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The legacy of pasture improvement causes recruitment failure in grassy eucalypt woodland conservation reserves in the Midlands of Tasmania

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Supplementary material

Appendix 1. Environmental characteristics of the land-type categories used in this study

Vegetation categories are adapted from TasVeg 3.0. Geology categories are modified from 1: 250,000 Digital Geology Tasmania map, the most common vegetation and geology type for sample points is listed first. Mean values are presented with minimum and maximum values in parentheses. WB – water balance.

	Land-type	Vegetation category	Geology	Elev. (m)	Slope (degrees)	Rainfall (mm)	WB (mm)
Native Forest	Native Forest	*E. viminalis*, *E. amygdalina*, *E. ovata* woodland and forest, lowland grassland complex	Jurassic dolerite, quartz sandstone, basalt	463 (249–600)	7 (0–20)	600 (513–685)	-173 (-322 – -34)
Conservation	Public	*E. amygdalina* inland forest and woodland on Cainozoic deposits or on dolerite*, E. viminalis* grassy forest and woodland	Cainozoic sediments (Laterite, sands, gravels), Jurassic dolerite	212 (195–238)	2 (0–8)	487 (526–589)	-255 (-313 – -278)
	Private Unimproved	*E. amygdalina* inland forest and woodland on Cainozoic deposits	Cainozoic sediments (Laterite, sands, gravels)	205 (174–247)			
	Private Improved	*E. amygdalina* woodland on dolerite or sandstone, *E. viminalis* woodland, lowland grassland complexes, agricultural land and regenerating agricultural land	Quartz sandstones Jurassic dolerite	260 (233–294)	4 (1–9)	507 (499–517)	-345 (-367 – -310)
Production	Rangeland	Agricultural land and regenerating agricultural land, *E. viminalis* woodland, *E. amygdalina* woodland on dolerite or sandstone, lowland grassland complexes, *Bursaria-Acacia* scrub	Jurassic dolerite, quaternary sediments, quartz sandstone	267 (213–335)	4 (0–13)	510 (499–534)	-340 (-373 – -293)
	Improved Pasture	Agricultural land, lowland *Poa* grassland, *E. viminalis* grassy forest and woodland, *E. amygdalina* woodland on dolerite	Basalt, Jurassic dolerite, quartz sandstone	217 (196–293)	2 (0–7)	497 (401–511)	-372 (-390 – -338)

Appendix 2. Summary of the statistical models exploring the relationship of tree density in different size classes as a function of land-type

The response variable was the count of trees in each 10-cm DBH class in each transect for each land-type. SC indicates size class, df shows the number of parameters for each model, ΔAICc the difference between the model AICc and the minimum AICc in the set of models, and AICc weights (w_i) indicate the relative support for model i.

	df	*E. amygdalina*		*E. viminalis*		*A. dealbata*		*B. marginata*	
Model		ΔAICc	wi	ΔAICc	wi	ΔAICc	wi	ΔAICc	wi
SC * land-type	12	0.0	0.969	0.0	1	0.0	1	7.0	0.029
SC + land-type	8	6.9	0.031	44.3	<0.001	49.1	<0.001	0.0	0.971
SC	4	132	<0.001	81.4	<0.001	143	<0.001	21.1	<0.001
Land-type	7	623	<0.001	285.7	<0.001	500	<0.001	74.5	<0.001
Null	3	743	<0.001	326.0	<0.001	584	<0.001	97.8	<0.001

Appendix 3. Density (mean ± s.e.) of live trees by species in five of the six land-type categories.

Improved Pasture land-type is excluded as there were only 13 live *E. viminalis* trees, all at one transect. The number of transects (n) where the species was present is listed. Densities for individual species are averaged for only the plots where the species was present. The species in bold are those used in the statistical analysis. Dashes indicate a species is absent from a land-type category. 'n.a.' indicates not applicable.

Land-type	Native Forest			Public Conservation			Private Unimproved Conservation			Private Improved Conservation			Rangeland		
Species	*n* (transects/ 52)	density (ha^{-1})	s.e.	*n* (transects/ 26)	density (ha^{-1})	s.e.	*n* (transects/ 15)	density (ha^{-1})	s.e.	*n* (transects/ 20)	density (ha^{-1})	s.e.	*n* (transects/ 46)	density (ha^{-1})	s.e.
Acacia dealbata	**35**	**503**	**81**	**21**	**158**	**30**	**15**	**190**	**36**	**3**	**553**	**283**	**9**	**92**	**55**
Acacia mearnsii	6	40	20	3	60	17	-	-	-	2	15	5	8	103	65
Acacia melanoxylon	4	23	6	-	-	-	-	-	-	-	-	-	-	-	-
Acacia – unidentified	1	70	n.a.	2	140	70	-	-	-	-	-	-	-	-	-
Allocasuarina littoralis	2	10	0	10	33	8	4	81	47	-	-	-	2	15	5
Banksia marginata	**2**	**10**	**0**	**14**	**136**	**44**	**7**	**304**	**125**	-	-	-	**2**	**10**	**0**
Bursaria spinosa	9	34	16	1	10	n.a.	-	-	-	1	10	n.a.	-	-	-
Coprosma quadrifida	6	15	3	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus amygdalina	**23**	**239**	**52**	**23**	**147**	**16**	**14**	**148**	**24**	**1**	**40**	**n.a.**	-	-	-
Eucalyptus delegatensis	5	228	91	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus globulus	1	480	n.a.	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus ovata	6	50	32	6	22	5	-	-	-	-	-	-	-	-	-
Eucalyptus pauciflora	4	13	3	-	-	-	3	28	12	-	-	-	1	40	n.a.
Eucalyptus tenuiramis	1	200	n.a.	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus viminalis	**36**	**76**	**13**	**14**	**33**	**13**	**14**	**26**	**7**	**9**	**43**	**11**	**8**	**36**	**15**
Eucalyptus - unidentified	2	10	0	3	13	3	1	5	n.a.	-	-	-	-	-	-
Exocarpos cupressiformis	1	10	n.a.	2	25	5	3	8	3	1	10	n.a.	-	-	-
Leptomeria drupacea	-	-	-	-	-	-	1	15	n.a.	-	-	-	-	-	-
Olearia argophylla	1	10	n.a.	-	-	-	-	-	-	-	-	-	-	-	-
Ozothamnus sp.	2	10	0	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. Summary of the statistical models exploring the relationship between tree seedling density as a function of land-type for three dominant genera; *Eucalyptus*, *Acacia*, *Banksia*.

The response variable was the count of seedlings in each transect for each land-type. df shows the number of parameters in each model, ΔAICc the difference between the model AICc and the minimum AICc in the set of models, and AICc weights (w_i) indicate the relative support for model i.

		Eucalyptus		*Acacia*		*Banksia*	
	df	ΔAICc	w_i	ΔAICc	w_i	ΔAICc	w_i
Land-type	7	0.0	1	0.0	1	0.0	1
null	2	75.5	<0.001	19.3	<0.001	31.8	<0.001

Appendix 5. Density and standard error (s.e.) by species of seedlings in five of the six land-type categories

No seedlings were found at the Improved Pasture land-type. As for Appendix 3 except for seedlings. Only live seedlings were recorded. 'n.a.' indicates not applicable.

Land-type	Native Forest			Public Conservation			Private Unimproved Conservation			Private Improved Conservation			Rangeland		
Species	*n* (plots/ 52)	density (ha^{-1})	s.e.	*n* (plots/ 26)	density (ha^{-1})	s.e.	*n* (plots/ 15)	density (ha^{-1})	s.e.	*n* (plots/ 20)	density (ha^{-1})	s.e.	*n* (plots/ 46)	density (ha^{-1})	s.e.
Acacia dealbata	**22**	**2036**	**572**	**16**	**713**	**202**	**13**	**415**	**72**	**3**	**1666**	**796**	**4**	**3624**	**1888**
Acacia mearnsii	2	100	0	2	250	150	-	-	-	-	-	-	2	150	0
Acacia melanoxylon	1	200	n.a.	1	11700	n.a.	-	-	-	-	-	-	-	-	-
Acacia - unidentified	5	2780	1928	2	300	282	-	-	-	-	-	-	1	1000	n.a.
Allocasuarina littoralis	-	-	-	3	67	17	1	325	n.a.	-	-	-	1	200	n.a.
Banksia marginata	**3**	**233**	**33**	**12**	**371**	**220**	**6**	**1013**	**455**	**-**	**-**	**-**	**2**	**50**	**0**
Bursaria spinosa	8	238	74	1	100	n.a.	-	-	-	1	100	n.a.	1	50	n.a.
Coprosma quadrifida	8	625	273	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus amygdalina	**11**	**614**	**228**	**19**	**432**	**100**	**13**	**192**	**51**	**-**	**-**	**-**	**-**	**-**	**-**
Eucalyptus delegatensis	4	313	263	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus ovata	2	1175	1125	6	233	68	-	-	-	-	-	-	-	-	-
Eucalyptus pauciflora	2	50	0	-	-	-	-	-	-	-	-	-	1	200	n.a.
Eucalyptus tenuramis	1	200	n.a.	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus viminalis	**15**	**93**	**19**	**2**	**50**	**0**	**6**	**29**	**4**	**1**	**50**	**n.a.**	**1**	**150**	**n.a.**
Eucalyptus – unidentified	2	125	25	1	350	n.a.	-	-	-	-	-	-	-	-	-
Exocarpos cupressiformis	-	-	-	1	250	n.a.	-	-	-	-	-	-	-	-	-
Lomatia	1	1150	n.a.	-	-	-	-	-	-	-	-	-	-	-	-
Lycium ferocissimum	-	-	-	-	-	-	-	-	-	1	150	n.a	-	-	-
Ozothamnus	1	1800	n.a.	-	-	-	-	-	-	-	-	-	-	-	-
All acacias	28	1137	331	20	931	452	13	360	72	3	250	169	6	350	36
All eucalypts	28	247	74	20	386	87	13	177	49	1	3	2.5	2	8	5
All species	38	1018	34	21	1019	59	15	750	56	4	140	19	7	190	16

Appendix 6. Summary of the statistical models exploring the relationship between tree sapling density as a function of land-type for three dominant genera; *Eucalyptus*, *Acacia*, *Banksia*.

The response variable was the count of saplings in each transect for each land-type. df shows the number of parameters in each model, ΔAICc the difference between the model AICc and the minimum AICc in the set of models, and AICc weights (w_i) indicate the relative support for model i.

		Eucalyptus		*Acacia*		*Banksia*	
	df	ΔAICc	w_i	ΔAICc	w_i	ΔAICc	w_i
Land-type	7	0.0	1	0.0	1	0.0	1
null	2	72.5	<0.001	23.1	<0.001	30.5	<0.001

Appendix 7. Intercept and slope estimates (and standard errors) for the statistical models of the relationship of tree density in each size class as a function of land-type for four abundant species: *Eucalyptus amygdalina, E. viminalis, Acacia dealbata, Banksia marginata.*

A negative slope indicates consistency with the negative exponential distribution. The models with a w+ > 0.73 are in bold. 'n.a.' indicates that no individuals were present.

	E. amygdalina		*E. viminalis*		*A. dealbata*		*B. marginata*	
	estimate	s.e.	estimate	s.e.	estimate	s.e.	estimate	s.e.
Native Forest								
Intercept	**-1.08**	**0.75**	**0.29**	**0.26**	**5.26**	**0.31**	-0.08	0.37
Slope	**-0.43**	**0.03**	**-0.39**	**0.03**	**-1.76**	**0.13**	-0.26	0.04
Public Conservation								
Intercept	**1.56**	**0.18**	**-1.39**	**0.46**	**4.55**	**0.36**	**1.84**	**0.76**
Slope	**-0.32**	**0.02**	**-0.26**	**0.05**	**-1.90**	**0.20**	**-1.44**	**0.24**
Private Unimproved Conservation								
Intercept	**2.14**	**0.25**	**-0.05**	**0.37**	**5.49**	**0.42**	**1.82**	**1.70**
Slope	**-0.32**	**0.02**	**-0.26**	**0.04**	**-2.15**	**0.22**	**-1.80**	**0.32**
Private Improved Conservation								
Intercept	-11.09	6.15	-2.92	0.74	**-6.95**	**2.65**	n.a.	n.a.
Slope	-0.06	0.10	-0.06	0.04	**-1.09**	**0.21**	n.a.	n.a.
Rangeland								
Intercept	n.a.	n.a.	-7.57	1.87	**-6.02**	**1.71**	-11.39	6.20
Slope	n.a.	n.a.	-0.04	0.06	**-0.65**	**0.22**	0.63	1.03