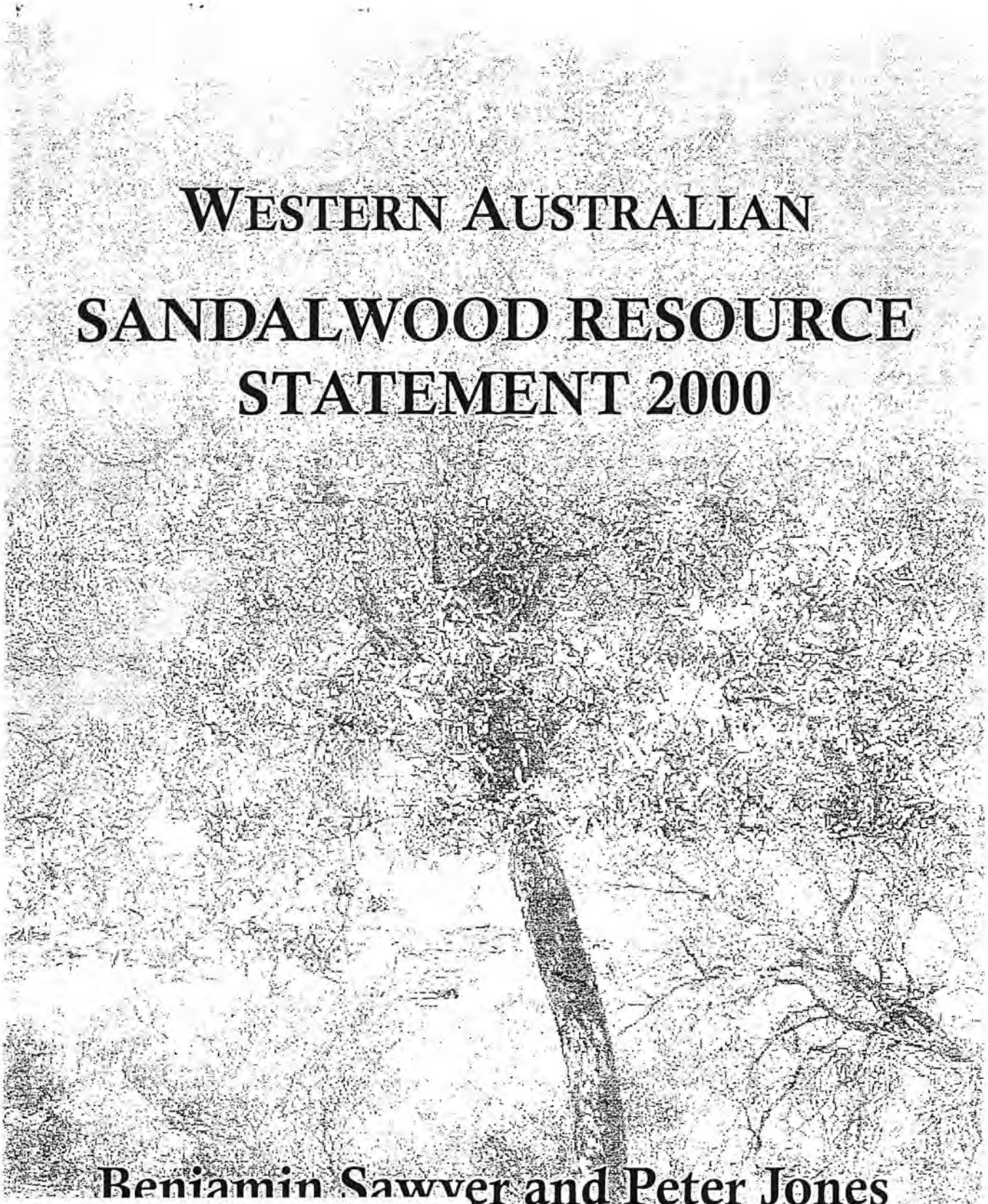
WESTERN AUSTRALIAN SANDALWOOD RESOURCE STATEMENT 2000



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PREFACE

An inventory of the estimated resource of Western Australian Sandalwood (*Santalum spicatum*) was carried out by the Forests Department in 1980-1984. That project estimated that there was a resource base of approximately 137,000 tonnes of merchantable sandalwood. At an annual harvest of 2,000 tonnes, and ignoring ingrowth of trees less than merchantable size it was estimated the harvesting could continue for 76 years.

In 1992 Wildlife Management Plan No. 8 "The Management of Sandalwood" was approved by the Executive Director of Conservation and Land Management. Since that time the management of the sandalwood industry has been in accordance with this plan.

The last 20 years has seen a significant change in the market acceptability of dead wood (trees that have been killed by drought or fire and can be salvaged standing or on the ground). Improvements in utilisation of each green tree harvested have also occurred. Enhancements have also been made identifying geographic "supply areas" and for managing the industry.

These significant changes to operations within the industry and access to improved planning techniques and technologies culminated in the preparation and implementation of improved management methods. These methods are documented in CALM's Sandalwood Operations Manual which was approved in 1999.

This resource statement builds on the 1984 work and gives confidence to decision makers that the sandalwood industry based on harvesting dead or green sandalwood from the rangelands, in accordance with management guidelines approved from time to time, can be maintained for the foreseeable future.

D J Keene
ACTING GENERAL MANAGER, FOREST PRODUCTS DIVISION

August 2000

EXECUTIVE SUMMARY

A comprehensive evaluation of the sandalwood resource was completed between the years 1995-1999. The objective was to provide a statement of dead and green sandalwood (*Santalum spicatum*) available for harvest in accordance with the Sandalwood Act (1929).

The sandalwood resource, both dead and green, on tenure that permits harvesting is approximately 234,000 tonnes. Included in this figure, is green sandalwood located within non-harvested buffers determined by operational plans in accordance with CALM management plans.

This resource statement represents a snapshot of the resource and has not been concerned with calculating the ingrowth of the sandalwood population. This will be addressed in a future inventory.

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1. BACKGROUND

Western Australian Sandalwood *(Santalum spicatum)* is a widely distributed hemi-parasitic small tree. Sandalwood is highly valued and supports a significant export industry due to the aromatic quality of the timber. The primary demand for sandalwood is in South-East Asia where it is made into joss sticks (incense).

Under the provision of the *Sandalwood Act 1929 as amended,* the Department of Conservation and Land Management (CALM) is entrusted with the management of sandalwood throughout its distribution in Western Australia. This management is primarily concerned with maintaining the biological integrity of indigenous *Santalum* species and facilitating an ongoing research program to further knowledge of their ecology and biology CALM also ensures sandalwood is represented throughout its distribution within a comprehensive and adequate reserve system in which no harvesting may take place. The CALM facilitates the sustainability of sandalwood products for domestic and overseas markets. The CALM also conducts research into the development and promotion of value added sandalwood products. This is achieved through the management of contracts to harvest, transport and market sandalwood growing on crown land for the state.

The crown land harvest is set in accordance with the Sandalwood Act 1929 as amended. The harvest is made of green and dead sandalwood. CALM issues licences for the harvest of sandalwood located on private property.

This Sandalwood inventory was concerned with the resource on Crown lands, within the Sandalwood Supply Areas (Appendix 3)

1.1 1984 Inventory

A comprehensive resource inventory was completed between the years 1980-1984. This data, although remaining valuable, became dated due to changes in utilization, industry and technology changes.

The field sampling method (tally plot) was retained as the most effective way of assessing sandalwood.

For further details see Kealley 1991

1.2 1999 Inventory

1.2.1 Objectives

The 1999 inventory (1995 – 1999) was instigated to recalculate the estimated sandalwood resource on the Crown lands of Western Australia. It made use of improvements in land mapping, computing and global positioning technology.

The key objective of the inventory was to:

- Provide a statement of green and dead sandalwood (*Santalum spicatum)* available for harvest in accordance with the Act, to be used in planning the management of the industry for the medium to long term.

Other objectives were:

- Calculate available sandalwood resource at specific locations for operational planning.
- Identify the amount of sandalwood in reserves that is unavailable for harvest.

It is not the objective of this report to calculate the sustainable yield or make recommendations on the future management of sandalwood. These points will be covered in future management plans.

2. METHODS

2.1 Field

The field method description in this report is intended as an overview. A detailed description of sandalwood inventory methods are covered by the *Sandalwood Inventory Manual,* 1998.

A management unit of land is selected as a sample location. A management unit is defined as a pastoral lease, or other crown land area of between 50 000 hectares and 400 000 hectares. The land units are strategic locations within a supply area which may be considered representative of the supply area. Supply areas comprise of many management units. Supply areas range from 949 000 ha to 84 140 000 ha in size.

Appendix 3 details supply areas.

Supply Areas break the state into 16 areas, each with individual sandalwood qualities. The Supply areas were determined by identifying the economies of production of sandalwood supply, distribution of the total population and easily identified operational boundaries.

Maps demonstrating land type information (vegetative and geological) and also cadastral information were gathered for the sample location. A crew of two sandalwood assessors use a 4WD vehicle to assess the sample location.

Sample locations were selected to:

(a) meet the ongoing need for accurate inventory ahead of existing sandalwood harvesting operations, and

(b) to provide an overall assessment of the local variations that can occur due to the large geographical distribution of the population.

In general sample locations were selected that contained representation of land types typical of the supply area in which the sample location was located.

The objective of assessment is to traverse all possible access (roads, tracks and fencelines) within the defined area. Whilst traversing the access, each sandalwood stem within 30 metres of the access (road) edge is counted and recorded in 1 kilometre sections. Each one kilometre section has a sample width of 60 metres, therefore equal to an area of 6 hectares.

Bias in the sampling technique was identified as a problem that needed to be addressed and accounted for.

Within the pastoral area, roads are generally located in areas where they are easiest to construct. Likewise fencing is located with a reference to stock management; not necessarily land types.

Bias can also occur due to the location of unharvested buffers which are adjacent to certain roads and fencelines. In this scenario, sandalwood counted in the buffers alongside roads may give inaccurate estimates if the area has been harvested.

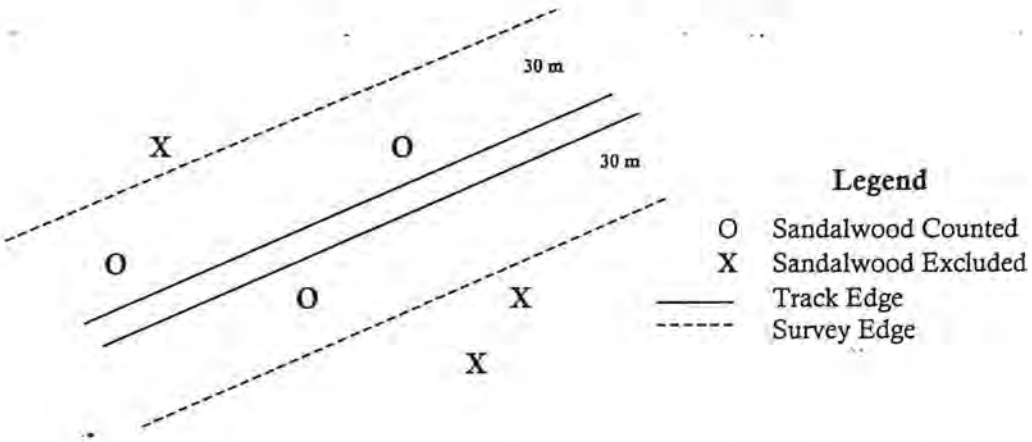
In order to eliminate these forms of bias cross-country traverses were undertaken at regular intervals. This involved assessment teams following a compass heading, off road, whilst counting sandalwood stems.

Within each sample location a minimum target of 3% of sample areas must be achieved for each land system, within a sample location.

The sandalwood recorded is quantified into 5 live stem diameter classes or as dead pieces. Each one kilometre section has a dominant land type recorded against the sandalwood counted.

An example of a recording sheet is Appendix 2.

FIGURE 1
(Figure 1 - Demonstrates a sample line diagram)



The counting and size class sorting is done by eye. To check that the assessor is accurate, checks are completed in the form of Measurement Plots. The assessors walk a 1 kilometre section, measuring each sandalwood with a diameter tape. These plots are recorded on a separate form.

These checks were compared with the tally actuals. Where a large deviation in stem numbers as estimated sizes occurred the cause of the deviation was investigated. If warranted the assessment was re-done.

The checks also provide an opportunity for assessment crews to "keep their eye in" and check visual estimates of size classes against actuals.

After the field work is completed, each land type has sandalwood tallies calculated against the kilometres travelled and the sandalwood recorded in each size class. From these tallies a coefficient expressing stems per hectare for each size class is calculated. The coefficient is equal to the stems divided by the hectares sampled (number of km multiplied by 6), for each particular land type.

To calculate total sandalwood available, the relevant coefficient is applied to the total calculated area for each land type sampled at the location. The total stems calculated is then converted to tonnes using mean weights for each size class.

2.2 Stem Weights

Green sandalwood was removed at several locations in the Goldfields and Coolgardie Supply Areas, debarked and weighed. From this information a regression line between stem diameter and utilizable wood weight was determined.

Stem weights for dead sandalwood are a mean weight of samples taken at the above locations.

Appendix 1 is a more detailed discussion of the stem weight determination methods.

These two supply areas were chosen as they provided a full range of size classes. The regression line produced although accurate for the purpose of this broad scale inventory could be further refined. Future work will focus on developing a unique regression line for each Supply Area.

2.3 Data Application

For the final calculations, which form the estimates for this report all data was stratified by land types generalized from Beard's Vegetation Survey (1976). These land types were:

A Rock or Hills with varying vegetation depending on supply area.

B Undulating or flat loam plains generally with mixed vegetation species including *Acacia, Eremophila, Nemophila, Dodenea etc.*

C Any form of sandplain either dominated by *Triodia* species, mallee species or *Acacia aneura.*

D. Plains with a dominant overstorey of *Eucalyptus* tree species. Otherwise described as *Eucalyptus* woodland.

E Drainage plains dominated by *Maireana* and *Atriplex* species.

F Saltlake fringe consisting of sand or kopi dunes with a range of vegetation species.

Maps and tables were obtained through CALM's Information Management Branch and AgWA that calculated Beard's land type area (hectares) in each Sandalwood Supply Area. The data was quantified into available and unavailable lands for sandalwood harvesting. Available lands are Pastoral Lease and Vacant Crown Land. Unavailable are lands identified in the *CALM Act, Sandalwood Act or Wildlife Conservation Act* identified as not permitting the harvest of sandalwood or other forest produce.

An early assumption was made that each supply area was mutually exclusive to all others with respect to sandalwood concentrations. This had the implication that only inventory data gathered in a given supply area could be used for that supply area.

All inventories completed were categorized by supply area. From this the land types recorded in each inventory were rationalized to fit into the six afore mentioned sandalwood land types.

The decision to rationalize the land types into the six used resulted from the practicalities of conducting such a large-scale resource assessment over a large area.

Originally it was planned to utilize data gathered by Agriculture WA, in its rangeland survey project (PARIS data). This data allowed the creation of excellent maps giving good stratification of land/vegetation complexes.

Within the timeframe allocated for this assessment, the data required to provide coverage of the sandalwood distribution was not going to be collected and available in a useable form.

Beards vegetation survey also provided useful information for nearly all of the areas in which sandalwood occurred.

In order to utilize the excellent data from the PARIS system and the coverage of data from Beards survey, the relationships between the two sets of data were examined.

It became clear that the two sets of data, along with local knowledge developed during the field assessments, allowed the formulation of a set of unique land types.

It is important to note that the land types have been developed specifically for the purpose of this project.

Totals for each inventory summarized the total area assessed (hectares) and the number of stems recorded over 125 mm diameter within each of the six land types.

These totals were then added to the total of other inventories undertaken for that particular supply area. This data produces a coefficient in terms of stems per hectare for each of the six land types, for each supply area.

The data from the measurement plots is then taken into account to calculate the mean size of mature sandalwood in each supply area. All measurement plots from each inventory were combined from other inventories in each supply area. The total number of stems over 125mm recorded in all of the measurement plots is calculated.

Each recorded stem in the measurement plots is rounded to the nearest ten. For example trees recorded in the 135 to 144 size range were all rounded to 140 mm diameter. Each of the recorded trees over 125 mm were added in term of size i.e. 130 + 130 + 130 +140 +170 + 220 = 920. This is divided by the number of stems (6) to give the mean harvestable size in each supply area (i.e. 153.3mm in this example).

This mean is logarithmically transformed to a base 10. The logarithm is applied to the regression line formula ($\log y = 2.8045 \log x - 4.7331$). The final value (antilog) is the mean stem weight for the given mean sandalwood size.

This value is applied to the coefficient and converted to tonnes per hectare. The coefficient is applied to the total land areas for each land type in each supply area. This will give 12 figures. Six land types in available area and six unavailable. The addition of these twelve figures produces the total sandalwood tonnage (>125 mm) of sandalwood per supply area.

Finally the addition of the tonnes for each supply area gives the total sandalwood resource in the State on crown land.

3. RESOURCE AND TENURE

The total *Santalum spicatum* resource (green sandalwood above 125 mm size class and dead sandalwood) within its natural distribution, located on Crown land is estimated to be 298 444 tonnes.

Of this amount 43 246 is located on Crown land tenure that does not permit harvesting. The total amount of green sandalwood resource above 125 mm size class and dead sandalwood resource, on tenure that permits harvesting is 233 982 tonnes.

Included in the figure of 233 982 tonnes, is green sandalwood located within non-harvested buffers determined by operational plans in accordance with CALM management plans. It is not possible to estimate the tonnage located in these buffers due to the natural distribution of sandalwood. Exact tonnages for specific operations areas are calculated during the preparation of operations plans.

It is important to note that resource figures for the Desert supply area are not included in the above figures as it was not possible to adequately sample the area within the resources and timeframe of this project.

It should also be noted that this statement represents a snapshot of the resource and has not been concerned with the ingrowth of the population. This will be addressed in future management plans.

TABLE 1
(Total Green Sandalwood resource above 125 mm size class)

SUPPLY AREA	Available Estimated (t)	Tonnes Removed (after 1970)	Available Total Remainining	Unavailable Estimated (t)
Agnew	9118	94	9024	10
Barlee	31921	209	31712	332
Coolgardie	6800	166	6634	822
Desert	U	805	U	U
Gascoyne	5284	260	5024	1867
Kalgoorlie	11176	662	10514	9086
Kambalda	2747	324	2423	1355
Leonora	8692	102	8590	296
Murchison	4028	0	4028	233
Paynes Find	20555	4422	16133	7494
Sandstone	13156	62	13094	320
Savage	23497	383	23114	1285
Shark Bay	3549	242	3307	4
Wiluna	2963	36	2927	964
Woodlands	33230	479	32751	10838
Yalgoo	16052	317	15735	2529
Yilgarn	38456	4341	34115	2447
Total	**231229**	**12904**	**218325**	**39882**

Note: *Resource within Desert was not included.*

GREEN SANDALWOOD DISTRIBUTION BY SUPPLY AREAS

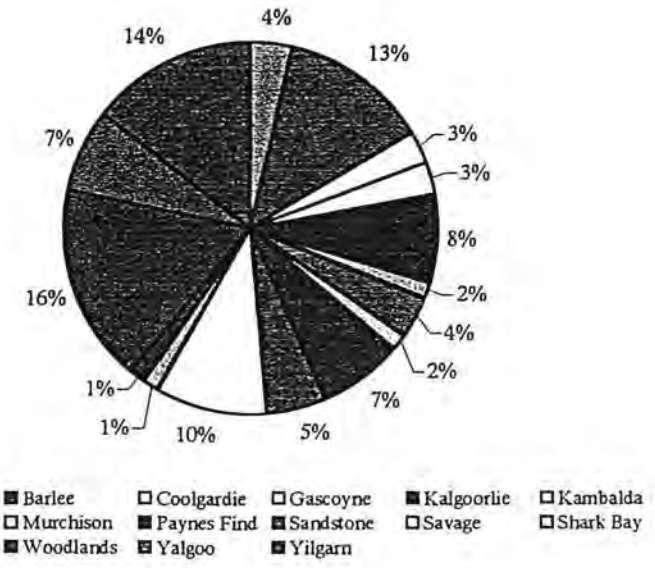
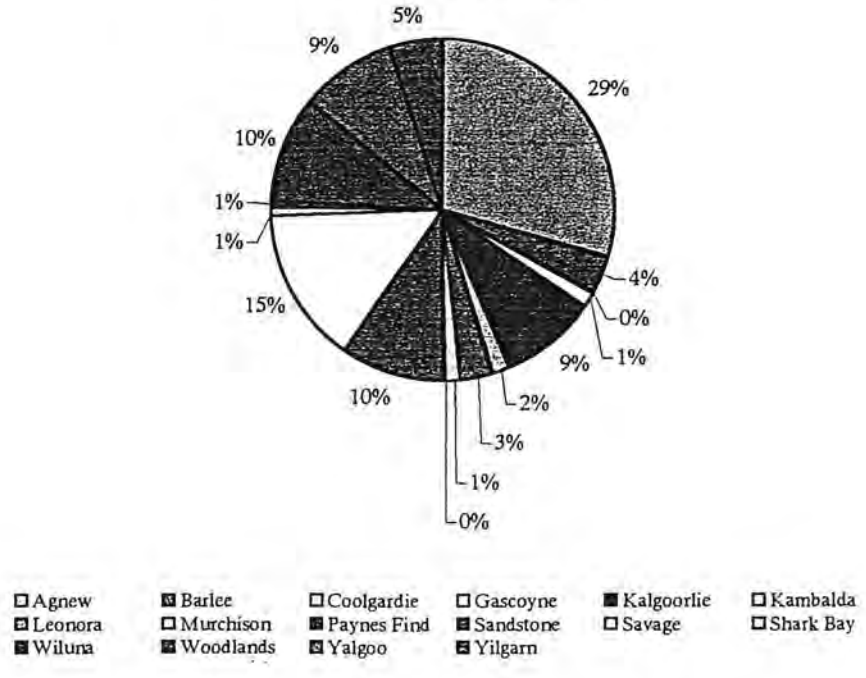


TABLE 2
(Total Dead Sandalwood Resource)

SUPPLY AREA	Available Estimated (t)	Tonnes Removed (after 1970)	Available Total Remainining	Unavailable Estimated (t)
Agnew	5684	18	5666	6
Barlee	872	122	750	15
Coolgardie	157	244	-87	10
Desert	U	2537	U	U
Gascoyne	255	324	-69	138
Kalgoorlie	3082	2791	291	1413
Kambalda	592	1330	-738	321
Leonora	669	88	581	17
Murchison	312	0	312	41
Paynes Find	331	2054	-1723	71
Sandstone	1926	181	1745	40
Savage	3928	1333	2595	197
Shark Bay	188	12	176	0
Wiluna	86	9	77	25
Woodlands	2071	1014	1057	738
Yalgoo	1735	180	1555	237
Yilgarn	1719	867	852	95
Total	**23607**	**13104**	**15657**	**3364**

Note: Resource for Desert not included.
Negative values for remaining resource are given zero value for the purpose of calculations.

DEAD SANDALWOOD DISTRIBUTION BY SUPPLY AREAS



3.1 Tenure of the Sandalwood Estate

Tenure of the sandalwood estate was separated into those categories of tenure that either permitted harvesting or excluded harvesting. Land with freehold title has not been considered in this report.

- Tenure permitting harvest
  - Vacant Crown land
  - Pastoral leases
  - State Forest
  - Timber Reserves
- Tenure excluding harvest
  - Nature Reserves
  - Conservation parks
  - National Parks
  - Land Proposed for Reservation into any of the above categories via CALM management plan.
  - Land held by the Aboriginal Lands Trust
  - Land described in regulation 7, Sandalwood Regulations 1993

Tenure permitting harvest	81 870 012 hectares	51%
Tenure excluding harvest	79 256 444 hectares	49%
Total	161 126 456 hectares	100%

3.2 Size, Distribution and Tenure by Supply Area

3.2.1 Agnew

The Agnew supply area is located within the North East Goldfields and is predominantly pastoral lease. The dominant vegetation type is *acacia* shrublands. The area has been harvested sporadically in the past and there are no current harvesting operations at present.

GREEN RESOURCE SUMMARY

AGNEW SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	1	Number of Samples:	13
Total Area:	2490650	Average Mature Size:	145
Sample Area:	5735	Log 10 Average Weight:	1.32522156
Sample Stems >125 mm:	798	Average Weight (kg/stem):	21.1

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1161	274	0.0050	96961	484
B	585	114	0.0041	1799153	7376
C	1526	185	0.0026	401266	1043
D	0	0	0.0000	0	0
E	176	20	0.0024	89659	215
F	0	0	0.0000	100505	0
Not Vegetated = 60628 ha				**Total Available Tonnes:**	9118

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1161	274	0.0050	0	0
B	585	114	0.0041	1515	6
C	1526	185	0.0026	1576	4
D	0	0	0.0000	0	0
E	176	20	0.0024	14	0
F	0	0	0.0000	0	0
Not Vegetated = 0 ha				**Total Unavailable Tonnes:**	10
				TOTAL SUPPLY AREA TONNES	**9128**

DEAD RESOURCE SUMMARY

AGNEW SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	2490650
Sample Area:	5735
Dead Stems:	2592
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1161	1184	0.0036	96961	349
B	585	444	0.0027	1799153	4858
C	1526	464	0.0011	401266	441
D	0	0	0.0000	0	0
E	176	18	0.0004	89659	36
F	0	0	0.0000	100505	0
Not Vegetated = 60628 ha				**Total Available Tonnes:**	5684

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1161	1184	0.0036	0	0
B	585	444	0.0027	1515	4
C	1526	464	0.0011	1576	2
D	0	0	0.0000	0	0
E	176	18	0.0004	14	0
F	0	0	0.0000	0	0
				Total Unavailable Tonnes:	6
				TOTAL SUPPLY AREA TONNES	**5690**

Tenure		
Tenure permitting harvest	2 548 173	100%
Tenure excluding harvest	3 106	
Total	2 551 279	100%

3.2.2 Barlee

Barlee supply area is located between Lake Barlee and Sandstone. Vegetation is dominated by *Acacia* shrublands and extensive salt lake systems. The area has been sporadically harvested in the past. The area is currently being harvested at approximately 150 tonnes per annum.

GREEN RESOURCE SUMMARY

BARLEE SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	2	Number of Samples:	59
Total Area:	2513656	Average Mature Size:	155
Sample Area:	8372	Log 10 Average Weight:	1.41301034
Sample Stems >125 mm:	1612	Average Weight (kg/stem):	25.9

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	890	300	0.0087	161594	1406
B	618	438	0.0183	1548389	28335
C	2436	221	0.0023	496288	1141
D	0	0	0.0000	0	0
E	6	0	0.0000	80711	0
F	681	216	0.0082	126672	1039
Not Vegetated = 17670 ha				**Total Available Tonnes:**	31921

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	890	300	0.0087	485	4
B	618	438	0.0183	8145	149
C	2436	221	0.0023	54431	125
D	0	0	0.0000	0	0
E	6	0	0.0000	30302	0
F	681	216	0.0082	6639	54
Not Vegetated = 14.98 ha				**Total Unavailable Tonnes:**	332
				TOTAL SUPPLY AREA TONNES	**32253**

DEAD RESOURCE SUMMARY

BARLEE SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	2513656.42
Sample Area:	8188
Dead Stems:	595
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1074	252	0.0008	161594	129
B	434	45	0.0004	1548389	619
C	2436	109	0.0002	496288	99
D	0	0	0.0000	0	0
E	-6	0	0.0000	80711	0
F	681	40	0.0002	126672	25
Not Vegetated = 17670 ha				**Total Available Tonnes:**	872

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1074	252	0.0008	485	0
B	434	45	0.0004	8145	3
C	2436	109	0.0002	54431	11
D	0	0	0.0000	0	0
E	6	0	0.0000	30302	0
F	681	40	0.0002	6639	1
Not Vegetated = 15 ha				**Total Unavailable Tonnes:**	15
				TOTAL SUPPLY AREA TONNES	**887**

Tenure		
Tenure permitting harvest	2 431 324	96%
Tenure excluding harvest	100 017	4%
Total	2 531 341	100%

3.2.3 Coolgardie

Coolgardie supply area is situated to the west of Kalgoorlie. The area is dominated by *Eucalyptus* woodlands extending into *acacia* shrublands in the north. The majority of the area is under pastoral lease although many of these leases have recently been purchased by mining interests.

The area has been extensively harvested in the past due to its close proximity to the major population centres of Kalgoorlie and Coolgardie. Current operations are based on 200 tonnes per annum.

GREEN RESOURCE SUMMARY

COOLGARDIE SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	2	Number of Samples:	78
Total Area:	805102	Average Mature Size:	154
Sample Area:	5002	Log 10 Average Weight:	1.40362564
Sample Stems >125 mm:	2105	Average Weight (kg/stem):	25.3

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	150	136	0.0230	6159	141
B	48	25	0.0132	62945	830
C	1006	335	0.0084	95055	798
D	848	216	0.0065	450739	2930
E	339	262	0.0196	55738	1092
F	185	159	0.0218	46297	1009
Not Vegetated = 20027 ha				**Total Available Tonnes:**	6800

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	150	136	0.0230	38	1
B	48	25	0.0132	16503	218
C	1006	335	0.0084	21575	181
D	848	216	0.0000	28535	0
E	339	262	0.0196	21321	418
F	185	159	0.0218	197	4
Not Vegetated = 2339 ha				**Total Unavailable Tonnes:**	822
				TOTAL SUPPLY AREA TONNES	**7622**

DEAD RESOURCE SUMMARY

COOLGARDIE SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	805102
Sample Area:	3290
Dead Stems:	253
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	130	43	0.0012	6159	7
B	12	0	0.0000	62945	0
C	702	22	0.0001	95055	10
D	848	83	0.0003	450739	134
E	18	0	0.0000	55738	0
F	0	0	0.0000	46297	0
Not Vegetated = 20027 ha				**Total Available Tonnes:**	157

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	130	43	0.0012	38	0
B	12	0	0.0000	16503	0
C	702	22	0.0001	21575	2
D	848	83	0.0003	28535	8
E	18	0	0.0000	21321	0
F	0	0	0.0000	197	0
Not Vegetated = 2339 ha				**Total Unavailable Tonnes:**	10
				TOTAL SUPPLY AREA TONNES	**167**

Tenure		
Tenure permitting harvest	736 960	89%
Tenure excluding harvest	90 508	11%
Total	827 468	100%

3.2.4 *Desert*

The Desert supply area is the largest in the State containing a diverse range of vegetation types. Sandalwood is distributed throughout the area and concentrated in localised stands. This supply area has not been harvested to any large extent with the exception of the area around Plumridge Lakes.

Green wood harvesting is excluded from the desert supply area.

No data was collected for this area in relation to resource available for harvest as future operations will be limited to dead wood only.

Tenure		
Tenure permitting harvest	2 305 9751	27%
Tenure excluding harvest	61 080 529	73%
Total	84 140 281	100%

3.2.5 *Gascoyne*

The Gascoyne supply area takes in the western half of the Pilbara. The primary land use within this area is pastoralism and mining. The land types are diverse with many different vegetation types. Sandalwood predominantly occurs within the creek systems and watercourses of this area.

Minimal harvesting has occurred in this area in the past. Current operations are limited to 100 tonnes per annum consisting of over 70% deadwood.

GREEN RESOURCE SUMMARY

GASCOYNE SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	3	Number of Samples:	237
Total Area:	22224931	Average Mature Size:	146
Sample Area:	16708.7	Log 10 Average Weight:	1.34
Sample Stems >125 mm:	414	Average Weight (kg/stem):	21.9

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	4503	157	0.0008	2546338	2037
B	8118.2	252	0.0007	4282017	2997
C	3205.5	5	0.0000	7344168	250
D	0	0	0.0000	0	0
E	866	0	0.0000	183151	0
F	16	0	0.0000	417794	0
Not Vegetated = 140740 ha				**Total Available Tonnes:**	5284

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	4503	157	0.0008	397210	318
B	8118.2	252	0.0007	1967652	1377
C	3205.5	5	0.0000	5052094	172
D	0	0	0.0000	0	0
E	866	0	0.0000	25474	0
F	16	0	0.0000	9033	0
Not Vegetated = 154783 ha				**Total Unavailable Tonnes:**	1867
				TOTAL SUPPLY AREA TONNES	**7151**

DEAD RESOURCE SUMMARY

GASCOYNE SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	22224931
Sample Area:	39989.4
Dead Stems:	286
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	6274	169	0.0001	2546338	255
B	10147	97	0.0000	4282017	143
C	5566	10	0.0000	7344168	46
D	0	0	0.0000	0	0
E	866	0	0.0000	183151	0
F	278	0	0.0000	417794	0
Not Vegetated = 140740 ha				**Total Available Tonnes:**	255

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	6274	169	0.0001	397210	40
B	10147	97	0.0000	1967652	66
C	5566	10	0.0000	5052094	32
D	0	0	0.0000	0	0
E	866	0	0.0000	25474	0
F	278	0	0.0000	9033	0
Not Vegetated = 154783 ha				**Total Unavailable Tonnes:**	138
				TOTAL SUPPLY AREA TONNES	**393**

Tenure		
Tenure permitting harvest	14 914 208	66%
Tenure excluding harvest	7 606 247	34%
Total	22 520 455	100%

3.2.6 *Kalgoorlie*

The Kalgoorlie supply area is centred on Kalgoorlie. This area is dominated by *Eucalypt* woodland with most of the area taken up by pastoral leases and mining leases.

This area has been extensively harvested in the past. Current operations are 200 tonnes per annum.

GREEN RESOURCE SUMMARY

KALGOORLIE SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	2	Number of Samples:	27
Total Area:	1513717	Average Mature Size:	150
Sample Area:	2769	Log 10 Average Weight:	1.37275158
Sample Stems >125 mm:	1302	Average Weight (kg/stem):	23.6

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	419	436	0.0245	14707	360
B	884	776	0.0207	479142	9918
C	155	13	0.0020	116104	232
D	136	32	0.0056	118952	666
E	0	0	0.0000	133354	0
F	0	0	0.0000	208784	0
Not Vegetated = 142686 ha				**Total Available Tonnes:**	11176

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	419	436	0.0245	0	0
B	884	776	0.0207	438699	9081
C	155	13	0.0020	1512	3
D	136	32	0.0056	330	2
E	0	0	0.0000	116	0
F	0	0	0.0000	2017	0
Not Vegetated = 1906 ha				**Total Unavailable Tonnes:**	9086
				TOTAL SUPPLY AREA TONNES	**20262**

DEAD RESOURCE SUMMARY

KALGOORLIE SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	1513717
Sample Area:	6307
Dead Stems:	4759
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	467	412	0.0031	14707	45
B	463	425	0.0032	479142	1533
C	691	292	0.0015	116104	174
D	1210	1264	0.0037	118952	440
E	321	214	0.0023	133354	306
F	235	191	0.0028	208784	584
Not Vegetated = 142686 ha				**Total Available Tonnes:**	3082

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	467	412	0.0031	0	0
B	463	425	0.0032	438699	1404
C	691	292	0.0015	1512	2
D	1210	1264	0.0037	330	1
E	321	214	0.0023	116	0
F	235	191	0.0028	2017	6
Not Vegetated = 1906 ha				**Total Unavailable Tonnes:**	1413
				TOTAL SUPPLY AREA TONNES	**4495**

Tenure		
Tenure permitting harvest	1 213 729	73%
Tenure excluding harvest	444 580	27%
Total	1 658 309	100%

3.2.7 Kambalda

Kambalda supply area is located to the south of Kalgoorlie and comprises of *Eucalypt* woodland and Lake Lefroy and Lake Cowan systems. The area contains freehold land known as the Hampton area and pastoral leases. It also contains some of the first sandalwood reserves established.

The northern end of this supply area is excluded from geenwood harvesting under the Sandalwood Act. Current operations are 50 tonnes per annum.

GREEN RESOURCE SUMMARY

KAMBALDA SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	1	Number of Samples:	61
Total Area:	1423532	Average Mature Size:	144
Sample Area:	5070	Log 10 Average Weight:	1.32085928
Sample Stems >125 mm:	1003	Average Weight (kg/stem):	20.9

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	594	289	0.0102	5091	52
B	36	56	0.0326	4589	149
C	649	197	0.0064	53857	345
D	1260	104	0.0017	699670	1189
E	217	9	0.0009	50863	46
F	76	19	0.0052	185842	966
Not Vegetated = 9311 ha				**Total Available Tonnes:**	2747

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	594	289	0.0102	2355	24
B	36	56	0.0326	0	0
C	649	197	0.0064	25236	161
D	1260	104	0.0017	114755	195
E	217	9	0.0009	113335	102
F	76	19	0.0052	167939	873
Not Vegetated = 11520 ha				**Total Unavailable Tonnes:**	1355
				TOTAL SUPPLY AREA TONNES	**4102**

DEAD RESOURCE SUMMARY

KAMBALDA SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	1423532
Sample Area:	5070
Dead Stems:	863
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	594	303	0.0018	5091	9
B	36	14	0.0014	4589	6
C	649	96	0.0005	53857	27
D	1260	133	0.0004	699670	280
E	217	13	0.0002	50863	10
F	76	31	0.0014	185842	260
Not Vegetated = 9311 ha				**Total Available Tonnes:**	592

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	594	303	0.0018	2355	4
B	36	14	0.0014	0	0
C	649	96	0.0005	25236	13
D	1260	133	0.0004	114755	46
E	217	13	0.0002	113335	23
F	76	31	0.0014	167939	235
Not Vegetated = 11520 ha				**Total Unavailable Tonnes:**	321
				TOTAL SUPPLY AREA TONNES	**913**

Tenure		
Tenure permitting harvest	1 009 224	70%
Tenure excluding harvest	435 143	30%
Total	1 444 367	100%

3.2.8 *Leonora*

The Leonora supply area is dominated by *Acacia* shrublands. The area comprises in the main of pastoral leases centred on the town of Leonora.

Moderate levels of harvesting have occurred in the past centred on mining centres. Current operations are 150 tonnes per annum.

GREEN RESOURCE SUMMARY

LEONORA SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	3	Number of Samples:	350
Total Area:	2101898	Average Mature Size:	160
Sample Area:	17417	Log 10 Average Weight:	1.44508767
Sample Stems >125 mm:	2604	Average Weight (kg/stem):	27.9

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	3391	687	0.0056	89164	499
B	1785	281	0.0044	1330714	5855
C	4595	744	0.0045	356097	1602
D	0	0	0.0000	9928	0
E	320	30	0.0026	170018	442
F	313	44	0.0039	75408	294
Not Vegetated = 115043 ha				**Total Available Tonnes:**	8692

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	3391	687	0.0056	355	2
B	1785	281	0.0044	31936	140
C	4595	744	0.0045	29210	131
D	0	0	0.0000	38	0
E	320	30	0.0026	9030	23
F	313	44	0.0039	0	0
Not Vegetated = 61855 ha				**Total Unavailable Tonnes:**	296
				TOTAL SUPPLY AREA TONNES	**8988**

DEAD RESOURCE SUMMARY

LEONORA SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	2101898
Sample Area:	17703
Dead Stems:	1230
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	3361	463	0.0005	89164	44
B	1785	195	0.0004	1330714	532
C	4609	244	0.0002	356097	71
D	0	0	0.0000	9928	0
E	320	3	0.0000	170018	0
F	457	39	0.0003	75408	22
Not Vegetated = 115043 ha				**Total Available Tonnes:**	669

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	3361	463	0.0005	355	0
B	1785	195	0.0004	31936	12
C	4609	244	0.0002	29210	5
D	0	0	0.0000	38	0
E	320	3	0.0000	9030	0
F	457	39	0.0003	0	0
Not Vegetated = 61855 ha				**Total Unavailable Tonnes:**	17
				TOTAL SUPPLY AREA TONNES	**686**

Tenure		
Tenure permitting harvest	2 146 372	94%
Tenure excluding harvest	132 424	6%
Total	2 278 796	100%

3.2.9 *Murchision*

The Murchision Supply Area encompasses the catchments of the Murchision River with surrounding pastoral leases. Sandalwood is generally confined to water courses.

There has been minimal sandalwood harvesting in the Murchison in the past. Presently there are no sandalwood harvesting operations.

GREEN RESOURCE SUMMARY

MURCHISION SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	1	Number of Samples:	22
Total Area:	11904205	Average Mature Size:	151
Sample Area:	2560.8	Log 10 Average Weight:	1.38
Sample Stems >125 mm:	41	Average Weight (kg/stem):	24.0

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	798	16	0.0005	837834	419
B	1306	25	0.0005	7217430	3609
C	234	0	0.0000	718675	0
D	0	0	0.0000	0	0
E	120	0	0.0000	22587	0
F	102	0	0.0000	1098205	0
Not Vegetated = 25016 ha				**Total Available Tonnes:**	4028

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	798	16	0.0005	389725	195
B	1306	25	0.0005	77084	38
C	234	0	0.0000	621532	0
D	0	0	0.0000	0	0
E	120	0	0.0000	3944	0
F	102	0	0.0000	2313	0
Not Vegetated = 1441 ha				**Total Unavailable Tonnes:**	233
				TOTAL SUPPLY AREA TONNES	**4261**

DEAD RESOURCE SUMMARY

MURCHISION SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	10989329
Sample Area:	4323
Dead Stems:	28
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	798	20	0.0001	837834	84
B	1306	8	0.0000	7217430	155
C	234	0	0.0000	718675	0
D	0	0	0.0000	0	0
E	120	0	0.0000	22587	0
F	102	0	0.0000	1098205	0
Not Vegetated = 25016 ha				**Total Available Tonnes:**	312

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	798	20	0.0001	389725	39
B	1306	8	0.0000	77084	2
C	234	0	0.0000	621532	0
D	0	0	0.0000	0	0
E	120	0	0.0000	3944	0
F	102	0	0.0000	2313	0
Not Vegetated = 1441 ha				**Total Unavailable Tonnes:**	41
				TOTAL SUPPLY AREA TONNES	**353**

Tenure		
Tenure permitting harvest	9 925 884	90%
Tenure excluding harvest	1 096 040	10%
Total	11 021 924	100%

3.2.10 Paynes Find

Paynes Find extends from Perth to Geraldton and east to a northern alignment with Southern Cross. The western half of this area comprises mainly of freehold land. Vegetation types are dominated by *Acacia* shrubland and *Eucalyptus* woodland.

Paynes Find has supported extensive harvesting historically. Current operations are 150 tonnes per annum.

GREEN RESOURCE SUMMARY

PAYNES FIND SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	3	Number of Samples:	14
Total Area:	2596045	Average Mature Size:	174
Sample Area:	7918	Log 10 Average Weight:	1.54751672
Sample Stems >125 mm:	1699	Average Weight (kg/stem):	35.3

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	482	116	0.0085	411565	3498
B	1724	521	0.0107	510031	5457
C	1281	201	0.0055	279672	1538
D	475	241	0.0179	127320	2279
E	36	0	0.0000	32640	0
F	202	89	0.0155	502145	7783
Not Vegetated = 106615 ha				**Total Available Tonnes:**	20555
Unincluded = 9052028 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	482	116	0.0085	9090	77
B	1724	521	0.0107	60531	648
C	1281	201	0.0055	223244	1228
D	475	241	0.0179	212398	3802
E	36	0	0.0000	115190	0
F	202	89	0.0155	112219	1739
Not Vegetated = 139988 ha				**Total Unavailable Tonnes:**	7494
Unincluded = 523585 ha					
				TOTAL SUPPLY AREA TONNES	**28049**

DEAD RESOURCE SUMMARY

PAYNES FIND SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	2483826
Sample Area:	8256
Dead Stems:	332
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	422	38	0.0003	411565	123
B	2060	110	0.0002	510031	102
C	1619	83	0.0002	279672	56
D	0	0	0.0000	127320	0
E	0	0	0.0000	32640	0
F	238	9	0.0001	502145	50
Not Vegetated = 106615 ha				**Total Available Tonnes:**	331
Unincluded = 9052028 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	422	38	0.0003	9090	3
B	2060	110	0.0002	60531	12
C	1619	83	0.0002	223244	45
D	0	0	0.0000	212398	0
E	0	0	0.0000	115190	0
F	238	9	0.0001	112219	11
Not Vegetated = 139988 ha				**Total Unavailable Tonnes:**	71
Unincluded = 523585 ha					
				TOTAL SUPPLY AREA TONNES	**402**

Tenure		
Tenure permitting harvest	1 969 988	58%
Tenure excluding harvest	1 396 244	42%
Total	3 366 232	100%

3.2.11 *Sandstone*

Sandstone Supply Area is centred on the township of Sandstone. The dominant vegetation is *Acacia* shrublands. Pastoralism is the dominant land use.

Sandalwood has been harvested sporadically in the past. Current 100 tonnes per annum is harvested.

GREEN RESOURCE SUMMARY

SANDSTONE SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	2	Number of Samples:	36
Total Area:	3201154	Average Mature Size:	168
Sample Area:	10916	Log 10 Average Weight:	1.508182585
Sample Stems >125 mm:	1122	Average Weight (kg/stem):	32.2

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	912	474	0.0167	274083	4577
B	2097	226	0.0035	1750926	6128
C	2356	149	0.0020	1011715	2023
D	0	0	0.0000	0	0
E	330	19	0.0019	5239	10
F	219	43	0.0063	66383	418
Not Vegetated = 61061 ha				**Total Available Tonnes:**	13156

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	912	474	0.0167	1507	25
B	2097	226	0.0035	75334	263
C	2356	149	0.0020	15967	32
D	0	0	0.0000	0	0
E	330	19	0.0019	0	0
F	219	43	0.0063	0	0
Not Vegetated = 842 ha				**Total Unavailable Tonnes:**	320
				TOTAL SUPPLY AREA TONNES	**13476**

DEAD RESOURCE SUMMARY

SANDSTONE SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	3201154
Sample Area:	10964
Dead Stems:	1702
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	912	703	0.0027	274083	740
B	2073	247	0.0004	1750926	700
C	2404	276	0.0004	1011715	404
D	0	0	0.0000	0	0
E	330	27	0.0003	5239	2
F	219	73	0.0012	66383	80
Not Vegetated = 61061 ha				**Total Available Tonnes:**	1926

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	912	703	0.0027	1507	4
B	2073	247	0.0004	75334	30
C	2404	276	0.0004	15967	6
D	0	0	0.0000	0	0
E	330	27	0.0003	0	0
F	219	73	0.0012	0	0
Not Vegetated = 842 ha				**Total Unavailable Tonnes:**	40
				TOTAL SUPPLY AREA TONNES	**1966**

Tenure		
Tenure permitting harvest	3 169 407	97%
Tenure excluding harvest	93 646	3%
Total	3 263 053	100%

3.2.12 Savage

Savage Supply area is bordered on the West by Kalgoorlie and on the East by Desert. *Eucalyptus* woodland is the dominant vegetation type in the South. Tenure is mainly vacant crown land.

Sandalwood has been harvested at moderate intensity in the past. Currently 300 tonnes are harvested per annum.

GREEN RESOURCE SUMMARY

SAVAGE SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	2	Number of Samples:	46
Total Area:	1649020	Average Mature Size:	157
Sample Area:	5013	Log 10 Average Weight:	1.42496323
Sample Stems >125 mm:	2370	Average Weight (kg/stem):	26.6

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	119	110	0.0246	159926	3934
B	539	574	0.0283	272098	7700
C	1408	673	0.0127	736020	9347
D	277	87	0.0084	70619	593
E	223	83	0.0099	194237	1923
F	0	0	0.0000	145780	0
Not Vegetated = 93340 ha				**Total Available Tonnes:**	23497

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	119	110	0.0246	0	0
B	539	574	0.0283	25882	732
C	1408	673	0.0127	43544	553
D	277	87	0.0000	0	0
E	223	83	0.0099	19	0
F	0	0	0.0000	895	0
Not Vegetated = 139 ha				**Total Unavailable Tonnes:**	1285
				TOTAL SUPPLY AREA TONNES	**24782**

DEAD RESOURCE SUMMARY

SAVAGE SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	1649020
Sample Area:	10403
Dead Stems:	6798
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	143	75	0.0018	159926	288
B	1083	941	0.0030	272098	816
C	2842	2164	0.0027	736020	1987
D	299	227	0.0027	70619	191
E	220	121	0.0019	194237	369
F	686	379	0.0019	145780	277
Not Vegetated = 93340 ha				**Total Available Tonnes:**	3928

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	143	75	0.0018	0	0
B	1083	941	0.0030	25882	78
C	2842	2164	0.0027	43544	117
D	299	227	0.0027	0	0
E	220	121	0.0019	19	0
F	686	379	0.0019	895	2
Not Vegetated = 139 ha				**Total Unavailable Tonnes:**	197
				TOTAL SUPPLY AREA TONNES	**4125**

Tenure		
Tenure permitting harvest	1 672 020	96%
Tenure excluding harvest	70 478	4%
Total	1 742 498	100%

3.2.13 *Shark Bay*

Shark Bay Supply Area is a coastal supply area located north of Geraldton. Vegetation is dominated by thick *Acacia* shrubland on deep coastal sands. The tenure Pastoral Lease.

Shark Bay has traditionally supported sandalwood harvesting in low levels for many years. Sandalwood harvesting has been identified as an acceptable land use within the Shark Bay Regional Strategy. Currently 20 tonnes is harvested per annum.

GREEN RESOURCE SUMMARY

SHARK BAY SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	1	Number of Samples:	180
Total Area:	104815	Average Mature Size:	183
Sample Area:	464	Log 10 Average Weight:	1.61268337
Sample Stems >125 mm:	384	Average Weight (kg/stem):	41.0

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	0	0	0.0000		0
B	0	0	0.0000		0
C	232	192	0.0339	104692	3549
D	0	0	0.0000		0
E	0	0	0.0000		0
F	0	0	0.0000		0
				Total Available Tonnes:	3549

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	0	0	0.0000		0
B	0	0	0.0000		0
C	232	192	0.0339	123	4
D	0	0	0.0000		0
E	0	0	0.0000		0
F	0	0	0.0000		0
Area in need of Further Survey = 844825 ha				**Total Unavailable Tonnes:**	4
				TOTAL SUPPLY AREA TONNES	3553

DEAD RESOURCE SUMMARY

SHARK BAY SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	104815
Sample Area:	464
Dead Stems:	120
Average Weight (kg/stem):	7.0

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	0	0	0.0000		0
B	0	0	0.0000		
C	232	60	0.0018	104692	188
D	0	0	0.0000		0
E	0	0	0.0000		0
F	0	0	0.0000		0
				Total Available Tonnes:	188

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	0	0	0.0000		0
B	0	0	0.0000		0
C	232	60	0.0018	123	0
D	0	0	0.0000		0
E	0	0	0.0000		0
F	0	0	0.0000		0
Area in need of Further Survey = 844825 ha				**Total Unavailable Tonnes:**	0
				TOTAL SUPPLY AREA TONNES	**188**

Tenure		
Tenure permitting harvest	811 574	85%
Tenure excluding harvest	138 065	15%
Total	949 639	100%

3.2.14 *Wiluna*

The Wiluna supply area is located to the north east of Wiluna. Dominant vegetation types are open plains with *Acacia* pockets.

Very little harvesting has taken place in this supply area. Currently there are no operations.

GREEN RESOURCE SUMMARY

WILUNA SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	1	Number of Samples:	141
Total Area:	8137413	Average Mature Size:	152
Sample Area:	5638.2	Log 10 Average Weight:	1.39
Sample Stems >125 mm:	141	Average Weight (kg/stem):	24.6

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	570	30	0.0013	423510	550
B	2772	75	0.0007	2377515	1664
C	1548	5	0.0001	797875	80
D	0	0	0.0000	0	0
E	647	25	0.0009	653509	588
F	100	6	0.0015	54019	81
Not Vegetated = 67369 ha				**Total Available Tonnes:**	2963
Unincluded = 4121892 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	570	30	0.0013	30119	39
B	2772	75	0.0007	729496	510
C	1548	5	0.0001	2937175	294
D	0	0	0.0000	0	0
E	647	25	0.0009	134001	121
F	100	6	0.0015	194	0
Not Vegetated = 173441 ha				**Total unavailable Tonnes:**	964
Unincluded = 105751 ha					
				TOTAL SUPPLY AREA TONNES	**3927**

DEAD RESOURCE SUMMARY

WILUNA SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	8137413
Sample Area:	10706.4
Dead Stems:	40
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	570	5	0.0000	423510	13
B	2772	13	0.0000	2377515	39
C	1548	1	0.0000	797875	2
D	0	0	0.0000	0	0
E	647	8	0.0000	653509	28
F	100	2	0.0001	54019	4
Not Vegetated = 67369 ha				**Total Available Tonnes:**	86
Unincluded = 4121892 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	570	5	0.0000	30119	1
B	2772	13	0.0000	729496	12
C	1548	1	0.0000	2937175	7
D	0	0	0.0000	0	0
E	647	8	0.0000	134001	6
F	100	2	0.0001	194	0
Not Vegetated = 173441 ha				**Total unavailable Tonnes:**	25
Unincluded = 105751 ha					
				TOTAL SUPPLY AREA TONNES	**111**

Tenure		
Tenure permitting harvest	4 373 798	52%
Tenure excluding harvest	4 110 176	48%
Total	8 483 974	100%

3.2.15 *Woodlands*

Woodlands extends from the great Eastern Highway west of the Coolgardie Esperance road south to the coast and west to the agricultural areas. It is predominantly *Eucalypt* woodland interspersed with numerous salt lake systems.

Moderate harvesting has occurred within this are mainly in the north east corner. Currently annual operation are set at 250 tonnes.

GREEN RESOURCE SUMMARY

WOODLANDS SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	1	Number of Samples:	44
Total Area:	5740144	Average Mature Size:	153
Sample Area:	2396	Log 10 Average Weight:	1.40
Sample Stems >125 mm:	1415	Average Weight (kg/stem):	25.1

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	164	365	0.0559	32042	1791
B	0	0	0.0000	0	0
C	40	10	0.0063	1295661	8163
D	2180	1048	0.0121	1923627	23276
E	0	0	0.0000	1024006	0
F	12	2	0.0042	2	0
Not Vegetated = 306214 ha				**Total Available Tonnes:**	33230
Unincluded = 117744 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	164	365	0.0559	377	21
B	0	0	0.0000	0	0
C	40	10	0.0063	826531	5207
D	2180	1048	0.0121	463523	5609
E	0	0	0.0000	174222	0
F	12	2	0.0042	153	1
Not Vegetated = 46167 ha				**Total Unavailable Tonnes:**	10838
Unincluded = 268705 ha					
				TOTAL SUPPLY AREA TONNES	**44068**

DEAD RESOURCE SUMMARY

WOODLANDS SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	5740144
Sample Area:	4628
Dead Stems:	1034
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	164	112	0.0024	32042	77
B	0	0	0.0000	0	0
C	40	6	0.0005	1295661	648
D	2180	454	0.0007	1923627	1346
E	0	0	0.0000	1024006	0
F	12	1	0.0003	2	0
Not Vegetated = 306214 ha				**Total Available Tonnes:**	2071
Unincluded = 117744 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	164	112	0.0024	377	1
B	0	0	0.0000	0	0
C	40	6	0.0005	826531	413
D	2180	454	0.0007	463523	324
E	0	0	0.0000	174222	0
F	12	1	0.0003	153	0
Not Vegetated = 46167 ha				**Total Unavailable Tonnes:**	738
Unincluded = 268705 ha					
				TOTAL SUPPLY AREA TONNES	**2809**

Tenure		
Tenure permitting harvest	4 699 297	73%
Tenure excluding harvest	1 779 679	27%
Total	6 478 976	100%

3.2.16 *Yalgoo*

The Yalgoo supply area extends from Mount Magnet in the east to Mullewa in the west and the adjacent pastoral leases to the north and south. The dominant vegetation types are *Acacia* shrublands with some pockets of *Eucalypt* woodland in the south.

The area has a long history of harvesting and most pastoral leases have been harvested at some stage during the past. Current annual operations are 50 tonnes.

GREEN RESOURCE SUMMARY

YALGOO SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	5	Number of Samples:	137
Total Area:	3577116	Average Mature Size:	153
Sample Area:	15649	Log 10 Average Weight:	1.40
Sample Stems >125 mm:	2076	Average Weight (kg/stem):	24.8

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1103	261	0.0059	955807	5639
B	4086	1053	0.0064	1313165	8404
C	2856	361	0.0031	448182	1389
D	0	0	0.0000	0	0
E	129	2	0.0004	174836	70
F	202	18	0.0022	249930	550
Not Vegetated = 23777 ha				**Total Available Tonnes:**	16052

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1103	261	0.0059	5257	31
B	4086	1053	0.0064	380237	2433
C	2856	361	0.0031	14941	46
D	0	0	0.0000	0	0
E	129	2	0.0004	32255	13
F	202	18	0.0022	2506	6
Not Vegetated = 0 ha				**Total Unavailable Tonnes:**	2529
				TOTAL SUPPLY AREA TONNES	**18581**

DEAD RESOURCE SUMMARY

YALGOO SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	3577116
Sample Area:	15685
Dead Stems:	1074
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1103	278	0.0009	955807	860
B	4001	630	0.0006	1313165	788
C	2874	68	0.0001	448182	45
D	0	0	0.0000	0	0
E	214	8	0.0001	174836	17
F	202	7	0.0001	249930	25
Not Vegetated = 23777 ha				**Total Unavailable Tonnes:**	1735

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1103	278	0.0009	5257	5
B	4001	630	0.0006	380237	228
C	2874	68	0.0001	14941	1
D	0	0	0.0000	0	0
E	214	8	0.0001	32255	3
F	202	7	0.0001	2506	0
Not Vegetated = 0 ha				**Total Available Tonnes:**	237
				TOTAL SUPPLY AREA TONNES	**1972**

Tenure		
Tenure permitting harvest	3 165 698	88%
Tenure excluding harvest	435 198	12%
Total	3 600 896	100%

3.2.17 *Yilgarn*

The Yilgarn supply area extends north from the Great Eastern Highway between Southern Cross to Coolgardie to a point adjacent to Menzies. The vegetation types are mainly sandplain interspersed with *Eucalypt* and *Callitris* woodlands.

The area has been moderately harvested in the past mainly in areas of *Eucalypt* woodland. Current operation are 250 tonnes per annum.

GREEN RESOURCE SUMMARY

YILGARN SUPPLY AREA

Assessment and Cruise Assessment		Measurement Plot and Weight Summary	
Assessed Area:	5	Number of Samples:	132
Total Area:	3885849	Average Mature Size:	154
Sample Area:	11461	Log 10 Average Weight:	1.40383731
Sample Stems >125 mm:	4597	Average Weight (kg/stem):	25.3

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1121	581	0.0131	66990	877
B	1408	664	0.0120	744015	8928
C	1327	367	0.0070	1347623	9433
D	1339	644	0.0122	1191303	14534
E	156	95	0.0154	194213	2991
F	940	570	0.0154	109928	1693
Not Vegetated = 370447 ha				**Total Unavailable Tonnes:**	38456
Unincluded = 3726 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1121	581	0.0131	1733	23
B	1408	664	0.0120	16067	193
C	1327	367	0.0070	97772	684
D	1339	644	0.0122	75880	926
E	156	95	0.0154	30907	476
F	940	570	0.0154	9418	145
Not Vegetated = 12523 ha				**Total Available Tonnes:**	2447
Unincluded = 0 ha					
				TOTAL SUPPLY AREA TONNES	**40903**

DEAD RESOURCE SUMMARY

YILGARN SUPPLY AREA

Assessment and Cruise Assessment

Assessed Area:	5
Total Area:	3885849
Sample Area:	14557
Dead Stems:	1953
Average Weight (kg/stem):	3.5

Available Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1121	333	0.0010	66990	67
B	2581	538	0.0007	744015	521
C	1667	182	0.0004	1347623	539
D	1334	154	0.0004	1191303	476
E	156	11	0.002	194213	39
F	980	194	0.0007	109928	77
Not Vegetated = 306214 ha				**Total Unavailable Tonnes:**	1719
Unincluded = 117744 ha					

Unavailable Land Description	Sample Area	Sample Stems	Tonnes/ Hectare	Total Area	Total Tonnes
A	1121	333	0.0010	1733	2
B	2581	538	0.0007	16067	11
C	1667	182	0.0004	97772	39
D	1334	154	0.0004	75880	30
E	156	11	0.0002	30907	6
F	980	194	0.0007	9418	7
Not Vegetated = 46167 ha				**Total Available Tonnes:**	95
Unincluded = 268705 ha					
				TOTAL SUPPLY AREA TONNES	**1814**

Tenure		
Tenure permitting harvest	4 028 24	94%
Tenure excluding harvest	244 364	6%
Total	4 272 608	100%

4. DISCUSSION

This sandalwood inventory produced a total resource outside reserve (available) over 125 mm diameter of 234 782 tonnes. The sandalwood inventory of 1984 produced a result outside of reserves of "merchantable" sandalwood 137 100 tonnes (Kealley 1991).

Since the 1984 inventory, utilization standards have improved. This has been accompanied by an acceptance within markets of a lower grade of sandalwood products. This has resulted in the yield per stem increasing since 1984. This partly explains the increase in resource available between 1984 and 1999.

In order to take account of this stem weights were calculated by harvesting and weighing stems cut to current harvesting specifications.

Stems were harvested in the Kalgoorlie and Coolgardie supply areas. Stems were harvested debarked and graded. Prior to harvesting each stem diameter was recorded.

The weight of sandalwood that met current harvesting specifications was weighed and recorded against stem diameter giving a yield per stem relating to size class.

Improved technology, access to the resource and improved mapping systems have also contributed to improved sampling of the resource.

When the 1998 calculations relating to yield per stem are applied to the 1984 data the resource estimated in 1984 can be calculated in 1999 terms. The resource calculation in 1984 was based on a mean green stem weight of 16.18 kilograms for the size class 125mm to 175mm diameter and 28.76 kilograms the size class greater than 175mm (Kealley 1991).

Using the same calculation methods and using 1999 yield estimates a mean green stem weight of 23.43 kilograms for the size class 125mm to 175mm diameter and 52.5 kilograms for the size class greater than 175mm, a green sandalwood resource estimate of 180 400 tonnes is calculated using 1984 data. This represents an increase in yield between 1984 and 1998 of approximately 44% in the 125mm to 175 mm size class and 82% in the size class above 175mm. This increase in yield equates to a green sandalwood resource estimate of 180 400 tonnes calculated from 1984 data. The difference in the data from 1984, corrected using 1998 yield estimates, and the 1998 data is approximately 30%.

The yield data for dead sandalwood from 1984 is comparable the data calculated in 1999. The 1984 dead sandalwood resource estimate was 27 100 tonnes. The 1999 estimate of the dead sandalwood resource is 26 971 tonnes. Neither of these figures account for sandalwood removed, during harvesting operations over the period.

4.1 Errors

Given the immense area covered by the assessment, the sample size, in area, is relatively small. This was a function of the resources and time available to complete the project. Multiplying any misrepresenting coefficients (produced from a small sample) can affect the population total estimates.

The stem yield was also calculated from a relatively small sample given the large number of stems in the total population. To increase the accuracy of the yield sample, it is recommended that a minimum of 30 green stems > 125mm and 30 dead stems be randomly sampled from several locations within each supply area for future reference. In this assessment the dead stem sample (12) was particularly small.

Within the experimental design assumptions were made. These are as follows;

In compiling the data, assessment locations were identified in specific supply areas. The assumption is that supply areas have sandalwood concentrations that are mutually exclusive. Sandalwood supply areas were drawn up on a basis of economic conditions of production and delivery and ease of delineation, not necessarily sandalwood ecology.

Assessments of strategic locations for future assessment must be chosen in mutually exclusive bio-regions. Analysis of variance (ANOVA) between samples within supply areas would determine if the populations are significantly similar and therefore be applied to the same set of land type areas.

Similarly ANOVA would determine if the differences between supply areas are statistically significant in terms of stems/ha coefficients, and therefore to be treated as mutually exclusive or otherwise. Sampling error may be accountable for differences evident between the mean coefficients.

Calculation of remaining tonnages assumes that no ingrowth has occurred. The calculation of sustained yield within the population and within supply areas will be calculated in future management plans.

There is an inherent difficulty in recognizing previously harvested areas in the field particularly where no records have been kept. This may have resulted in some assessments being inadvertently biased due to previous sandalwood harvesting.

The above errors and assumptions require acknowledgment that the data should be used in the generalized form in which it exists. To determine accurate data for specific locations and operational planning further assessment must be undertaken.

ACKNOWLEDGMENTS

The production of this report has involved many staff within the Department of Conservation and Land Management.

Without the dedication, skills and good humour of those involved with the collection and analysis of data, preparation of text, tables and maps this report would not have been possible. In particular the many hours spent by assessment crews in the field often in high temperatures and adverse conditions is acknowledged.

The following people in particular have assisted in the production of this report and are thanked for their professional (and unprofessional) contributions.

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- David Evans
- John Brand
- Assessment Crews
- CALM Information Management Branch
- Dave Shepard – AgWa
- Angas Hopkins
- Shannon White

and

- The many station owners and managers who provided local knowledge and hospitality throughout the rangelands of WA.

REFERENCES

The Management of Sandalwood (1991) Ian. G. Kealley, Department of Conservation and Land Management, Perth WA

Sandalwood Inventory Manual (1998) Department of Conservation and Land Management - Unpublished.

APPENDIX 1

STEM WEIGHT CALCULATION

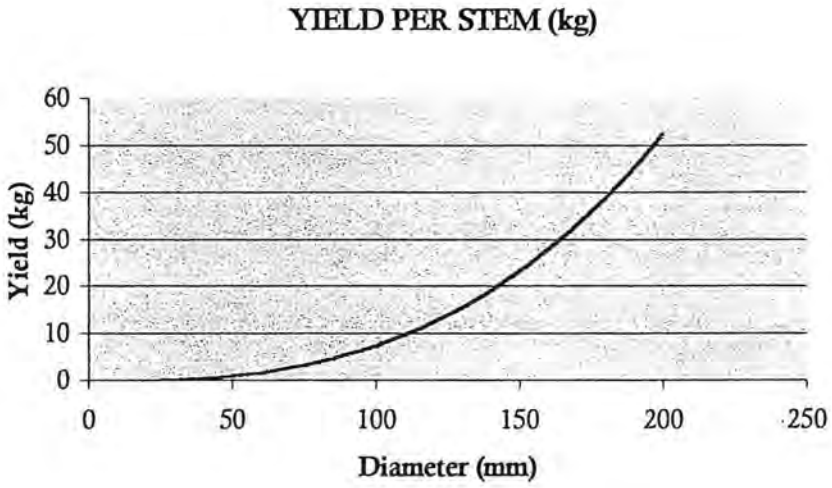
The data set revealed a strong positive correlation (0.8233) between the diameter at 150mm and the weight of sandalwood product in each sample. A very strong positive correlation (0.9392) was demonstrated by the transformed data sets of *log x* and *log y*.

For this reason regression analysis was performed with the transformed data sets.

The relationship between the stem diameter (over bark) 150 mm above the ground and the weight of sandalwood meeting product specification is;

$$Log\ y = 2.8045\ log\ x - 4.7331$$

Where x is the stem diameter and y is the weight of sandalwood product.



Mean stem sizes for each supply area are used to calculate the total weight using the regression formula.

APPENDIX 2

15/09/1999 13:50 090-217831 CALM GOLDFIELDS PAGE 02

SANDALAS XLS

CONSERVATION AND LAND MANAGEMENT
SANDALWOOD SURVEY.

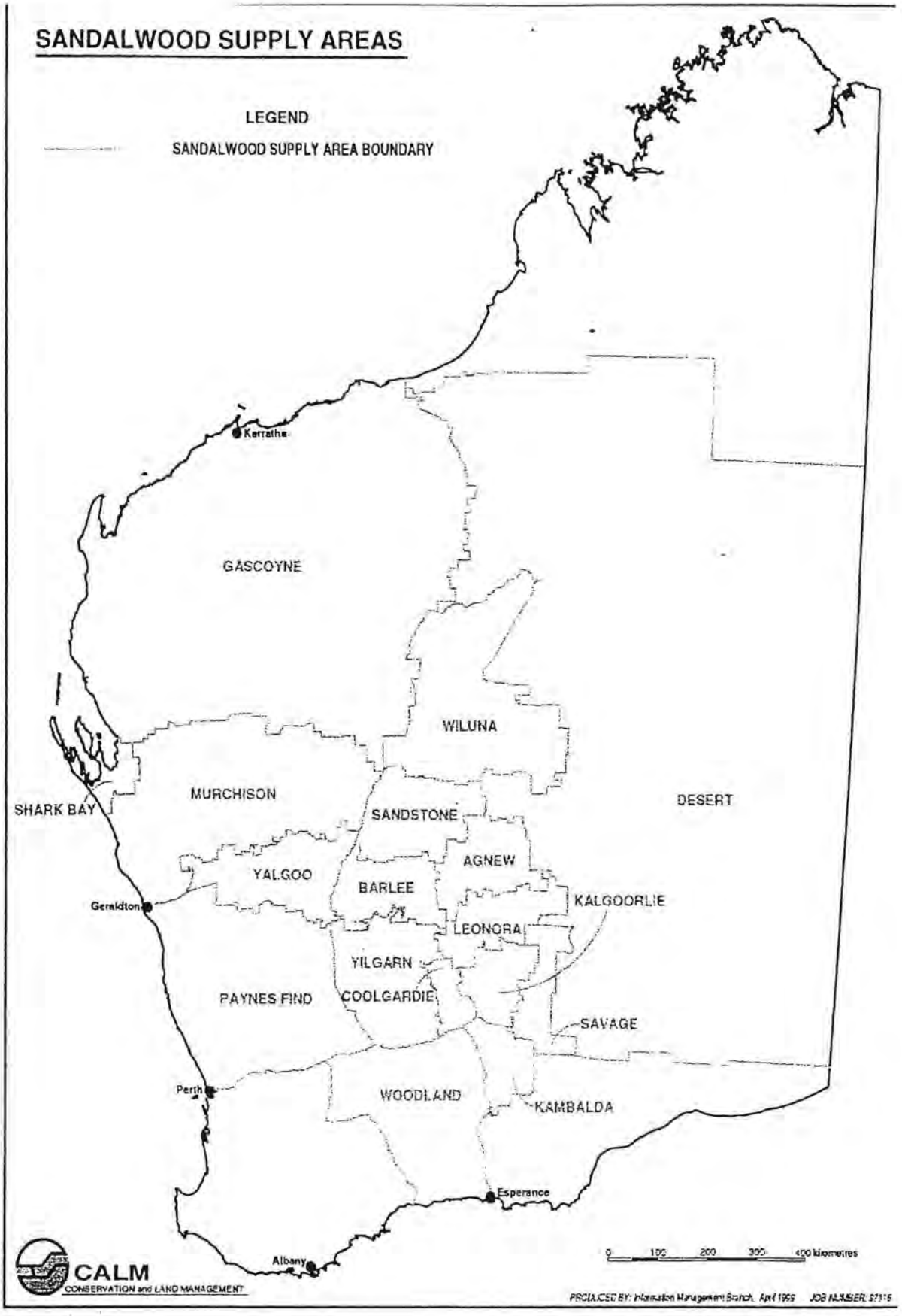
AREA: LAKE EAD LEE
RUN No: (4)
DATE: 10/12/98
ASSESSORS: [illegible] STURMER

1:250 000 MAP:
GPS or AMG REF: START south 29 18 19
east 119 09 91
GPS or AMG REF: STOP south 29 17 90
east 119 03 35

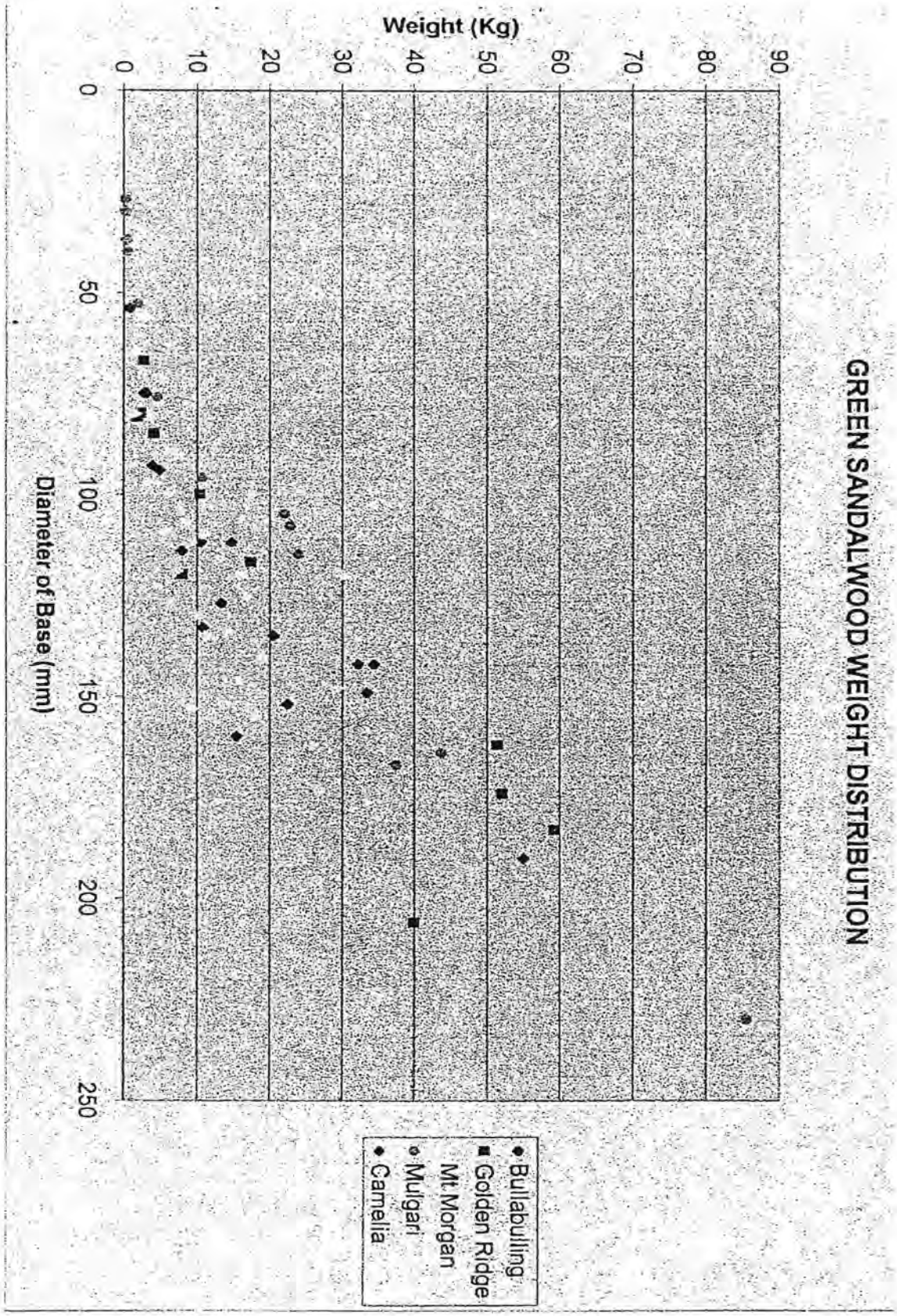
DISTANCE TRAVEL km	NUMBER OF STEMS BY DIAMETER CLASSES (mm) 0 - 24	25 - 74	75 - 124	125 - 174	175+	pieces	COMMENTS (include veg. type and GPS and)
0 – 1							HILLHEAD CAR STAND
1 – 2		33%	IIII	IIII IIII	IIII	II	MIX / STONEY
2 – 3			IIII II	IIII		IIII	MIX / STONEY
3 – 4							Mulga / Sandy / Stony
4 – 5			I		I	I	MIX / STONEY / STONEY
5 – 6				BNR			MULGA / SANDY / SANDY
6 – 10						5	Euc / SANDY / STONEY
@ 8 km		24 17	501	119 03	000		
10 – 11							MULGA / SANDY
@ 11.0	FENCE CLOSE ENDS	TURN NE ON FENCE				2917 500 119 03 255	
11 –							DOG / SANDY
@ 12.1	SEC	III	III			I	Euc
12 – 13			I	III	I	I I	MULGA / STONEY
13 –		32%	IIII	IIII III		III	Euc
@ 14	ROAD TO LEFT						
14 – 15			II		I	Yow	MIXED / ROCKY
@ 15.6	TRACK	CONTINUE	EAST	WEST			
15 – 16							MULGA / SANDY
16 – 18			II	II	III		MIXED / STONEY
18 –		I	IIII	IIII		IIII WAG	MIXED / STONEY
@ 19.7	BEACH	40%					
		END OF RUN					

30 metre either side of road clearing = 4 ha per km

APPENDIX 3


SANDALWOOD SUPPLY AREAS
LEGEND
SANDALWOOD SUPPLY AREA BOUNDARY
Kerratha
GASCOYNE
WILUNA
MURCHISON
SHARK BAY
SANDSTONE
DESERT
AGNEW
YALGOO
BARLEE
KALGOORLIE
Geraldton
LEONORA
YILGARN
PAYNES FIND
COOLGARDIE
SAVAGE
Perth
WOODLAND
KAMBALDA
Esperance
Albany
0 100 200 300 400 kilometres
CALM
CONSERVATION and LAND MANAGEMENT
PRODUCED BY: Information Management Branch, April 1995 JOB NUMBER: 07115

APPENDIX 4


GREEN SANDALWOOD WEIGHT DISTRIBUTION
Weight (Kg)
0
10
20
30
40
50
60
70
80
90
0
50
100
150
200
250
Diameter of Base (mm)
Bullabulling
Golden Ridge
Mt Morgan
Mulgari
Camelia

APPENDIX 5

DEAD SANDALWOOD WEIGHT SAMPLES

Tree Number	Weight (kg)
1	7.8
2	2.5
3	1.3
4	1.85
5	3.75
6	17.2
7	1.2
7	3.3
8	3
9	3.9
10	7.1
11	3.8
12	2.4
Total	**59.1**