

Appendix 1. Environmental factors (mean \pm 1 s.e.) at nine grasslands in the mid-north of South Australia

Radiation is potential direct incident radiation based on location and quadrat slope. EC = electric conductivity, N = nitrogen, P = phosphorus and n = number of quadrats per site

	Site 1 ($n = 25$)	Site 2 ($n = 20$)	Site 3 ($n = 25$)	Site 4 ($n = 25$)	Site 5 ($n = 25$)	Site 6 ($n = 30$)	Site 7 ($n = 30$)	Site 8 ($n = 20$)	Site 9 ($n = 20$)	Overall ($n = 220$)
Slope ($^{\circ}$)	–	8.67 \pm 1.07	–	1.71 \pm 0.66	7.76 \pm 1.15	10.98 \pm 1.32	7.21 \pm 1.16	13.17 \pm 1.31	5.26 \pm 0.90	6.02 \pm 0.44
Microtopography	Near zero	-3.96 \pm 1.31	Near zero	-0.79 \pm 1.24	-0.26 \pm 0.84	-0.33 \pm 0.86	0.98 \pm 0.71	-0.50 \pm 1.20	0.69 \pm 0.31	-0.37 \pm 0.29
Radiation (MJ cm $^{-2}$ year $^{-1}$)	0.90 \pm 0.00	0.84 \pm 0.01	0.90 \pm 0.00	0.91 \pm 0.01	0.87 \pm 0.01	0.87 \pm 0.01	0.91 \pm 0.01	0.97 \pm 0.02	0.86 \pm 0.01	0.89 \pm 0.004
Soil depth (cm)	34.76 \pm 2.53	29.55 \pm 3.06	> 50 cm	> 50 cm	41.54 \pm 2.45	38.03 \pm 2.27	34.22 \pm 3.22	39.28 \pm 3.12	45.90 \pm 2.06	40.37 \pm 0.90
%gravel (0–5 cm)	4.41 \pm 0.65	2.93 \pm 0.45	3.80 \pm 0.53	1.21 \pm 0.50	9.50 \pm 2.46	13.15 \pm 2.76	10.85 \pm 1.80	8.45 \pm 2.66	4.26 \pm 1.45	6.84 \pm 0.66
%gravel (15–20 cm)	8.77 \pm 2.00	22.76 \pm 8.90	6.86 \pm 1.78	1.31 \pm 0.46	17.61 \pm 4.66	23.79 \pm 2.75	31.40 \pm 6.42	16.07 \pm 6.67	14.74 \pm 3.29	16.32 \pm 1.64
%gravel (25–30 cm)	48.19 \pm 9.13	48.79 \pm 10.67	3.58 \pm 1.15	1.67 \pm 0.55	28.11 \pm 7.17	28.28 \pm 5.01	49.22 \pm 7.91	35.32 \pm 9.95	22.20 \pm 5.23	29.73 \pm 2.57
%clay (0–5 cm)	13.35 \pm 0.25	24.69 \pm 1.42	17.46 \pm 0.69	35.05 \pm 1.91	19.53 \pm 1.05	13.35 \pm 0.37	21.00 \pm 0.83	34.44 \pm 1.71	32.09 \pm 1.17	22.68 \pm 0.65
%silt (0–5 cm)	14.03 \pm 0.22	14.54 \pm 0.58	16.05 \pm 0.59	15.60 \pm 0.84	16.40 \pm 0.63	34.50 \pm 1.29	18.08 \pm 0.79	12.56 \pm 0.86	13.25 \pm 0.64	18.00 \pm 0.54
%sand (0–5 cm)	72.63 \pm 0.34	60.78 \pm 1.55	66.49 \pm 1.08	49.35 \pm 2.09	64.08 \pm 1.46	52.15 \pm 1.43	60.92 \pm 1.51	53.00 \pm 2.27	54.66 \pm 1.48	59.32 \pm 0.71
pH (0–5cm)	6.09 \pm 0.04	8.30 \pm 0.05	6.53 \pm 0.12	8.29 \pm 0.04	6.48 \pm 0.13	7.60 \pm 0.16	6.57 \pm 0.13	7.72 \pm 0.14	7.96 \pm 0.10	7.23 \pm 0.07
EC (μ S) (0–5 cm)	38.88 \pm 1.76	127.65 \pm 5.94	63.29 \pm 5.65	123.04 \pm 3.43	55.12 \pm 6.06	92.10 \pm 5.91	86.73 \pm 8.50	111.75 \pm 6.71	114.50 \pm 5.04	88.53 \pm 2.79
Org. C (% of DW) (0–5 cm)	0.55 \pm 0.02	1.41 \pm 0.05	0.88 \pm 0.05	0.87 \pm 0.06	1.26 \pm 0.07	1.61 \pm 0.06	1.18 \pm 0.03	1.35 \pm 0.08	1.79 \pm 0.07	1.21 \pm 0.03
Org. C (% of DW) (15–20 cm)	0.37 \pm 0.02	0.75 \pm 0.09	0.52 \pm 0.03	0.41 \pm 0.02	0.69 \pm 0.04	0.90 \pm 0.05	0.65 \pm 0.07	0.97 \pm 0.10	1.25 \pm 0.06	0.71 \pm 0.03
Org. C (% of DW) (25–30 cm)	0.13 \pm 0.03	0.41 \pm 0.09	0.51 \pm 0.03	0.36 \pm 0.04	0.51 \pm 0.05	0.65 \pm 0.06	0.36 \pm 0.06	0.66 \pm 0.12	0.90 \pm 0.06	0.49 \pm 0.02
Total N (% of DW) (0–5 cm)	0.05 \pm 0.01	0.17 \pm 0.01	0.08 \pm 0.01	0.10 \pm 0.01	0.13 \pm 0.01	0.22 \pm 0.01	0.14 \pm 0.01	0.17 \pm 0.01	0.24 \pm 0.01	0.14 \pm 0.01
Available P (ppm) (0–5 cm)	3.48 \pm 0.31	4.99 \pm 0.38	4.92 \pm 0.66	4.08 \pm 0.39	7.24 \pm 0.80	6.71 \pm 0.30	6.07 \pm 0.65	5.02 \pm 0.37	7.15 \pm 0.36	5.54 \pm 0.19

Appendix 2. %Frequency of perennial grasses and aboveground biomass of annual grasses (g DW m⁻²) (mean ± 1 s.e.) at nine mid-north grasslands

n = number of quadrats per site. *Introduced species

Species	Site 1 (<i>n</i> = 25)	Site 2 (<i>n</i> = 20)	Site 3 (<i>n</i> = 25)	Site 4 (<i>n</i> =25)	Site 5 (<i>n</i> = 25)	Site 6 (<i>n</i> = 30)	Site 7 (<i>n</i> = 30)	Site 8 (<i>n</i> = 20)	Site 9 (<i>n</i> = 20)
%frequency of perennial grasses									
<i>Aristida behriana</i>	5.12 ± 1.17		1.44 ± 1.00		4.64 ± 1.96		7.47 ± 2.15	1.80 ± 1.40	0.25 ± 0.25
<i>Austrodanthonia</i> spp.	0.96 ± 0.42	2.40 ± 1.12	0.64 ± 0.64	6.08 ± 2.12	7.36 ± 2.12	6.28 ± 1.64	2.67 ± 0.91	0.80 ± 0.68	6.00 ± 2.16
Juvenile <i>Austrodanthonia</i>	0.48 ± 0.35	1.40 ± 1.20	0.16 ± 0.16	5.12 ± 2.51	1.92 ± 0.68	3.2 ± 1.04	5.20 ± 2.68	0.820 ± 0.48	1.60 ± 0.76
<i>Austrostipa blackii</i>	1.60 ± 0.65	2.00 ± 0.84	8.16 ± 2.02	0.64 ± 0.64	9.28 ± 2.60			0.80 ± 0.48	2.00 ± 0.58
<i>A. eremophila</i>		2.00 ± 0.76		4.32 ± 1.63	5.44 ± 2.16	24.12 ± 3.96	1.87 ± 0.81	4.00 ± 1.80	1.80 ± 0.58
<i>A. nitida</i>	0.80 ± 0.46		0.32 ± 0.32						
<i>A. nodosa</i>		0.20 ± 0.20				0.92 ± 0.44			
<i>A. scabra</i>					0.80 ± 0.80				
Juvenile <i>Austrostipa</i>	2.40 ± 0.92	0.20 ± 0.20	5.96 ± 1.56	4.80 ± 1.53	0.64 ± 0.38	2.24 ± 0.88	10.93 ± 2.64	0.20 ± 0.20	0.60 ± 0.44
<i>Enneapogon nigricans</i>								4.40 ± 2.28	
<i>Themeda triandra</i>							2.53 ± 1.06		0.40 ± 0.04
<i>Triodia irritans</i>			1.60 ± 1.60						
Perennial grass	1.60 ± 1.06		0.16 ± 0.16	3.84 ± 2.48	0.64 ± 0.48		0.13 ± 0.13	0.80 ± 0.48	1.60 ± 0.84
Total	13.0 ± 1.71	8.2 ± 2.2	18.3 ± 3.1	24.8 ± 3.3	30.7 ± 5.0	36.8 ± 4.8	30.8 ± 4.6	14.0 ± 3.2	15.0 ± 3.1
Aboveground biomass of annual grasses									
<i>Aira caryophyllea</i> *			4.68 ± 1.56		0.004 ± 0.004				
<i>Avena barbata</i> *	168.96 ± 13.52	21.12 ± 3.32	118.68 ± 0.68	9.04 ± 5.28	72.76 ± 11.28	58.24 ± 11.32	148.00 ± 19.68	140.44 ± 24.20	53.12 ± 8.24
<i>Brachypodium distachyon</i> *		150.04 ± 16.76		50.00 ± 8.04	1.76 ± 0.88		10.84 ± 3.00	71.84 ± 18.56	153.28 ± 15.96
<i>Bromus diandrus</i> *		0.48 ± 0.28	0.68 ± 0.04	1.96 ± 1.24	29.76 ± 11.88	5.40 ± 3.68	0.92 ± 0.52	17.28 ± 9.20	31.72 ± 9.72
<i>B. hordeaceus</i> *				0.008 ± 0.008	0.52 ± 0.32	0.16 ± 0.12	0.64 ± 0.28	0.008 ± 0.008	
<i>B. madritensis</i> *				0.004 ± 0.004			0.04 ± 0.04		
<i>B. rubens</i> *						2.32 ± 1.16	0.008 ± 0.008		
<i>Hordeum</i> sp.*						0.04 ± 0.04			
<i>H. vulgare distichon</i> *					0.12 ± 0.12				
<i>Lophochloa cristata</i> *				0.004 ± 0.004		0.012 ± 0.012		0.08 ± 0.04	
<i>Lolium</i> * spp.		0.24 ± 0.16		0.32 ± 0.12	1.16 ± 0.40	1.72 ± 1.00	0.004 ± 0.004	1.48 ± 0.92	3.52 ± 0.88
<i>Vulpia myuros</i> *	0.36 ± 0.08	0.88 ± 0.60	0.84 ± 0.60	0.20 ± 0.16	5.44 ± 2.20	2.00 ± 0.80	2.40 ± 0.60	0.76 ± 0.40	0.28 ± 0.28

Vegetative material		8.96 ± 3.12			8.56 ± 2.32	2.52 ± 0.76		14.60 ± 4.44	32.00 ± 3.24
Total	169.2 ± 13.6	181.6 ± 18.8	124.8 ± 16.0	61.6 ± 12.0	120.0 ± 14.4	72.4 ± 12.8	162.8 ± 18.8	246.4 ± 29.6	274.0 ± 21.6

Appendix 3. Spearman's ρ between the dry weight (DW, g m⁻²) of annual grasses (AGs), the %frequency of perennial grasses (PGs) and environmental factors at Sites 1, 5 and 9

$P < \alpha$, Bonferroni adjustments with 27–55 comparisons. $\alpha = 0.001$ for Site 5, Site 9 and the overall analysis. $\alpha = 0.02$ for Site 1. EC = electric conductivity. P = phosphorus and n = number of quadrats per site

	Site 1		Site 5		Site 9		All sites together	
	AGs	PGs	AGs	PGs	AGs	PGs	AGs	PGs
%frequency of perennial grasses	-0.13 ^{ns}		-0.49 ^{ns}		-0.57 ^{ns}		See Table 4	
Relative elevation	-0.06 ^{ns}	-0.14 ^{ns}	-0.50 ^{ns}	0.55 ^{ns}	-0.03 ^{ns}	-0.24 ^{ns}	See Table 4	
Soil depth (cm)	-0.12 ^{ns}	-0.04 ^{ns}	-0.09 ^{ns}	0.40 ^{ns}	0.13 ^{ns}	-0.24 ^{ns}	See Table 4	
Quadrat aspect (°)	–	–	-0.49 ^{ns}	-0.55 ^{ns}	0.54 ^{ns}	-0.23 ^{ns}	0.10 ^{ns}	< 0.01 ^{ns}
Quadrat slope (°)	–	–	-0.44 ^{ns}	-0.55 ^{ns}	0.40 ^{ns}	-0.11 ^{ns}	0.12 ^{ns}	-0.01 ^{ns}
Microtopography	–	–	0.16 ^{ns}	0.40 ^{ns}	0.23 ^{ns}	-0.28 ^{ns}	-0.02 ^{ns}	0.13 ^{ns}
Radiation (MJ cm ⁻² year ⁻¹)	–	–	-0.09 ^{ns}	0.40 ^{ns}	-0.02 ^{ns}	-0.04 ^{ns}	-0.12 ^{ns}	0.21 ^{ns}
%gravel (0–5 cm)	-0.13 ^{ns}	0.10 ^{ns}	-0.18 ^{ns}	-0.26 ^{ns}	0.28 ^{ns}	0.04 ^{ns}	-0.09 ^{ns}	0.13 ^{ns}
%gravel (15–20 cm)	-0.25 ^{ns}	0.19 ^{ns}	-0.04 ^{ns}	-0.05 ^{ns}	-0.13 ^{ns}	0.14 ^{ns}	See Table 4	
%gravel (25–30 cm)	0.21 ^{ns}	0.10 ^{ns}	-0.30 ^{ns}	-0.07 ^{ns}	-0.10 ^{ns}	0.26 ^{ns}	See Table 4	
%clay (0–5 cm)	-0.45 ^{ns}	0.15 ^{ns}	0.38 ^{ns}	-0.19 ^{ns}	0.23 ^{ns}	-0.23 ^{ns}	See Table 4	
%silt (0–5 cm)	-0.17 ^{ns}	0.42 ^{ns}	0.15 ^{ns}	0.12 ^{ns}	-0.02 ^{ns}	-0.28 ^{ns}	See Table 4	
%sand (0–5 cm)	0.41 ^{ns}	-0.36 ^{ns}	-0.33 ^{ns}	0.14 ^{ns}	-0.14 ^{ns}	0.27 ^{ns}	See Table 4	
Organic C (% of DW) (0–5 cm)	0.19 ^{ns}	-0.43 ^{ns}	0.35 ^{ns}	0.02 ^{ns}	0.34 ^{ns}	-0.16 ^{ns}	See Table 4	
Organic C (% of DW) (15–20 cm)	0.33 ^{ns}	-0.01 ^{ns}	0.39 ^{ns}	-0.18 ^{ns}	0.29 ^{ns}	-0.06 ^{ns}	See Table 4	
Organic C (% of DW) (25–30 cm)	-0.06 ^{ns}	-0.09 ^{ns}	0.49 ^{ns}	0.03 ^{ns}	0.17 ^{ns}	-0.19 ^{ns}	See Table 4	
Total N (% of DW) (0–5 cm)	0.29 ^{ns}	-0.18 ^{ns}	0.39 ^{ns}	-0.06 ^{ns}	0.38 ^{ns}	-0.28 ^{ns}	See Table 4	
Available P (ppm of DW) (0–5cm)	0.05 ^{ns}	-0.04 ^{ns}	0.49 ^{ns}	-0.20 ^{ns}	0.57 ^{ns}	-0.26 ^{ns}	0.10 ^{ns}	0.06 ^{ns}
pH (0–5 cm)	-0.08 ^{ns}	0.03 ^{ns}	-0.17 ^{ns}	-0.24 ^{ns}	0.26 ^{ns}	-0.43 ^{ns}	0.01 ^{ns}	-0.10 ^{ns}
EC (μS) (0–5 cm)	0.39 ^{ns}	0.07 ^{ns}	0.24 ^{ns}	-0.19 ^{ns}	0.59 ^{ns}	-0.29 ^{ns}	0.09 ^{ns}	-0.10 ^{ns}
Grazing prior destocking							0.02 ^{ns}	0.20 ^{ns}
Time since destocking (years)							-0.18 ^{ns}	-0.12 ^{ns}
Time since destocking (years)							0.05 ^{ns}	0.19 ^{ns}
Long-term annual rain (mm)							0.18 ^{ns}	0.13 ^{ns}
Mean rain last 1 year (mm)							0.25 ^{ns}	<0.01 ^{ns}
Mean rain last 3 years (mm)							0.26 ^{ns}	0.03 ^{ns}
Mean rain last 5 years (mm)							0.25 ^{ns}	0.07 ^{ns}
Mean rain last 10 years (mm)							0.20 ^{ns}	0.11 ^{ns}