and recreation in accordance with designated land use priorities. In addition, 18 ha of dieback affected forest were rehabilitated by the Forests Department in areas not influenced by bauxite mining.

Karri Forest

During the winter of 1980, 2 260 ha of cut over karri and karri-marri forest were regenerated, of which 1 367 ha were hand planted and fertilized. In addition, 683 ha were established by natural seedfall from retained seed trees. Artificial seeding methods were used on a further 210 ha.

Rehabilitation Work

A large programme of rehabilitation of log landings and snig tracks was completed in co-operation with the timber industry. Some 320 landings and associated snig tracks were ripped, fertilized and planted. A total of 217 000 karri seedlings in jiffy pots was planted.

Wandoo Forest

In the Helena Catchment, 130 ha of wandoo were planted. In the eastern zone, 88 ha were prepared for natural regeneration.

Mallet Forest

The State forest at Dryandra contains most of the mallet forest under Forests Department control. The area is managed primarily for the conservation of flora and fauna. The first draft of a land management plan for the area has been prepared.

Thinning to produce mallet fence posts and material for tool handles was carried out on 143 and 41 ha respectively.

Tuart Forest

Regeneration in the tuart forest by clearing and burning the peppermint understorey and replanting tuart seedlings on the ashbeds was carried out on 63 ha.

A further 50 ha were prepared for next year's programme, which together with an additional 30 ha will be regenerated using the seed tree method.

Softwood Forest

Pine Planting

During the year the Forests Department planted 2 595 ha of pines. This total includes 35 ha of second rotation planting in Myalup. State pine plantations now cover 50 356 ha. There were 212 ha of plantations clear felled.

Tending Pine Plantations

The following plantation tending was carried out:

	ha
Scrub control	5 872
Fertilizing with superphosphate	1 885
Fertilizing with minor elements	2 417
High pruning	3 629
Low pruning	2 157

Departmental Plantation Areas

The areas of plantation (by Divisions) as at December 1980 were as follows:

AREAS OF PLANTATIONS (ha)

Division	<i>P. radiata</i>	<i>P. pinaster</i> and other species	Total
Wanneroo	722.0	18 896.9	19 618.9
Mundaring	849.5	708.1	1 557.6
Jarrahdale	324.2	1 009.6	1 333.8
Dwellingup	536.1	74.9	611.0
Harvey	3 706.2	2 298.2	6 004.4
Collie	2 744.9	83.5	2 828.4
Kirup	7 080.3	82.4	7 162.7
Nannup	6 586.5	133.6	6 720.1
Busselton	2 646.1	1 455.2	4 101.3
Manjimup	207.9	.....	207.9
Pemberton	180.4	29.7	210.1
Total	25 584.1	24 772.1	50 356.2
Experimental Planting	226.1	238.6	464.7
Grand Total	25 810.2	25 010.7	50 820.9

Areas planted in 1980, totalling 2 594.5 ha, are detailed below:

1980 PLANTING (ha)

Division	<i>P. radiata</i>	<i>P. pinaster</i> and other species	Total
Wanneroo	.....	538.4	538.4
Harvey*	124.3	45.3	169.6
Collie	12.0	.....	12.0
Kirup	556.9	.....	556.9
Nannup	271.2	20.3	291.5
Busselton	652.4	373.7	1 026.1
Total	1 616.8	977.7	2 594.5

* Includes 35.6 ha second rotation planting.

NURSERY PRODUCTION
(Number of Trees Supplied)

Nursery	For sale to the Public		For Departmental Use		Total
	Potted stock	Open rooted stock	Potted stock	Open rooted stock	
Commercial Nurseries (mainly hardwood)—					
Narrogin	129 455	32 300	5 538	.....	167 293
Hamel	94 620	10 500	574 146	.....	679 266
Hardwood Nursery—					
Manjimup	.....	.....	350 000	1 861 450	2 211 450
Pine Nurseries—					
Gnangara	.....	59 200	590 900	.....	650 100
Nannup	.....	233 350	2 755 300	.....	2 988 650
Total	224 075	335 350	4 275 884	1 861 450	6 696 759

Tree Nurseries

Forests Department nurseries at Hamel, Narrogin and Manjimup produced trees for shelter and amenity purposes as well as for regeneration and rehabilitation projects. These included some 420 000 trees raised for reforestation of catchment areas for the Public Works Department.

Departmental pine nurseries at Gnangara and Nannup raised seedlings for Departmental and private pine plantation projects.

Seed Collection

Seed was collected from Departmental seed orchards, high-quality plantations, State forests and timber reserves.

Returns from sales from the seed store were \$9 967 for the year.

Summary of Tree Planting

In addition to the natural regeneration of cut over jarrah forest, some 5 858 ha of reforestation and afforestation was carried out by the Forests Department during the year by means of planting and seeding. This was made up as follows:—

	ha
Pine afforestation	2 595
Karri regeneration	2 260
Tuart regeneration	63
Reforestation of gravel pits	38
Reforestation of catchment areas	594
Reforestation of mined areas	105
Reforestation of dieback killed forest	203*
Total	5 858

* Includes 185 ha in the F.I.R.S. programme.

RESOURCE MANAGEMENT

Water

As most surface water supplies in the south-west of Western Australia come from catchments within State forests, catchment protection is of high priority in Departmental planning. Protection is carried out in close co-operation with the Public Works Department and the Metropolitan Water Supply, Sewerage and Drainage Board. The co-operation involves not only integrated research, but also modification of forest utilization and regeneration techniques, for instance heavy thinning of young pine stands on the coastal plain is designed to increase the replenishment of shallow aquifers used to supply the metropolitan area with water. Rehabilitation strategies in former bauxite mines are an attempt to avoid surface erosion and ensure potable water. The possibility of thinning jarrah regeneration areas to increase runoff is under investigation. The preliminary work, including several years of prior stream monitoring and thorough assessment of initial catchment cover, has been completed.

The Forests Department assisted the Public Works Department with the reforestation of catchments in which agricultural clearing had resulted in increased salinity and deteriorating quality of surface water resources.

Wood Production

Timber Production

During the year, 28 106 ha of hardwood forests were cut over for sawlogs.		ha
Jarrah forest		22 933
Karri forest—		
Clear felled or cut to seed trees		2 079
Removal of seed trees		1 292
Thinnings		183
Wandoo forest		1 435
Mallet forest		184

The production of 353 817 m³ of sawn timber from all sources represented an increase of 1 000 m³ compared with the previous year's figures, but represented a decrease of 45 451 m³ compared with the 1976 figure. The increase in production was caused by the industry's acceptance of lower quality logs.

Details of the annual intake of mill logs and production of sawn timber are provided in the accompanying tables. The summary of log production for the period 1968/1981 is shown in Appendix 5.

Local plywood factories obtained the following quantities of peeler logs:		m ³
Karri		1 951
Jarrah		5 488
Pine		7 439

In accordance with the provisions of Working Plan No. 86 of 1977, the jarrah sawlog cut from Crown land decreased from 668 240 m³ in 1976 to 605 262 m³ in 1981. Similarly, the karri sawlog cut from Crown land decreased from 310 063 m³ in 1976 to 251 071 m³ in 1981. This represents a reduction of 121 970 m³ for these species.

Five sawmills operating on Crown land closed during the year.

Timber Inspection

The total quantity of timber inspected during the year was 57 819 m³ as follows:

Railway sleepers—	m ³
Ex Crown land	30 796
Ex private property	5 426
Re-inspected	141
	36 543
Other sawn timber	21 375

QUANTITY (m³) OF SAWN TIMBER PRODUCED FROM CROWN LAND AND PRIVATE PROPERTY DURING THE PAST TWO YEARS

Year Ended 30 June	From Crown land		From Private property		Total Quantity
	Sawn timber other than sleepers	Sawn sleepers	Sawn timber other than sleepers	Sawn sleepers	
1980	282 596	30 559	33 995	5 661	352 811
1981	287 672	30 976	29 743	5 426	353 817

PRODUCTION OF LOG TIMBER FOR YEAR ENDED 30 JUNE 1981 NOT INCLUDING MINING TIMBER, FIREWOOD, POLES AND PILES

Tenure	Sawlog volume by species (1) (m ³)								Total	Other log material (2) (m ³)		Total (m ³)	Grand Total (m ³)
	Jarrah	Karri	Wandoo	Yarri	Sheoak	Marri	Pine	Other		Hard-wood	Pine		
Crown land	605 262	251 071	2 632	4 714	959	11 689	64 074	558	940 959	515 075	137 478	652 553	1 593 512
Private property	62 929	23 365	7 635	4 801	120	4 887	2 988	658	102 983	58 983	.....	58 983	161 966
Total	668 191	274 436	10 267	9 515	1 079	12 176	67 062	1 216	1 043 942	574 058	137 478	711 536	1 755 478

- (1) Includes sawlogs and logs used in the production of plywood veneer.
 (2) Includes Chipwood.

Woodchip Operations

A total of 515 075 m³ of marri and karri, jarrah and yellow tingle chip logs was supplied to the W.A. Chip and Pulp Company's mill at Diamond for the production of woodchips. This intake consisted of 75.42 per cent marri and 23.91 per cent karri plus small parcels of jarrah and yellow tingle.

This woodchip material, unsuitable for sawmilling, came from a total area of 4 865 ha (2 572 ha karri-marri forest and 2 293 ha from jarrah-marri forest).

In addition, some 58 983 m³ of chip logs were obtained from private property.

Sawmills supplied 187 501 t of chips prepared from offcuts.

Sandalwood

Exports for the year amounted to 1 652.5 t. Sandalwood received at the Spearwood depot of the Australian Sandalwood Co. Ltd., during the 1980-81 year totalled 1 977 t, compared with 1 646 t for the previous year.

These totals may be broken down as follows:

	1979/80 (t)	1980/81 (t)
Sandalwood from Crown land—		
Green sandalwood—		
Logwood (including roots and butts)	862	1 092
Dead sandalwood		
Burnt wood	85	193
Cleaned wood	30	35
Pieces	605	645
Sandalwood from private property	64	12
	1 646	1 977

The amount of sandalwood obtained from private property declined sharply this year.

Twenty-four sandalwood licences are currently held and there are approximately 100 people employed in the industry.

Firewood Production and Consumption

	Crown land (t)	Private property (t)	Total (t)
General purpose and sleeper sawmills—			
For sale	38 464		38 464
Own use	2 375		2 375
Private property sawmills—			
For sale		7 905	7 905
Own use		356	356
Domestic—			
Local Firewood Permit	3 029		3 029
Forest Produce Licence	11 017		11 017
Industry—			
Wundowie	40 024		40 024
Kalgoorlie	1 580		1 580
Total	96 489	8 261	104 750

Other Forest Produce

Poles and piles obtained from Crown land during the year amounted to 318 480 m, compared with 291 581m for the previous year. Supplies of piles and poles from private property are dwindling, but accurate production figures are not available.

The number of fence posts and strainers cut from Crown lands totalled 301 498. Records received show that 23 210 posts and strainers were obtained from private property, but this was probably only a small percentage of the total production from this source.

The following table details the amounts and sources of other forest produce obtained during the year.

Description of forest produce	South-west Division and Agricultural Areas		Goldfields Area Crown land	Total
	Crown land	Private property		
Mining Timber South-west	3 727	.....	.....	3 727
Mining Timber Goldfields Area	.....	.....	166 984	166 984
Piles, Poles and Bridge Timber	318 480	.....	.....	318 480
Fence Posts and Rails	232 160	23 210	35 229	290 599
Strainers	29 798	.....	4 311	34 109
Boronia	.....	.....	.....	.....
Gravel and Stone	249 713	.....	.....	249 713
Sand	126 959	.....	.....	126 959
Sawdust as fuel	36 434	.....	.....	36 434
Bean Sticks	4 310	.....	600	4 910

Softwood Production

Pine log production from Departmental plantations, mainly in the form of thinnings, amounted to 201 552 m³, which was an increase of 10 189 m³ (5.32%) on production during 1979/80. The following figures show the trend in pine log removals in recent years.

Year ended 30 June	m ³ (under bark)
1950	8 044
1955	20 131
1960	28 394
1965	48 766
1970	81 281
1971	86 245
1972	90 761
1973	100 420
1974	123 393
1975	129 086
1976	105 567
1977	120 859
1978	125 548
1979	176 944
1980	191 363
1981	201 552

Removals by category were as follows:

	Total (m ³) (under bark)
Sawlogs and peeler logs	64 074
Other log material	137 478
Total	201 552

Production from the various plantations was as follows:

	Total (m ³) (under bark)
Wanneroo	33 148
Manjimup ....	....
Harvey	18 007
Collie	16 537
Kirup (Grimwade)	39 998
Nannup	54 090
Busselton	25 252
Pemberton	5 939
Mundaring	8 581
Total	201 552

Sawn production from all sources was 22 954 m³, which is an increase of 1 554 m³ on 1979/80.

Softwood Utilization

Pine log sales from State forests increased from 191 363 m³ to 201 552 m³ during the year. These logs, which included peelers, mill logs, case logs, fence posts and rails and particle board logs were delivered by private contractors for the Department to the various users of the products. During the year the Department's pine logging operations in the Northern Region were transferred to a private contractor after the calling of tenders.

The Department continued to log steep country in the Blackwood Valley using cable extraction methods. These have proven to be environmentally acceptable during all weather conditions.

Production research into *Pinus pinaster* milling carried out at the Harvey mill identified some of the milling, drying and dressing problems associated with old stands of *Pinus pinaster*. During the later part of this year a proof grader was purchased for the Harvey mill and will be installed during 1981/82. The sawn produce from the mill was sold under contract of sale. The Forests Department adopts and promotes the quality control methods included in the rules of the Radiata Pine Association of Australia. Close liaison is maintained with all sections of the expanding pine industry.

Hardwood Utilization

Commercial thinning of karri stands that were regenerated after clear felling in the 1930s continued throughout the year. Karri logs from these thinnings were delivered by Departmental contractors to plywood factories, sawmills and the Diamond chip plant. The Forests Department mill at Dwellingup continued to operate throughout the year and the sawn product was sold by contract of sale.

Trials to produce sliced veneer from small jarrah logs were undertaken during the year.

Timber Industry Regulation Act, 1926-1969

A total of 137 mills were registered under the provisions of the Act on 31 December 1980; 70 mills on Crown land and 67 mills on private property.

The average number of persons employed in the timber mills each month throughout the year was 2 136, an increase of 48 compared with the 1979/80 figure of 2 088.

The District and Workmen's Inspectors made 1 039 mill inspections and 914 bush inspections.

There were 110 notifiable accidents during the year; one of these was fatal.

The number of accidents per 100 persons employed was 5.15, a decrease compared with 1979/80 figure of 5.36.

The cost of administering the Timber Industry Regulation Act for the year was as follows:

Salaries	\$ 49 619
Travel allowances, office rent, plant cost and sundries	21 703

Recreation and Landscape Planning

The Department's efforts in the field of forest recreation were highlighted by two achievements during the past year. The first was the completion of a study on the results of the forest-wide visitor survey of recreational use. The study, which outlines the growing demand for and use of State forest for a range of recreational activities, is available for public perusal at the Department's library at Como.

The second achievement was the preparation of a recreation framework plan for the area of State forest stretching south from Wanneroo to the Murray River. Currently in draft stage, this plan represents the Department's first attempt at comprehensive recreation planning at a regional level. In addition, a draft of a five-year recreation working plan for the Mundaring area has been prepared and is to be used as a model for future recreation plans.

At the Divisional level, the Department continued to give priority to the upgrading of existing recreation areas and facilities. Two new areas were also developed during the year and plans prepared for an additional six sites. Work is also nearing completion on the remarking of the Bibbulmun Track and its various circuit routes.

Landscape plans for the development of the grounds around the State Headquarters were finalized. Extension Branch officers also assisted in a number of other landscape planning projects including parkland plantings in Manjimup townsite and the development of an arboretum near Balingup in co-operation with the local Progress Association.

Flora and Fauna

Liaison with the Department of Fisheries and Wildlife on native flora protection, under the revised Wildlife Conservation Act, was maintained throughout the year, particularly in the control of boronia picking in the south-west.

The Road Verge Conservation Committee, under the Chairmanship of the Conservator of Forests, met three times during the year. The Committee continued its role in protecting flora along road verges throughout the State. During the year a Committee member, Mr. P. N. Hewett, delivered a paper to a roadside vegetation seminar in Melbourne at the invitation of the organizers.

The collection and identification of tree species commenced in the Pilbara region and continued in the Kimberley region.

As reported in the Research (Manjimup) Section of this report, the study of native fauna continued in the Perup Forest Management Priority Area (Conservation).

Mining Rehabilitation

Bauxite Mining Rehabilitation

A total of 294.6 ha of pits and access roads were reforested by hand planting. The Forests Department planted 104.8 ha at Jarrahdale, and Alcoa of Australia planted 189.8 ha at the Del Park and Huntly mine sites.

Species planted include *E. wandoo*, *E. maculata*, *E. resinifera*, *E. saligna*, *E. patens* and *E. accedens*. These trees have been selected largely because of their resistance to dieback disease and their potential, in their natural environment, to produce trees of commercial size and quality. Selected areas of *E. muellerana*, *E. marginata*, *E. crebra* and *E. diversicolor* were planted to investigate their potential to survive in the modified environment.

Present treatment includes the planting of trees in random mixtures of two or three species, fertilizing with nitrogen and phosphate at three and nine weeks after planting, and sowing a native understorey (mainly legumes) at the rate of 1 kg of seed per hectare, bulked with 450 kg/ha of super-phosphate.

During the year Departmental officers reviewed past bauxite mining rehabilitation and compiled a new and comprehensive rehabilitation prescription. The prescription is based on considerations such as land use objectives, current research findings, vegetation monitoring, susceptibility to dieback and requirements for water quality and fire protection.

Mineral Sands Mining Rehabilitation

Associated Minerals Consolidated Ltd., seeded 45 ha of land with crop or pasture species following mining at Coolilup. The Forests Department established tree planting trials involving 11 species, while the mining company planted 6 500 trees for amenity purposes.

At Yoganup 8 ha of land was seeded with crop and pasture species by Westralian Sands Ltd. Tree planting trials involving seven species were established by the company according to a Forests Department design.

Coal Mining Rehabilitation

The 1979 Agreements between the State, Griffin Coal Mining Co. Ltd., and Western Collieries Ltd., require each company to submit detailed proposals for mining and rehabilitation for their next 15 years of operations.

The Forests Department is represented on the inter-departmental committee which reviews rehabilitation proposals. In August 1980 the Griffin Coal Mining Company's proposals were approved on the basis that the company established a series of trials to test a range of rehabilitation methods. The success of these will be evaluated in three years time. Proposals from Western Collieries were only received in May 1981 and are still being examined.

Catchment Rehabilitation

The Department replanted 594 ha of former farmland in the Wellington and Helena Catchment areas on behalf of the Public Works Department (540 ha) and the State Energy Commission (54 ha).

Protection: Fire

The area of land under control of the Forests Department and protected from fire was 2 012 804 ha. In addition, assistance was provided to shires and other government organizations in the protection of private and public lands adjacent to State forest.

The fire season this year was mild and relatively cool, although prolonged by the unusually late commencement of autumn rains. Weather data recorded at Dwellingup and Pemberton are shown in the table as follows:

	Dwellingup		Pemberton	
	Average	1980-81	Average	1980-81
Rainfall—				
Annual (mm)	1 289	1 271	1 245	1 185
October to April inclusive (mm)	278	277	355	302
Number of wet days—				
Annual	129	132	169	191
October to April inclusive	45	43	70	85
Temperature—				
Mean maximum October to April °C	25.6	24.8	22.7	22.3
Number of days 30°C and over	52.5	41	27.4	22
Number of days 40°C and over	0.4	.....	0.2	.....
Relative Humidity—				
Number of days of 15% minimum or less	6.5	.....	1.5	.....
Number of days between 16% and 25%	32.3	28	8.8	16

Prescribed Burning

Areas of prescribed burning for the past five fire seasons are shown below:

	Fire Season				
	1976-77 (ha)	1977-78 (ha)	1978-79 (ha)	1979-80 (ha)	1980-81 (ha)
State forest—					
Hand burning	49 405	36 567	57 801	53 137	42 561
Aircraft burning	185 236	233 931	311 733	282 965	207 428
Total	234 641	270 498	369 534	336 102	249 989
Advance, top disposal and regeneration burns	3 563	3 674	3 861	3 051	9 014
Plantations—					
Clearing burns	2 752	2 530	2 008	987	3 749
Burning under pine canopy	2 284	1 779	1 932	1 938	1 798
Total	5 036	4 309	3 940	2 925	5 547

A large increase in the area burnt for regeneration is the result of a record karri regeneration programme and treatment of jarrah-marri forest following chipwood logging trials in these stands.

Expansion of the pine planting programme in the Donnybrook Sunkland has resulted in the large increase in clearing burns during 1980/81.

The Department assisted the Bush Fires Board, the Army, the National Parks Authority and the Public Works Department with aerial prescribed burning. Similar assistance in prescribed burning was given to the State Energy Commission, the South Perth City Council and W.A.I.T. on lands under their control.

Detection

The main fire detection service was provided by surveillance pilots flying light aircraft. Nine aircraft were used, flying a total of 7 378 hours during the fire season. During the year the detection system was improved by:

- the introduction of four new Piper Super Cubs,
- the erection of hangars at Dwellingup and Manjimup,
- the construction of a new runway at Nannup.

Five fire towers were manned regularly and 20 others kept in full readiness for fire emergencies. The surveillance period was as follows:

	Pine plantations	Jarrah forest	Karri forest
First watch	31 October	29 October	1 November
Last watch	21 May	21 May	16 April

Wildfires

The following table shows the number of wildfires attended and the area burnt during the past five fire seasons:

	Fire Season				
	1976-77	1977-78	1978-79	1979-80	1980-81
Number of wildfires attended—					
Indigenous State forest	120	221	121	81	95
Private property and Crown land adjacent to State forest	86	150	101	72	70
Pine plantation	21	11	13	5	13
Total Number	227	382	235	158	178
Area of State forest fires (ha)—					
Indigenous	5 553	8 211	2 960	1 885	7 392
Pine plantation	17	364	32	10	15
Total Area	5 570	8 575	2 992	1 895	7 407

For the second year in succession the number of wildfires occurring on State forest was below average. The total area burnt however, was the highest for the last five years, some of which resulted from 11 fires occurring on a dangerous fire weather day in January. These fires burnt in excess of 5 000 ha in the Manjimup and Walpole Divisions.

General

Two four-day courses on fire control were held for 58 Forests Department officers and representatives of the Bush Fires Board.

An incendiary machine for use in prescribed burning has been designed and built by Wait-Aid Ltd., and is to be used operationally during the 1981/82 spring burning programme.

In May, the Department conducted a most successful display at Collie of plant and equipment used for fire control in different regions of the forest. The project was designed to familiarize staff with the range of fire control equipment and their operation. Many Bush Fires Board staff and shire personnel took the opportunity to attend.

Protection: Disease

The area of State forest which has been proclaimed dieback disease risk forest remained static in 1980/81 at 719 561 ha, 38.5 per cent of all State forest.

The entry permit system designed to control access into proclaimed disease risk areas was maintained, and a further 154 permits were issued. Since its inception in 1976, this brings the total number of permits to 1 617. Of these only 199 permits are in current use.

Patrols were conducted on 870 occasions to curtail and monitor illegal entries into proclaimed disease risk areas.

Three seminars on dieback hygiene planning requirements in operations on State forest were held during the year. These were attended by Forests Department staff and representatives from:

- Alcoa of Australia Ltd.
- Worsley Alumina Pty. Ltd.
- Whittakers Ltd.
- Millars (W.A.) Pty. Ltd.
- Bunning Bros. Pty. Ltd.
- Main Roads Department
- Bush Fires Board
- Department of Fisheries and Wildlife
- Metropolitan Water Supply, Sewerage and Drainage Board
- Public Works Department
- National Parks Authority
- State Energy Commission

The wide range of forest users participating in these seminars indicates the positive approach to disease protection adopted by major users of the forest. The roading and logging trial in proclaimed disease risk forest near Dwellingup continued according to plan. A further trial has been planned near Nannup to test differing site and climatic variables and is expected to commence in the summer of 1981/82.

Forest Offences

During the year 22 persons were reported and nine persons prosecuted for offences against the Forest Diseases Regulations. Action to prosecute one offender for contravention of the Forests Diseases Regulations is currently pending. Warning letters were issued in those cases where prosecution was not warranted.

General

Twelve offenders were reported during the year for other offences against the Forests Act and Regulations. Two offenders were prosecuted for offences against the Forest Regulations and four cases were settled without prosecution. Warnings were issued in all other cases.

SUPPORT SERVICES AND RESEARCH PROGRAMMES

Research

Como

Soil and Nutrition

The work of this section was adversely affected by the absence of the Officer in Charge, for part of the year, on extended sick leave. Nevertheless, plant and soil analyses continued for several research programmes, including *P. radiata* and *P. pinaster* nutrition, the effect of fire on forest soils and the dieback disease-soil type relationship.

Pinus radiata—Mycorrhiza—Phytophthora cinnamomi Project

This project, financed by a grant from the Rural Credits Development Fund of the Reserve Bank, was completed during the year. It has provided the first survey of mycorrhizal fungi in Western Australian *P. radiata* plantations and has shown that at least 19 different fungal species form a mycorrhizal association with the pine. Most of these species were previously undescribed.

In a pot trial set up to examine the effect of inoculation with both beneficial (mycorrhizal) and pathogenic (*Phytophthora cinnamomi*) fungi in combination with water logging and fertilization, infection of the seedling roots by the pathogen was found in all treatments. Collar rot and mortality occurred in all treatments except those incorporating fertilization with superphosphate-trace element mixture.

By contrast, fertilization with phosphate-nitrogen mixture increased mortality. The increase in tolerance to the pathogen following superphosphate application was associated with increased mycorrhiza numbers and changes in plant-nutrient status.

Although the original project funded by the Reserve Bank has now ended, work continues at Como on the factors influencing deaths of *P. radiata* in the Sunkland. The incidence of death in young trees is highest in the first year in the field and subsequently declines to very low levels. The level of incidence is not an immediate management problem, but warrants continuation of research so that the host-pathogen relationship can be evaluated.

P. cinnamomi has continued to be the species most commonly isolated from the collar and/or roots of dying trees. *P. cryptogea* is the next most commonly isolated species. Two other species *P. megasperma* var. *sojae* and *P. citricola* have been found on rare occasions.

In addition to the work described above, the problem is also being studied at Busselton and Wanneroo, examining the ecological and genetical factors of the dieback disease.

Data Analysis

Early in the year a terminal and line printer linked to the CYBER computer at the Regional Computer Centre was installed at the Como Research Institute. It has greatly speeded up the analysis of a wide variety of data from chemical, ecological, biogeographical and silvicultural research. New methods of analysis are also being investigated.

Publications Section

The Section published two Bulletins (Nos. 91 and 92) and a third is at the printer. In addition, four Research Papers were published and articles prepared by Departmental officers for outside journals or conference proceedings were reprinted. Details of publications are given in Appendix (6).

During the year, the Section was given responsibility for a wider range of functions, including the production of Forest Focus and the Annual Report. It will continue to publish the work of the Research Branch.

Ecology of the Northern Jarrah Forest

A long-term study of the effect of a moderately-intense fire on the invertebrate animals inhabiting the soil and leaf litter in jarrah forest has been under way since December 1979. Four groups of animals (spiders, ants, beetles and earwigs) inhabiting the leaf litter have been captured frequently enough in pitfall traps for statistical comparison to be made. Only spiders are considered here.

As spiders are predators, it was expected that they would provide a sensitive indication of the impact of fire on their food supply, particularly on the length of time population levels take to return to pre-fire values.

It is clear from Figures 1 and 2 that the fire caused an immediate significant decline in the frequency and mean number of spiders captured. However, the decrease was transitory. Two months after the fire, similar numbers of spiders were found in burnt and unburnt plots and all differences disappeared after five months.

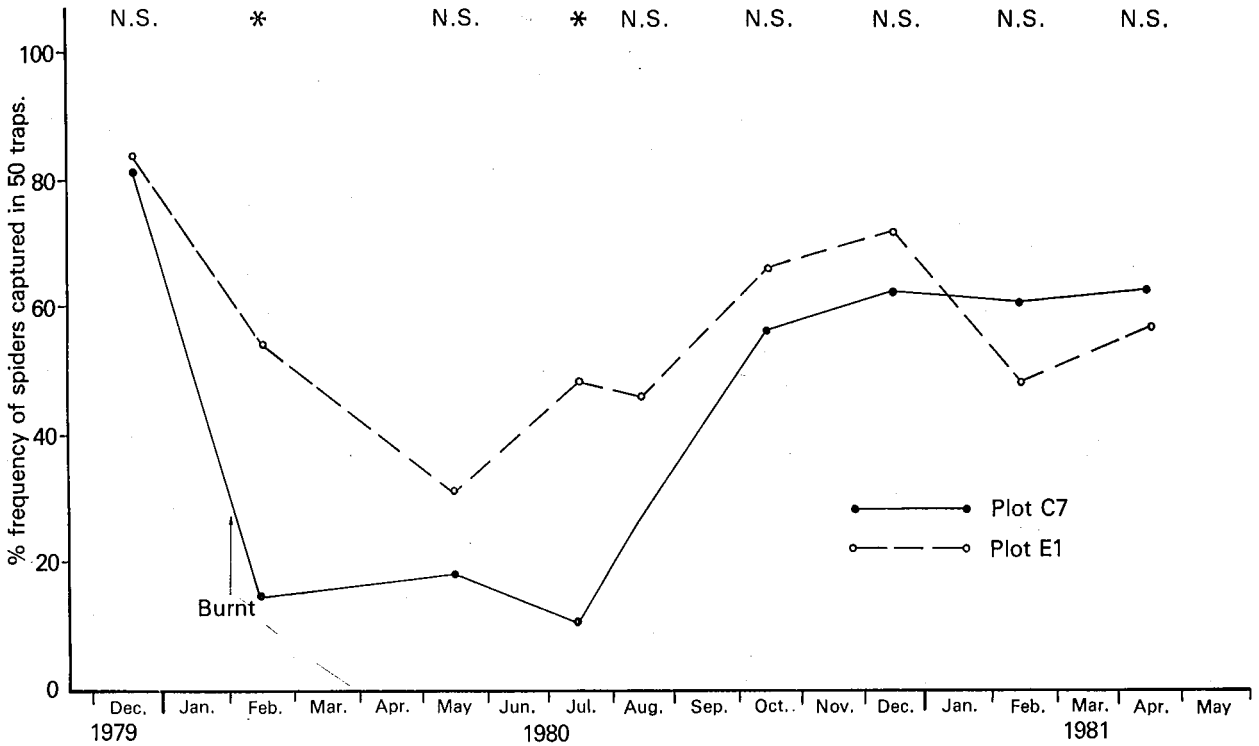


Fig. 1
 The percentage frequency of 50 pitfall traps containing at least one spider, sampled on nine occasions. Plot C7 was not burnt; plot E1 was burnt in January 1980. Statistical comparisons between E1 and C7 for each sampling date were made with the χ^2 test (N.S. means no significant differences between points at $P > 0.005$, * means difference between points significant at $P < 0.001$).

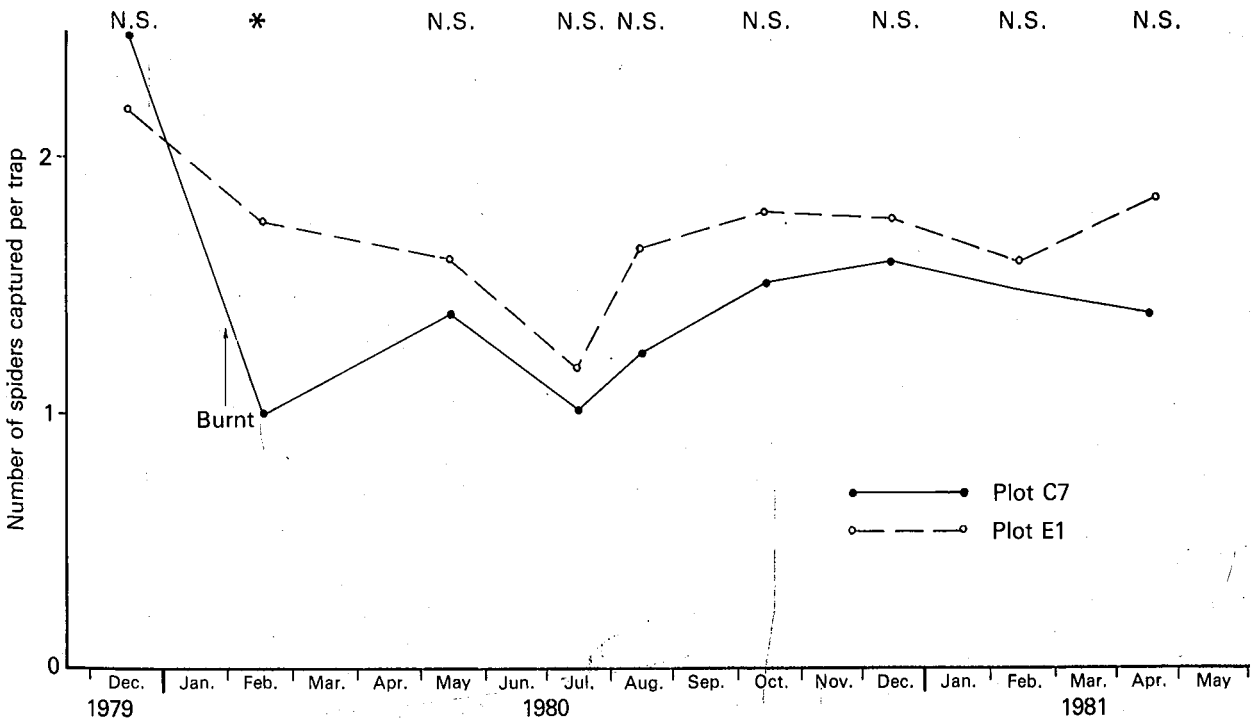


Fig. 2
 The mean number of spiders captured per pitfall trap (excluding traps without spiders), sampled on nine occasions. Statistical comparisons between E1 and C7 for each sampling date were made with the t test. (N.S. means no significant differences between points at $P > 0.005$, * means difference between points significant at $P < 0.001$).

To obtain information on the long-term growth patterns of jarrah, sample plots established as far back as the 1930s have been relocated and remeasured. These were subsequently combined with data from more recent increment plots to obtain a better understanding of growth rates and changes in stand structure over a range of ecological types.

The study of bull banksia continued during the year. Field experiments were initiated to determine the effect of various litter types on the germination of this species, whose ecological importance is being increasingly realized.

Wanneroo

Tree Improvement

Following a review of progeny trial data, the Mullaloo *P. pinaster* seed orchard was culled to remove 44 unsatisfactory genotypes. This action will result in higher quality seed for this species in the future.

Considerable variation in susceptibility to the dieback disease caused by *Phytophthora cinnamomi*, of different seedlots of *P. radiata*, was reported last year. This variation, originally observed in pot trials, has now been substantiated by field trials in the Sunland. A strong association has been found between genotype, the presence of *Phytophthora cinnamomi* and seedling deaths (Fig. 3).

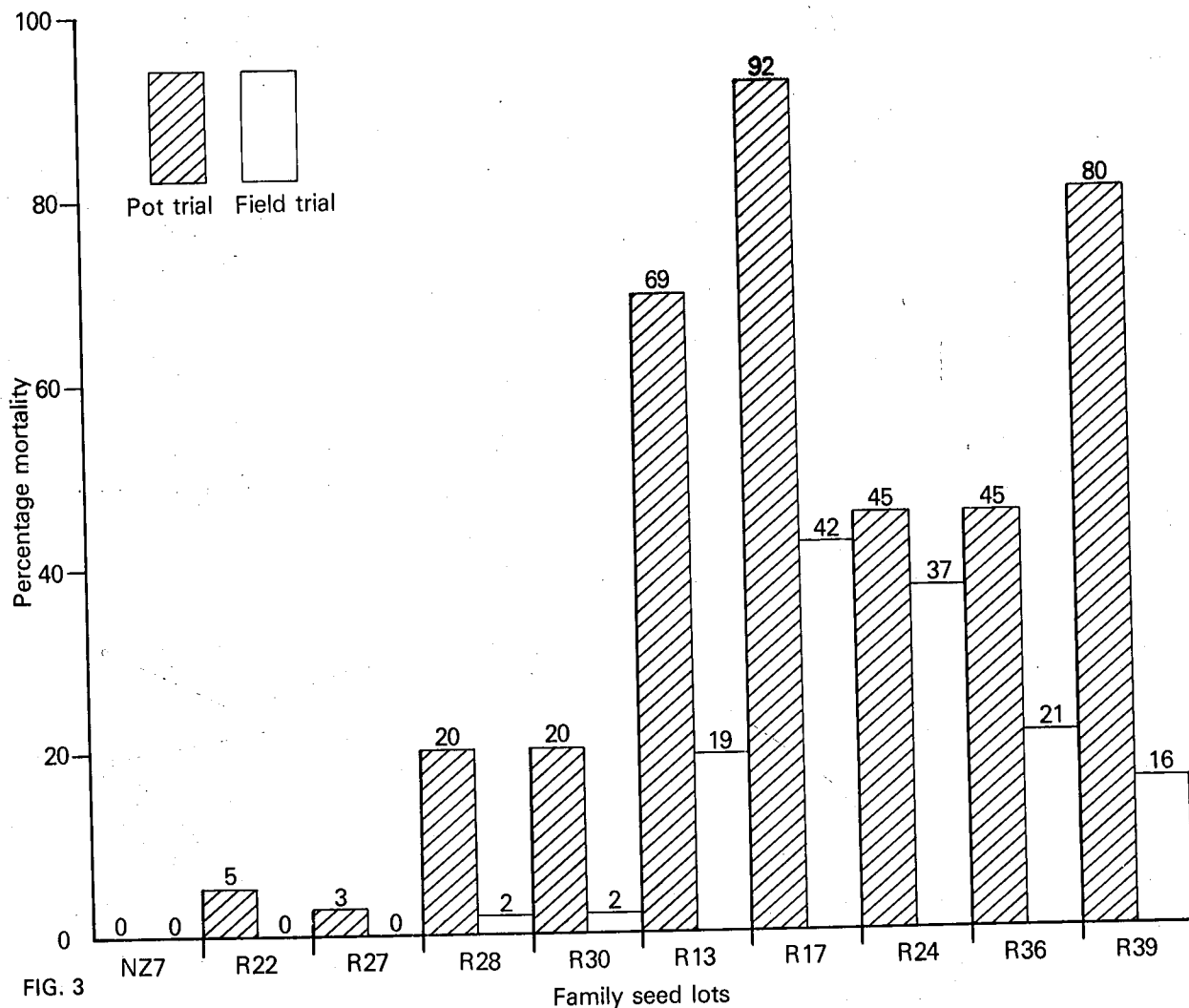


FIG. 3

Death in one-year-old *Pinus radiata* seedlings, 25 weeks after inoculation with *Phytophthora cinnamomi*.

Of the 90 parent trees in the West Manjimup *P. radiata* seed orchard, 48 have been screened for tolerance to the disease and highly susceptible genotypes have been culled. All other parents are now being screened. It is planned to test all *P. radiata* genotypes in Australian pine breeding programmes for tolerance to the dieback disease fungus. Only tolerant genotypes will be used for future seed supplies.

An extensive collection of seed of provenances of *E. wandoo* was undertaken as part of a project to define the optimum seed source of this species for two requirements, namely the rehabilitation of areas mined for bauxite and the reforestation of saline areas in water catchments. Salt tolerance of various seedlots is under study both in a pot trial and in a progeny trial in the Wellington Catchment.

Dwellingup

A major advance during the year was confirmation that the dieback disease fungus *Phytophthora cinnamomi* can invade the large suberized roots and collar region of jarrah. This has led to the hypothesis that the extensive jarrah mortality observed during the 1950s and 1960s was caused by the fungus acting as a collar rot pathogen.

Recent evidence suggests that seasonal conditions have a marked effect on zoospore inoculum levels, particularly on the freely drained soils which constitute the bulk of the forest area. Research is in progress to permit a precise definition of the sequence of climatic events required to generate zoospores.

On moisture-gaining sites within the forest, conditions for fungal survival and reproduction occur for long periods every year, and it is unlikely any susceptible species will survive on these sites in the long term. The presence of relatively high densities of *Phytophthora cinnamomi* in the soil at these sites throughout the year, means that such areas are a potential source of inoculum for accidental spread of the disease.

Another major advance during the year was the initiation of research on the resistance mechanism of jarrah, marri and radiata pine. It is in line with the greater emphasis being placed on the host-pathogen relationship.

Hydrology

A detailed vegetation survey in a sub-catchment of the Yarragil Brook was completed as the first step in the evaluation of the hydrological effect of a silvicultural thinning operation. The data are also being used to develop a computer simulation of the affect of thinning regimes on the supply of wood products and on the residual stand structure.

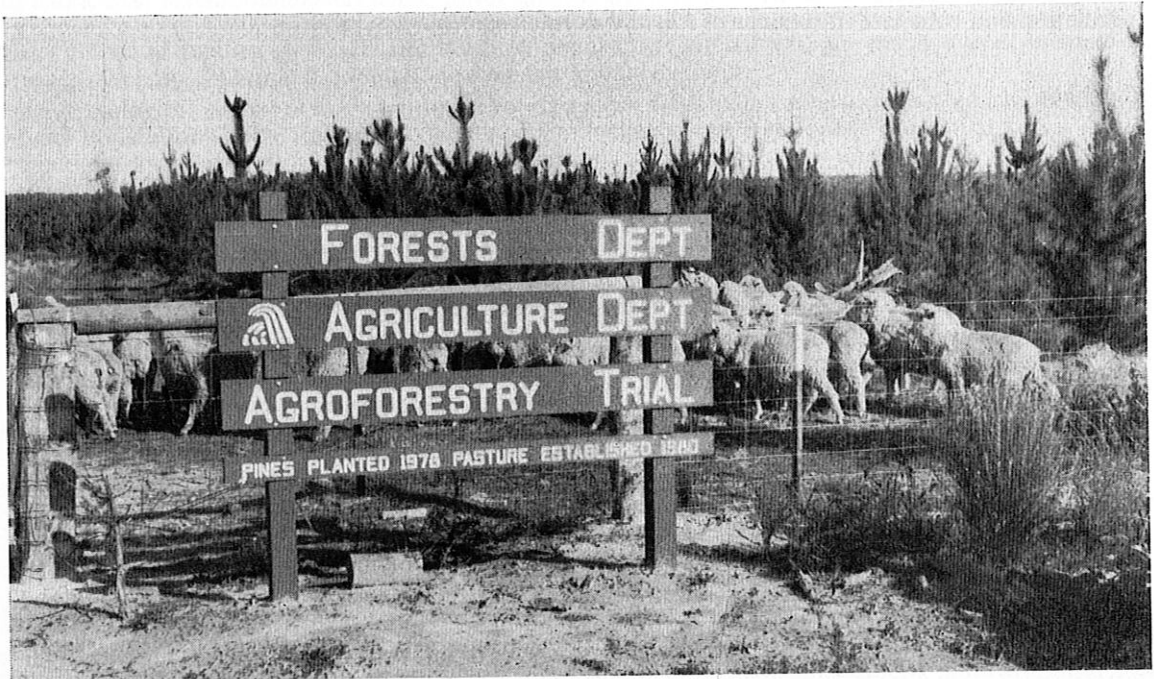
Assessment of crown cover in jarrah pole stands thinned during the 1960s has shown that their crown cover remains below that of unthinned stands.

The correlation between water yield and crown density was confirmed by crown cover measurements on the Dandalup group of research catchments.

Monitoring of water levels and salinity in bores established in the vicinity of Dwellingup continued throughout the year.

Reforestation in Areas Mined for Bauxite

A joint Forests Department, C.S.I.R.O. and Alcoa project design to measure the transpiration of vegetation in native forest and disturbed areas by the ventilated chamber method, continued during the year. Development problems slowed down the progress initially, but a major redesign of the chambers has been completed. The construction and testing of prototypes has indicated that the measurement of water loss by trees can now proceed.



The joint Forests Department and Agriculture Department agroforestry trial at Jarrahwood Plantation on the Sunkland

Busselton

Agroforestry

The widespread salinity problem in Western Australia has emphasized the need for a greater amount of research into agroforestry. Consequently agroforestry research has been increased and one officer is now working full-time in this field.

Methods of combining tree growing for salinity control with farming activities are being studied in conjunction with the Public Works Department, in several areas, especially in the Collie River Catchment where the salinity problem is most acute. One such study examines the grazing potential under a range of tree densities. Another study involves growing pines in strips with pasture in between. Several co-operative studies with C.S.I.R.O. in the Helena Catchment complement this work.

In a new trial established in the Donnybrook Sunkland, comprising 40 ha, grazing potential of young pine stands of varying densities is being investigated closely, so that an economic analysis of the pine-grazing system can ultimately be made. This is made possible through close co-operation with the Department of Agriculture, which is also co-operating on another agroforestry trial at Esperance. In this region, where farmers are concerned about wind erosion and stock losses, research is concentrating on the integration of farming with widely spaced pine planting.

Pine Nutrition

Established nutrition trials were maintained, and foliar samples were taken for analysis of the levels of elements essential for growth. A trial comparing a slow-release fertilizer with a conventional nitrogen/phosphorus fertilizer showed that the latter was more effective for tree growth.

Weed control

Several methods of controlling marri coppice by herbicides were tested. The trials showed that notch applications of the herbicide Velpar to the stems was superior to foliar spraying or applying Velpar to cut stumps. Further trials in progress are examining the effectiveness of liquid or granule applications of the herbicide to the soil in different seasons.

Pine silviculture

Several long-term spacing, pruning and thinning trials were remeasured. The appointment of a research officer with extensive utilization experience has made it possible to integrate silvicultural and utilization aspects of pine plantation management. One such aspect studied was the relationship between branch diameters in green crowns of *Pinus radiata* and the corresponding grade recovery of structural timber of logs taken from these crowns. The sample trees for the study came from a range of stand densities.

As windthrow is a potential risk in Sunkland pine plantations, the root configuration of five-year-old trees from a range of sites was examined by excavation. It was found that the physical factors, such as impermeable layers of clay or concreted gravel, had a more important restricting effect on root development than a high perched water table.

In another silvicultural trial, the effect of varying stand density was related to the potential for dieback disease of pines. Under the closed canopy of unthinned stands the conditions are generally unfavourable to the pathogen, even in the spring. Under the more open canopy of stands thinned to 750 stems per hectare, there are several weeks during spring when the conditions are favourable to sporulation and zoospore movement of *Phytophthora cinnamomi*.

Manjimup

Fauna Ecology

Long-term fauna studies in the Warren Block have revealed the changing nature of fauna populations following disturbance. When the experimental area was burnt in 1970, there was an invasion of introduced mice. Subsequently, the native bush rats reappeared and recolonized the area and the mice declined in numbers. In 1977, mardos were first observed, initially in the dense sword grass and hazel shrub of the valleys. Trapping this year showed a decline in the number of bush rats and extension of the mardo populations into the more open vegetation of the uplands.

Three of the trapped mardos were equipped with radio transmitters and tracked for up to 15 days. The tracking confirmed earlier observations and also identified fallen logs and dead standing trees as nesting sites for mardos.

A five-year-old study of the impact of selection logging and slash burning on the bird population continued in the Iffley Block. Of the original inhabitants of this jarrah-marri forest prior to logging, 53 per cent of resident species were still present after the disturbance. Parrots, cockatoos, robins, whistlers, honey eaters, magpies, shrike thrushes and diamond birds declined, whereas wrens and thornbills increased in numbers.

Research into the fire ecology of tammar thickets, centred on the Perup Fauna Priority Area, continued with prescribed burning in spring, summer and autumn. An experimental area of 100 ha in the Boyicup Block was burnt under hot summer conditions to stimulate the regeneration of the heartleaf poison thickets. Parallel studies of the effect of fires on possums, utilizing field observations and radio-tracking, revealed that some brush-tailed and ringtail possums were killed by the fire and that 38 per cent of the trees containing hollows, used as nesting sites by the possums, were rendered uninhabitable. This indicates that the type of treatment which may be beneficial to one species, can adversely affect others and that no single prescription is beneficial to all.

Two numbats caught in the jarrah forest at Perup were fitted with radio transmitters and tracked for up to 40 days. The studies revealed the movements, feeding and resting patterns of this rare species. The male was more wide ranging in its movements. The numbats use logs in their territory for hiding, and feed on termites from under twigs and branches which are mostly residue from jarrah logging operations. The numbats' resting periods are longer during the hot summer than in autumn.



Male numbat with radio-tracking transmitter

Faunal studies of the Hakea Block near Dwellingup, which was burnt at moderate to high intensity in the autumn of 1980, revealed some changes in the initially low faunal populations. After the fire, the number of reptiles increased and the bird populations altered without much overall increase in species diversity. Mammal population remained low throughout.

A biological survey of the karri-tingle forest south of Walpole revealed higher and more diverse faunal populations in the treeless flats and woodlands than in the high forest. A similar survey of the Frankland River area is in progress. On present indications, the area is fairly rich in both flora and fauna, including such rare species as the little brown snake, Mueller's snake, the honey possum and the red-eared fire-tail finch. It includes the extreme westerly occurrence of Albany blackbutt and south-westerly occurrence of wandoo.

The laboratory facilities at Manjimup have been widely used in dieback disease baiting, fungal identification and scat and hair analysis. Hair analysis has proved very helpful in work on mammal distribution, particularly in the identification of hair obtained from fox and dingo scats. In several cases it has confirmed the presence of mammal species not previously recorded in a particular area. A supplement covering some local species of mammals has been prepared for "The Identification of Mammalian Hair" by Brunner and Coman (1974).

Eucalypt Silviculture

Research on karri regeneration continued with a spot-sowing trial established to improve understanding of the factors affecting seedling survival. Spot sowing is an alternative to broadcast sowing and planting.

Future karri seed supply is an important consideration in research and planning. During the year a further 25 ha of karri seed orchard was established, bringing the total to 57 ha.

Assistance was provided by the C.S.I.R.O. to establish a trial assessing soil disturbance from thinning operations in karri regrowth stands. Soil bulk density changes were monitored and related to logging machinery activity and soil moisture conditions. Permanent growth plots were established to quantify the effect of the disturbance on the growth of the residual trees.

However, during the current year the main emphasis was on jarrah silviculture. The major task undertaken was a broad-scale survey of southern jarrah forest types, aimed at the understanding of factors that influence the stand structure and dynamics, including seedling establishment and growth.

Fire Behaviour

It is obvious from recent fire studies that the investigation of fire behaviour under dry summer conditions is a much more difficult task than is the case under moist fuel conditions in the spring.

The analysis of results from a number of summer and autumn experimental fires in jarrah forest indicate that the size of such fires has an important influence on fire behaviour. Small plots do not allow fast spreading fires to reach a steady state. When such a state is reached, fires may be large enough to influence local fire weather by increasing wind strength and temperature, thus amplifying the rate of fire spread and flame height. Under these conditions, fire may be spread by transport of burning embers, which is something that cannot be studied in small experimental burns.

In addition, the behaviour of merging fires in dry fuel conditions is much more intense and much less predictable than under moist fuel conditions. Mass ignition, as currently practised in prescribed burns undertaken to reduce fuel, inevitably leads to merging of fires. Consequently, summer and autumn prescribed burns can only be used for specific purposes involving limited risk, such as the research or the creation of suitable habitats for fauna.

Inventory and Planning

Hardwood Inventory

One thousand six hundred and ninety hectares of management level inventory was carried out in eight Divisions throughout the Northern and Central Regions providing resource information for 87 880 ha of hardwood forest. Additional inventory included assessment of the 1981 winter cutting coupes in Jarrahdale Division using dieback categories, and assessment of several locations in the southern catchment areas for the purpose of land exchange and compensation claims where clearing bans apply.

Seventy permanent increment plots were established throughout the hardwood forest and 32 plots remeasured for growth information. A further 122 permanent plots were established and 32 plots remeasured to provide correction factors to update previous assessments.

Thirty-four utilization plots were measured to monitor the standards of the inventory and planning branch assessors against current mill standards.

Softwood Inventory

During the year 1 535 permanent plots were remeasured and a further 508 permanent plots were established to update information on the softwood resource.

Remeasurements were taken of the 62 plots providing information on the agroforestry project in the Helena Catchment.

An additional eight plots were established and 64 existing plots remeasured to monitor the response to the current management regime. The majority of the original plots have now reached the required basal area and have undergone the prescribed thinning to 250 stems per hectare.

Other Projects

Sandalwood Survey: A member of the Inventory and Planning field staff was seconded for three months to a sandalwood survey of 16 pastoral leases in the Goldfields and Murchison areas. The survey, funded by the Australian Sandalwood Co., will continue over several years to provide valuable information over a vast area.

Photography: Oblique and vertical aerial photography was used extensively to monitor forest operations. In the Central Region 35 mm oblique photography was used to record hardwood and pine operations, to plot bauxite operations and to plan inventory. In the Southern Region acquisition of a 70 mm Hasselblad camera enabled vertical aerial photographs to be taken of cut over and regenerated coupes.

Forest Management Information System (F.M.I.S.): Thirty-two attributes, describing conditions such as land tenure, tree species and cutting history have been coded for the entire Southern Region to meet the requirements of the General Working Plan revision.

The system will be operationally evaluated for the Southern Region for 12 months prior to expanding the project. Five attributes have also been coded for the Central Region.

Logging Plans: Comprehensive, integrated hardwood logging plans were produced for all regions. Subsequent one-year plans for individual mills and coupes were produced for Divisions and industry. A pine-logging plan was produced for the Central Region.

Soil Disturbance Trials: In conjunction with Research Branch and the C.S.I.R.O., 19 plots were established in Treen Brook to monitor soil disturbance caused by thinning operations.

Karri Seed Forecast: The section was responsible for planning and co-ordinating the programme to forecast seed supply on 35 logging coupes during the year.

Quarantine Logging Trials: A draft plan for a quarantine logging trial in Beaton Block has been produced and several other plans are in their preliminary stages.

Chipwood Weight/Volume Ratio: Measurement of logs for determining weight/volume ratio was discontinued during the year. Sufficient data has been collected over the last five years to confirm the value of the ratio currently used for determining chipwood royalties.

Air Photo and Interpretation Section

The dieback photography programme closed on 22 June with 55 000 ha of quarantined State forest having been photographed by crews operating from Bunbury and Manjimup. Air operations were hindered by aircraft and navigational equipment malfunctions, resulting in a reduced coverage this year. The total area photographed to date is 210 000 ha.

Three teams of interpreters, stationed at Manjimup, Bunbury and Kelmscott completed the interpretation of photographs covering 77 000 ha of State forest. The field work associated with interpretation has generated new information on disease impact, thus enabling improved standards for field recognition at an operational level.

Special projects included monitoring the occurrence of tree deaths in some pine stands in the Busselton Plantations, a fauna research burn at Manjimup, and crown growth plots in Dwellingup Division.

Economics

A major effort was applied to the forecasting of future timber demands. Other work included a review of softwood stumpages, a review of the accounts system and work connected with the Industrial Assistance Commission inquiry into wood and articles of wood. Cost/benefit analysis of the Donnybrook Sunkland Afforestation and other projects were continued.

Automatic Data Processing—Scientific Applications

Forest Management Information System (F.M.I.S.): As reported elsewhere, 32 map attributes covering 1.66 million hectares have now been incorporated into the retrievable computer data base.

In addition to the existing multiple map overlay programme, several new capabilities have been built into the system. These include a capacity to automatically generate timber volume resource statements for any given map and to plot multi-coloured maps at any desired scale.

The system has been used to generate a wide range of area statements and to provide detailed resource statements required for the revision of the General Working Plan. It has also provided a means for rapidly extracting data needed for answering Parliamentary questions.

Mensuration: Data from many permanent and temporary plots on both pine and hardwood inventory projects were processed during the year.

The pine sample plot data base was transferred from the University of Western Australia CYBER to the Forests Department's computer. Scheduling for preparation of pine-logging plans was carried out at field centres.

Consultancy Service: The consultancy service to private pine plantation owners, which commenced in 1980, continued to be used in yield forecasting and cost/benefit analysis.

Mapping

Publications included the new 1:3 000 000 map entitled "Vegetation of Western Australia", in collaboration with Dr J. S. Beard. This map replaces the one last published in 1967 which was based on work by Jutson and Gardner.

The 1:500 000 map "South-West of Western Australia Forest Areas" was revised and published and is available with an overlay showing forest blocks and indices to the 1:25 000 and 1:50 000 map series.

Dieback areas interpreted from 70 mm photography have been mapped on the new 1:25 000 Topographical map series.

Completion of the 1:50 000 coloured map series has been somewhat curtailed by concentration on the production of multi-coloured maps for the Framework Plan for Forest Recreation in the Northern Region and the Land Use Management Plan for the Swan Coastal Plain (North).

Aerial mapping of areas cleared for bauxite mining continued.

Cartography

Two new standard lithographs were published and nine more are nearing completion. Project work involved the production of numerous maps, graphs and diagrams to illustrate publications and reports.

Mapping from Aerial Photographs

New sets of maps were prepared for use in aircraft engaged on detection of fires and breaches of quarantine.

Plantation plans were revised to show new clearing and planting. A plan was compiled of the Pemberton forestry headquarters, and two new arboreta were mapped.

General Drafting

The special plans used for aerial prescribed burning operations were supplied to Divisions and 14 map reference boards for fire detection were prepared. A relief model was constructed of an area near Dwellingup for use in operational planning. Conversion of land tenure plans from paper to a transparent plastic base continued.

Extension

Public enquiries relating to the planting and maintenance of trees continued and there was a significant increase in the number of enquiries from agricultural areas seeking advice on tree planting for amenity purposes and for the control of soil erosion and salinity.

The Branch was involved in a number of tree seeding and planting trials on farms but requests for such projects exceeded our capability to service them all.

Other experimental work included the rehabilitation of fly-ash dumps from coal-fired power stations in the Fremantle area, in conjunction with representatives of the Department of Agriculture.

Displays covering several aspects of forestry were mounted at 11 centres in the south-west at agricultural shows, log chops, and various festivals. Two audio-visual productions were made and used as part of the displays. The subjects covered were leisure, forest recreation and softwood production.

Revision and updating of Departmental advisory publications about tree planting and maintenance in agricultural areas was started during the year.

Talks were given to 25 schools in the metropolitan area. On request, talks were also given to various other organizations and schools.

Arbor Day was transferred to 5 June to coincide with the Western Australia Week Celebration of the "Day of Trees". Tree planting ceremonies, competitions and talks were organized for the occasion.

Private Plantations

Private interests planted 234 ha of new plantation in 1980. The total area of private pine forest is now recorded as 11 636 ha.

The Forests Department was represented at a meeting of State Government officers held in Sydney to discuss private forestry plantation matters, and also at 10 meetings of the Australian Forest Development Institute.

Education

There was a steady demand for speakers to address educational and other groups during the year.

Forests Department staff played a primary role in conducting the Education Department's second Expedition Skills (Bushwalking) Course at Albany.

Arboreta

The total available areas have now been planted in the Coolgardie and Helms (Esperance) arboreta.

A further review of arboreta in Wheatbelt areas was carried out to determine which ones warranted improvement. The Department is co-operating with local authorities and property owners to improve several of these sites.

The unsuccessful arboretum at the Chapman Valley Agricultural Research Station was replanted.

Kimberley and Pilbara Regions

The Kimberley Division is now in its second year of operation. A study of the distribution of tree species has been commenced and compilation of an herbarium for the region is continuing.

Work has commenced on an arboretum at Kununurra, and an amenity tree planting scheme has been established for the Warmun Community at Turkey Creek.

A species and fertilizer trial is proceeding in the Ord Irrigation Area in co-operation with the C.S.R.I.O.

The Department opened an office at Karratha on 1 September 1980 to service the Pilbara area. Departmental activity in this area involved:

- (a) the establishment of a "low-water" garden to demonstrate the potential for reducing the present extravagant use of water in Pilbara towns,
- (b) collection and identification of tree species that have potential for town and pastoral settlement use,
- (c) technical advice on nursery practice and tree growing in the field,
- (d) liaison with other environmental agencies in the region,
- (e) assistance in the formation of the Gascoyne Environmental Committee at Carnarvon.

Library

There was an increase in use of all library services again this year as the following figures show:

	1979/80	1980/81
Periodicals circulated	7 726	9 323
Items processed (accessioned)	566	1 163
Loans:		
From the library to staff	3 477	6 351
From other libraries to staff	316	551
To other libraries	160	224
Enquiries	2 329	2 975

Forest Engineering

Roading

A total of 398 km of roads, tracks and firelines were constructed and 5 472 km of roads were maintained.

Plant and Workshops

The Departmental fleet of 500 vehicles and 112 units of industrial plant was regularly inspected and maintained. The Department's 14 Divisional workshops were staffed by 37 tradesmen and 18 apprentices.

A five-day school for apprentices was held to consider workshop operations and safety procedures in preparation for trade examinations.

A one-day school for workshop staff was held to discuss systematic and safe procedures for workshop operations and plant inspections.

During the year 126 light units and 11 items of industrial plant were purchased as essential fleet replacements.

A number of fabrication projects were completed. They included the following:

- (a) automated seeding of potted nursery stock comprising soil mixing, pot filling, sterilization, vacuum seeding and covering at the West Manjimup nursery,
- (b) a seed drill for direct sowing and fertilizing of loose or pelleted eucalypt seed,
- (c) installation of water chlorination equipment for Manjimup and Hamel nurseries,
- (d) four heavy duty slip-on pumping units with 3 000 l tanks,
- (e) thirteen pumping units with 900 l tanks,
- (f) four pumping units with 100 l tanks,
- (g) forks, blades and rakes for Cat 930 loader,
- (h) one high pressure washdown unit for disease control,
- (i) rebuilding of eight truck bodies to suit fire pumper units,
- (j) three Lowther-type pine planting machines and major modifications to eight others,
- (k) three mounding ploughs for pine planting,
- (l) one trash slasher and blower for firebreak maintenance.

Housing and Building

The general programme of housing, building and settlement maintenance included the relocation and renovation of two houses, the conversion of one office into single officers' quarters in the Southern Divisions, the purchase of two houses at Nannup and the construction of two houses at Mundaring and Jarrahdale. A new general store at Margaret River and aircraft hangers at Dwellingup and Manjimup airstrips were also erected.

The new State Headquarters at Como is near completion and will be occupied in August 1981.

Communications

Repeater Stations

To improve radio communication, it was necessary to construct two 50 m guyed radio masts at the East Kirup and Pemberton repeater stations and to install a second antenna at the Mornington repeater tower.

Six other repeater stations were provided with upgraded antenna systems and solar power.

Divisional Offices

Very high frequency radios were installed at Dwellingup and Narrogin offices and Dryandra tower to provide direct radio contact with the local shires and bush fire brigades in fire emergencies.

This radio contact with shires proved successful.

Further improvements to V.H.F. radio equipment and antennae were carried out at Nannup, Bunbury, Gnangara and Como.

Aircraft

Very high frequency communication equipment was installed in the ten aircraft used in fire spotting.

Intercom and ground liaison communication systems were fitted to the two twin-engined aircraft used for prescribed burning and aerial photography.

Good results were obtained from trials of two new vehicle mounted navigation aids for aerial prescribed burning.

General

All vehicle radio wiring was checked and maintained at country Divisions. One hundred and thirty vehicles were equipped with aerial and wiring harness and a high frequency single side band (HF/SSB) radio was provided for the Karratha office to allow direct contact with headquarters at Como.

Training in radio communication was provided for field staff at two fire schools held at Busselton.

ADMINISTRATION

Finance

All Territorial and Departmental Revenue is paid into the Consolidated Revenue Fund. Allocations are made from this Fund for forest maintenance activities and from the General Loan Fund for forest development.

Source and Application of Funds

	1980-81
	\$
Source—	
Consolidated Revenue Fund	20 133 004
General Loan Fund	3 000 000
Commonwealth Aid Road Grant	286 245
Commonwealth Softwood Forestry Agreement	811 352
Mining Compensation	796 672
Sundry Revenue	139 353
Conservator's Borrowings	1 200 000
	26 366 626
Application—	
Forest development	6 626 473
Forest maintenance	20 189 556
Decrease in unexpended balance	— 449 403
	26 366 626

Grants Commission Review

Continuing activity in relation to the Commonwealth Grants Commission review of tax sharing arrangements included submission of updated and restructured financial information and a review of a critique of submissions by other States.

Industries Assistance Commission Inquiry

Formal evidence was prepared and presented to the Industries Assistance Commission inquiry into wood and articles of wood and their specific inquiries as to the effects of Commonwealth assistance on plantation establishment and the adequacy of timber industry statistics.

Accounting Computer

Following a detailed feasibility study, tenders have been analyzed for the purchase of additional equipment to upgrade the Department's computer system.

Improvements were made to the Pine Logging and Sundry Debtors systems and a census system for plant was developed.

Departmental Staff

Public Service Act

Mr S. J. Quain was promoted to the position of Assistant Conservator.
 Messrs D. E. Grace, P. N. Hewett and A. C. van Noort were promoted to Chief of Division.
 Messrs R. J. Underwood and A. R. Hill were promoted to Superintendent.
 Dr S. R. Shea, Dr P. E. S. Christensen, Messrs F. J. Bradshaw and N. G. Ashcroft were promoted to Inspector.
 Messrs D. J. Keene and E. A. Jenkins were reclassified to Inspector.
 Messrs A. R. Lush, B. E. Harvey, P. J. Bryant, J. H. Murch and P. M. Jones were reclassified to Senior Divisional Forest Officer.
 Mr I. R. Darragh was seconded from the Public Works Department as Acting Plant Engineer.
 Mr P. S. Downes was promoted to Senior Computer Officer (Maintenance).
 Mr W. J. Ireland was appointed as Clerk in Charge of Internal Audit.

Forests Act

Mr N. Phelps was promoted to District Forester.
 Mr T. J. Welch retired after 26 years with the Department as Plant Mechanical Engineer.
 Mr D. L. Watkins resigned from the position of Publications Officer.

Training Programmes

Twenty-three cadets commenced the first year of their training programme at Bunbury Technical College. Thirteen cadets successfully completed their first year and commenced the second year of the course in January with one mature-age student joining this second year group.

Fourteen field cadets who had completed their training in December 1980, graduated in April 1981 at a ceremony in the Bunbury Regional Office, where they also received individual safety awards.

Twenty-one candidates were successful at the staff promotional exams held in August 1980.

The Department conducted training courses in accident prevention, fire control, dieback hygiene and financial management.

Officers attended courses in managerial development, secretarial skills and public relations, conducted by the R. H. Doig Development Centre and the Australian Institute of Management.

An Organization Development programme was initiated by group discussions with all officers.

Conferences, Study Tours and Awards

The Conservator attended the 11th Commonwealth Forestry Conference held in Port of Spain, Trinidad, in September 1980. An inspection of forest operations in British Columbia and the United States of America was undertaken on this trip.

Twenty-four officers attended 19 interstate conferences, courses and study tours covering a wide range of subjects.

Inspector S. R. Shea attended a major seminar on *Phytophthora cinnamomi* in the United States of America, at which he was the keynote speaker.

Inspector B. J. White toured forestry operations areas in New Zealand as part of an officer exchange programme sponsored by the Australian Government.

Senior Divisional Forest Officer J. A. Skillen was awarded a Gottstein travel award to study forestry and the timber industry in Tasmania.

Senior Divisional Forest Officer R. J. Sneeuwjagt received the inaugural travel award presented by the Institute of Foresters of Australia, which enabled him to examine forestry practices in Victoria and New South Wales.

Forest Guard B. Humble was awarded the prize for being top student for the year at Bunbury Technical College. This enabled him to tour forest areas in Queensland.

Superintendent A. J. Williamson, Inspector F. J. Bradshaw, Divisional Forest Officer R. J. Chandler and Technical Officer T. R. K. Brittain received a merit award from the Productivity Promotion Council of Australia for developing a system using large-scale aerial photographs for detecting the occurrence of jarrah dieback disease.

Divisional Forest Officer R. J. Chandler, Assistant Divisional Forest Officer K. R. Vear, Technical Officer N. A. Hamilton and pilot A. Egerton-Green received a merit award from the Productivity Promotion Council of Australia for developing a computerized navigation system to enable precisely located aerial photographs to be taken over jarrah forest subject to quarantine restrictions.

Inspector F. J. Bradshaw, Research Officer C. J. Pearce, Technical Assistant D. Blechynden and Technical Assistant R. Sinnibaldi received a merit award from the Productivity Promotion Council of Australia for developing a computer based forest management information system.

Employment in Forestry and the Timber Industry

The number of wage earners directly employed in forestry and the timber industry was estimated at 3 651, comprised of:

Forestry—		
Professional officers	....	88
General field staff	....	317
Clerical and drafting	....	93
Cadets—		
Professional	....	6
Field	....	37
Full-time wage employees	....	511
* Contract personnel	....	150
		1 202
Timber Industry—		
† Sawmill employees including bush workers	....	2 136
Firewood and mining timber cutters and pole getters working under permits	....	46
Sandalwood workers	....	100
Apiarists estimated (2 320 sites registered)	....	169
		2 449
		3 651

* Contractors are employed periodically for clearing, road building, pine logging and hardwood logging. It is not feasible to calculate an annual number that is meaningful, but it is estimated that at the year's end there were some 150 contract personnel at work in the forest.

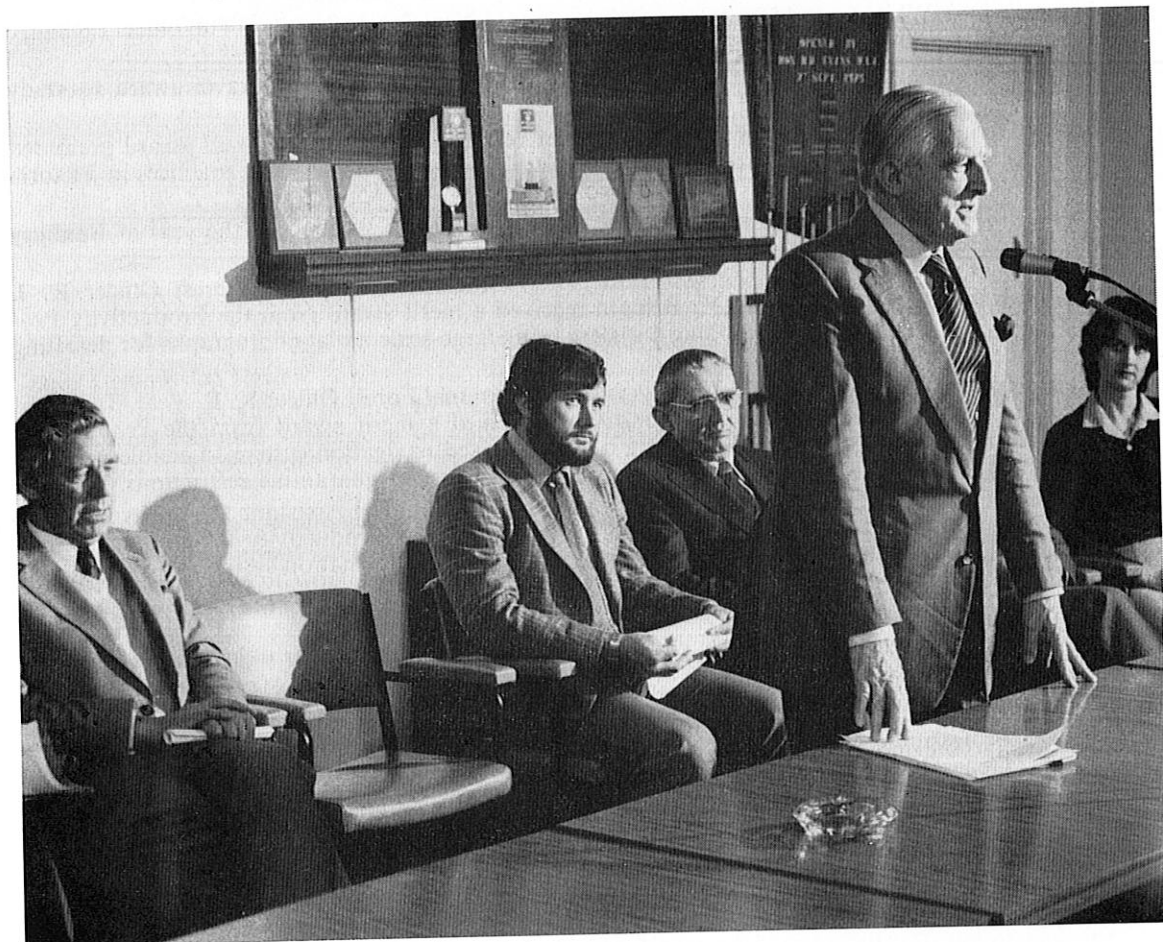
† Includes employees of registered sawmills only and excludes persons employed in associated yards in the metropolitan area.

OCCUPATIONAL SAFETY, HEALTH AND WELFARE

The number of lost-time injury accidents in the Forests Department continued to decrease. One thousand and fifty-two full-time and 59 part-time personnel worked 1 897 463 man-hours and suffered 24 accidents with a corresponding frequency rate of 13, the lowest figure ever recorded.

The number of man-days lost also decreased by 448 in comparison with those for the previous year. However, of the 490 days lost, 136 were carryovers from two accidents incurred the year before.

The Walpole, Manjimup, Kirup, Pemberton, Nannup, Jarrahdale, Collie and Narrogin Divisions, the Cadet Training School and Head Office achieved accident-free periods of 12 months. Special mention again must be made of Walpole Division, who surpassed their own previous record by completing their tenth consecutive accident-free year. This is the longest accident-free period recorded by any organization in the Western Australian forest and timber industries, and according to available data, also an Australian record for the same industries. Walpole was the first Division in the Forests Department to achieve 500 000 accident-free hours this year, closely followed by the Manjimup Division who also registered the same accident-free period shortly after.



The Walpole Divisional Office Safety Presentation for this Division's record ten-year accident-free period

Left to right: The Hon. D. Wordsworth, Minister for Forests; Mr. J. Kay, Officer in Charge of the Walpole Divisional Office; Mr. B. J. Beggs, Conservator of Forests; The Hon. Sir Charles Court, Premier of Western Australia and Sister J. Adams, Occupational Health Nurse

A series of schools was conducted including seven live-in seminars for 97 professional and field staff officers and overseers. Nominated personnel attended specialist safety courses on shot-firing, welding, abrasives, defensive driving, laboratory techniques, first aid, manual handling, tree felling and chainsaw operations as well as lectures on physical fitness, stress management, ergonomics, drug and alcohol problems and occupational health.

A three-week residential faller training school encompassing both pine and hardwood operations was held this year.

An officer attended a softwood harvesting school for supervisors at Mount Gambier. Occupational health activities included:

- (a) eyesight and audiometric screening for selected personnel,
- (b) investigation of possible chemical hazards in liaison with outside agencies,
- (c) development and introduction of standards, semi-disposable first-aid kits,
- (d) counselling of staff and employees who had health or personal problems,
- (e) presentation of a comprehensive demonstration of health and welfare aids at the Departmental Fire Exposition.

The Safety Officer attended the third annual meeting of State Government forest service safety officers held in New South Wales.

The table following sets out in more detail the Department's safety record over the last 15 years.

Year	M.H.W.	L.T.A.	M.T.A.	Total Accidents	Frequency Rate			Man Days Lost	Duration Rate (days)
					L.T.A.	M.T.A.	L.T.A.+ M.T.A.		
1966-67	....	185	....	....	100+	....	100+	2 896	....
1967-68	1 895 600	124	312	436	65	164	230	1 701	14
1968-69	2 019 568	96	155	251	48	76	124	1 738	18
1969-70	1 901 020	70	129	199	37	67	104	721	10
1970-71	1 808 406	48	158	206	27	76	110	458	9
1971-72	1 759 888	40	128	168	23	72	95	275	6
1972-73	1 728 577	45	112	157	26	64	90	414	9
1973-74	1 651 621	45	119	164	27	72	99	359	8
1974-75	1 748 219	55	127	182	31	72	104	634	11
1975-76	1 762 693	31	113	144	17.5	64	82	383	12
1976-77	1 707 635	32	157	189	19	92	111	620	19
1977-78	1 764 519	26	151	177	15	86	100	731	28
1978-79	1 835 917	44	143	187	24	76	100	810	18
1979-80	1 826 452	32	125	157	17.5	68	86	938	14
1980-81	1 897 463	24	135	159	13	71	84	490*	15†

M.H.W.—Man Hours Worked. L.T.A.—Lost Time Accidents. M.T.A.—Medical Treatment Accidents.

* Of the 490 days lost, 136 were carried over from accidents sustained during the previous year.

† The Duration Rate for the 24 L.T.A. and this year is 15 days. If the 136 days lost from the two carryover accidents are taken into account, the Duration Rate is 19 days.

APPENDIX 1A

Statement of Revenue Paid into Consolidated Revenue Fund for the year ended 30 June 1981

1979-80		1980-81
\$	<i>Royalties</i>	\$
5 870 795	Logs	6 942 374
324 956	Chip Logs	788 015
35 897	Sleepers	43 387
356 197	Poles and Piles	312 078
.....	Mining Timber	19 733
33 660	Firewood	27 287
50 880	Posts	48 309
44 134	Sandalwood	62 521
56 795	Miscellaneous	61 596
<hr/>		<hr/>
6 773 314		8 305 300
	<i>Pine Conversion</i>	
2 698 173	Pine Logs	4 002 806
388 057	Sawn Pine	520 375
<hr/>		<hr/>
3 086 230		4 523 181
	<i>Hardwood Conversion</i>	
206 773	Sawn Hardwood	219 547
273 928	Logs	217 658
5 854	Posts and Other	8 089
<hr/>		<hr/>
486 555		445 294
	<i>Other Sales and Fees</i>	
196 271	Seeds and Trees	229 704
80 684	Inspection Fees	92 696
68 204	Rents and Leases	99 860
1 122 120	Miscellaneous	1 404 536
<hr/>		<hr/>
1 467 279		1 826 796
	<i>Recoupable Projects</i>	
394 543	Miscellaneous	681 874
<hr/>		<hr/>
394 543		681 874
12 207 921		15 782 445

APPENDIX 1B

Forestry Fund Account for the year ended 30 June 1981

1979-80		1980-81
\$	<i>Expenditure</i>	\$
1 215 971	Hardwood Forests—Establishment and Tending	1 438 188
3 382 454	Softwood Forests—Establishment and Tending	3 709 495
339 811	Access Roads Construction	355 952
58 982	Land Purchases	70 512
273 425	Plant and Equipment	445 759
411 925	Housing and Buildings	573 082
94 085	Sawmilling and Seasoning Plant	33 484
2 025 637	Forest Protection	2 487 932
482 523	Access Roads Maintenance	514 140
1 596 408	Research and Other Services	1 829 468
2 850 984	Commercial Operations.....	3 246 440
185 933	Trade Operations	207 938
479 434	Recoupable Projects	637 672
	Salaries	8 095 120
5 747 629	Less Charged to Development	1 054 000
<hr/>		<hr/>
3 243 825	Administration Expenses	4 868 294
	Less Charged to Development	700 000
<hr/>		<hr/>
5 940	Cash Order Balance	4 168 294
<hr/>		<hr/>
22 394 966		56 553
		<hr/>
	<i>Source of Revenue</i>	
274 844	Balance Brought Forward	486 722
309 424	Commonwealth Aid Road Grants	286 245
909 596	Commonwealth Softwood Agreement	811 352
641 528	Mining Compensation	796 672
16 612 373	C.R.F. Contribution	20 133 004
2 870 000	General Loan Fund	3 000 000
1 200 000	Conservator's Borrowings	1 200 000
63 923	Sundry Revenue	139 353
<hr/>		<hr/>
22 881 688		26 853 348
486 722	Less Balance Carried Forward	37 319
<hr/>		<hr/>
22 394 966		26 816 029

APPENDIX 2A

Exports of Timber, Timber Products and Essential Oils from Western Australia for the Year ended 30 June 1980

Item and Destination		Quantity	Value	Item and Destination		Quantity	Value
1	Wood, in the rough or roughly squared— Conifer— Interstate (a) Overseas N.R.S. N.R.S.	m ³	\$	7	Flooring— Interstate (a) Overseas (b) N.R.S. N.R.S.	m ³	\$
2	Wood, in the rough or roughly squared, non-conifer (including poles, piling, posts and other wood in the rough)— Interstate (a) Overseas N.R.S. N.R.S.			8	Other (d)— Interstate— Total 6 112 1 087 737		
3	Sleepers— Interstate (a) Overseas— Belgium-Luxembourg 13 949 2 121 760 Christmas Island 3 604 Cocos Islands 4 311 Germany, Federal Republic of 72 12 354 Greece 100 17 301 Iraq 2 845 514 476 Jordan 65 16 124 United Kingdom 15 035 2 822 334 Total 32 073 5 515 264				Overseas— Belgium-Luxembourg 15 2 688 Germany, Federal Republic of 7 1 699 Greece 1 604 308 023 Italy 145 31 989 United Kingdom 105 26 323 U.S.A. 12 4 418 Total 1 888 375 140 Total Timber Items 1-8 71 955 12 265 737		
4	Timber sawn lengthwise, sliced or peeled, but not further prepared, of a thickness exceeding 5 mm—Non-conifer. Jarrah— Interstate— Total 8 281 1 312 675 Overseas— Bahrain 26 9 451 Belgium-Luxembourg 1 132 214 741 Christmas Island 2 701 Mauritius 11 2 527 New Zealand 9 3 465 South Africa, Rep. of 63 14 545 United Kingdom 106 20 831 U.S.A. 70 36 041 Total 1 419 302 302			9	Wood, sawn lengthwise, sliced or peeled, but not further prepared, veneer sheets and sheets for plywood, of a thickness not exceeding 5 mm—plywood, blockboard, laminboard, and the like; inlaid wood, cellular wood panels, whether or not faced with base metal— Interstate N.R.S. N.R.S. Overseas— China—Taiwan Province only 1 194 6 390 Christmas Island 2 493 3 100 Hong Kong 20 211 104 086 Singapore, Republic of 74 116 355 922 United Kingdom 595 5 590 Total 98 609 475 088		
5	Karri— Interstate— Total 17 904 2 776 938 Overseas— Belgium-Luxembourg 1 050 184 668 Canada 52 11 592 Germany, Fed. Rep. of 570 115 396 Greece 130 23 614 Italy 14 2 287 New Zealand 777 173 692 South Africa, Rep. of 540 112 618 Namibia 20 3 974 United Kingdom 475 95 847 U.S.A. 621 164 424 Total 4 249 888 112			10	Reconstituted wood (also known as particle board, chip board, sliver board, shaving board, flake board, residue board and wood waste board)— Interstate N.R.S. N.R.S. Overseas (d) (d)		
6	Other— Interstate (a) N.R.S. N.R.S. Overseas— Cocos Islands 13 2 880 Italy 16 4 689 Total 29 7 569 Timber (including blocks, strips and friezes for parquet or wood block flooring, not assembled), planed, tongued, grooved, rebated, chamfered, V-jointed, beaded, centre beaded or the like but not further manufactured—			11	Casks, vats, barrels, etc., Empty— Interstate N.R.S. N.R.S. Overseas— United Kingdom 24 327 Total 24 327		
				12	Manufacturers of wood (except furniture), N.E.S. (e)— Interstate N.R.S. N.R.S. Overseas— Cocos Islands 51 422 Lybian Jamahiriya 35 784 Norfolk Island 21 Singapore, Republic of 264 Sweden 3 315 U.S.A. 1 449 Total 92 255		
				13	Essential oils; concretes and absolutes; resinoids— Interstate N.R.S. N.R.S. Overseas— Malaysia 6 17 Singapore, Republic of 144 238 Total 150 255 Total value of exports on this return 12 857 662		

- (a) Interstate exports included in Item 8.
- (b) Relates to overseas exports of conifer flooring only.
- (c) See footnotes (a) and (b).
- (d) Details are not available for publication
- (e) Includes cork manufactures.

N.E.S. Denotes "Not Elsewhere Specified".
N.R.S. Denotes "Not Recorded Separately".
Basis of Value—F.O.B. at point of final shipment.
(Information supplied by the Australian Bureau of Statistics)

APPENDIX 2B

Imports of Timber, Timber Products, Tanning Substances and Essential Oils to Western Australia for the Year ended 30 June 1980

Item and Origin		Quantity	Value		Item and Origin		Quantity	Value
1	Sawlogs and veneer logs, in the rough or roughly squared, non-conifer, (including poles, piling, posts and other wood in the rough)— Interstate Overseas	m ³ N.R.S.	\$ N.R.S.	12	Wooden beading and mouldings (including moulded skirting and other moulded boards)— Interstate (d) Overseas— Canada China—Taiwan Prov. only Germany, Fed. Rep. of Italy Japan Malaysia South Africa, Rep. of..... New Zealand United Kingdom U.S.A.	m ³ N.R.S.	\$ N.R.S.	
2	Railway Sleepers— Interstate Overseas— Malaysia Total	N.R.S. 4 650	N.R.S. 1 088 418		Total		126 433	
3	Timber, sawn lengthwise, sliced or peeled, but not further prepared, of a thickness exceeding 5 mm—Conifer— Douglas Fir— Interstate Overseas (b)— New Zealand U.S.A. Total	N.R.S. 58 893	N.R.S. 5 896 394 653	13	Timber (including blocks, strips and friezes for parquet or wood block flooring, not assembled), planed, tongued, grooved, rebated, chamfered, V-jointed, beaded, centre-beaded or the like, but not further manufactured— Interstate Overseas— Canada Ecuador Germany, Federal Republic of Malaysia New Zealand Singapore, Republic of U.S.A. Total	N.R.S. 112 3	N.R.S. 15 350 6 629	
4	Other— Interstate Overseas (c)— Canada United Kingdom U.S.A. Total	N.R.S. 72	N.R.S. 24 190		Total	2 232	631 143	
5	Timber, sawn lengthwise, sliced or peeled, but not further prepared, of a thickness exceeding 5 mm—Non-Conifer— Meranti— Interstate Overseas— (b) Indonesia Malaysia Singapore, Rep. of Total	N.R.S. 119 1 066 249	N.R.S. 19 236 210 142 33 636	14	Wood, sawn lengthwise, sliced or peeled, but not further prepared, veneer sheets and sheets for plywood, of a thickness not exceeding 5 mm; plywood, blockboard, laminboard and the like, inlaid wood, cellular wood panels, whether or not faced with base metal— Interstate (f)— Total		1 335 112	
6	Ramin— Interstate Overseas (b)— Indonesia Malaysia Singapore, Rep. of Total	N.R.S. 54 220 615	N.R.S. 16 323 68 720 185 203		Overseas— Brazil China—excluding Taiwan Province China—Taiwan Province only Germany, Federal Republic of Italy Japan Malaysia New Zealand Singapore, Republic of South Africa, Republic of Sweden Thailand United Kingdom U.S.A. Total	1 490 3	475 904 448 27 225 105 108	
7	Teak— Interstate Overseas (b)— Burma, Soc. Rep. of the Union of Singapore, Rep. of Total	N.R.S. 7 62	N.R.S. 7 734 70 543		Total	2 232	631 143	
8	Kapur— Interstate Overseas (b)— Malaysia Singapore, Rep. of Total	N.R.S. 3 523 283	N.R.S. 677 947 58 130	15	Reconstituted wood (also known as particle board, chip board, sliver board, shaving board, flake board, residue board and wood waste board)— Interstate (g) Total	2 554 245	6 479 002	
9	Keruing— Interstate Overseas (b)— Malaysia Singapore, Rep. of Total	N.R.S. 1 671 91	N.R.S. 216 545 11 414		Overseas Total Timber Items 14, 15		9 627 408	
10	Nyatoh— Interstate Overseas (b)— Malaysia Singapore, Rep. of Total	N.R.S. 10 031 872	N.R.S. 2 269 418 194 787		Total Timber Items 1-15 (e)		17 422 246	
11	Other— Interstate Overseas (b)— Indonesia Malaysia Philippines, Republic of..... Singapore, Rep. of U.S.A. Total	N.R.S. 26 1 733 1 221 26 1	N.R.S. 6 680 299 597 266 143 4 391 203	16	Match splints; wooden pegs or pins for footwear— Interstate (d) Overseas— Japan Total	N.R.S.	N.R.S.	
		10 903	2 464 205		Total		34	
		N.R.S.	N.R.S.	17	Rulers, wooden— Interstate Overseas— Hong Kong Netherlands United Kingdom Total	Number N.R.S.	N.R.S.	
		3 007	577 014	18	Wood Flour— Interstate (d) Overseas— United Kingdom Total	1 200 1 400 344	915 1 703 1 952	
					Total	1 580	145	

APPENDIX 2B—continued

Imports of Timber, Timber Products, Tanning Substances and Essential Oils to Western Australia for the Year ended 30 June 1980

	Item and Origin	Quantity No.	Value \$		Item and Origin	Quantity No.	Value \$
19	Tool handles, Wooden				Germany, Fed. Rep. of		2 398
	Interstate (h)—				Hong Kong		53 815
	Total		206 614		India		2 643
	Overseas—				Indonesia		1 748
	Singapore, Republic of	640	318		Israel		20 809
	Thailand	24	96		Italy		261 882
	United Kingdom	7	58		Japan		20 472
	U.S.A.	7 728	13 294		Korea, Rep. of		27
	Total	8 399	13 766		Malaysia		14 323
	20	Doors not incorporating locks, hinges or similar fittings—				New Zealand		68 360
Interstate (d)—		N.R.S.	N.R.S.	Philippines, Rep. of		3 343	
Overseas—				Portugal		72	
China—Taiwan Prov. only		16 203	158 182	Romania		2 721	
Singapore, Rep. of		6 200	47 131	Singapore, Rep. of		264 559	
South Africa, Rep. of		1 855	13 684	South Africa, Rep. of		20 589	
United Kingdom		5	101	Spain		2 414	
Total		24 264	219 098	Sweden		2 042	
21		Manufacturers of wood (except furniture) N.E.S. (i)—			Switzerland		729
		Interstate—			Thailand		2 402
	Total		4 756 178	United Kingdom		500 487	
	Overseas—			U.S.A.		291 542	
	Austria		460	Yugoslavia		4 644	
	Bangladesh		105	Total		2 095 988	
	Canada		36 449	23	Tanning Extracts of Vegetable Origin		
	China-Excl. Taiwan Prov.		6 888		Wattle Bark extract—		
	Taiwan Prov. only		342 791		Interstate (k)—	kg	N.R.S.
	Denmark		20 366		Overseas—	N.R.S.	N.R.S.
France		15 716	South Africa, Rep. of		368 400	173 793	
Germany, Fed. Rep. of		17 277	Total		368 400	173 793	
Hong Kong		13 354	24		Other—		
India		8 368			Interstate (k)—	N.R.S.	N.R.S.
Indonesia		6 078			Overseas—		
Israel		780			Argentina	10 000	5 345
Italy		18 191		Belgium-Luxembourg	1 050	3 004	
Japan		55 296		South Africa, Rep. of	79 400	38 414	
Korea, Rep. of		165		United Kingdom	5 480	7 819	
Malaysia		37 356		Total	95 930	54 582	
Mauritius		724		25	Synthetic Tanning Substances; Artificial		
Malta		231			Bates for Pre-tanning; tanning (Tannic		
New Zealand		19 140	Acids) and other Salts, Esters				
Netherlands		37	Derivatives—				
Philippines, Republic of		64 999	Interstate (l)—				
Singapore, Rep. of		20 542	Total			260 463	
Spain		13 898	Overseas—				
Sweden		11 389	Belgium-Luxembourg		18 000	119 835	
Switzerland		1 999	Germany, Fed. Rep. of		16 800	12 947	
Thailand		37 503	New Zealand		9 774	16 100	
United Kingdom		11 741	United Kingdom	5 002	3 801		
U.S.A.		166 931	U.S.A.	500	406		
Yugoslavia		172	Total	50 076	153 089		
Total		928 946	26	Essential Oils; concretes and absolutes; resin-			
22	Furniture, wood or wooden framed (j)—				Interstate—	N.R.S.	N.R.S.
	Interstate—				Overseas—		
	Total			1 154 131	Germany, Federal Rep. of		343
	Overseas—				Italy		690
	Brazil			14 921	Malaysia		72
	Canada			5 431	U.S.A.		13
	China-Excl. Taiwan Prov.			12 668	Total		1 118
	Taiwan Prov. only			475 633	Total value of imports on this return		27 444 761
	Czechoslovakia			22 266			
	Denmark		5 195				
Finland		1 891					
France		15 962					

- (a) Excludes overseas imports of veneer logs in the rough. Details are not available for publication.
- (b) Excludes details of shooks and staves.
- (c) Overseas imports include shooks and staves.
- (d) Details included in Item 21.
- (e) Includes an interstate value of \$894 417 covering Items 1–11, 13.
- (f) Relates to interstate imports of plywood only.
- (g) Includes interstate details of "improved" wood.
- (h) Includes brush and broom handles and the like.
- (i) See Footnote (d).
- (j) Excludes imports, if any, of wooden medical, dental, surgical or veterinary furniture, non-domestic chairs and furniture parts.
- (k) Details included in Item 25.
- (l) Includes details of Items 23 and 24.

N.E.S. denotes "not elsewhere specified".
 N.R.S. denotes "not recorded separately".
 Basis of value: Overseas—F.O.B. at the point of final shipment.

Interstate: landed cost in Western Australia.
 (Information supplied by the Australian Bureau of Statistics.)

APPENDIX 3
SUMMARY OF EXPORTS OF FOREST PRODUCE—SINCE 1968

Year	Timber		Wood Manufacture Value	Essential Oils and Tanning Material*
	m ³	value		
Brought forward	13 081 830	\$ 177 786 912	\$ 8 536 935	\$ 17 368 964
1968	84 569	4 947 595	3 016 850	280 806
1969	86 455	4 984 098	3 802 927	267 565
1970	96 275	5 661 547	3 906 699	317 553
1971	79 362	4 803 842	2 110 802	343 512
1972	101 191	6 439 732	2 369 541	348 762
1973	111 547	7 036 637	2 604 116	377 736
1974	98 200	7 366 709	3 769 461	433 627
1975	100 127	9 080 092	132 278	479 019
1976	94 136	9 823 037	993 199	214 918
1977	77 352	10 150 025	205 173	45 767
1978	58 833	8 809 324	4 625 089	41 422
1979	66 420	10 560 052	8 122 584	61 525
1980	71 955	12 265 737	591 670	255
1981†				

* Tanning materials not recorded separately since 1967.
† Not Available.

APPENDIX 4
SUMMARY OF IMPORTS OF FOREST PRODUCE—SINCE 1968

Year	Timber Woodware	Tanning Materials	Essential Oils
Brought Forward	\$ 63 937 163	\$ 1 344 397	\$ 4 600 226
1968	8 135 532	75 657	143 696
1969	8 731 114	109 905	206 309
1970	10 968 170	153 169	293 845
1971	6 761 806	103 857	175 331
1972	5 578 819	144 219	227 530
1973	8 326 939	225 463	366 786
1974	11 738 861	420 010	271 713
1975	14 053 751	465 884	641 859
1976	19 960 421	373 331	131 515
1977	24 857 792	603 819	39 143
1978	24 039 952	912 669	620
1979	18 200 508	614 628	48
1980	26 801 716	641 927	1 118
1981†			

† Not available.

APPENDIX 5
SUMMARY OF LOG PRODUCTION—SINCE 1968

Year	Crown Land m ³	Private Property m ³	Total m ³
Brought Forward	44 466 501	15 455 468	78 705 715*
1968	1 231 517	228 281	1 459 798
1969	1 143 705	160 771	1 304 476
1970	1 121 396	175 686	1 297 082
1971	1 145 161	161 990	1 307 151
1972	1 096 236	106 993	1 203 229
1973	1 060 359	102 992	1 163 351
1974	1 084 463	91 884	1 176 347
1975	1 096 356	87 957	1 184 313
1976	1 194 667	111 761	1 306 428
1977	1 429 493	106 848	1 536 341
1978	1 445 465	119 706	1 565 171
1979	1 489 515	129 665	1 619 180
1980	1 582 018	165 076	1 747 094
1981	1 593 512	161 966	1 755 478

* Includes 18 783 746 m³ estimated cut prior to 1917.
Note—as in previous years this total includes log material used for reconstituted wood and chipwood.

APPENDIX 6

FORESTS DEPARTMENT RESEARCH PUBLICATIONS PRODUCED DURING THE YEAR ENDED 30 JUNE 1981

Departmental Research Papers

- 63—C. J. Schuster Aspects of Spot Seeding and Seed Pelleting for the Regeneration of Karri (*Eucalyptus diversicolor* F. Muell.)
- 64—C. J. Schuster Regeneration in a Jarrah (*Eucalyptus marginata* Sm.) and Marri (*E. calophylla* R. Br.) Forest following Logging and Burning.
- 65—S. R. Shea and M. J. Dillon Rate of Spread of *Phytophthora cinnamomi* Rands Infections in the Jarrah (*Eucalyptus marginata* Sm.) Forest
- 66—P. Ritson, E. J. Herbert and S. R. Shea Groundwater Hydrology Studies in the Yarragil Catchment. Western Australia.

Departmental Bulletins

- 91—P. E. S. Christensen The Biology of *Bettongia penicillata* Gray, 1837, and *Macropus eugenii* (Desmarest, 1817) in Relation to Fire.
- 92—E. M. Heddle Effects of Changes in Soil Moisture on the Native Vegetation of the Northern Swan Coastal Plain, Western Australia.







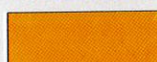
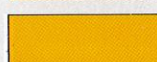



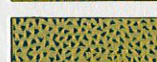
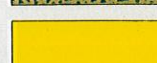








External Publications

- Butcher, T. B. Competitive Effect of Pine Regrowth and Woody Weeds on the Growth of *Pinus pinaster* Australian Forestry Vol. 43, No. 2, 1980.
- Christensen, P. E. S., Recher, H. and Moore, J. Responses of Open Forest to Fire Regimes. Fire and the Australian Biota. Australian Academy of Science 1981, 367-394.
- Shea, S. R., Gillen, K. J. and Peppard, W. I. Seasonal Variation in Population Levels of *Phytophthora cinnamomi* Rands in Soil in Diseased, Freely-Drained *Eucalyptus marginata* Sm. sites in the Northern Jarrah Forest of South-Western Australia. Protection Ecology, Vol. 2, No. 2, October 1980.
- Glossop, B. L., Bell, D. T. and Shea, S. R. Changes in the Nitrogen and Phosphorus Levels in Foliage and Connecting Branches of Jarrah (*Eucalyptus marginata* Don ex Sm.) after Intense Fire Australian Forest Research 10, 1980.
- Batini, F. E., Black, R. E., Byrne, J. and Clifford, P. J. An Examination of the Effects of Changes in Catchment Condition on Water Yield in the Wungong Catchment, Western Australia. Australia Forest Research 10 No. 1, March 1980.
- Shea, S. R., Peet, G. B. and Cheney, N. P. The Role of Fire in Forest Management. Fire and the Australian Biota Australian Academy of Science 1981, 443-470.
- Shea, S. R. and Dell, B. Structure of the Surface Root System of *Eucalyptus marginata* Sm. and its Infection by *Phytophthora cinnamomi* Rands. Australian Journal of Botany, Vol. 29, No. 1, 1981.
- Shearer, B. L., Shea, S. R. and Fairman, R. G. Infection of the Stem and Large Roots of *Eucalyptus marginata* by *Phytophthora cinnamomi*. Australasian Plant Pathology Vol. 10, No. 1, March 1981.
- Heddle, E. M., Loneragan, O. W. and Havel, J. J. Vegetation complexes of the Darling System, Western Australia. In Atlas of Natural Resources Darling System Western Australia, 35-72 and 3 maps. Department of Conservation and Environment Western Australia 1980.

- Havel, J. J. Application of fundamental Synecological Knowledge to Practical Problems in Forest Management
 I Theory and Methods
 Forest Ecology and Management 3:1-29 (1980)
 II Application
 Forest Ecology and Management 3:81-111 (1980)
- Havel, J. J. Identification of Vulnerable Communities and Prediction of Disease Spread. In *Phytophthora and Forest Management in Australia* (K. M. Old, Ed), 64-72, 1980.
- Shea, S. R. Forest Management and *Phytophthora Cinnamomi* in Australia. In *Phytophthora and Forest Management in Australia* (K. M. Old, Ed), 73-110.
- Shea, S. R. and Broadbent, P. Developments in Cultural and Biological Control of *Phytophthora* Diseases. Paper presented to the International Conference on *Phytophthora*, April 1981.
- Shea, S. R. Multiple-Use Forest Management in a Mediterranean Ecosystem—The Jarrah Forest, a Case Study. Paper presented to the International Symposium on Mediterranean-Type Ecosystems.

KEY

PHYSIOGNOMIC VEGETATION TYPES

	Tall Trees	
Tall forest		Tall forest, mainly karri <i>Eucalyptus diversicolor</i>
	Medium-height Trees	
Forest		Forest, mainly jarrah and marri <i>E.marginata E.calophylla</i>
Woodland		Jarrah, marri and wandoo woodlands <i>E.marginata E.calophylla E.wandoo</i>
		Other species: Tuart, York gum, Salmon gum etc. <i>E.gomphocephala E.loxophleba E.salmonophloia</i>
	Low Trees	
Low forest		Acacia or Rottneest pine <i>A. rostellifera Callitris preissii</i>
		Jarrah, Banksia and/or Sheoak <i>E. marginata Banksia spp. Casuarina fraserana</i>
Low woodland		Mulga <i>Acacia aneura</i>
		Other species: Acacia, Banksia, Peppermint <i>Acacia spp. Banksia spp. Agonis flexuosa</i>
	Tall Shrubland	
Shrubland with scattered trees		Pindan woodland. Acacia thicket with medium trees <i>A. tumida E. tectifera E. grandifolia</i>
		Pindan. Acacia thicket with low trees <i>A. eripoda Eucalyptus Erythrophloeum Gyrocarpus</i>
		Acacia scrub with low trees <i>Acacia with Eucalyptus Callitris Casuarina</i>
		Scrub-heath with low trees Mixed composition
Thicket		Acacia, Casuarina and Teatree thickets <i>Acacia—Casuarina—Melaleuca</i> alliance
Scrub		Wattle, teatree and other scrub <i>Acacia Melaleuca</i> and other species
		Mangrove <i>Avicennia marina Rhizophora Bruguiera</i> etc.
Mallee		Sparse scrub Usually <i>Acacia</i> spp.
		Eucalypt shrubland <i>E. eremophila E. redunca</i> and spp.
	Low Shrubland	
Mallee-heath		Heath with scattered mallee <i>E. tetragona</i> conspicuous
Scrub-heath		Heath with scattered taller shrubs Mixed composition <i>Proteaceae</i> and <i>Myrtaceae</i>
Heath		Closed low shrubs <i>Dryandra Calothamnus</i> etc.
Low scrub		Open low shrubs <i>E. eremophila Cassia</i> etc.