Land suitable for *Pinus pinaster* in the 400-600 mm rainfall zone of south-western WA

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1. Summary

The land base available for *Pinus pinaster* within the 400-600 mm rainfall isohyets was estimated on the basis of:

- total cleared farmland excluding native bushland in reserves or on farms (5.75 million ha)
- soils suitable for *Pinus pinaster* (non-saline, adequate depth, non-waterlogged) (3.3 million ha)
- that the trees will be either dispersed across farms or planted in particular niches (20% of landscape, 0.67 million ha)
- planted within 150 km of Dardanup, Esperance, Mount Barker or Perth (0.34 million ha)

The areas which were likely to be suitable within each of these potential mill zones were:

Zone	*Area (ha)*	*Notes*
Dardanup	59,350	
Esperance	85,828	Possibly another 5,000 ha is suitable with rainfall >600 mm
Mount Barker	152,866	
Perth	86,082	Extra land will be available with rainfall >600 on the Swan Coastal Plain both north and south of Perth, and on Darling Plateau east of Perth.
Total	342,041	Takes into account overlap between adjoining cells (Perth-Dardanup, Dardanup-Mt Barker)

Note that total area for the four individual mill zones (384,126 ha) is greater than the combined area for all zones (342,041 ha) due to overlap between adjacent zones (i.e. Perth-Dardanup, Dardanup-Mt Barker).

2. Land degradation and benefits of tree planting

Land degradation problems in the 400-600 mm rainfall zone are summarized in various reports (Robertson 1988; Select Committee into Land Conservation 1990). Major issues include salinity, wind and water erosion, water-logging, acidification, soil structural decline and water repellency (Harper 1994).

Salinity has the potential not only to destroy large areas of agricultural land, but also adjacent nature reserves. Recent Agriculture WA estimates (Ferdowsian *et al.* 1996) suggest that 1.8 million ha (9% of cleared land) is currently saline, with this area eventually increasing to 6.1 million ha (32%), unless remedial action is taken. Much of this land is in areas with rainfall <600 mm. Salinity is caused by a hydrological imbalance induced by replacing deep rooted native vegetation with shallow rooted agricultural plants.

In contrast to salinity, most damage from wind erosion follows a combination of poor seasonal conditions and very strong winds. These conditions recur every few years and can cause spectacular damage to farm infrastructure, remnant vegetation and soils (Harper and Gilkes 1995).

Trees have a role not only in restoring the water balance and providing protection against wind erosion, but also in providing shelter for crops, pastures and livestock (Shea and Bartle 1988). Similarly, they are a viable land-use option for soils, such as deep sands, which are poorly productive to shallow-rooted agricultural crops and pastures.

3. Map legend

The map shows the distribution of landscape units with different potentials for *Pinus pinaster*. This estimate used the 1967 CSIRO Atlas of Australian Soils Mapping (Northcote *et al.* 1967), with 112 polygons, over the target area. Each unit contains an array of soils.

Land available within 150 km radii, for the four land classes, of four possible mill-sites is summarized in Appendix 1.

Classes on the map are:

Class	Proportion plantable (%) (no soil limitation)	Colour
I	>75	Blue
II	50-75	Green
III	25-50	Orange
IV	<25	Yellow

4. Assumptions

4.1 Soil constraints

Constraints were considered to be:

a) shallow soils such as occur on valley sides, with rock outcrop (e.g. Bindoon, York, Chapman Valley)

b) salinity either due to natural salinity (salt lakes) or induced by agriculture

c) heavy textured valley floor soils such as gilgai flats near Dongara and Moora and heavy textured, alkaline sub-soils such as near Meckering and Wagin

4.2 Soil conditions for success

The soil factors most likely to affect *Pinus pinaster* survival and growth are related to soil water storage and salinity. For successful planting of the trees in this lower rainfall environment we need:

a) non-saline conditions, either current, or likely to develop during the rotation.

b) adequate soil depth (at least 2-3 m) or access to moisture under the adjacent crop or pasture

c) fresh water additions from run-on, seepage or groundwater (George 1991)

4.3 Manageable soil properties

For this analysis, the following soil properties were assumed to be non-limiting to establishment and tree growth:

a) lateritic hard pans (duricrusts) which were either limited in extent, or could be ripped. Other types of hardpans (silcrete and calcrete) were of limited extent in the soils considered suitable.

b) non-saline waterlogged areas which could be drained and mounded.

c) duplex (“sand over clay”) soils

d) water repellency and soil acidity, which are prevalent in the wheatbelt

e) plant nutrients

5. Unknown factors

Soils considered most favourable were mostly those formed on deeply weathered lateritic profiles and lateritic sandplain. These were considered to have the best water storage.

There are however several unknown factors which may impact on the area estimates:

a) There are limited data on the salt concentration at depth in these profiles. Hence, it is not known whether the sub-soils will be exploitable by *Pinus pinaster* roots. Part of the success of the plantations on the northern Swan Coastal Plain may have been due to access to fresh groundwater. In contrast the groundwaters of the wheatbelt are mainly saline. SALTMAP from World Geoscience Corp. may be useful in defining these areas.

b) It is not known whether the tight sodic sub-soil clays which are commonly encountered in the wheatbelt will pose a problem for root penetration. A current LWRRDC funded project I have with Dr Keith Smettem (UWA), investigating the rooting of sub-soils, may help solve this if we extend it into the 400-600 mm rainfall zone.

c) Tree performance on the duplex soils formed both on lateritic pallid zone (e.g. Bindoon-Tambellup) and the Plantagenet sediments between Albany and Esperance is not known. These soils comprise a large proportion of the target area, and are known to be susceptible to seasonal waterlogging (McFarlane and Barrett–Lennard 1987; McFarlane *et al.* 1989), which affects crop and pasture production. Many of these soils may have sub-soils as described in (b).

6. Further work

6.1 Detailed feasibility studies for each mill zone

As a next stage it is recommended that a more detailed feasibility study be undertaken for each mill site. An example is the report I completed for *Eucalyptus globulus* in Esperance (Harper *et al.* 1991).

These feasibility studies would:

a) consider more detailed (1:100 000 scale) Agriculture WA soil-landscape mapping to determine area of different soils

b) use *Pinus pinaster* yield estimates for major soils from Peter Ritson's work

c) summarize local hydro-geology conditions

6.2 Research and Development

There are a number of soil related issues that require further research or development. These include:

a) Develop geophysical techniques (SALTMAP, radiometrics) for land evaluation for *Pinus pinaster* plantings

b) Determining root penetration of sub-soils (effects of salinity, sub-soil structure)

c) Relating productivity to soil and site properties

d) Turning water repellency to our advantage

e) Producing soil-specific establishment recommendations (i.e. cultivation, fertilization)

7. References

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8. Appendix 1 Area estimates[1]

Mill zone	Soil class	Total area (no limitations) (ha)				20% planted, suitable soils only			
		Distance (km)				Distance (km)			
		50	100	150	Total	50	100	150	Total
Dardanup	I	0	9,275	25,638	34,913	0	1,614	4,461	6,075
	II	0	10,344	107,281	117,625	0	1,283	13,303	14,586
	III	0	24,625	495,075	519,700	0	1,822	36,636	38,458
	IV	0	0	9,653	9,653	0	0	232	232
	Total	0	44,244	637,647	681,891	0	4,719	54,631	59,350
Esperance	I	0	59,488	115,863	175,351	0	10,351	20,160	30,511
	II	181,806	196,650	13,631	392,087	22,544	24,385	1,690	48,619
	III	10,431	13,875	20,550	44,856	772	1,027	1,521	3,319
	IV	30,925	98,031	11,813	140,769	742	2,353	284	3,378
	Total	223,162	368,044	161,857	753,063	24,058	38,115	23,655	85,828
Mount Barker	I	82,800	148,969	143,994	375,763	14,407	25,921	25,055	65,383
	II	47,550	31,406	93,844	172,800	5,896	3,894	11,637	21,427
	III	21,019	367,538	432,188	820,745	1,555	27,198	31,982	60,735
	IV	24,744	88,231	108,719	221,694	594	2,118	2,609	5,321
	Total	176,113	636,144	778,745	1,591,002	22,453	59,130	71,283	152,866

[1] Note that total area for the four individual mill zones is greater than the total area for all zones due to overlap (i.e. Perth-Dardanup, Dardanup-Mt Barker)

Perth	I	0	40,363	145,925	186,288	0	7,023	25,391	32,414
	II	0	4,419	44,681	49,100	0	548	5,540	6,088
	III	0	112,306	412,644	524,950	0	8,311	30,536	38,846
	IV	0	203,288	160,606	363,894	0	4,879	3,855	8,733
	Total	0	360,376	763,856	1,124,232	0	20,761	65,322	86,082
All areas	I	82,800	258,094	402,438	743,332	14,407	44,908	70,024	129,340
	II	229,356	242,819	154,800	626,975	28,440	30,110	19,195	77,745
	III	31,450	518,344	1,016,063	1,565,857	2,327	38,357	75,189	115,873
	IV	55,669	389,550	349,894	795,113	1,336	9,349	8,397	19,083
	Total	399,275	1,408,807	1,923,195	3,731,277	46,511	122,725	172,806	342,041