



Genetic Evaluation of *Eucalyptus cladocalyx* Growth and Form in Western Australia

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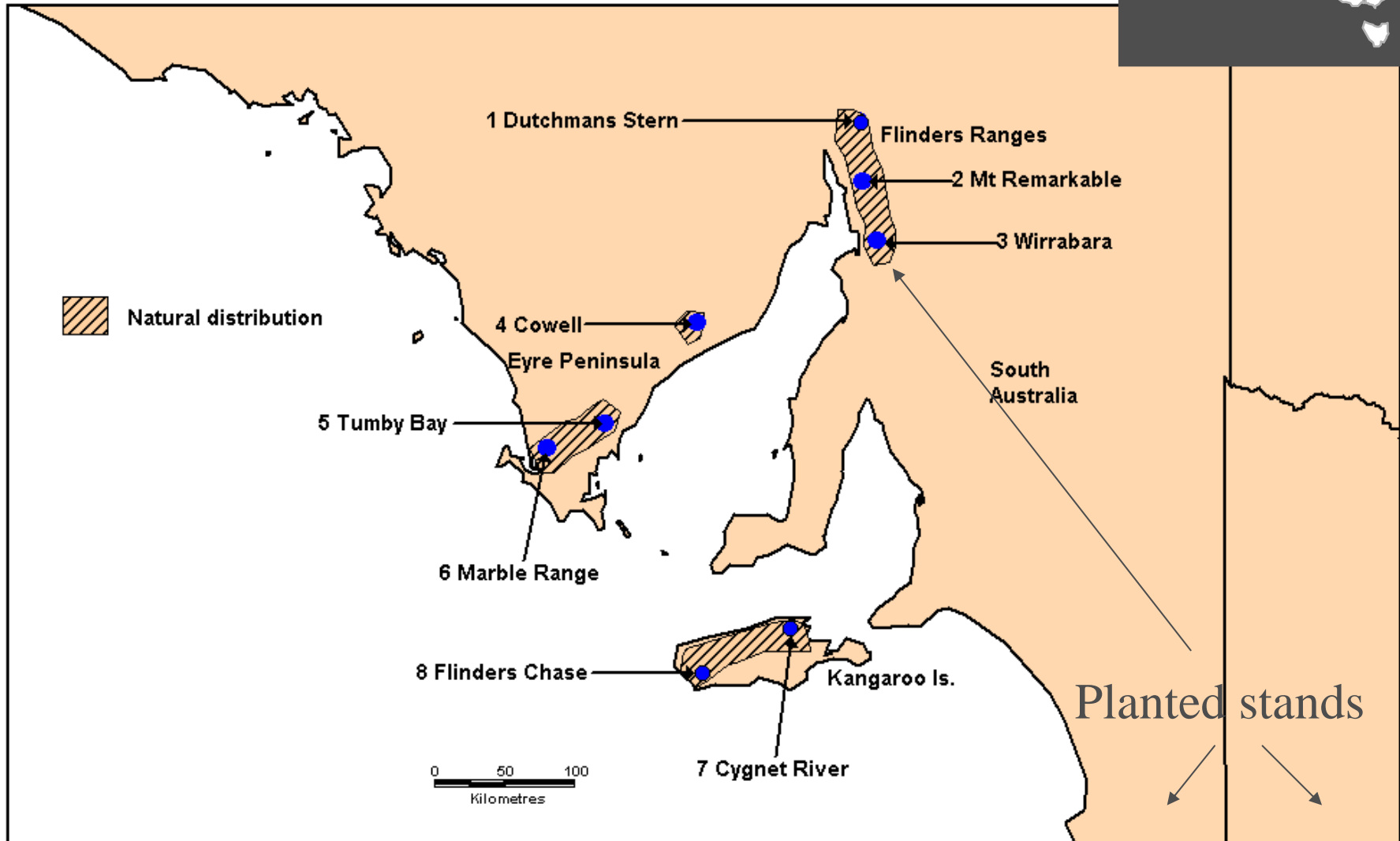
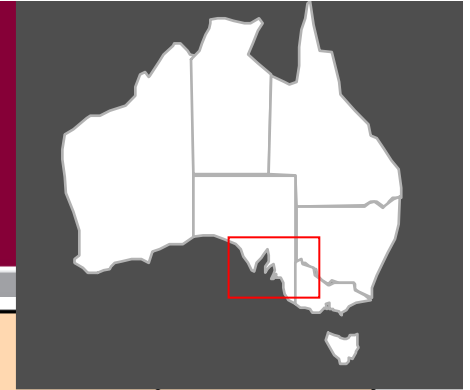
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Sugar gum (*Eucalyptus cladocalyx*)

- High-value durable timber
- Suited to medium-rainfall (400-600 mm)
- Tolerates a range of soils
- Endemic to South Australia in three disjunct regions

Natural distribution



Traits of high commercial importance:

- Growth rate
- Stem straightness
- Branch thickness
- Apical dominance
- Wood properties (???)



ITC Sugar Gum Trials

ITC established three sugar gum family trials in 2001 to:

- Evaluate the performance of the species in the medium-rainfall zone
- Identify superior seed sources
- Participate in the ALRTIG improvement program

Seed Origins of Trial Material

Region-of-provenance group	Seed source	Selection method	Families
S. Flinders Ra.	Wirrabara State Forest	Random (ex wild)	4
S. Flinders Ra.	Wilmington	Random (ex wild)	2
S. Flinders Ra.	Mt. Remarkable	Random (ex wild)	2
Kangaroo Island	Flinders Chase National Park	Random (ex wild)	7
Kangaroo Island	Cygnets River	Random (ex wild)	3
Kangaroo Island	American River	Random (ex wild)	3
Planted Stand	Kersbrook SPA	Phenotypically selected mother and pollen parents	10
Planted Stand	Majorca	Phenotypically selected mother	5
Planted Stand	Mt. Burr	Phenotypically selected mother	4
Planted Stand	Lismore	Phenotypically selected mother	2

Due to the small sample size (42 families) we grouped families according to region-of-provenance

- Southern Flinders Ranges (ex-wild)
- Kangaroo Island (ex-wild)
- Planted Stands (phenotypically selected)



Sites have a similar climate:

- Hot dry summers, cool wetter winters
- Around 500 mm rainfall
- 1300 to 1700 mm pan evaporation

Kojonup – Duplex (sand over loam) soil for 2m
over granite

Wellstead – grey deep sandy soil

Esperance – yellow deep sandy soil



Trial Assessments

Height; 3.5 / 5.5 years

DBH; 3.5 / 5.5 years

Volume Index; 3.5 / 5.5 years

Stem Straightness (1-6); 3.5 years

Branch Thickness (1-6); 3.5 years

Axis Persistence (1-6); 5.5 years

ASReml solved mixed model equations:

Multivariate

- Within-site analyses of multiple traits
- Type A genetic correlations
- Used to estimate heritabilities

Univariate

- Single trait analysed across three sites
- Type B genetic correlations

Narrow sense heritability estimated within region of provenance

$$h^2 = \frac{2.5\sigma_f^2}{\sigma_f^2 + \sigma_P^2 + \sigma_B^2 + \sigma_e^2},$$

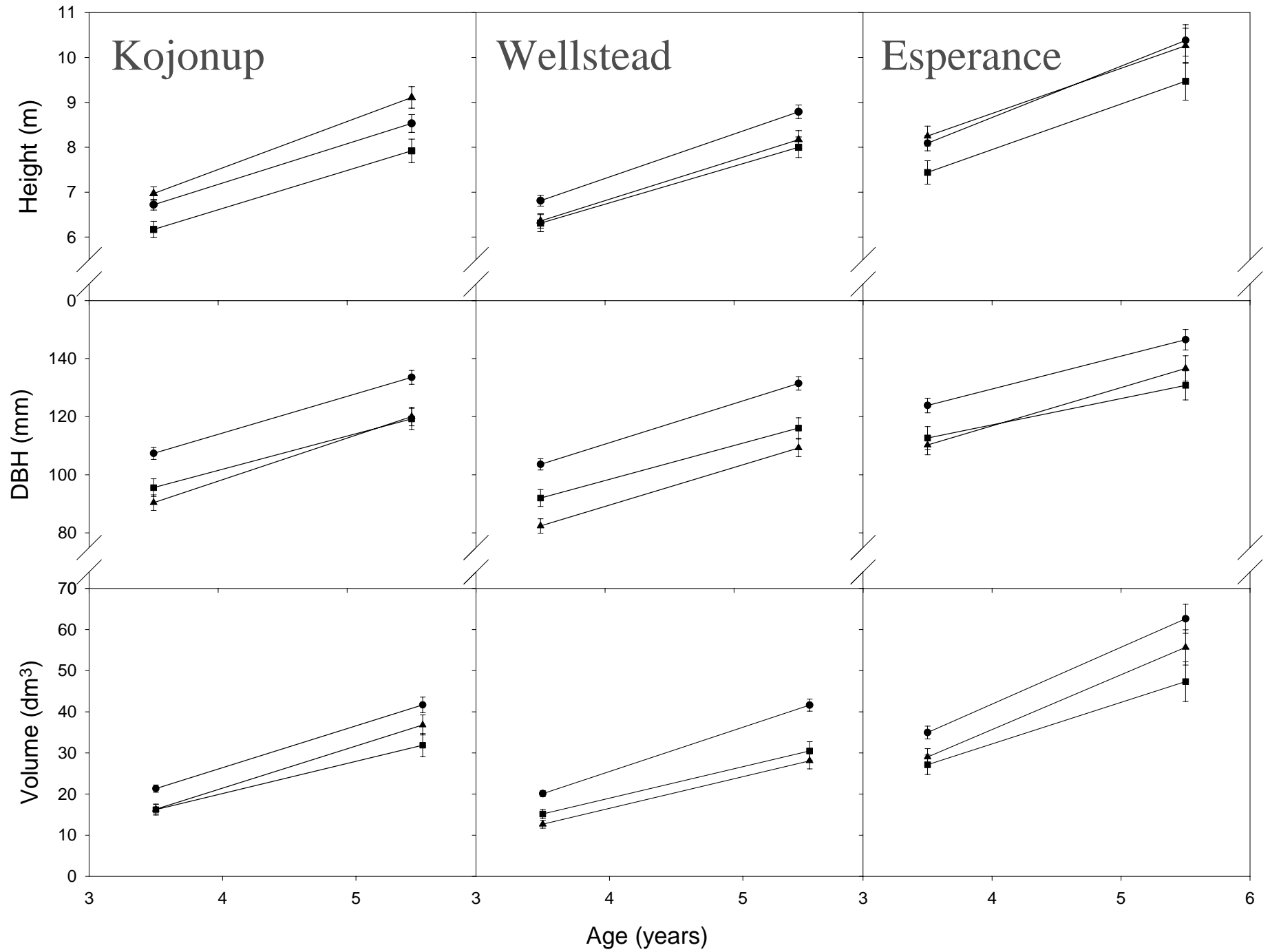
Variance Components:

Family (f), Plot (P), Incomplete Block (B), Error (e)

Coefficient of Relationship = $1/2.5$ to account for inbreeding



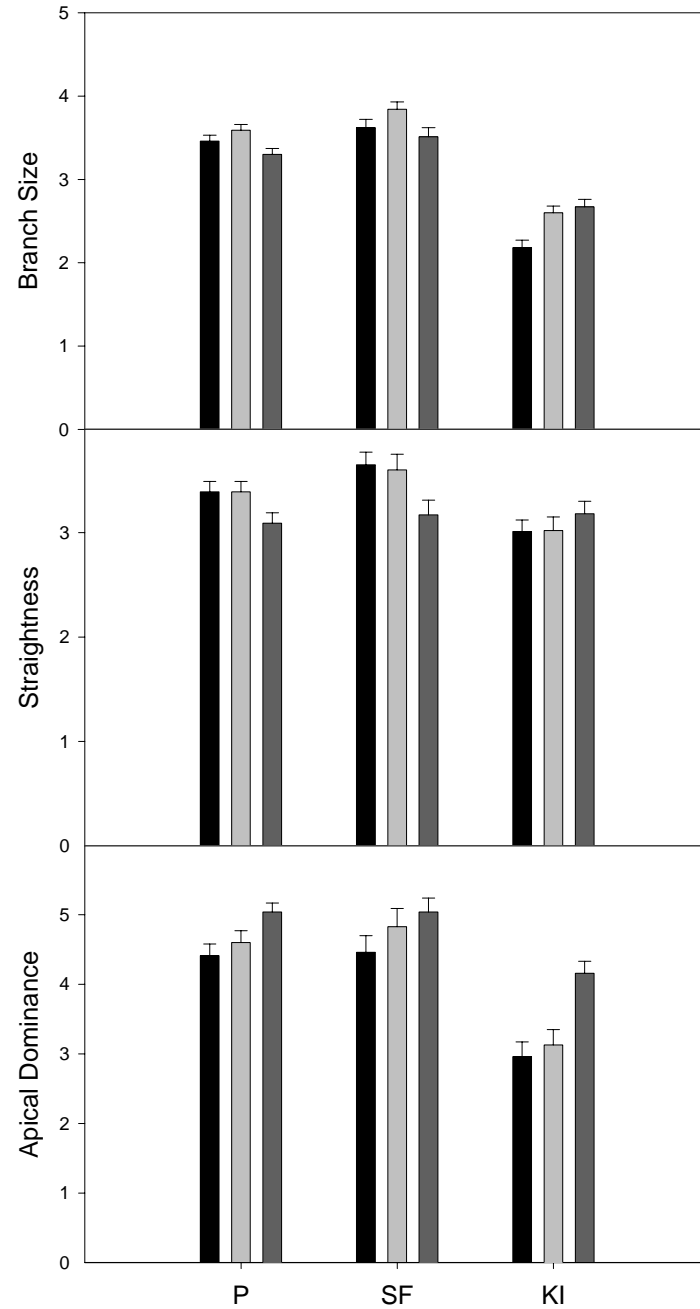
Results – Genetic Groups





Effects of genetic groups on tree form

Results support previous findings





Heritability Estimates

	Kojonup		Wellstead		Esperance	
Height 3.5 yr	0.55	(0.12)	0.85	(0.15)	0.78	(0.14)
Height 5.5 yr	0.60	(0.13)	0.79	(0.14)	0.58	(0.14)
DBH 3.5 yr	0.44	(0.10)	0.43	(0.10)	0.41	(0.10)
DBH 5.5 yr	0.42	(0.10)	0.44	(0.10)	0.41	(0.10)
Volume 3.5 yr	0.47	(0.11)	0.40	(0.10)	0.43	(0.10)
Volume 5.5 yr	0.47	(0.11)	0.42	(0.10)	0.41	(0.10)
Branching	0.17	(0.07)	0.03	(0.04)	0.12	(0.06)
Stem Straightness	0.16	(0.07)	0.50	(0.11)	0.21	(0.07)
Apical Dominance	0.19	(0.07)	0.23	(0.08)	0.21	(0.08)

Our h^2 estimates may be inflated by:

- Greater inbreeding than assumed 0.3
- Broad genetic grouping
 - up to 20% inflation of h^2 compared with precise provenance grouping (David Bush unpublished)
- Small number of families
 - Increases the effect of a few outlying families
- NOT GxE, at least across our three sites



Type A Genetic Correlations

Genetic correlations between the same trait measured at 3.5 and 5.5 years **range from 0.96 to 1.00**

Correlations between growth and form traits generally favourable but not statistically significant

- **Possibly limited by small sample size**
- **Suggests good potential to concurrently improve multiple traits**



Type B Genetic Correlations

Type B genetic correlations not significantly different to 1.0 for Ht (5.5), DBH, Volume and Stem Straightness

- No GxE for these Traits

Significant GxE for branch size (common $r_B = 0.50$)

Significant GxE for apical dominance involving one pair of sites ($r_B = 0.78$)



Conclusions

This study is a first look at the potential to improve sugar gum for commercial plantations

Prospects for genetic improvement appear positive

- High heritability for key traits
- Stable genetic ranking in early growth
- No adverse trait-trait correlations
- Stability across the southern WA environment