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Supplementary Materials for

Glucocorticoid exposure predicts survival in female baboons

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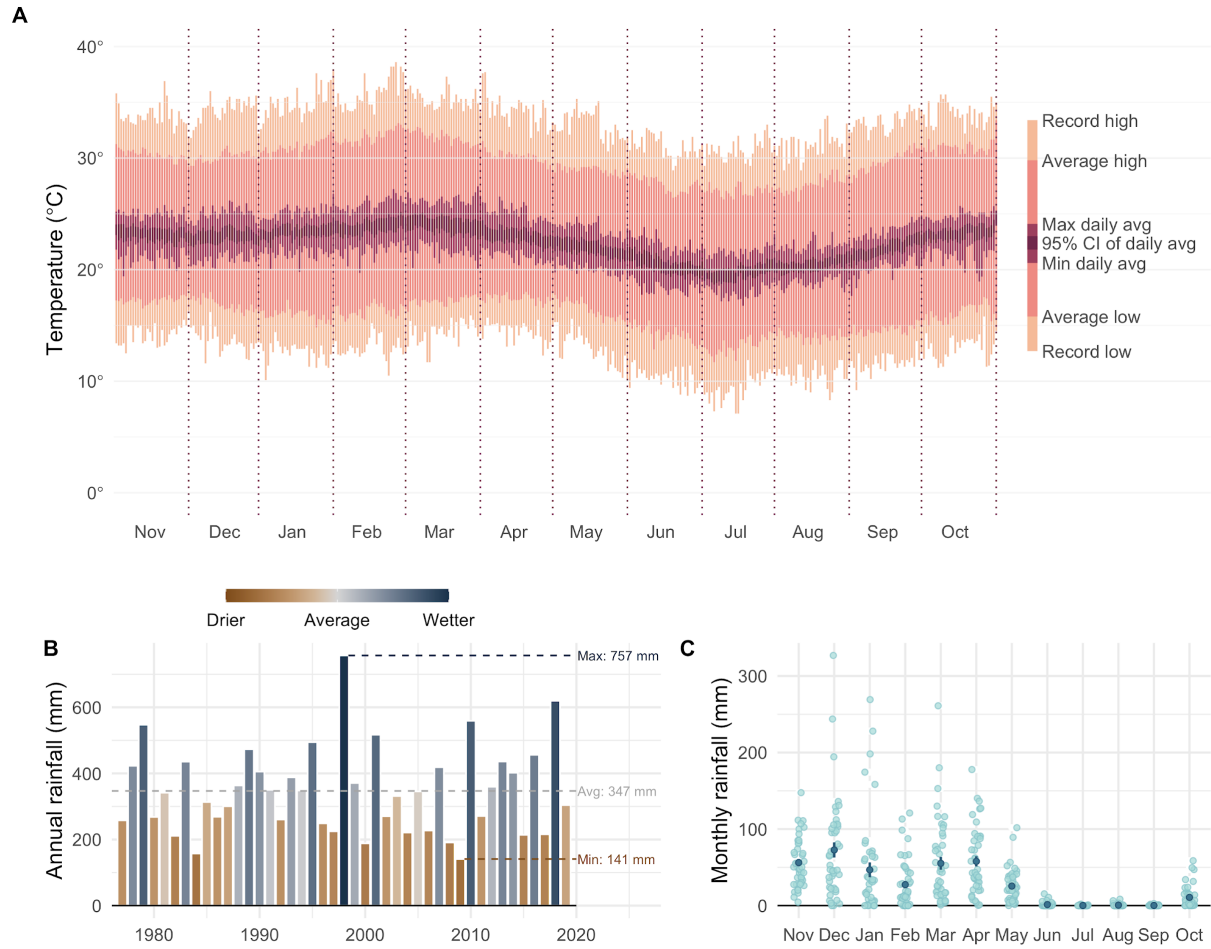


Fig. S1. Climate patterns in the Amboseli basin, Kenya, during hydrological years (Nov – Oct). (A) Annual cycle of ambient air temperatures measured at 1-hr intervals from 2003 to 2019, summarized for each day of the year, using a Weatherhawk Weather Station. (B) Total annual rainfall from 1976 to 2019 using a standard rain gauge. (C) Total monthly rainfall (light dots), with means and standard errors (dark dots/lines) from 1976 to 2019 using a standard rain gauge.

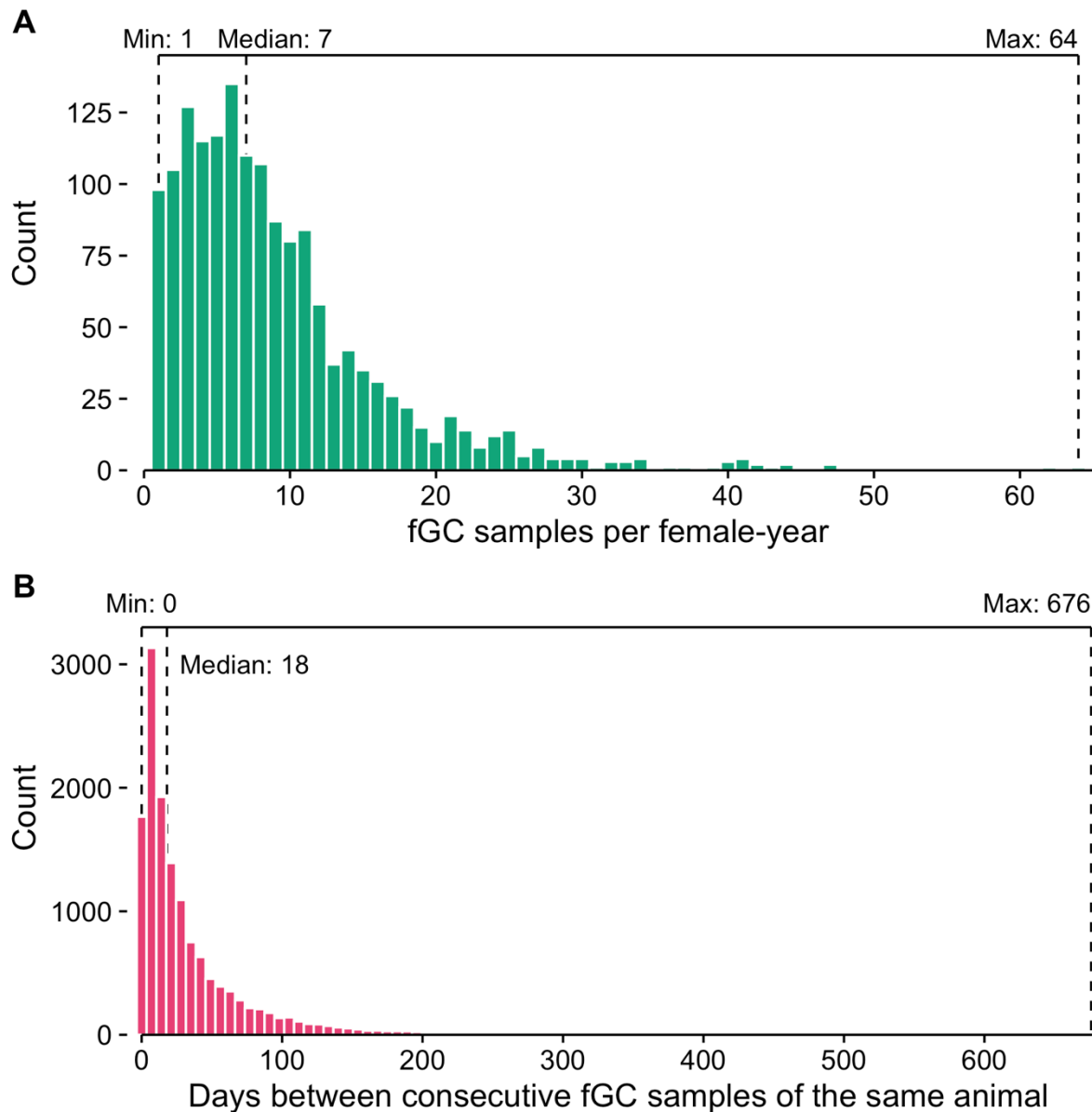


Fig. S2. Distributions and descriptive statistics of sampling of adult female baboon fGC concentrations (N = 14173). (A) The number of fGC samples represented in each female life-year (N = 1634) ranged from 1 to 64, with a median of 7 fGC samples per female per life-year. (B) The number of days between consecutive samples from the same animal ranged from 0 to 676 days, with a median of 18 days. Approximately 98% of time gaps between consecutive samples were smaller than 6 months. Each bar in the histogram represents 7 days.

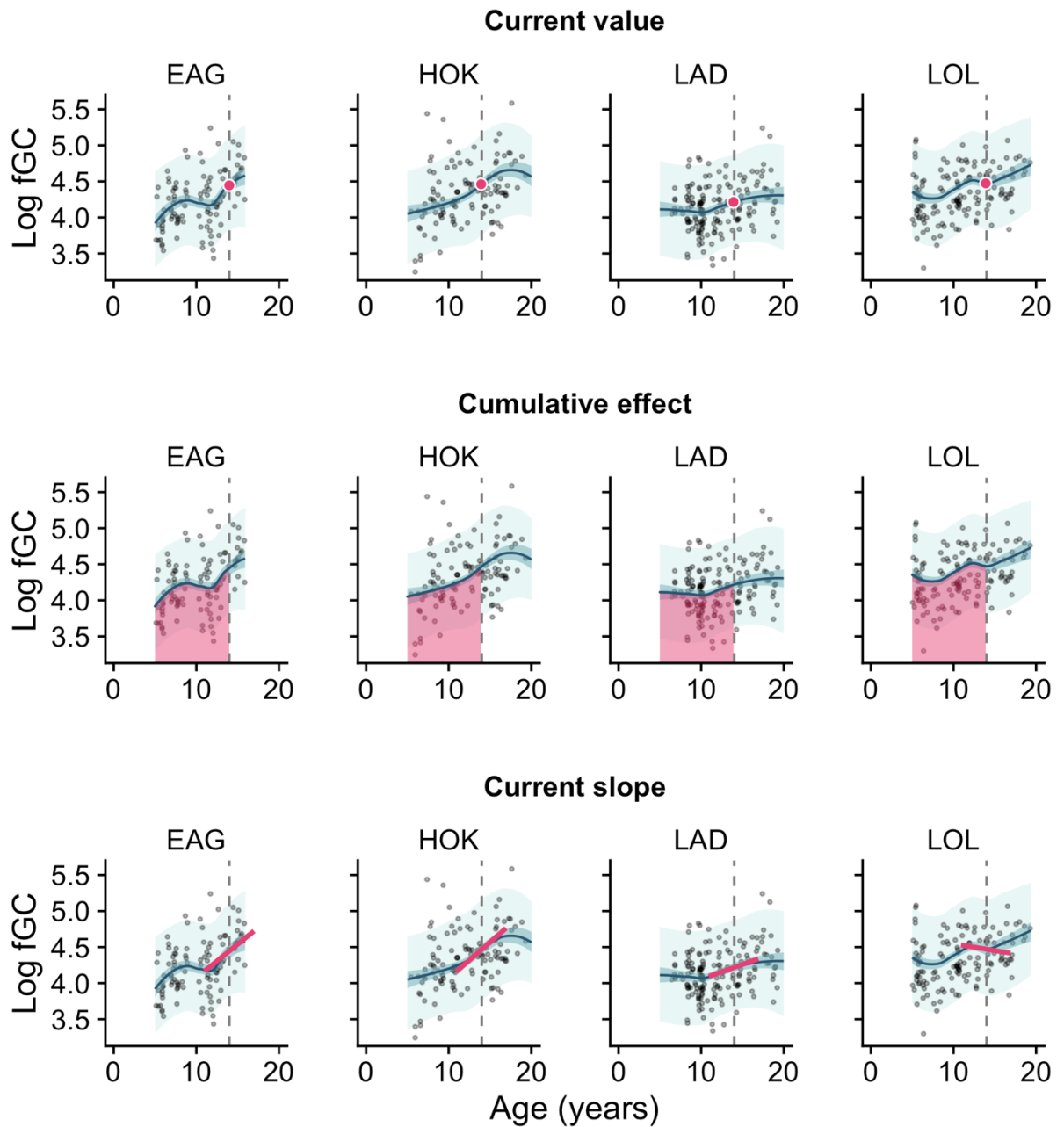


Fig. S3. Examples illustrating the cumulative effect, current value, and current slope association structures used in the joint models of longitudinal fGC and survival in four adult female baboons. The points show measured fGC sample values, the teal line is the modeled longitudinal fGC profile, and the shaded regions represent 90% credible intervals (inner) of the mean and 90% prediction intervals (outer) of the raw fGC values. The vertical dashed line represents a time point at which some aspect of the fGC profile, shown in red, is associated with the value of the mortality hazard.

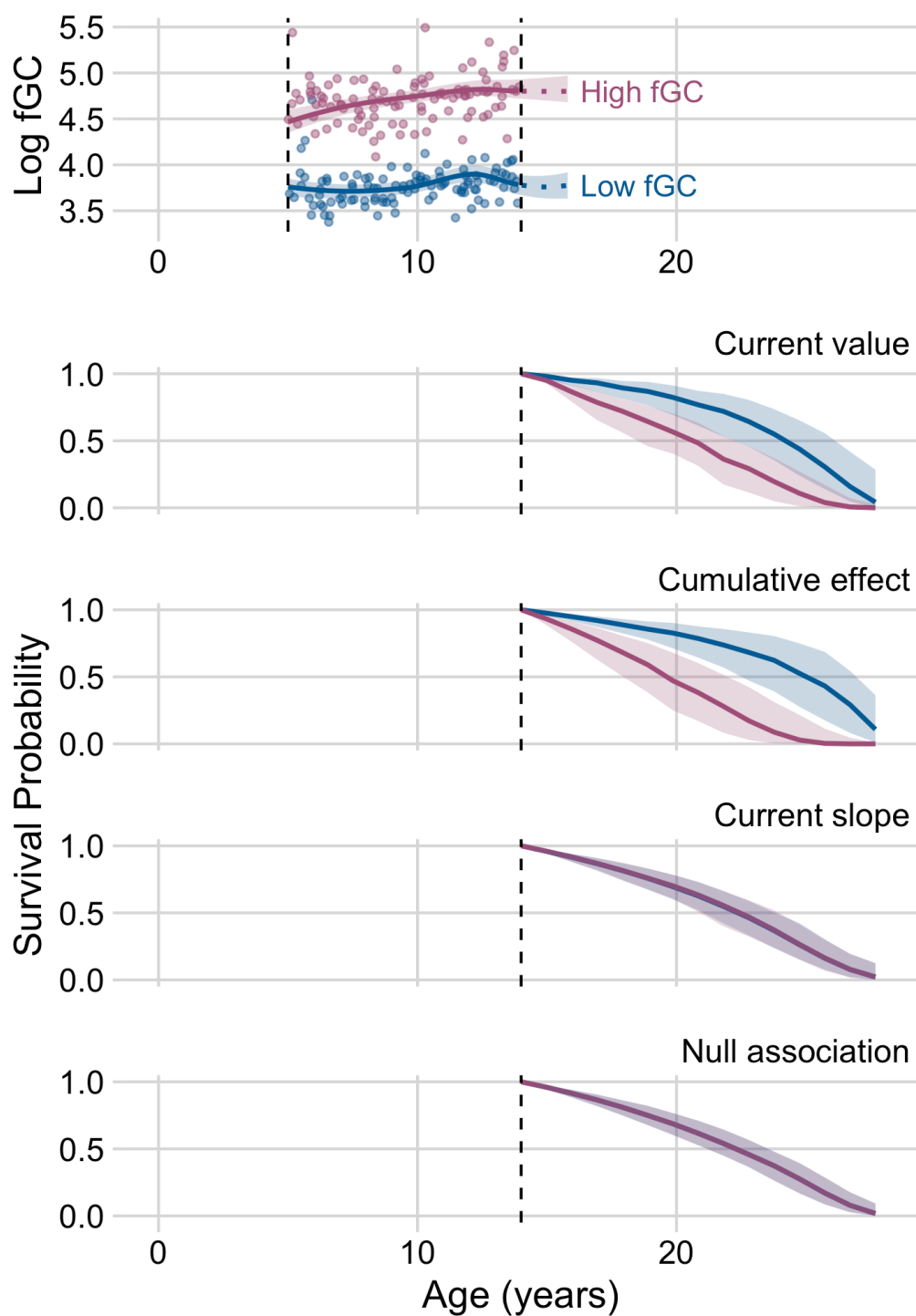
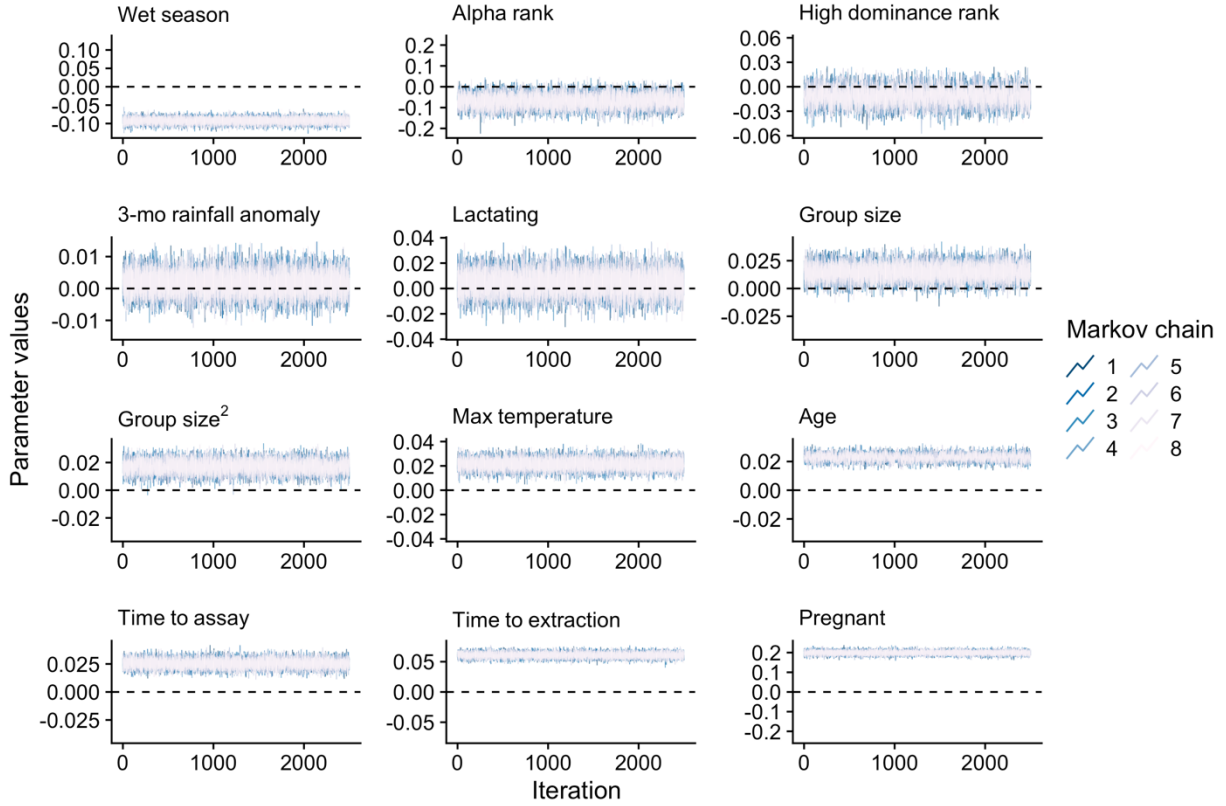


Fig. S4. Comparison of dynamic predictions of survival from joint models with different association structures for simulated high-GC and log-GC individuals. The elements of the plot are as described in Fig. 3, which shows only the “current value” and “cumulative effect” models.

fGC submodel



Survival submodel

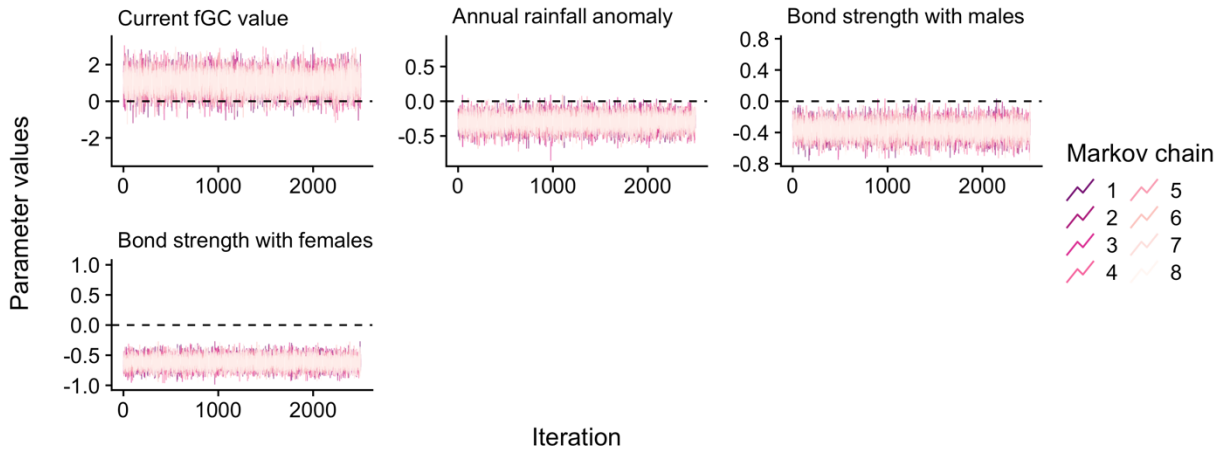
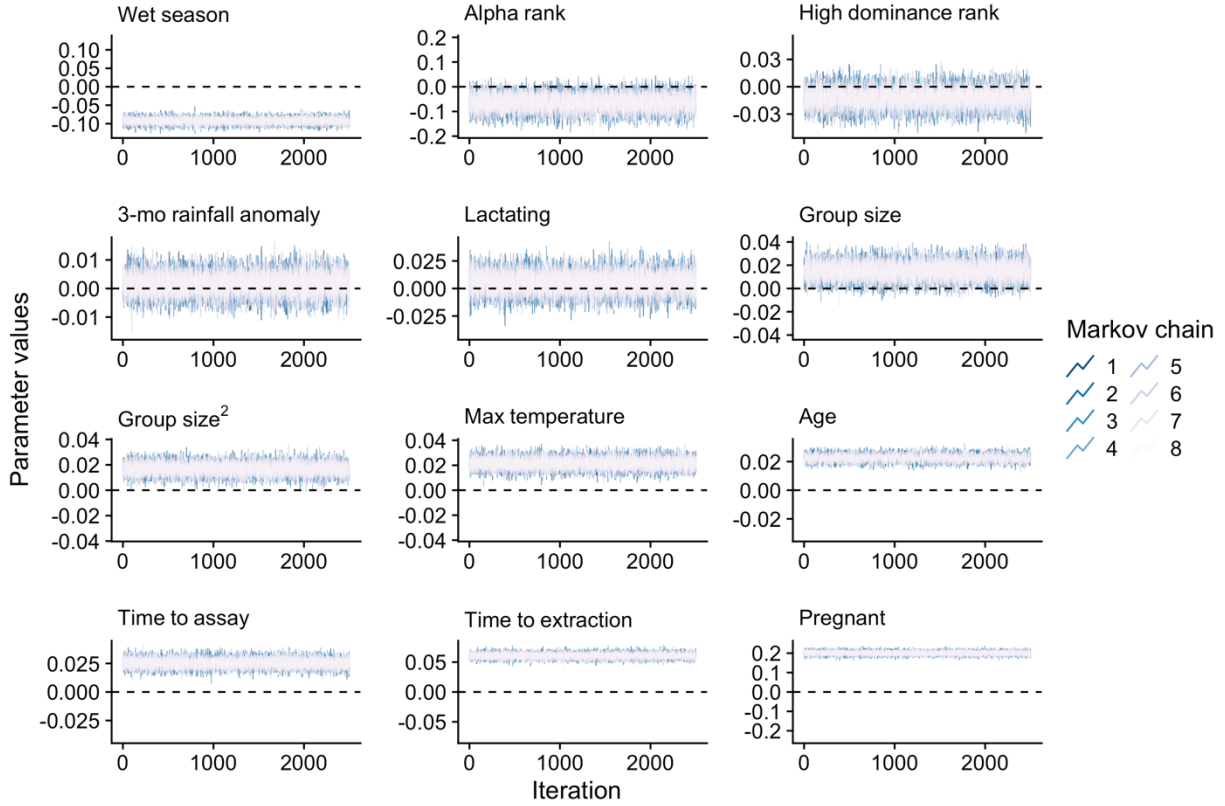


Fig. S5. MCMC diagnostic traces of the parameter estimates in the current value joint model of fGC and survival. The eight Markov chains showed good convergence to the same posterior distributions for each parameter in both the fGC and survival submodels. The dashed horizontal lines show the priors. Note the differently scaled y-axes in each panel.

fGC submodel



Survival submodel

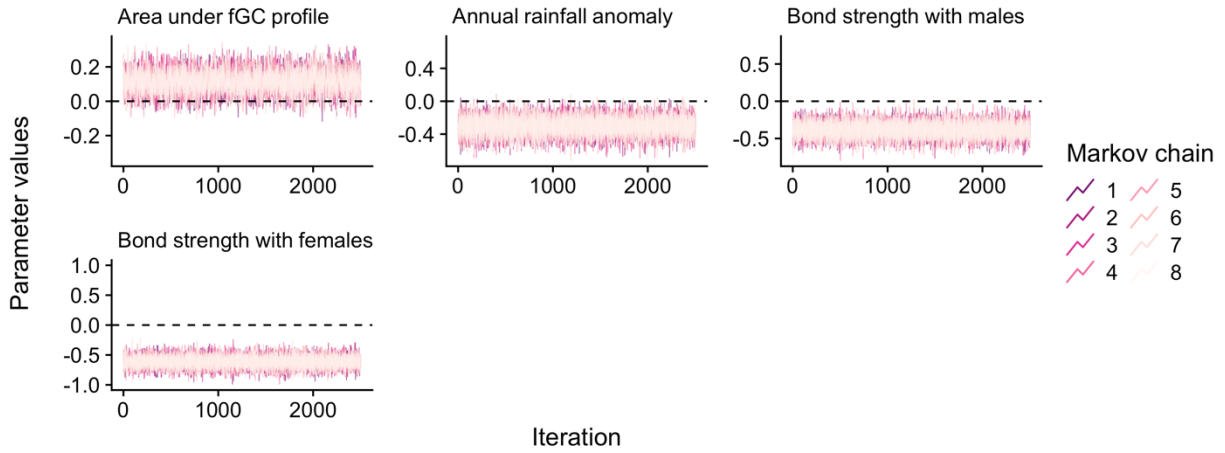
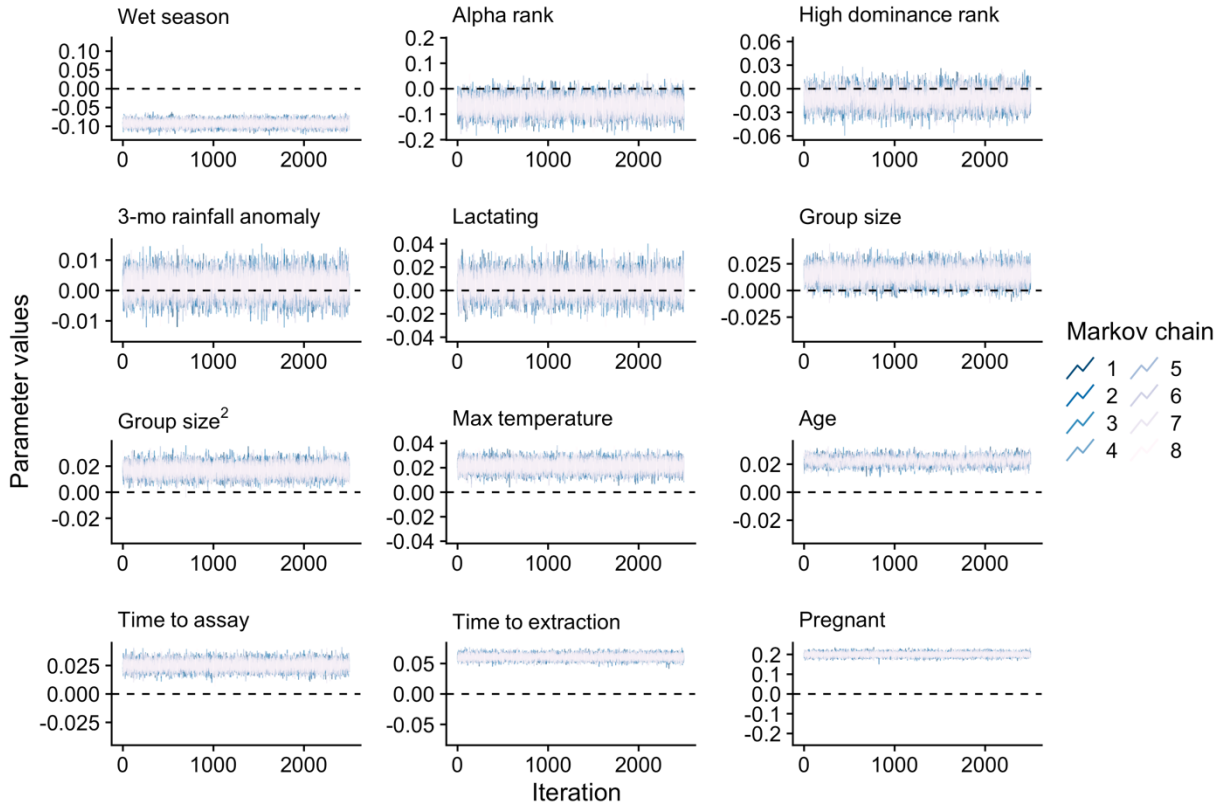


Fig. S6. MCMC diagnostic traces of the parameter estimates in the cumulative effect joint model of fGC and survival. The eight Markov chains showed good convergence to the same posterior distributions for each parameter in both the fGC and survival submodels. The dashed horizontal lines show the priors. Note the differently scaled y-axes in each panel.

fGC submodel



Survival submodel

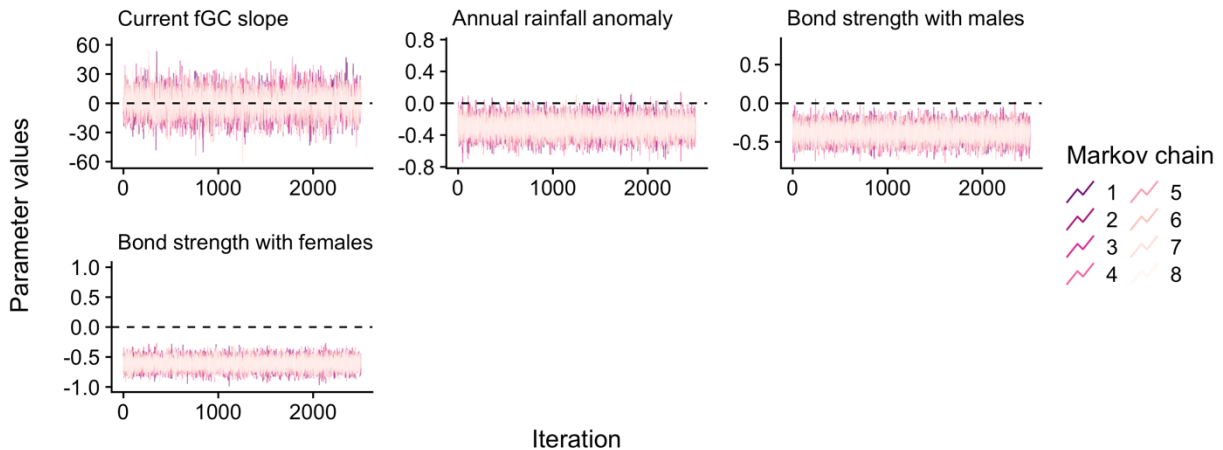


Fig. S7. MCMC diagnostic traces of the parameter estimates in the current slope joint model of fGC and survival. Although the eight Markov chains for most parameters converged to the same posterior distributions in both the fGC and survival submodels, the traces for the current fGC slope parameter in the survival submodel showed large variance centered on zero, indicating the parameter was not useful for predicting adult female survival. The dashed horizontal lines show the priors. Note the differently scaled y-axes in each panel.

Table S1. Summary and diagnostics of current value joint model of longitudinal fGC and survival.

Submodel	Parameter	Mean	Std. Error	90% CI	N_{eff}	\hat{R}
fGC	Lactating	0.0044	0.009	[-0.0105, 0.0191]	20272	1.0000
	Pregnant	0.1989	0.0099	[0.1829, 0.2151]	21337	1.0000
	Wet season	-0.0925	0.0084	[-0.1063, -0.0786]	26676	0.9999
	Group size	0.0147	0.0072	[0.003, 0.0266]	10621	1.0007
	Group size ²	0.017	0.0046	[0.0095, 0.0246]	13446	1.0001
	Alpha rank	-0.0687	0.0317	[-0.121, -0.0161]	9960	1.0004
	High dominance rank	-0.0115	0.0105	[-0.029, 0.0055]	6402	1.0008
	Max temperature	0.0214	0.0044	[0.0143, 0.0287]	25426	0.9999
	3-mo rainfall anomaly	0.0016	0.0036	[-0.0043, 0.0076]	33482	1.0001
	Time to extraction	0.0608	0.0044	[0.0536, 0.0681]	17311	1.0002
	Time to assay	0.0254	0.004	[0.0188, 0.032]	22549	1.0001
	Age	0.0229	0.0026	[0.0187, 0.0271]	3313	1.0017
Survival	Bond strength with females	-0.6162	0.0978	[-0.7763, -0.453]	32710	0.9998
	Bond strength with males	-0.3639	0.104	[-0.5334, -0.1924]	34379	0.9998
	Annual rainfall anomaly	-0.2981	0.1079	[-0.4793, -0.1221]	34701	0.9999
Association	Current fGC value	1.0408	0.5616	[0.1196, 1.9637]	19750	1.0001

Table S2. Summary and diagnostics of cumulative effect joint model of longitudinal fGC and survival.

Submodel	Parameter	Mean	Std. Error	90% CI	N_{eff}	\hat{R}
fGC	Lactating	0.0053	0.0089	[-0.0094, 0.0198]	25156	0.9999
	Pregnant	0.2002	0.0097	[0.1842, 0.2163]	27685	0.9999
	Wet season	-0.0926	0.0084	[-0.1063, -0.0786]	34175	0.9998
	Group size	0.015	0.0071	[0.0033, 0.0267]	13647	1.0002
	Group size ²	0.0169	0.0046	[0.0094, 0.0245]	16593	1.0001
	Alpha rank	-0.0652	0.0316	[-0.1171, -0.0133]	14179	1.0001
	High dominance rank	-0.0121	0.0104	[-0.0293, 0.005]	9086	1.0006
	Max temperature	0.0215	0.0043	[0.0144, 0.0286]	30381	0.9998
	3-mo rainfall anomaly	0.0016	0.0037	[-0.0044, 0.0077]	41076	0.9998
	Time to extraction	0.0607	0.0044	[0.0534, 0.068]	23130	0.9999
	Time to assay	0.0254	0.004	[0.0189, 0.0321]	29368	0.9998
	Age	0.0226	0.0025	[0.0184, 0.0267]	4158	1.0011
Survival	Bond strength with females	-0.6146	0.0969	[-0.7743, -0.4544]	42151	0.9998
	Bond strength with males	-0.3859	0.1029	[-0.556, -0.2165]	44722	0.9998
	Annual rainfall anomaly	-0.302	0.1065	[-0.4773, -0.1275]	47943	0.9997
Association	Area under fGC profile	0.115	0.0625	[0.0116, 0.2179]	5492	1.0015

Table S3. Summary and diagnostics of current slope joint model of longitudinal fGC and survival.

Submodel	Parameter	Mean	Std. Error	90% CI	N_{eff}	\hat{R}
fGC	Lactating	0.0049	0.0089	[-0.0098, 0.0195]	20037	1.0000
	Pregnant	0.1999	0.0097	[0.184, 0.2159]	22298	0.9999
	Wet season	-0.0923	0.0084	[-0.1063, -0.0784]	25810	1.0000
	Group size	0.0149	0.0071	[0.0031, 0.0266]	11334	1.0003
	Group size ²	0.0173	0.0046	[0.0097, 0.0249]	13363	1.0000
	Alpha rank	-0.0662	0.0314	[-0.1175, -0.015]	10178	1.0002
	High dominance rank	-0.012	0.0105	[-0.0292, 0.0051]	6848	1.0007
	Max temperature	0.0215	0.0044	[0.0143, 0.0286]	26352	0.9998
	3-mo rainfall anomaly	0.0019	0.0036	[-0.0041, 0.0079]	38678	0.9999
	Time to extraction	0.0609	0.0044	[0.0537, 0.0681]	19624	1.0002
	Time to assay	0.0253	0.0041	[0.0186, 0.032]	23879	1.0001
	Age	0.0224	0.0028	[0.0178, 0.027]	2633	1.005
Survival	Bond strength with females	-0.6109	0.0962	[-0.7697, -0.4533]	35557	0.9999
	Bond strength with males	-0.384	0.1041	[-0.5543, -0.2123]	36150	0.9997
	Annual rainfall anomaly	-0.2965	0.1101	[-0.4806, -0.1187]	29669	0.9999
Association	Current fGC slope	0.5275	11.5869	[-18.6085, 19.0399]	3972	1.0029