Potential for *Eucalyptus globulus* in the Esperance District—

Evaluation of the climate and soils

Tree growth and relationship to environment

Recommendations

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1. *Summary*

The physical resources of the areas near Esperance, were examined in some detail, and a broad evaluation made of the potential for *Eucalyptus globulus*.

Assuming that *E. globulus* requires a minimum rainfall of 550 mm, there is approximately 108 700 ha of alienated land within 80 km of Esperance which could be suitable. Of this 57 800 ha, all east of Esperance, has a rainfall of >600 mm. Although up to 15% of the rainfall falls during summer this cannot be relied upon. Similarly, the mean rainfall in the past ten years was approximately 90% of that in the previous ten years. A cautious approach is therefore necessary towards any commercial tree planting in the area, and particularly so in the 550–600 mm rainfall zone.

Several major soil groups are apparent in a soil and land resource survey, with deep sandy soils (46%) and sand over clay soils (50%) dominating. The deep sands are likely to be more readily available for tree planting than the shallower soils, which are more productive to agriculture. Although it is certain that these soils will differ in their potential pulpwood productivity, there are insufficient plots of *E. globulus* to allow these differences to be quantified, and to ensure that it can be successfully established on deep sands.

Potential soil limitations such as sand depth, wind erosion, water repellency, salinity and waterlogging are discussed in terms of their likely affects on tree performance. Some of these limitations may be overcome through the use of alternative commercial species. Trees may have some beneficial effects on the soil, such as reducing wind erosion and in salinity control. In addition they may provide shelter for crops and livestock.

Economic analysis of the different options for tree establishment (viz. block plantings vs shelter–belts) should identify both the minimum production needed for profitable on-farm pulpwood production, and for a viable pulpwood industry in the Esperance area. Comparisons of the profitability of tree growing with other farm enterprises can only proceed when suitable growth data has been assembled.

It is clear that parts of the Esperance area have some potential for the establishment of trees for pulpwood production. There is insufficient growth data available on which to confidently predict the success of such an enterprise, therefore we strongly recommend the establishment of a series of trial plantings encompassing the variation in soils and climate.

2. *Introduction*

There is a general consensus that trees are required in the Esperance landscape, and more particularly on the Esperance sand plain, to overcome a number of land use problems which include salinity and wind erosion. Additional benefits from trees are thought to include crop and livestock protection from the wind, a general aesthetic improvement, and in enabling production from deep sandy soils, which are presently poorly productive to agriculture.

If a future income is desired, it is essential that the tree species planted have a potential market. The commercial species nominated in this report is *Eucalyptus globulus*, which has been successfully established in plantations and shelter–belts in the south-west of Western Australia.

The Department of Conservation and Land Management, and in the past the Forests Department, have been involved in promoting tree planting on farms for some time. In 1989 the CALM Esperance District staff, with the aid of National Afforestation Programme funding, established 5 trial plantings of *E. globulus* totalling approximately 20 ha. Early results from these plantings showed enough encouragement for further plantings to occur in 1990 (some 45 ha).

In this report the physical attributes of the Esperance area (climate and soils), which will affect the growth of trees, will be considered in some detail and an indication made of the potential for tree growth. An estimate of the area of land where trees can potentially be grown is derived from revised rainfall isohyets.

3. *Requirements for tree growth*

The broad climatic requirements of *E. globulus* have been summarized by Booth and Pryor (1991) (Table 1). This species is thought to have a minimum mean annual rainfall requirement of 550-600 mm, therefore this report will only consider those areas with a rainfall greater than this.

4. *Physical Resources*

4.1. *Location and Land Use*

Esperance is located on the south coast of Western Australia, 800 km south east of Perth, and 500 km east of Albany.

In areas alienated for agriculture native vegetation has now been mostly cleared and replaced with farming systems, which revolve around rotations of cropping and pasture.

4.2. *Climate*

4.2.1. *Rainfall*

4.2.1.1. *Introduction*

Rainfall records were obtained, from the Bureau of Meteorology, for 38 stations in the Esperance area. These had been recording for periods ranging from 6 to 71 years. Data from 4 stations were disregarded due to short recording periods or missing data. These data are summarized in Appendix 1.

4.2.1.2. *Amount and distribution*

The mean rainfall from all stations for all years has been mapped (Fig. 1) with 50 900 ha of alienated land with a mean rainfall of between 550 and 600 mm and 57 800 ha >600 mm (Table 1). The maximum potentially plantable area is therefore 108 700 ha, and this extends from 90 km east to 30 km west of Esperance. Land covered by lakes and farm infrastructure, and that land not yet cleared, has not been accounted for, and will possibly depress these estimates by 10%.

East of Esperance the 550 and 600 mm rainfall isohyets correspond to Fisheries (33°45′) and Merivale Roads (33°48′) respectively. The mean rainfall decreases at a rate of 6.5 mm/km with distance north, from a maximum of 715 mm near the northern boundary of Cape Le Grand National Park (Fig. 2).

It may be worthwhile to obtain additional rainfall data from several of the farms within the area, to verify the isohyets developed here. Butcher (1986) describes a method of predicting rainfall at a particular location, from that of surrounding locations, and this approach could be be useful, particularly as orographic effects will be minor.

4.2.1.3. *Rainfall distribution within years*

The distribution of rainfall through the year is also of importance. Table 3 indicates the proportion of the rainfall which falls between April and November, and May and October, for selected stations, which are of increasing distance from the coast. Although the *proportion* of non–winter rainfall is slightly higher in the inland, drier, areas (17%) compared to near the coast (12%) the mean rainfall received in this period is similar for all stations (83-85 mm). This no doubt reflects the different origins of the summer and winter rainfall.

Similarly, Fig. 3 illustrates the variability in rainfall for each month of the year, in terms of coefficient of variation (CV). Summer rainfall is much more variable (i.e. less reliable) than the winter rainfall, and must be considered a bonus rather than as an assured part of the annual rainfall.

4.2.1.4. Variation of rainfall between years

Rainfall reliability, and in particular the characteristics of the drier years will provide an indication of the gross suitability of a site for tree growth, with the rainfall during the driest years determining their survival. The water requirements of trees, and therefore the susceptibility to drought, will increase with tree age.

Rainfall reliability was assessed using three approaches:-

- The variability of the data was calculated as coefficients of variation (CV), and compared with location. The CV's ranged between 10 and 30% and did not vary systematically with latitude or longitude.

- The 10, 25, 50, 75 and 90th percentiles were calculated. The 10th percentile, for example, indicates the rainfall in the driest 10% of the years. Each of these measures is well related to the mean with correlations of 0.92, 0.93, 0.91, 0.91, 0.75 respectively (n=34). For example, a station with a mean rainfall of 610 mm, can expect a rainfall of ≤501 mm in 10% of the years and ≤540 mm in 25% of the years.

- The rainfall of the driest 10% of the years was calculated for each rainfall zone. In the 550-600 mm rainfall zone the rainfall in these years ranged from ≤439 mm to ≤491 mm, at different stations. Similarly, in the 600–650 mm zone comparable figures range from ≤501 to ≤532 mm. 10th percentile rainfall isohyets (550 and 600 mm) are mapped in Fig. 1.

- The mean rainfall for the period 1980-89 was compared with that of 1970-79, for the 15 stations where it was available. The rainfall in the last 10 years was related to that of the previous period by the equation:-

  $$\text{Rainfall (1980-89)} = 0.77 \times \text{Rainfall (1970-79)} + 103.6$$
  $$(r^2=0.81).$$

  A site with a rainfall of 600 mm in the period 1970-79 would have received 560 mm in the period 1980-89. It is not certain whether these fluctuations are due to long term climatic change or represent natural cycles in the rainfall pattern.

If commercial tree planting does proceed it will have to be based on the assumption that trees can produce economic returns with a mean rainfall of 550 or 600 mm, and more importantly that there is minimal likelihood of drought deaths.

4.2.2. Evaporation

The best estimates of evaporation are made with a U.S. Class A evaporation pan, however within the area identified here such data are only available for the Esperance Met. Office. Within a wider area, however, Luke *et al.* (1987) also provide data for Salmon Gums, which is 107 km north of Esperance (Table 4). Evaporation increases with distance from the coast, as the maritime influence decreases, compounding the effect of decreasing water availability with reduced rainfall. Broad evaporation patterns, which illustrate this trend are provided by the Bureau of Meteorology (1971), however the basis of derivation is not clear.

4.2.3. *Wind*

Strong winds represent a hazard to the establishment and survival of trees, both as a wind erosion hazard at planting and through wind–throw through the life of the trees. Although wind data are not available, the presence of mature trees indicates that trees can be established in this area. Wind erosion is generally caused by severe winds, which have an unknown return interval, rather than under the average conditions summarised by the Bureau of Meteorology (1971).

4.2.4. *Temperature*

Temperature data are only available for the Esperance Met. Office (Table 5). From similar areas, such as the Eyre Peninsula and the south-east of South Australia, certain trends can be surmised. Due to a maritime influence areas close to the coast will have less extreme fluctuations in temperature. Mean winter temperatures will be higher near the coast, whereas summer temperatures will be lower than those areas further inland. The inland distance of this effect is not known, however the area where commercial trees are most likely to survive is within 20 km of the coast.

The climatic attributes of Booth and Pryor (1991) can therefore only be applied to Esperance townsite. A climatic requirement of *E. globulus* is that the mean maximum temperature of the hottest month ranges between 19 and 30°C (Booth and Pryor 1991). The mean maximum temperature of 26.2°C for Esperance is within the acceptable range.

4.3. *Geomorphology and Geology*

The area is underlain by Proterozoic granitic rocks on to which the Plantagenet Group sediments were deposited in the Eocene (Morgan and Peers 1973). In the areas with a rainfall of >550 mm the land surface forms a very gently inclined plain, rising to an elevation of approximately 100 m, 20 km inland from the coast. Obvious drainage lines are confined to short creeks, which flow from 10 to 15 km inland to the coast. Elsewhere drainage is internal, with numerous swamps.

All parent materials were deeply weathered (lateritised) in the post-Tertiary period, forming a deep mantle of clayey materials with surficial ferruginous gravels. This mantle has subsequently been modified.

Down–cutting by several short rivers, which run in a northerly direction from the coast, has exposed a variety of parent materials in the river valleys. In some areas the basement granite emerges from the sediments to form domes of various sizes, Frenchmans' Peak to the south being a prominent example.

Much of the sand which has been retained in the landscape has been re-worked by the wind, resulting in the accumulation of sand deposits, these being present both as isolated sand dunes, dunefields and sand sheets. Sand dunes occur along the coast, and these tend to be calcareous at depth. Sand that has been previously carried by the wind is likely to be re-mobilized if the surface is de-stabilized.

4.4. *Soils*

4.4.1. *Introduction*

Broad descriptions of the soils of the Esperance area have been made by Teakle and Southern (1936), Burvill (1982) and Stoneman *et al.* (1990). Since 1985, the Western Australian Department of Agriculture has been mapping soils and landforms for agricultural land use purposes at a scale of 1:50 000 (Overheu *et al. in prep.*)

4.4.2. *Major soils*

Five combined units, which represent the major soils of the area with >550 mm of rainfall, were derived from the units identified by Overheu *et al.* (in prep.). The approximate proportion of each group is given in Table 6. Three of these groups reflect the depth of the sand horizon, the fourth are soils with pronounced columnar sub-soils with variable sand depth while the remainder comprise miscellaneous soils.

4.4.3. *Major properties of soils*

The general form of most of the soils is of a sandy textured surface horizon overlying ferruginous gravel and sandy clay. The soils are perhaps better understood if they are regarded in terms of individual layers, each of which have particular properties which will affect tree growth.

4.4.3.1. *Sand layer*

The major features of the sand horizons are:-

- It is composed predominantly of fine grained quartz sand, with small amounts of clay (<5%).
- An accumulation of organic matter in the surface horizon has caused dark staining.

- Small amounts of nutrients such as phosphorus, nitrogen and various trace elements occur near the soil surface. The present content of these nutrients reflects past fertiliser applications and management.
- The sand is of variable depth, depending on the location of the soil, ranging from a few centimetres to several metres deep on some sand dunes.
- The sand is usually white or grey in colour. Sands which are bright yellow at depth are generally regarded as being more fertile, perhaps due to slightly larger contents of clay and potassium.

4.4.3.2. Ferruginous gravels

Horizons composed of ferruginous gravels ("laterite") are a common feature of the soils. Descriptions of these horizons are limited, however the common features are:-

- Composed of loose, nodular, ferruginous gravel, which usually comprises >50% of the horizon.
- The horizon is of variable depth, tending to be deeper on old laterite surfaces.

The occurrence and extent of cemented horizons, which would impede root growth, such as seen in the Darling Range is not known.

4.4.3.3. Clayey horizons

Clayey horizons underlie the gravel and sandy horizons throughout the landscape, at variable depths.

- Clay horizons range in texture from sandy clay loams to medium clays.
- It is not clear if the clay horizon will form a barrier to plant roots. Where examined it had a weak to moderate structure, with roots penetrating along cracks and between ped faces.
- From limited analysis, the subsoil clays appear to be chemically more fertile than the sands, with accumulations of calcium, potassium and magnesium.
- Salinity often increases with depth.
- The depth of the clay horizons, above un–weathered rock is not known

4.4.3.4. Water Relations

Superimposed on the above sequence of materials, are the water relations of the soil, which are determined by local drainage conditions.

Tree growth will be affected both by an excess (waterlogging), or deficiency, of water, however the affects of these conditions on *E. globulus* are not well defined.

The location of soils in the landscape is important. Deep sandy soils for example can be well drained or poorly so; deep sand on a hill crest will provide different conditions for tree growth to deep sand found within a swamp.

- **Waterlogging**
  During the winter, when rainfall is high and evaporation low, water can accumulate above the poorly permeable clayey B horizons. As soils have been mapped on the basis of their topography some indication of the relative waterlogging risk can be gauged from the landform classification.

- **Soil water storage**
  The water storage of the soil is related to such soil attributes as texture, structure and depth of the soil available to roots.
  Factors affecting root penetration, and thereby effective soil depth, include, waterlogging, compaction and cementation, unfavourable chemical conditions such as salinity and extremes of pH and a shallow depth to underlying rock.

4.4.4. Value of existing soil mapping

The value of the existing soil mapping appears to lie as a tool for regional planning, allowing broad estimates of the range of soils and landforms. The scale of mapping, at 1:50 000, is inadequate for detailed farm planning (Dent and Young 1981), and if plantations or shelter–belts are to be established it will be necessary to survey the soils of each site at a larger scale, such as 1: 5 000 to 1: 10 000. In this way the tree plantings can be integrated objectively into the whole-farm enterprise.

Prior to any tree planting it will be important to examine soils below 90 cm, with particular regard to factors such as the depth, and nature, of any layers which might impede root growth.

4.4.5. Soil limitations

4.4.5.1. Introduction

Several aspects of the soils could potentially limit the establishment of trees and subsequent growth and these are outlined in this section. Several of these limitations are species specific, and could be overcome by the judicious choice of tree species. The commercial value of these species, relative to *E. globulus* will have to be determined.

Trees may ameliorate some of the soil limitations listed below, with for example reductions in salinity hazard and wind erosion. Many of these benefits however are likely to be localised and should not be overstated.

4.4.5.2. Deep sands

The deep sandy soils are the least productive under current agriculture, due to poor chemical fertility and water storage. Several alternative agricultural strategies have been proposed over the years, using species such as lucerne and tagasaste, however these have yet to be adopted on a large scale.

Trees could appear to be a promising land use on these soils, and large areas could be made available quite quickly. It is stressed, however, that careful evaluation should to be made of tree growth on these soils before trees are recommended as an alternative land–use. Experience suggests that these soils, and particularly those that are very well drained, are not capable of high production.

4.4.5.3. Waterlogging

Large areas of land south of Fisheries Road are subject to waterlogging, this ranging in intensity from permanent swamps to winter waterlogging. The effect of waterlogging on tree growth is species dependent, and the tolerance of *E. globulus* will have to be determined.

4.4.5.4. Salinity

The onset of salinity is believed to be a major problem in the Esperance area, however it appears that this is of greater importance in the country to the north of Fisheries Road. The groundwater salinity, of the Esperance area has been discussed by Morgan and Peers (1973) and Laws (1982), and several WA Department of Agriculture research projects are currently in progress.

4.4.5.5. Wind Erosion

The combination of fine sand grains and low clay contents predisposes many of the soils to wind erosion. The amount of surface cover provided by plants can modify the erosion risk; as plant productivity is related to soil depth, deeper sands often have less cover and are more susceptible to wind erosion. Wind erosion will only be a problem at establishment, with the trees increasing soil stability as they grow.

4.4.5.6. Water repellency

Water repellency is a condition which prevents the wetting of the soil at the start of the growing season. This is the soil feature most likely to cause problems for the establishment of trees. In a survey of Esperance soils, Summers (1987) found 70% to be water repellent.

Several techniques to overcome water repellency are currently being evaluated for agricultural purposes and these should be assessed for tree planting.

5. *Tree growth and its relationship to the environment*

5.1. *Present tree growth*

Trees were not measured as part of this study as it is clear a large programme will be required to obtain meaningful information about tree growth. Growth data, where available, is mainly for *P. pinaster*, growing in the 550-600 mm rainfall zone, and its growth is not promising. There are few established plantings of *E. globulus*.

In this section we outline some of the information needed before we can be certain that tree growing is economically viable in the Esperance area. We recommend that a feasibility study be undertaken to determine the most suitable tree species for the Esperance area and to determine the relationships between tree growth, soils and rainfall. This will involve two approaches:-

- **Evaluation of all available tree plantings in the area**
  This would include strip plantings, plots and plantations, it should be stressed however that many of these have been established with sub–optimal techniques and therefore may not give a true indication of the regions' potential. The experience of the local landholders in tree planting should not be ignored. Several farmers are tree planting enthusiasts and should be consulted as to what techniques and species have proved viable and which ones have failed.
  Where possible trees and soils should be measured and described along slope sequences, as this will help identify the impact of soil variation on tree growth.

- **Establishing a series of trial plots**
  These would be on a range of soil types with a range of species. Selection of species for the trial plots should be based on their known environmental requirements, previous performance in the Esperance area and commercial potential.
  To reflect future broadscale plantings it is important that any new plots be planted on farmland. Soil fertility and competition control will be dramatically different on farmland compared to ex–bush sites.

5.1.1. *Establishment and survival*

Few extensive plantings of *E. globulus* exist in the Esperance region. Survival and early growth data are available from four plots established with NAP funding in 1989. Data collected in March 1990, by David Bicknell, shows survival between 69 and 87% and mean height between 82 and 108 cm (Table 7). Survival close to 90% indicates that with good site preparation, satisfactory establishment is achievable in this environment. However, 1989 was a wet year with rainfall about 150 mm above average and this combined with the relatively mild 1989-90 summer probably provided good conditions for establishment. Such conditions may not always occur.

5.1.2. Growth of young trees

An inspection of a 1 year old, 7.5 ha planting, on deep dunal sands at Fels' property, on the north side of Fisheries Road, revealed variable growth. Survival was reasonable over the whole area. Tree growth was best on the lower slopes of the dune, and poorest at the crest, reflecting an increase in depth to the saturated zone in the soil from 1 to 4 m (Table 8), this suggesting that water availability in the first year was influencing growth on deep sands.

5.1.3. Growth of older trees

Few older trees for which age is known are available. Trees planted in shelter belts, approximately 20 to 23 years old, at the "Beef Machine" were 15 to 17 m tall and between 30 and 55 cm in diameter. Two areas of P 73 *E. globulus* in Helms' Arboretum were inspected. They were not measured as they were on shallow waterlogged ex bush sites that had never been fertilised, and were therefore considered atypical of the soils available in the target area. Helms is also somewhat drier than the area south of Fisheries Road.

5.2. Growth of other species

Extensive shelter–belts of *P. pinaster*, *P. radiata*, *E. gomphocephala* and *E. cladocalyx* exist in the region and in general appear to be growing well. The exceptions appear to be shallow wet sites on which *P. radiata* grows poorly, and in some cases dies. Similarly, in the drier inland areas some *P. radiata* suffers from what appears to be drought, again on shallow sands. In the most promising area (>600 mm rainfall) no evidence of drought was observed in the shelter–belts.

6. *Discussion*

It appears that there is an area of approximately 100 000 ha in the Esperance area that has some potential for producing commercial *E. globulus*.

There appears to be a strong interest in tree establishment in the region. This interest has developed due to the perception that trees can provide benefits in terms of wind erosion control and improvements in farm productivity by providing protection for crops and livestock. Trees could also provide an additional source of farm income if the trees are managed to produce specific wood products. The integration of trees onto farms will depend on a range of environmental and economic factors.

The major limitation to tree growth and survival in the region will be drought. The extremely low rainfall in 10% of the years indicates that planting strategies will have to take account of the low rainfall. Large block plantings (plantations) may require more water than is available from rainfall, thus blocks may have to be planted in zones of water accumulation. An alternative strategy would be to plant small blocks or strips so that the available soil water is not fully exploited.

Tree planting will have to take into account current farm management requirements and objectives. This will necessitate whole farm planning, and soil mapping will form an objective basis for this planning. The formulation of objective farm plans will require accurate information on tree performance on the range of soil types found in the target area. Similarly an economic analysis of the likely returns from trees can only proceed when growth rates have been determined from trial plots.

7. *Recommendations*

On the basis of this report several recommendations can be made:-

1 As all the land identified in this report is privately held, the degree of interest of landholders in establishing commercial trees should be determined.

2 Existing plantings of trees be evaluated and information on survival and performance of different species be obtained from landholders.

3 That an analysis of the economics of establishing an *E. globulus* industry in the Esperance area be undertaken. In the absence of growth data this would determine the minimum productivity required for profitability, both on the farm and for the whole enterprise.

4 That trial plots of a range of species, on a range of sites, be established prior to any large scale tree planting programme. These trial plots would allow the relationships between soil and site conditions to be developed, so that predictions could be made on future production at new sites. This work could be undertaken in cooperation with farmer soil conservation groups, and would also indicate priorities for research into establishment techniques.

5 Additional rainfall data be obtained from farmers to verify the rainfall isohyets developed in this report.

6 To facilitate the above recommendations, a position with appropriate technical support should be established to undertake this work. Ideally the position should be based in Esperance, with funds for on-going plot maintenance.

These recommendations should be considered in terms of CALM's existing programmes and priorities. External funding should be sought to undertake the necessary research.

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Tables and Figures

Table 1 Broad climatic requirements of *Eucalyptus globulus* (From Booth and Pryor 1991)

Mean annual rainfall (mm)	Dry season months	Mean maximum temp. hottest month (°C)	Mean minimum temp. coldest month (°C)	Mean annual temp. (°C)	Absolute minimum temp. (°C)
550-1500	0-7	19-30	2-12	9-18	>-8

Table 2 Estimate of the area of land within the 550-600 and >600 mm rainfall zones in the Esperance area

Rainfall zone	Direction	Maximum Distance (km)	Land area ('000 ha)
550-600 mm	East	90	32.6
	West	30	18.3
>600 mm	East	90	57.8
Total			**108.7**

Table 3 **Proportion of total rainfall received between April and November and May and October - selected stations.**

Station	Annual Rainfall (mm)	Proportion of total (%)	
		Apr—Nov	May—Oct
Esperance Downs	492	83	68
Esperance Aerodrome	573	85	70
Esperance Met. Office	627	87	72
Adina	715	88	74

Table 4 **Mean monthly and annual evaporation for Esperance and Salmon Gums (mm)** [1]

Station	LR	J	F	M	A	M	J	J	A	S	O	N	D	Total
Esperance	10	266	211	193	133	93	64	79	90	114	151	191	254	1840
Salmon Gums	7	337	260	221	156	103	73	89	97	127	187	241	297	2189

Table 5 **Mean monthly temperatures for Esperance** [2]

Temperature (°C)	J	F	M	A	M	J	J	A	S	O	N	D
Minimum	15.5	16.0	14.9	13.1	10.3	8.9	8.2	8.5	9.4	10.6	12.7	14.4
Maximum	26.2	26.4	25.2	23.1	20.2	17.9	17.1	17.7	19.2	21.1	22.9	24.8

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[1] From Luke et al, (1987), LR = length of record (years), other figures in mm.

[2] From 1989 WA Year Book

Table 6 **Estimated proportions of the major soils in the regions of the Esperance area with a mean annual rainfall >550 mm**

Mapping Unit	Major soil features	Proportion (%)
I	Sand <30 cm deep	15
II	Sand 30-80 cm deep	24
III	Sands >80 cm deep,	46
IV	Columnar clay B horizons	11
Other	Miscellaneous soils	4

Table 7 **Survival and height growth of *E. globulus* in 1989 NAP* trials, Esperance**

Property	Survival (%)	Mean height March 1990 (cm)
Wylie	69	86
Cabassi	83	82
Fels	87	108
Dept of Agric.	83	80

Table 8 **Height growth of 1 year old *E. globulus* at Fels property (June 1990)**

Plot	Slope position on dune	Depth to saturated sand (m)	Mean Height (m)
1	Lower	1.1	2.0
2	Mid	1.1	2.7
3	Mid to upper	2.0	1.8
4	Upper	3.9	1.0

Fig. 1 Rainfall distribution within the Esperance district