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Supplementary Materials

The more the merrier: using environmental flows to improve floodplain vegetation condition

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Supplementary Material

Table S1. Inundation depth recorded for each site for each survey and estimated duration of inundation from both environmental water and flooding in 2016-17. Environmental watering commenced in early September 2016 and overbank flooding occurred in early to mid-November 2016. Duration of inundation was estimated from both site notes and with reference to Sentinal imagery. Key: numeric value = approximate depth at time of survey (in centimetres) × = not inundated; waterlogged = site was boggy, but not inundated to a recordable depth; NA = site not surveyed; (%)* indicates the approximate proportion of the site that was inundated (where inundation was less than 100%). ^Site C_A retained some water until the end of September 2017.

Site	(Jun16)	(Oct16)	(Nov 16)	(Jan17)	(Feb17)	(Mar17)	Estimated duration of inundation
C_A	×	×	150 cm	30 cm	30 cm (75%)*	20 cm (50%)*	~10 months^
C_B	×	×	70 cm	×	×	×	~1 month
C_C	×	×	200 cm	×	×	×	~1 month
F0_A	×	100 cm	200 cm	20 cm	×	×	~5 months
F0_B	×	10 cm (40%)*	130 cm	×	×	×	~4 months
F0_C	×	30 cm	170 cm	×	×	×	~4 months
F1_A	×	30 cm	190 cm	×	×	×	~4 months
F1_B	×	70 cm	200 cm	×	×	×	~4 months
F1_C	×	70 cm	200 cm	×	×	×	~4 months
F2_A	×	40 cm	170 cm	waterlogged	×	×	~4.5 months
F2_B	×	40 cm	220 cm	×	×	×	~4.5 months
F2_C	NA	50 cm	170 cm	×	×	×	~4.5 months

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Table S2. The Lignum Condition Index (LCI) is comprised of visually assessed viability and colour scores used to assess the health of mature lignum plants.

The overall index is obtained by adding together the viability and colour scores to provide an LCI score on a scale of 0 to 11. Adapted from Scholz et al. (2007).

% viable	score	colour	score
> 95	6		
75 ≤ 95	5	all green	5
50 ≤ 75	4	mainly green	4
25 ≤ 50	3	half green, half yellow/brown	3
5 ≤ 25	2	mainly yellow/brown	2
0 ≤ 5	1	all yellow/brown	1
0	0	no viable stems	0

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Table S3. Condition categories for LCI combined scores. Condition categories include the authors application of condition as well as the alignment of condition definitions for lignum from Overton et al. (2014).

Key: *The category zero relates to lignum plants that were observed to have no viable above-ground biomass. These plants were presumed to be either dead, or dormant and persisting as viable underground rootstock.

LCI score (viability + colour)	Condition category (authors application)	Definition of condition aligned with LCI scores (Overton et al., 2014)	
0	zero*/critical	Critical	Stems reduced to brittle twigs, dull brown-greyish. Rootstock assumed to be non-viable after 11 years with no flooding
1 to 3	poor	Poor	Appearance is drab. Stems (branches) are brown, dead, and dried out, becoming brittle, possibly broken down if stock present.
4 to 6	moderate	Medium	Appearance is not vigorous. Does not have leaves, or recent growth, or flowers. Stems (branches) may look dull, greenish to grey, even brown, either still flexible or stiff, but not brittle.
7 to 9	good		
10 to 11	very good	Good	Appearance is vigorous. Has recent growth, may still have leaves (temporary) and has had abundant flowering. May show recent vegetative (clonal) expansion. Stems (branches) green.

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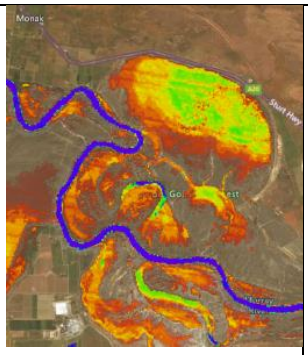
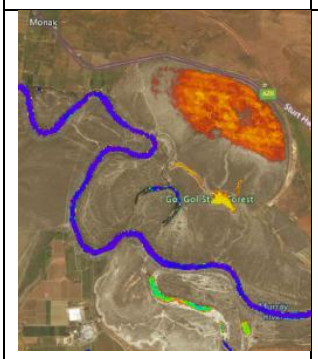
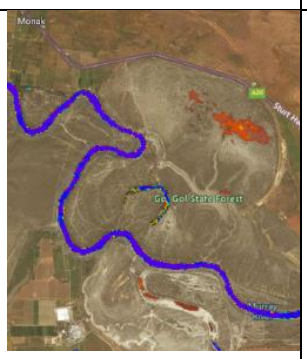
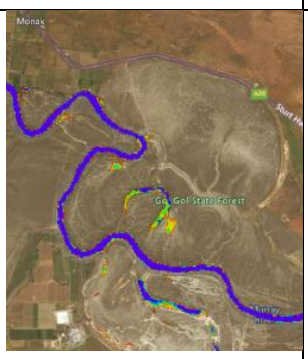
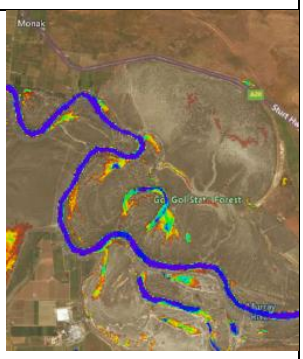
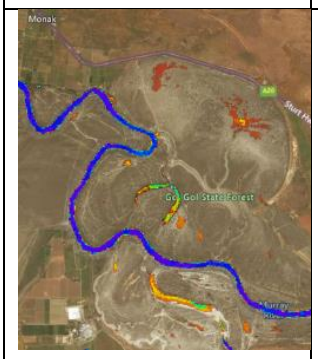
Table S4. The number of lignum plants surveyed at each site and each survey

	Sites												
Surveys	F0_A	F0_B	F0_C	F1_A	F1_B	F1_C	F2_A	F2_B	F2_C	C_A	C_B	C_C	Total lignum plants
Jun16	123	50	106	36	11	26	70	58		116	99	117	812
Oct16	74	53	68	22	11	32	50	48	77	129	96	174	834
Jan17	188	64	140	72	19	40	83	110	191	136	129	206	1378
Feb17	147	51	109	42	17	36	66	90	161	80	86	134	1019
Mar17	135	47	98	40	22	31	74	63	126	94	105	148	983
Total lignum plants	667	265	521	212	80	165	343	369	555	555	515	779	5026
Average density / quadrat	133.4	53	104.2	42.4	16	33	68.6	73.8	111	111	103	155.8	

Table S5: **Summary of the results of the random effects logistic regression model. The response variable was the number of alive plants and the total number of plants at each site during each survey as a binomial response.**

The fixed effects were variables classifying each site by flow treatment and each survey as before or after the environmental flow, plus the interaction between these two factors, with the control treatment before the environmental flow set as the reference class (intercept). Variables coding for both site, survey and an overdispersion term were included as random effects in the model.

Fixed effects	**Estimate**	**Standard error**	***P*-value**
Intercept	-1.30	0.38	
Before Flow0	-1.12	0.53	0.033
Before Flow1	-0.26	0.58	0.654
Before Flow2	1.34	0.65	0.037
After Control	-0.687	0.23	0.003
After Flow0	0.73	0.32	0.021
After Flow1	0.68	0.4	0.094
After Flow2	0.50	0.51	0.325
Random effects	Standard deviation		
Site	0.544		
Survey	0.046		
Overdispersion	0.261		

			
2018	2017	2016 Flood and e-flow	2015
			
2014 e-flow	2013 e-flow	2012	2011*
			
2010*	2009	2008	2007
			
2006	2005	2004	2003

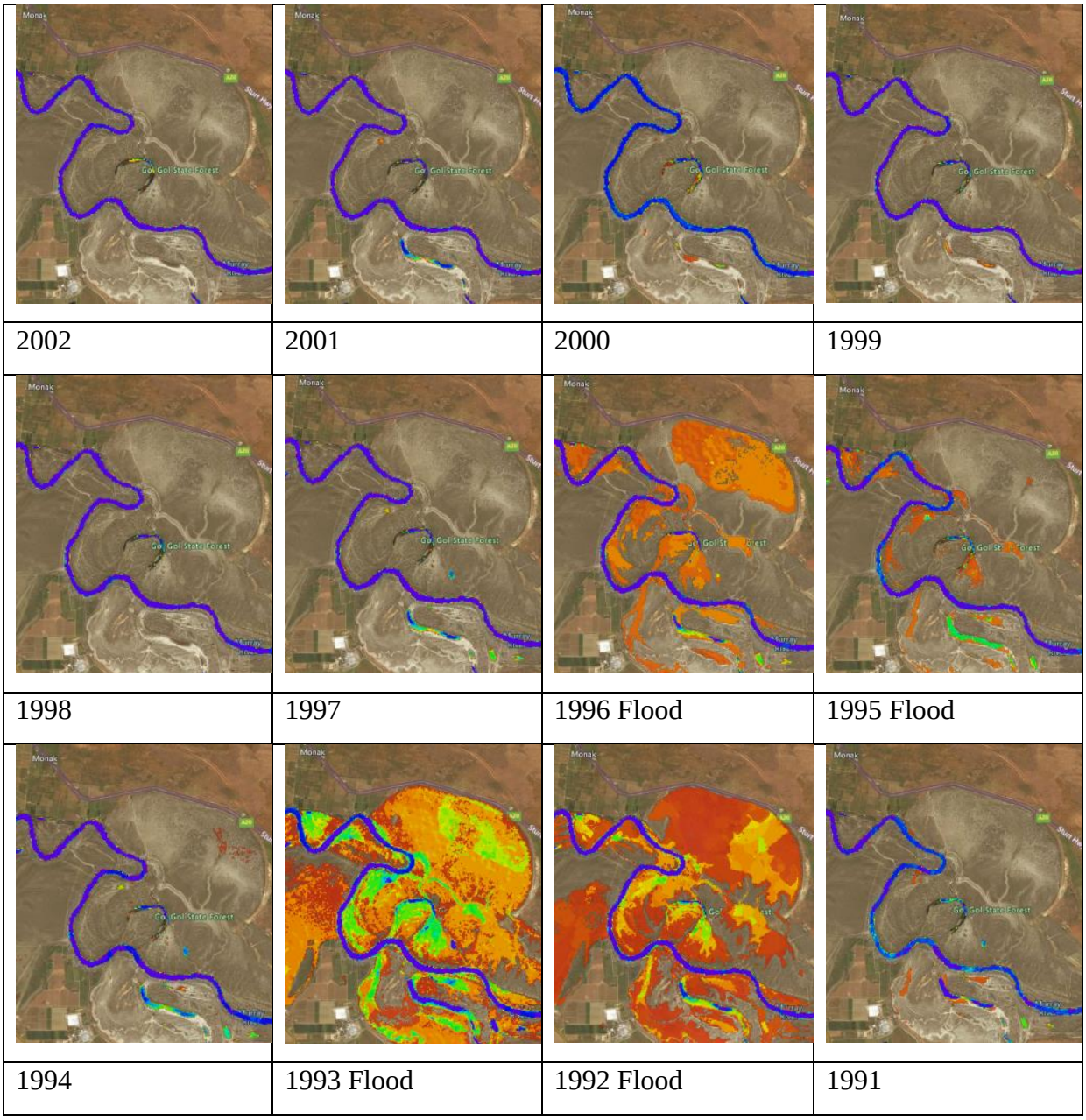


Figure S1. Annual inundation extents at Bottle Bend Reserve, Gol Gol State Forest, NSW, 1991 to 2018 (GEOSCIENCEAUSTRALIA, 2018)(data from Digital Earth Australia Map, GeoScience Australia 2018, accessed 20/04/2020). Years of overbank flooding and / environmental flows (e-flows) are indicated. * water observations from 2010 and 2011 are likely the result of very substantial rainfall events: +40mm on two occasions in late 2010 and ~190mm in two days in early 2011.

Figure S2. Control site C_A which was partially dry (foreground) and partially wet (background) during the last survey in March 2017. This site retained water for a prolonged period and appears to be located on the edge of a slow draining clay pan / wetland area (far background).

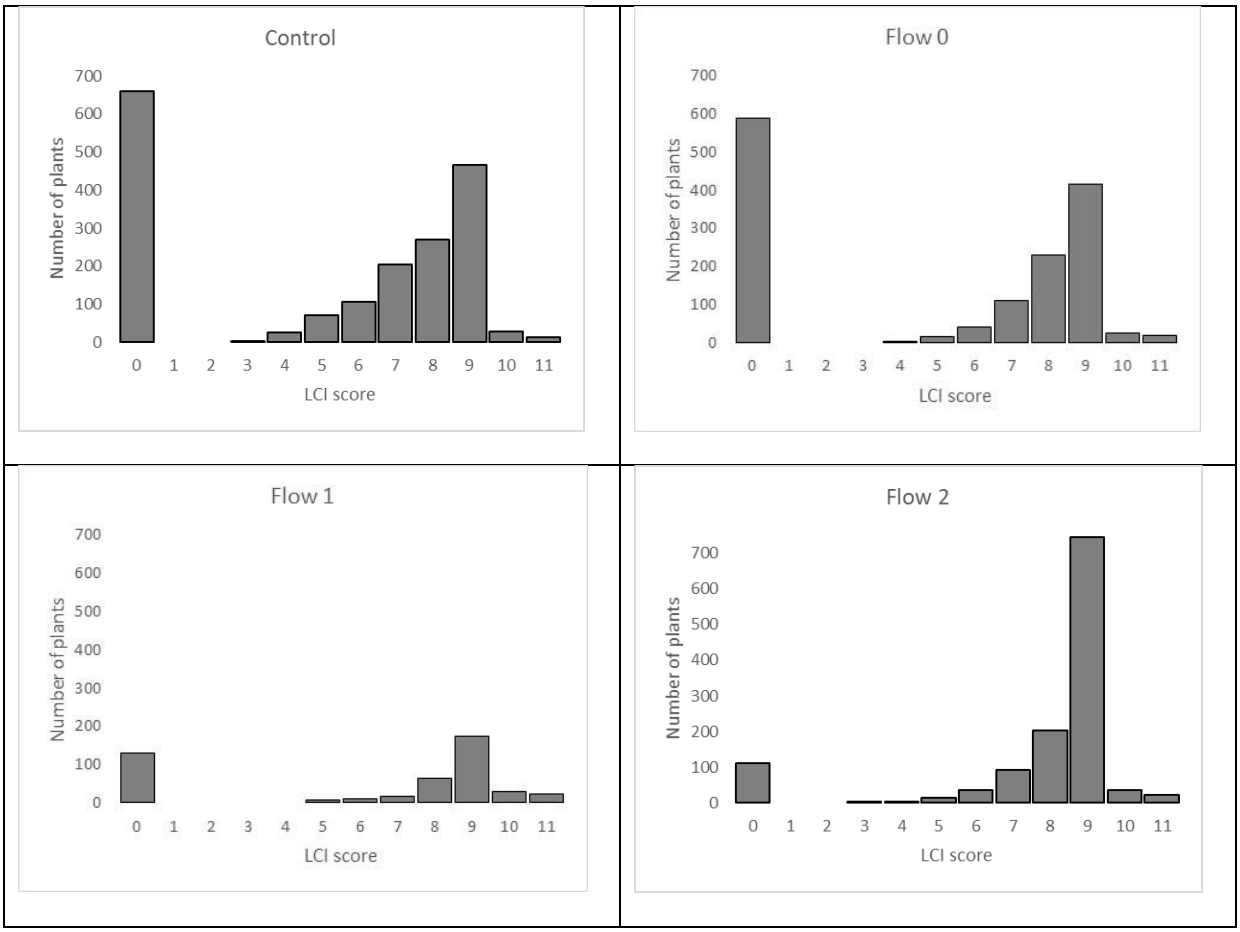


Figure S3. Distribution of lignum condition index (LCI) scores across all survey times within one of four flow categories representing recent environmental flow treatments (the panels; control = control sites, flow 0 = sites that received no environmental flows prior to September 2016, flow 1 = sites that received one previous environmental flow in 2014, flow 2 = sites that received two previous environmental flows in 2013 and 2014).

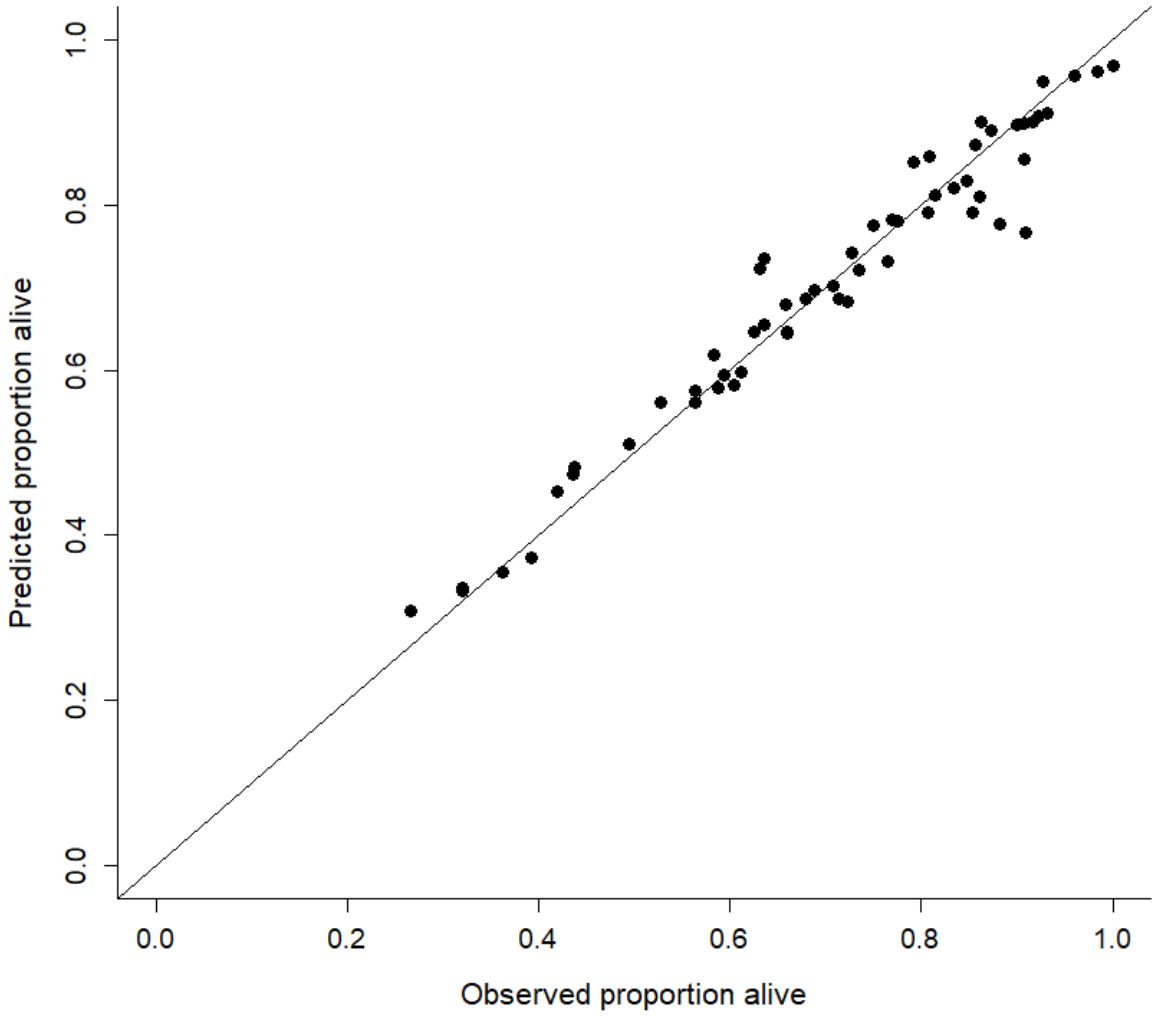


Figure S4. The proportion of lignum plants alive as predicted by the logistic regression model plotted against the observed number alive with the diagonal one-to-one line (n = 59 site by time survey points). The points fall approximately along the one-to-one line suggesting the model provides a reasonable fit to the data with no evidence of bias.

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