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Supplementary Material

Climate drying reduces serotinous seedbanks and threatens persistence in two fire-killed shrubs

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Table S1. Location details, time since last fire in years (TSF) and fire type (FT: W - Wild, P - Prescribed) for all *H. decurrens* and *B. ornata* plant populations sampled in Grampians and Little Desert National Parks, SE Australia in the 1990's and 2017.

Site name	Fire year	Census year	TSF (yrs)	FT	Data type	Latitude	Longitude
***H. decurrens* – Grampians N.P.**							
Golton Track	1992	1995	3	P	Plot	-36.93163	142.43975
Heatherlie	1990	1995	5	P	Plot	-37.04017	142.50854
Golton Track	1987	1995	8	P	Plot	-36.92324	142.4354
Mt Zero	1983	1995	12	W	Plot	-36.88719	142.37419
Roses Gap	1967	1991	24	P	Plot	-36.9329	142.43460
Roses Gap	1967	1995	28	P	Plot	-36.9329	142.43460
Heatherlie	2014	2017	3	P	Random walk	-37.02069	142.4989
Heatherlie	2011	2017	6	P	Random walk	-37.04017	142.50854
Heatherlie	2007	2017	10	P	Random walk	-37.0489	142.51905
Heatherlie	2003	2017	14	P	Random walk	-37.0150	142.49651
Heatherlie	1996	2017	21	P	Plot	-37.02469	142.5031
Heatherlie	1994	2017	23	P	Plot	-37.0184	142.49999
***B. ornata* – Grampians N.P.**							
Golton Track	1987	1990	3	P	Random walk	-36.92100	142.43528
Golton Track	1987	1992	5	P	Random walk	-36.92100	142.43528
Heatherlie	1990	1996	6	P	Random walk	-37.04017	142.50854
Golton Track	1987	1996	9	P	Random walk	-36.9210	142.43528
Mt Zero	1983	1996	13	P	Plot	-36.88900	142.37245
Roses Gap	1967	1992	25	P	Random walk	-36.93263	142.43476
Roses Gap	~1946	1996	50	-	Random walk	-36.96033	142.45854
Hollow Mntn	2014	2017	3	W	Plot	-36.88687	142.38306
Heatherlie	2011	2017	6	P	Random walk	-37.04017	142.50854
Heatherlie	2003	2017	14	P	Random walk	-37.0150	142.49651
MtZero	1996	2017	21	P	Plot	-36.88856	142.3737
Heatherlie	1996	2017	21	P	Random walk	-37.02469	142.5031
Mt Zero	1983	2017	34	W	Plot	-36.88783	142.37279
***B. ornata* – Little Desert N.P.**							
Matthews Trck	1993	1997	4	P	Random walk	-36.51720	141.79749
Centre Track	1991	1997	6	P	Random walk	-36.52409	141.81363
McDonald Hwy	1988	1997	9	P	Random walk	-36.58292	141.49052
Salt Lake Track	1983	1997	14	W	Random walk	-36.49691	141.79440
Albrechts Mill Track	~1960	1997	37	P	Random walk	-36.48058	141.81255
Salt Lake Track	2009	2017	8	P	Random walk	-36.48421	141.79202
Salt Lake Track	2008	2017	9	P	Random walk	-36.46902	141.79563
Nhil-Harrow Rd South	2007	2017	10	P	Plot	-36.60711	141.6491
Nhil-Harrow Rd East	2005	2017	12*	W	Random walk	-36.53871	141.65090
Mars Track	2003	2017	14	P	Plot	-36.58442	141.65749
Nhil-Harrow Rd West	1991	2017	24*	W	Plot	-36.53816	141.64684
Pomponderoo Hill Rd	1977	2017	40	P	Random walk	-36.49649	142.00349

* These sites burned in a 2015 wildfire and cone counts were done on standing dead skeletons 12 and 24 years old at the time of fire.

Table S2. Mean plant height (cm) ± standard error for (a) *Hakea decurrens* and (b) *Banksia ornata* sample populations in relation to time since fire in years (TSF), period of measurement (1990's vs 2017). and location (Grampians vs Little Desert; *B. ornata* only, rows aligned to facilitate easier comparison by TSF).

(a) *Hakea decurrens*

Grampians N.P.			
1990's		**2017**	
TSF	**Height**	**TSF**	**Height**
3	67 ± 4	3	94 ± 4
5	83 ± 3	6	96 ± 4
8	115 ± 4	10	173 ± 5
12	156 ± 5	14	135 ± 7
24	184 ± 5	21	157 ± 5
28	211 ± 7	23	235 ± 10

(b) *Banksia ornata*

Grampians N.P.					**Little Desert N.P.**					
1990's		**2017**			**1983**[1]		**1990's**[2]		**2017**	
TSF	**Height**	**TSF**	**Height**		**TSF**	**Height**	**TSF**	**Height**	**TSF**	**Height**
		3	59 ± 2				4	28 ± 2		
7	126 ± 4	6	72 ± 5		6	51	6	64 ± 2	8	99 ± 3
					7	51	9	67 ± 3	9	76 ± 2
10	137 ± 4				11	87			10	89 ± 3
13	207 ± 3	14	145 ± 6		16	89	14	94 ± 2	13	65 ± 3
14	196 ± 5	21	159 ± 8						13	101 ± 3
		21	254 ± 8		25	120			26	111 ± 5
		34	249 ± 12		38	154	37	127 ± 4	40	141 ± 4
50	217 ± 13				50	168				

1. Data from Gill & McMahon (1986), no error terms available
2. Data from Shaw (1997)

Table S3. Demographic and climate data for *Banksia ornata* sample populations by time since last fire (TSF), Little Desert National Park, SE Australia (demographic data from Gill and McMahon 1986). Mean rain differential is the difference in mm yr^{-1} (percentage in parentheses) from the mean annual rainfall at Nhil, Victoria for the period 1946 – 1990.

TSF (years)	n	Total cones $plant^{-1}$	Estimated viable seeds $plant^{-1}$	Mean rainfall differential mm yr^{-1} (%)
6	30	0.23	3	-6.7 (-1.5)
7	30	0.03	<1	-25.2 (-5.6)
11	30	3.57	42	12.1 (2.7)
16	30	7.26	98	0.3 (0.1)
25	30	13.00	160	-9.7 (-2.2)
38	30	121.36	2589	14.6 (3.2)
50+	30	122.23	1804	3.0 (0.7)

Table S4. Number of seedlings 2 years after fire in a 24 year-old *B. ornata* stand in Little Desert National Park in relation to number of pre-fire parents, estimated number of seeds per pre-fire parent, seeds per seedling and seedlings per pre-fire parent (Nhil – Harrow Road West site censused in 2017; see Table S1 for full site details). Data are for 8 x 16m^2 replicate quadrats, error term is standard error.

Replicate	**No. of Parent plants**	**Estimated Seeds plant^{-1}**	**No. of Seedlings**	**Seeds seedling^{-1}**	**Seedlings parent^{-1}**
1	4	444.6	42	42.3	10.5
2	4	370.5	47	31.5	11.8
3	2	912.6	18	101.4	9.0
4	7	639.6	37	121.0	5.3
5	8	347.1	41	67.7	5.1
6	5	290.2	29	50.0	5.8
7	2	499.2	37	27.0	18.5
8	3	405.6	49	24.8	16.3
Mean	**4.4±0.8**	**488.7±71.3**	**37.5±3.6**	**58.2±12.7**	**10.3±1.8**

Table S5. Model outputs for probability of reproductive maturity and total fruits/cones by species.

Hakea decurrens

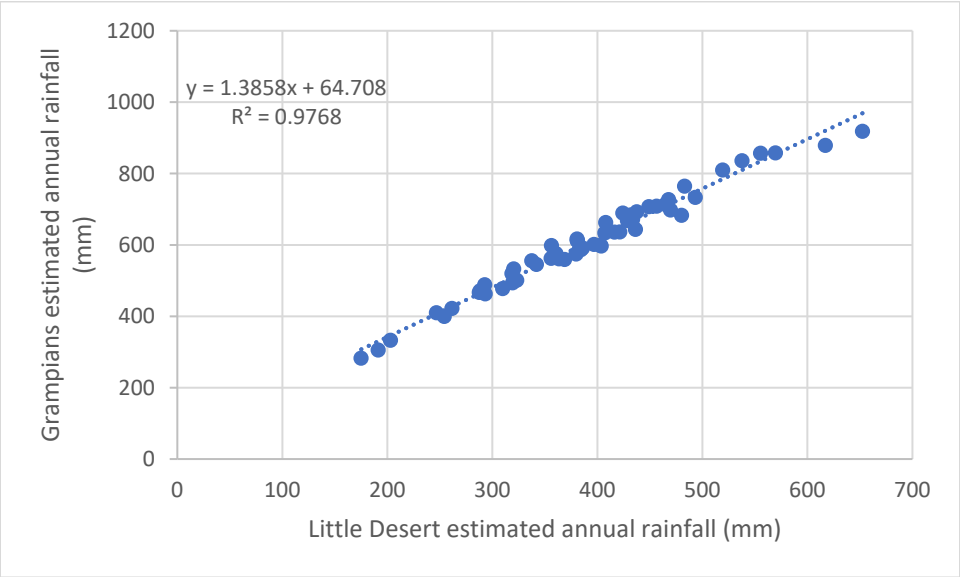
	Probability of reproductive maturity				Total fruits			
Predictor	β	SE	*P*		β	SE	*P*	
Stand age	2.959	0.474	<0.0001	**	1.728	0.126	<0.0001	**
Measurement era (2017)	-2.142	0.250	<0.0001	**	-2.063	0.107	<0.0001	**
Stand age:Measurement era (2017)	-0.130	0.558	0.8160		1.486	0.230	<0.0001	**
Stand age	3.048	0.288	<0.0001	**	2.478	0.118	<0.0001	**
Mean rain differential	0.880	0.554	0.1123		1.477	0.395	0.0002	**
Stand age:Mean rain differential	.	.	.		-1.610	0.276	<0.0001	**

Banksia ornata

	Probability of reproductive maturity				Total cones			
Predictor	β	SE	*P*		β	SE	*P*	
Stand age	17.851	5.396	<0.0001	**	1.282	0.291	<0.0001	**
Measurement era (2017)	-8.267	3.475	0.0174	*	-1.138	0.361	0.0016	**
Stand age:Measurement era (2017)	.	.	.		0.622	0.644	0.3343	
Stand age	16.359	3.352	<0.0001	**	1.297	0.237	<0.0001	**
Mean rain differential	13.544	3.380	<0.0001	**	1.117	0.306	0.0003	**
Stand age:Mean rain differential	25.979	7.968	0.0011	**	.	.	.	

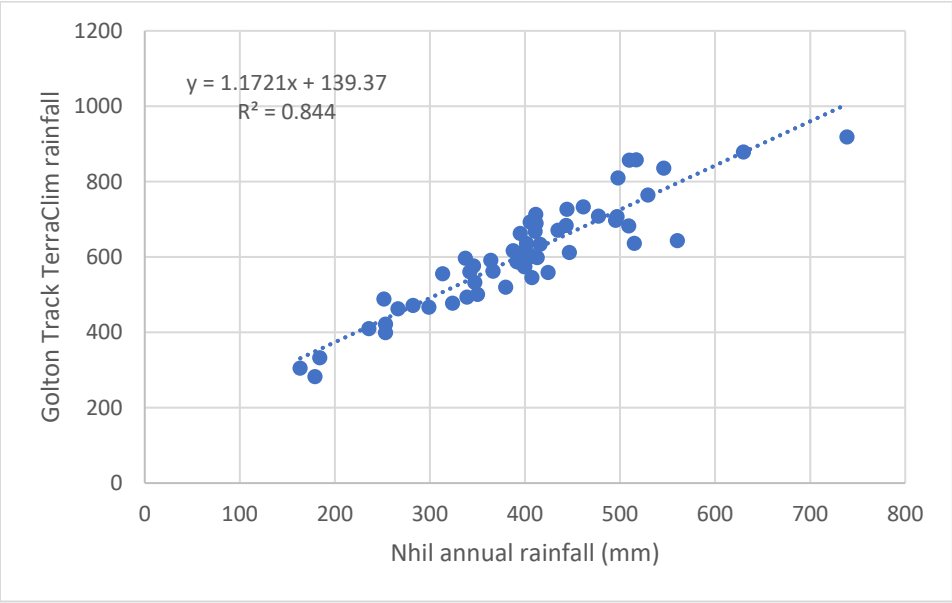
Notes: Standardized coefficient estimates (β), standard error (SE), and *P* values are reported for each predictor variable. Symbols indicate strength of evidence of an effect according to $P < \alpha = 0.01^{**}$ (strong), 0.05^{*} (moderate), 0.1^{+} (suggestive).

Supplementary Figure 1. Correlation between TerraClimate[1] estimated annual rainfall for sites in the Grampians National Park (Golton Track) and Little Desert National Park (Eastern block) for the period 1960 - 2016.



[1] Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data.

Supplementary Figure 2. Linear regression relationship between Nhil climate station annual rainfall and that for TerraClimate[1] estimated rainfall at Golton Track, Grampians N. P. for the period 1960 - 2016.



[1] Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data.