$$z_{year_{ij}} \sim N(z_{site_j}, \sigma^2_{z_{year_{ij}}}) \tag{A10-2}$$

$$z_{site_j} \sim N(\mu_{m_j}, \sigma^2_m)$$
$$\mu_{m_j} = \alpha_m + \beta_{m_1} * SIC_j + \beta_{m_2} * SA_j$$

$$\sigma_m \sim U(0, 10)$$

$$\alpha_m \sim N(0, 1000)$$

$$\beta_{m_1} \sim N(0, 1000)$$

$$\beta_{m_2} \sim N(0, 1000)$$

where i is year, j is site, z_{year} is the mean $\delta^{15}N$ value for a given site/year (derived from the previous model - see Equation A10-1), $\sigma^2_{z_{year}}$ is the variance about each estimate of z_{year} (derived from the previous model - see Equation A10-1), z_{site} is the mean $\delta^{15}N$ value for a given site, α_m is the intercept parameter, β_{m_1} represents the effect of average sea ice concentration within 150km of each breeding site during the austral summer (SIC) on $\delta^{15}N$ values, β_{m_2} represents the effect of shelf area within 150km of each site (SA) on $\delta^{15}N$ values, and σ_m represents the model error term.

Population growth rate ~ $\delta^{15}N$

Estimates of Adélie penguin population growth rates for all known breeding sites around the Antarctic continent were taken from Che-Castaldo et al. (2017). These estimates and mean $\delta^{15}N$ values at each site (and their associated uncertainties) were used to assess the relationship between penguin diet and population growth rate.

Inferences were obtained from 100,000 samples drawn from three chains, following a 'burn-in' period of 50,000 draws, a thinning rate of 20, and an adaptation phase of 8000 draws.

The following was used to assess the relationship between $\delta^{15}N$ values and population growth rates at Adélie penguin breeding colonies:

$$g_j \sim N(\mu_{p_j}, \sigma^2_{g_j}) \tag{A10-3}$$

$$z_{site_j} \sim N(\mu_{c_j}, \sigma^2_{site_j})$$

$$\mu_{p_j} \sim N(\mu_{f_j}, \sigma^2_f)$$

$$\mu_{f_j} = \alpha_p + \beta_p * \mu_{c_j}$$

$$\alpha_p \sim N(0, 1000)$$

$$\beta_p \sim N(0, 1000)$$

$$\mu_{c_j} \sim N(0, 1000)$$

where j is site, g_j is the mean estimated population growth rate (derived from Che-Castaldo et al. [2017]), $\sigma^2_{g_j}$ is the variance about each estimate of g_j (derived from Che-Castaldo et al. [2017]), z_{site} is the mean $\delta^{15}N$ value for a given site (derived from the previous model - see Equation A10-2), $\sigma^2_{z_{site}}$ is the variance about each estimate of z_{site} (derived from the previous model - see Equation A10-2), α_p is the intercept parameter, and β_p represents the effect of $\delta^{15}N$ values on population growth rates.

Model summary - $\delta^{15}N$ ~ time

All parameters converged and had acceptable effective sample sizes (n.eff) and Prior Posterior Overlap (PPO).

Table A10-3: Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
alpha[1]	20.001	1.003	17.918	20.029	21.931	1	10685
alpha[2]	20.992	1.418	18.082	21.004	23.752	1	11576
alpha[3]	23.562	1.245	21.068	23.574	26.003	1	11795
alpha[4]	26.935	1.222	24.480	26.947	29.347	1	10639
alpha[5]	22.160	1.226	19.738	22.172	24.550	1	11686
alpha[6]	25.672	1.232	23.284	25.644	28.221	1	11799
alpha[7]	25.116	1.276	22.560	25.129	27.631	1	10800
alpha[8]	20.928	1.035	18.812	20.952	22.928	1	10532
alpha[9]	24.163	1.188	21.757	24.180	26.519	1	12256
alpha[10]	18.832	1.343	16.084	18.856	21.386	1	10360
alpha[11]	21.134	0.825	19.449	21.162	22.701	1	9653
alpha[12]	23.314	1.212	20.809	23.341	25.655	1	10496
alpha[13]	24.577	1.188	22.292	24.547	26.999	1	10796
alpha[14]	24.101	0.953	22.202	24.113	25.958	1	11530
alpha[15]	27.268	0.961	25.308	27.296	29.106	1	9079
alpha[16]	23.883	1.466	20.959	23.898	26.793	1	11569
alpha[17]	19.269	1.437	16.364	19.281	22.037	1	10551
alpha[18]	23.005	0.842	21.485	22.958	24.764	1	5943
alpha[19]	23.267	1.026	21.248	23.265	25.284	1	12083
alpha[20]	21.166	1.190	18.686	21.213	23.437	1	10493
alpha[21]	23.489	1.059	21.476	23.463	25.708	1	10706
alpha[22]	23.115	1.003	20.957	23.188	24.904	1	7652
alpha[23]	21.423	1.168	19.002	21.453	23.663	1	11197
alpha[24]	27.588	1.646	24.344	27.560	30.856	1	11045
alpha[25]	27.970	1.295	25.415	27.961	30.528	1	10545
alpha[26]	24.066	0.972	22.076	24.079	25.976	1	10753
alpha[27]	23.311	1.484	20.382	23.315	26.270	1	11783
alpha[28]	20.274	1.286	17.584	20.349	22.636	1	10572
alpha[29]	21.083	1.172	18.746	21.112	23.335	1	11519
alpha[30]	23.670	1.077	21.667	23.605	25.981	1	10148

Table A10-3 (cont.): Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
alpha[31]	23.679	0.804	22.160	23.656	25.332	1	10788
alpha[32]	24.067	1.639	20.845	24.061	27.289	1	10968
alpha[33]	24.122	1.120	21.803	24.136	26.269	1	11030
alpha[34]	24.664	0.882	22.938	24.666	26.420	1	12153
alpha[35]	19.945	1.336	17.227	19.982	22.514	1	11028
alpha[36]	24.915	1.178	22.484	24.943	27.169	1	10846
alpha[37]	22.155	1.007	20.091	22.176	24.140	1	11803
alpha[38]	26.697	1.074	24.591	26.690	28.827	1	11494
alpha[39]	19.815	1.371	16.952	19.884	22.379	1	10721
alpha[40]	25.627	1.297	23.144	25.589	28.300	1	11230
alpha[41]	21.819	0.990	19.813	21.821	23.796	1	11707
alpha[42]	24.840	1.030	22.932	24.773	27.036	1	9838
alpha[43]	22.902	1.000	20.879	22.911	24.870	1	11727
alpha[44]	20.839	1.125	18.464	20.880	23.020	1	10909
alpha[45]	22.440	1.224	20.027	22.453	24.841	1	11698
alpha[46]	20.266	1.195	17.862	20.278	22.652	1	11438
alpha[47]	20.087	1.195	17.661	20.102	22.405	1	11110
alpha[48]	24.032	1.215	21.891	23.986	26.543	1	3009
alpha[49]	21.776	1.124	19.467	21.812	23.900	1	11742
alpha[50]	25.712	1.239	23.164	25.749	28.141	1	9857
alpha[51]	20.684	0.774	19.104	20.692	22.149	1	10725
alpha[52]	19.842	1.310	17.135	19.885	22.328	1	10226
alpha[53]	20.690	1.092	18.427	20.709	22.787	1	10901
alpha[54]	25.170	0.910	23.481	25.127	27.119	1	10522
alpha[55]	20.978	1.068	18.812	20.987	23.063	1	11894
alpha[56]	26.363	1.603	23.081	26.404	29.442	1	7993
alpha[57]	23.523	1.141	21.209	23.524	25.772	1	11668
alpha[58]	18.898	1.338	16.168	18.923	21.486	1	10222
alpha[59]	20.437	1.095	18.256	20.423	22.607	1	10690
alpha[60]	22.027	1.320	19.280	22.062	24.554	1	12000
alpha[61]	23.922	1.382	21.199	23.920	26.689	1	11175
alpha[62]	23.117	0.792	21.607	23.101	24.726	1	11272
alpha[63]	25.424	1.197	23.075	25.422	27.863	1	11853
alpha[64]	24.886	0.891	23.071	24.908	26.543	1	9134
alpha[65]	25.280	1.224	22.713	25.339	27.551	1	9034
alpha[66]	26.025	1.273	23.488	26.019	28.534	1	11353
alpha[67]	20.638	1.218	18.041	20.699	22.887	1	11227
alpha[68]	22.929	1.085	20.766	22.940	25.053	1	11875
alpha[69]	22.018	1.206	19.601	22.032	24.401	1	11581
alpha[70]	24.380	1.065	22.246	24.383	26.486	1	11650
alpha[71]	19.924	1.203	17.523	19.932	22.266	1	11047
alpha[72]	21.097	1.143	18.839	21.096	23.385	1	11886
alpha[73]	22.273	0.980	20.258	22.290	24.164	1	10927
alpha[74]	21.781	0.962	19.936	21.756	23.731	1	10598
alpha[75]	25.799	1.003	23.786	25.812	27.785	1	10906
alpha[76]	22.328	0.977	20.552	22.275	24.410	1	7344
alpha[77]	25.037	1.035	22.884	25.097	26.913	1	7494
alpha[78]	20.676	1.190	18.201	20.723	22.929	1	10547

Table A10-3 (cont.): Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
alpha[79]	21.799	1.309	19.080	21.867	24.219	1	9295
alpha[80]	21.206	1.137	18.928	21.215	23.424	1	10899
alpha[81]	25.597	1.208	23.221	25.588	28.068	1	11478
alpha[82]	23.887	1.036	21.845	23.878	25.977	1	11477
alpha[83]	25.673	1.063	23.597	25.673	27.779	1	11643
alpha[84]	19.763	1.331	16.978	19.809	22.309	1	11003
alpha[85]	22.333	1.167	19.991	22.344	24.660	1	12058
alpha[86]	26.275	1.353	23.674	26.257	28.960	1	10778
alpha[87]	21.354	1.444	18.412	21.388	24.175	1	10897
alpha[88]	20.513	1.413	17.627	20.532	23.296	1	11607
alpha[89]	24.121	0.832	22.557	24.083	25.856	1	9278
alpha[90]	23.694	1.684	20.402	23.694	27.002	1	12089
alpha[91]	22.214	1.055	20.131	22.222	24.332	1	12000
alpha[92]	25.261	1.039	23.155	25.272	27.343	1	10926
alpha[93]	20.655	1.492	17.628	20.683	23.548	1	11807
alpha[94]	19.904	1.238	17.267	19.966	22.193	1	10288
alpha[95]	19.885	1.390	17.125	19.910	22.605	1	11659
alpha[96]	24.690	1.025	22.497	24.746	26.574	1	7670
alpha[97]	23.895	1.149	21.428	23.953	26.043	1	9184
alpha[98]	23.684	0.897	21.842	23.732	25.353	1	9575
alpha[99]	21.883	1.069	19.730	21.887	24.021	1	11666
alpha[100]	19.119	1.336	16.480	19.145	21.715	1	10829
alpha[101]	25.405	0.903	23.586	25.433	27.102	1	8318
alpha[102]	22.441	1.110	20.379	22.391	24.780	1	11642
alpha[103]	25.505	1.247	22.937	25.516	27.956	1	11002
alpha[104]	20.625	1.233	18.152	20.638	23.036	1	10766
alpha[105]	24.989	1.362	22.335	24.977	27.769	1	11794
alpha[106]	21.903	1.336	19.038	21.992	24.338	1	8650
alpha[107]	25.917	0.866	24.232	25.897	27.662	1	12114
alpha[108]	27.405	1.112	25.463	27.320	29.802	1	4737
alpha[109]	24.559	0.837	22.972	24.534	26.285	1	10432
alpha[110]	23.295	1.126	21.072	23.291	25.542	1	12113
alpha[111]	24.561	1.410	21.786	24.575	27.321	1	10174
alpha[112]	24.019	1.457	21.144	24.011	26.954	1	11694
alpha[113]	25.186	0.877	23.472	25.175	26.938	1	11629
alpha[114]	25.529	1.281	22.916	25.565	28.016	1	10996
alpha[115]	21.384	1.145	19.123	21.354	23.755	1	10796
alpha[116]	21.732	1.161	19.357	21.754	24.038	1	12311
alpha[117]	22.550	0.875	20.739	22.573	24.257	1	10615
alpha[118]	20.849	1.468	17.861	20.874	23.680	1	11671
alpha[119]	24.487	1.180	22.156	24.494	26.830	1	11274
alpha[120]	26.107	1.164	23.794	26.119	28.380	1	10076
alpha[121]	20.524	1.245	18.043	20.541	22.902	1	11472
alpha[122]	22.586	1.099	20.476	22.541	24.920	1	11163
alpha[123]	22.502	0.887	20.777	22.487	24.286	1	11727
alpha[124]	22.296	1.304	19.689	22.284	24.868	1	11969
alpha[125]	21.981	0.958	19.964	22.018	23.795	1	10405
alpha[126]	26.219	1.225	23.754	26.228	28.648	1	11127

Table A10-3 (cont.): Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
alpha[127]	26.564	1.249	24.148	26.555	29.061	1	10994
alpha[128]	20.253	0.978	18.177	20.299	22.078	1	10510
alpha[129]	19.606	0.986	17.583	19.621	21.497	1	10206
alpha[130]	19.801	1.360	16.893	19.859	22.310	1	11151
alpha[131]	22.502	1.305	19.871	22.526	25.004	1	11272
alpha[132]	24.125	0.922	22.232	24.159	25.867	1	11394
alpha[133]	24.431	0.977	22.366	24.488	26.241	1	7101
alpha[134]	22.520	1.153	20.153	22.534	24.810	1	11679
alpha[135]	19.649	1.373	16.857	19.686	22.334	1	11252
alpha[136]	21.266	0.971	19.284	21.299	23.122	1	10918
beta[1]	0.012	0.042	-0.068	0.011	0.100	1	10119
beta[2]	0.006	0.048	-0.092	0.005	0.104	1	11549
beta[3]	0.025	0.045	-0.066	0.023	0.118	1	11537
beta[4]	0.047	0.047	-0.046	0.046	0.143	1	10144
beta[5]	0.026	0.045	-0.060	0.023	0.119	1	10408
beta[6]	0.026	0.045	-0.070	0.027	0.117	1	11556
beta[7]	0.041	0.046	-0.047	0.039	0.139	1	9469
beta[8]	0.016	0.043	-0.068	0.014	0.105	1	10349
beta[9]	0.025	0.044	-0.062	0.024	0.115	1	12040
beta[10]	-0.008	0.051	-0.109	-0.008	0.097	1	9610
beta[11]	0.026	0.036	-0.042	0.024	0.101	1	9372
beta[12]	0.030	0.044	-0.054	0.027	0.126	1	10444
beta[13]	0.011	0.042	-0.080	0.014	0.092	1	10930
beta[14]	0.030	0.039	-0.049	0.029	0.112	1	11600
beta[15]	0.056	0.042	-0.022	0.054	0.143	1	8024
beta[16]	0.029	0.047	-0.065	0.027	0.131	1	10847
beta[17]	-0.013	0.049	-0.112	-0.012	0.085	1	9596
beta[18]	-0.035	0.038	-0.115	-0.033	0.030	1	4933
beta[19]	0.014	0.040	-0.068	0.014	0.093	1	12638
beta[20]	0.019	0.045	-0.066	0.016	0.116	1	10254
beta[21]	0.003	0.042	-0.088	0.005	0.081	1	9997
beta[22]	0.053	0.042	-0.020	0.048	0.144	1	7044
beta[23]	0.012	0.044	-0.075	0.011	0.105	1	10898
beta[24]	0.048	0.053	-0.055	0.047	0.160	1	10871
beta[25]	0.055	0.049	-0.043	0.054	0.155	1	9968
beta[26]	0.030	0.040	-0.048	0.029	0.113	1	11388
beta[27]	0.013	0.045	-0.081	0.013	0.102	1	12102
beta[28]	0.016	0.048	-0.076	0.013	0.119	1	9907
beta[29]	0.013	0.044	-0.073	0.012	0.107	1	11283
beta[30]	-0.005	0.043	-0.098	-0.001	0.074	1	9081
beta[31]	0.000	0.034	-0.071	0.002	0.064	1	10222
beta[32]	0.020	0.046	-0.075	0.019	0.114	1	11598
beta[33]	0.030	0.043	-0.054	0.028	0.119	1	11577
beta[34]	0.023	0.039	-0.056	0.023	0.101	1	12131
beta[35]	-0.001	0.049	-0.099	-0.002	0.100	1	11229
beta[36]	0.043	0.044	-0.041	0.040	0.138	1	10656
beta[37]	0.012	0.040	-0.069	0.011	0.094	1	11939
beta[38]	0.038	0.043	-0.052	0.038	0.125	1	11815

Table A10-3 (cont.): Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
beta[39]	0.011	0.049	-0.080	0.008	0.117	1	10448
beta[40]	0.024	0.046	-0.072	0.025	0.116	1	11288
beta[41]	0.006	0.040	-0.075	0.006	0.085	1	11674
beta[42]	0.001	0.041	-0.089	0.004	0.076	1	8981
beta[43]	0.021	0.040	-0.059	0.019	0.104	1	11556
beta[44]	0.012	0.046	-0.078	0.010	0.112	1	10764
beta[45]	0.007	0.046	-0.087	0.008	0.097	1	11422
beta[46]	0.001	0.048	-0.096	0.001	0.100	1	10911
beta[47]	-0.002	0.047	-0.097	-0.002	0.094	1	10909
beta[48]	-0.081	0.056	-0.195	-0.079	0.013	1	2695
beta[49]	0.025	0.043	-0.058	0.022	0.117	1	10726
beta[50]	0.047	0.046	-0.042	0.045	0.145	1	9552
beta[51]	0.016	0.035	-0.051	0.015	0.089	1	9991
beta[52]	0.003	0.047	-0.090	0.002	0.101	1	10762
beta[53]	0.009	0.043	-0.076	0.008	0.101	1	11026
beta[54]	0.007	0.038	-0.076	0.010	0.076	1	9968
beta[55]	0.001	0.042	-0.082	0.002	0.087	1	11847
beta[56]	0.076	0.054	-0.015	0.070	0.196	1	6416
beta[57]	0.017	0.043	-0.071	0.016	0.105	1	11807
beta[58]	-0.007	0.051	-0.110	-0.008	0.096	1	9682
beta[59]	-0.007	0.044	-0.097	-0.005	0.080	1	10914
beta[60]	0.019	0.045	-0.068	0.017	0.119	1	11605
beta[61]	0.018	0.049	-0.082	0.018	0.118	1	11941
beta[62]	0.004	0.035	-0.068	0.005	0.072	1	11305
beta[63]	0.034	0.044	-0.056	0.033	0.125	1	11722
beta[64]	0.052	0.039	-0.017	0.049	0.134	1	8769
beta[65]	0.057	0.048	-0.028	0.052	0.162	1	7914
beta[66]	0.043	0.046	-0.048	0.041	0.138	1	11295
beta[67]	0.015	0.046	-0.072	0.013	0.115	1	11391
beta[68]	0.023	0.042	-0.062	0.022	0.111	1	11682
beta[69]	0.011	0.043	-0.074	0.011	0.098	1	11065
beta[70]	0.026	0.041	-0.058	0.026	0.112	1	11633
beta[71]	-0.012	0.045	-0.106	-0.010	0.076	1	9951
beta[72]	0.000	0.044	-0.093	0.001	0.088	1	11210
beta[73]	0.021	0.040	-0.056	0.019	0.107	1	10358
beta[74]	-0.007	0.039	-0.088	-0.005	0.070	1	10125
beta[75]	0.044	0.040	-0.035	0.042	0.127	1	9673
beta[76]	-0.028	0.042	-0.121	-0.024	0.046	1	7022
beta[77]	0.063	0.043	-0.013	0.060	0.154	1	6082
beta[78]	0.011	0.045	-0.076	0.009	0.105	1	10610
beta[79]	0.034	0.047	-0.050	0.029	0.139	1	8737
beta[80]	0.005	0.042	-0.080	0.006	0.090	1	11095
beta[81]	0.030	0.044	-0.061	0.030	0.119	1	11124
beta[82]	0.022	0.040	-0.061	0.021	0.103	1	11785
beta[83]	0.038	0.042	-0.043	0.037	0.125	1	11104
beta[84]	0.001	0.047	-0.092	0.001	0.100	1	10635
beta[85]	0.012	0.043	-0.077	0.012	0.099	1	12163
beta[86]	0.043	0.048	-0.049	0.041	0.144	1	10282

Table A10-3 (cont.): Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
beta[87]	0.008	0.045	-0.084	0.007	0.102	1	11136
beta[88]	-0.001	0.046	-0.095	0.000	0.091	1	11492
beta[89]	-0.005	0.036	-0.080	-0.002	0.062	1	8713
beta[90]	0.023	0.046	-0.074	0.022	0.117	1	11746
beta[91]	0.005	0.042	-0.083	0.006	0.089	1	11082
beta[92]	0.037	0.040	-0.042	0.036	0.121	1	9896
beta[93]	0.000	0.047	-0.095	0.001	0.096	1	11789
beta[94]	0.018	0.048	-0.072	0.015	0.123	1	9618
beta[95]	-0.001	0.049	-0.102	-0.001	0.100	1	10602
beta[96]	0.057	0.042	-0.016	0.054	0.148	1	6477
beta[97]	0.045	0.044	-0.036	0.041	0.142	1	9448
beta[98]	0.048	0.038	-0.021	0.045	0.129	1	7051
beta[99]	0.010	0.042	-0.077	0.010	0.096	1	11058
beta[100]	-0.010	0.049	-0.110	-0.010	0.091	1	10351
beta[101]	0.056	0.039	-0.016	0.053	0.138	1	8019
beta[102]	-0.004	0.043	-0.098	-0.001	0.078	1	11371
beta[103]	0.047	0.046	-0.041	0.044	0.143	1	10004
beta[104]	0.004	0.046	-0.090	0.004	0.098	1	11709
beta[105]	0.027	0.045	-0.066	0.027	0.118	1	11830
beta[106]	0.035	0.047	-0.049	0.029	0.138	1	8327
beta[107]	0.025	0.037	-0.051	0.025	0.097	1	11825
beta[108]	-0.028	0.048	-0.134	-0.024	0.053	1	4231
beta[109]	0.007	0.036	-0.068	0.009	0.074	1	11553
beta[110]	0.024	0.043	-0.061	0.022	0.115	1	11490
beta[111]	0.037	0.047	-0.055	0.034	0.138	1	10778
beta[112]	0.028	0.045	-0.062	0.027	0.123	1	11410
beta[113]	0.027	0.037	-0.048	0.027	0.101	1	11865
beta[114]	0.044	0.046	-0.046	0.041	0.140	1	10353
beta[115]	-0.003	0.044	-0.096	-0.001	0.084	1	10812
beta[116]	0.011	0.044	-0.077	0.010	0.102	1	11920
beta[117]	0.028	0.037	-0.045	0.026	0.107	1	11478
beta[118]	0.008	0.050	-0.091	0.007	0.109	1	10942
beta[119]	0.032	0.044	-0.056	0.030	0.125	1	11417
beta[120]	0.063	0.047	-0.020	0.059	0.167	1	7839
beta[121]	0.002	0.046	-0.092	0.002	0.093	1	10912
beta[122]	-0.001	0.043	-0.093	0.001	0.081	1	10717
beta[123]	0.006	0.037	-0.069	0.007	0.079	1	11614
beta[124]	0.009	0.047	-0.091	0.009	0.105	1	11528
beta[125]	0.028	0.040	-0.048	0.025	0.113	1	9822
beta[126]	0.047	0.047	-0.045	0.045	0.146	1	10180
beta[127]	0.034	0.047	-0.063	0.034	0.129	1	9886
beta[128]	0.015	0.041	-0.060	0.013	0.102	1	10181
beta[129]	0.005	0.041	-0.075	0.004	0.090	1	9955
beta[130]	0.013	0.048	-0.077	0.009	0.118	1	10003
beta[131]	0.021	0.046	-0.069	0.018	0.118	1	10934
beta[132]	0.040	0.039	-0.030	0.037	0.123	1	11112
beta[133]	0.064	0.042	-0.009	0.060	0.156	1	6277
beta[134]	0.016	0.043	-0.069	0.015	0.106	1	11812

Table A10-3 (cont.): Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
beta[135]	0.000	0.048	-0.096	-0.001	0.100	1	10667
beta[136]	0.018	0.040	-0.060	0.016	0.102	1	10746
mu.a	22.975	0.312	22.351	22.980	23.566	1	8490
mu.b	0.019	0.011	-0.002	0.019	0.040	1	6706
rho	0.005	0.322	-0.512	-0.037	0.765	1	2240
sigma.a	2.506	0.306	1.945	2.489	3.146	1	5954
sigma.b	0.047	0.015	0.015	0.047	0.075	1	1718
sigma.z	1.679	0.049	1.585	1.678	1.776	1	9603
sigma.z_scene	0.909	0.010	0.889	0.909	0.929	1	2691
sigma.z_year	0.776	0.010	0.757	0.776	0.796	1	2598

Trace plots and prior posterior overlap - $\delta^{15}N \sim$ time

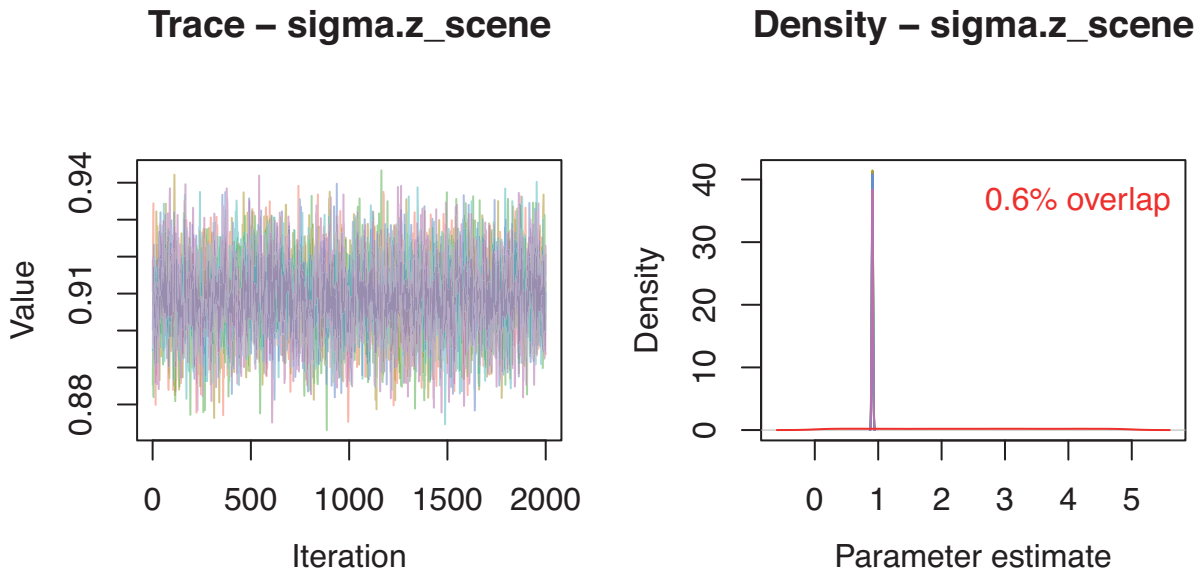

Figure A10-26: Posterior trace plot (left) and prior posterior overlap (right) for σ_{scene}

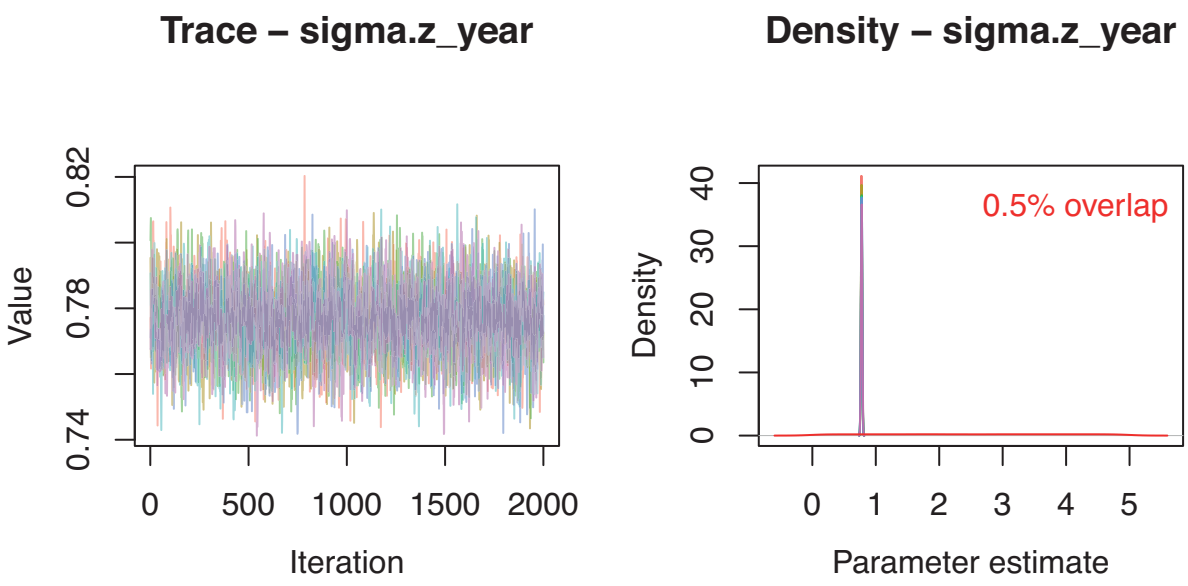

Figure A10-27: Posterior trace plot (left) and prior posterior overlap (right) for σ_{site}

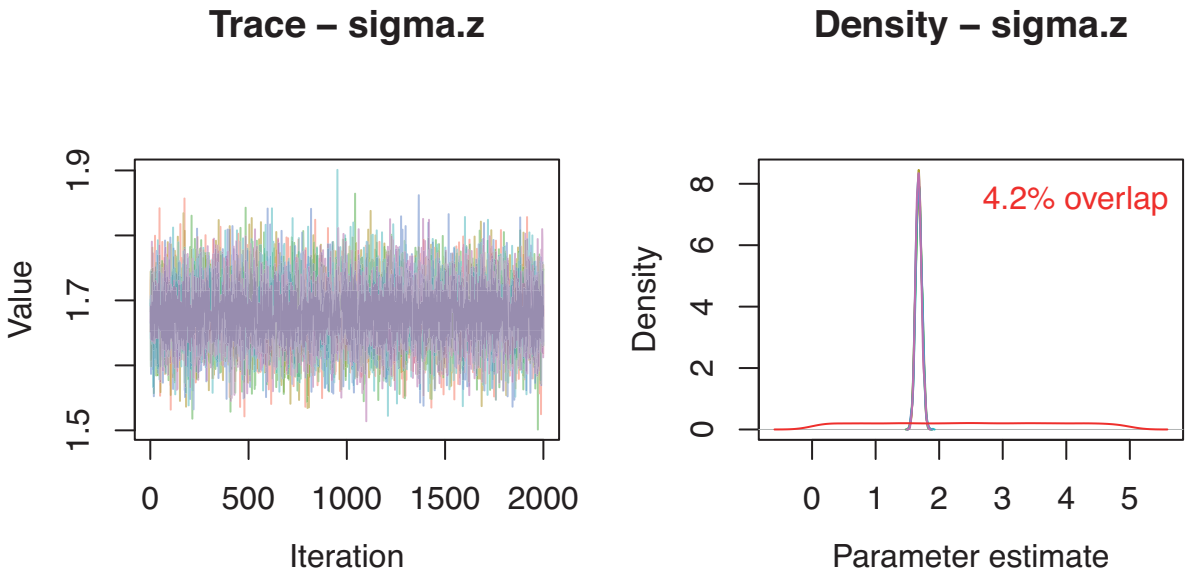

Figure A10-28: Posterior trace plot (left) and prior posterior overlap (right) for σ_z

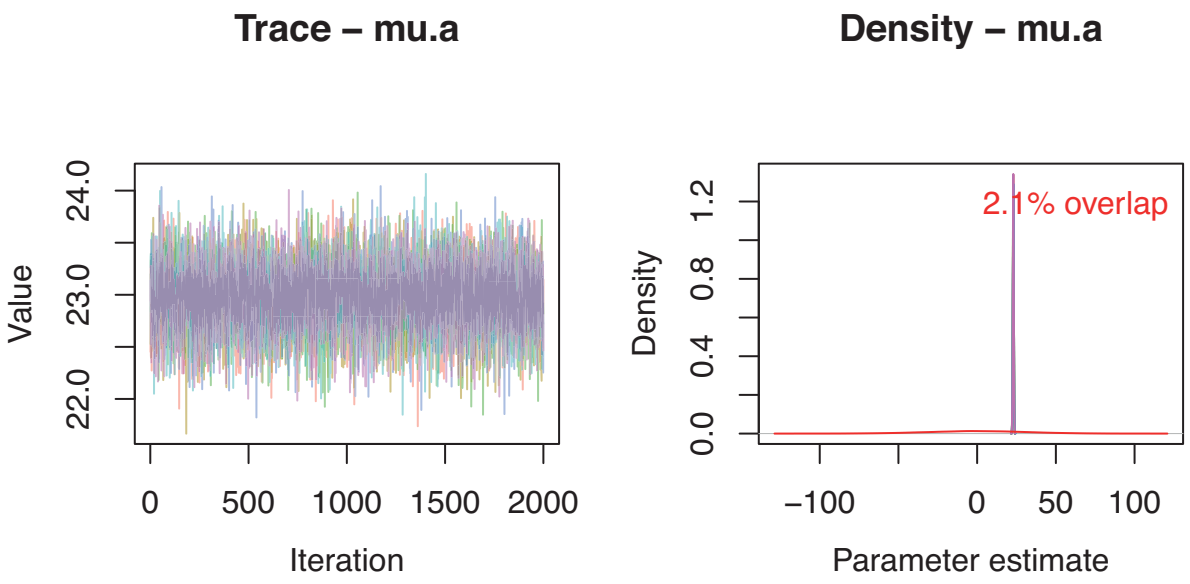

Figure A10-29: Posterior trace plot (left) and prior posterior overlap (right) for $\bar{\alpha}$

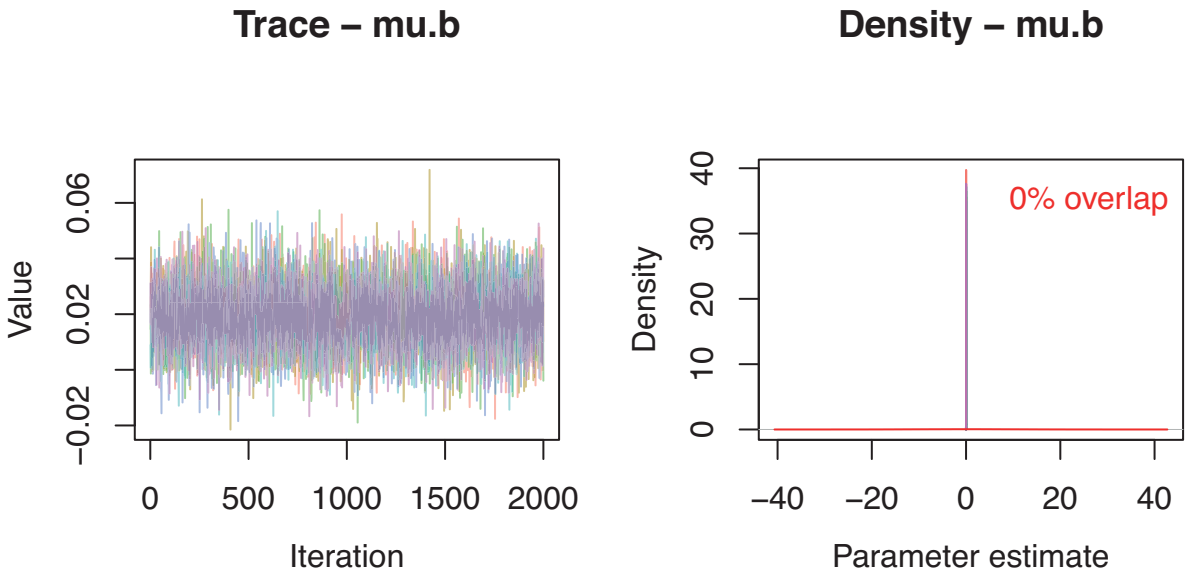

Figure A10-30: Posterior trace plot (left) and prior posterior overlap (right) for $\bar{\beta}$

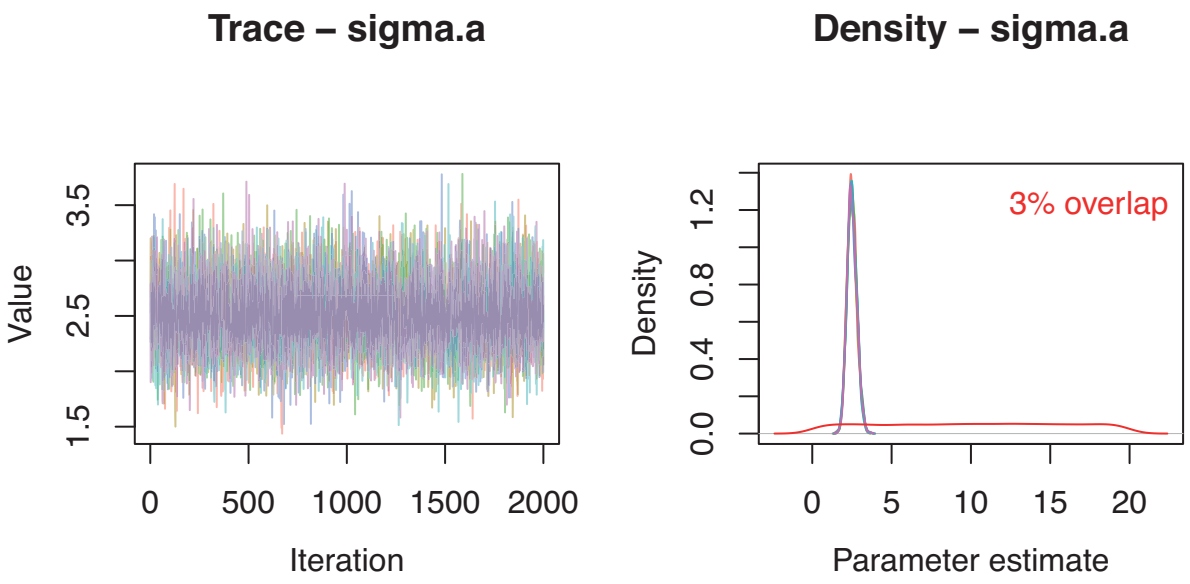

Figure A10-31: Posterior trace plot (left) and prior posterior overlap (right) for σ_α

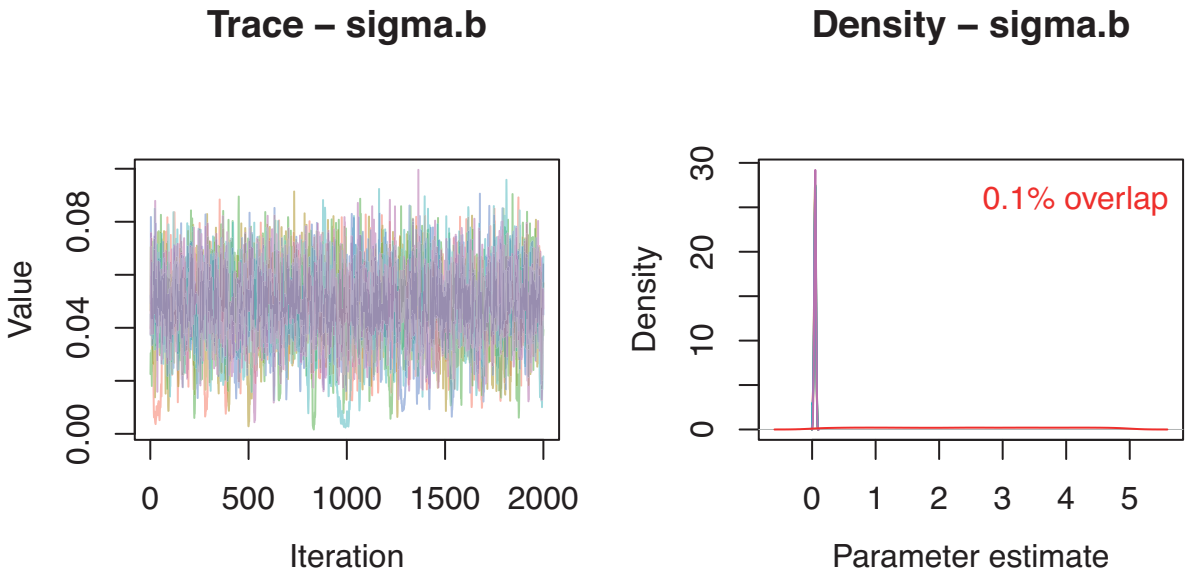

Figure A10-32: Posterior trace plot (left) and prior posterior overlap (right) for σ_β

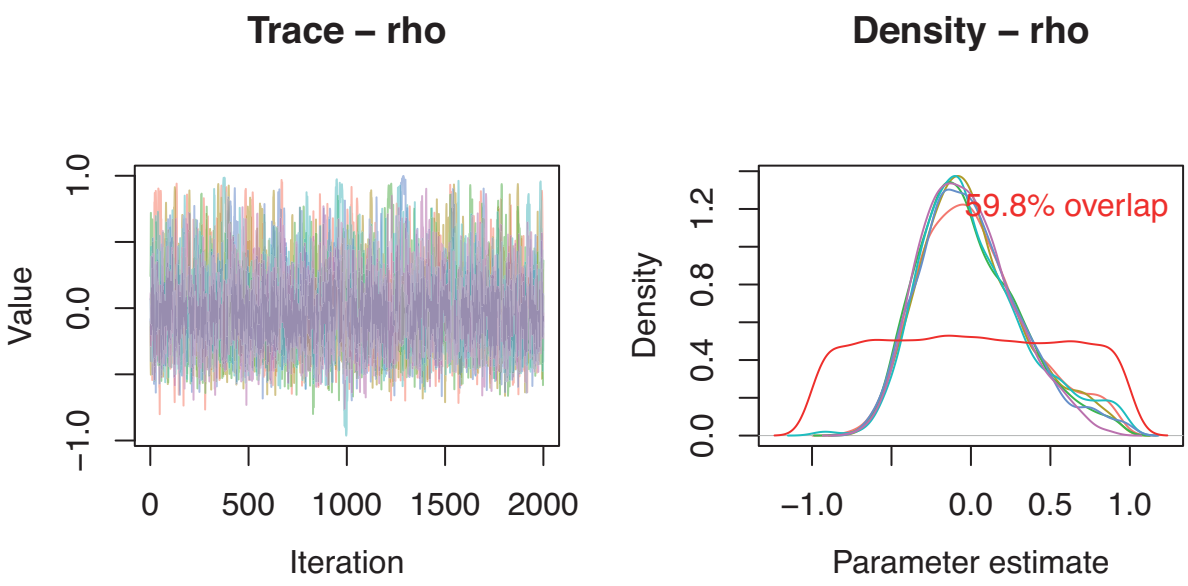

Figure A10-33: Posterior trace plot (left) and prior posterior overlap (right) for ρ

Model summary - $\delta^{15}N$ ~ SIC + SA

All parameters converged and had acceptable effective sample sizes (n.eff) and PPO.

Table A10-4: Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
alpha_m	23.183	0.165	22.861	23.182	23.506	1	28964
beta_m1	-0.234	0.198	-0.621	-0.235	0.158	1	27830
beta_m2	-2.009	0.197	-2.393	-2.009	-1.623	1	29456
sigma_m	1.888	0.119	1.673	1.881	2.136	1	16475

Trace plots and prior posterior overlap - $\delta^{15}N$ ~ SIC + SA

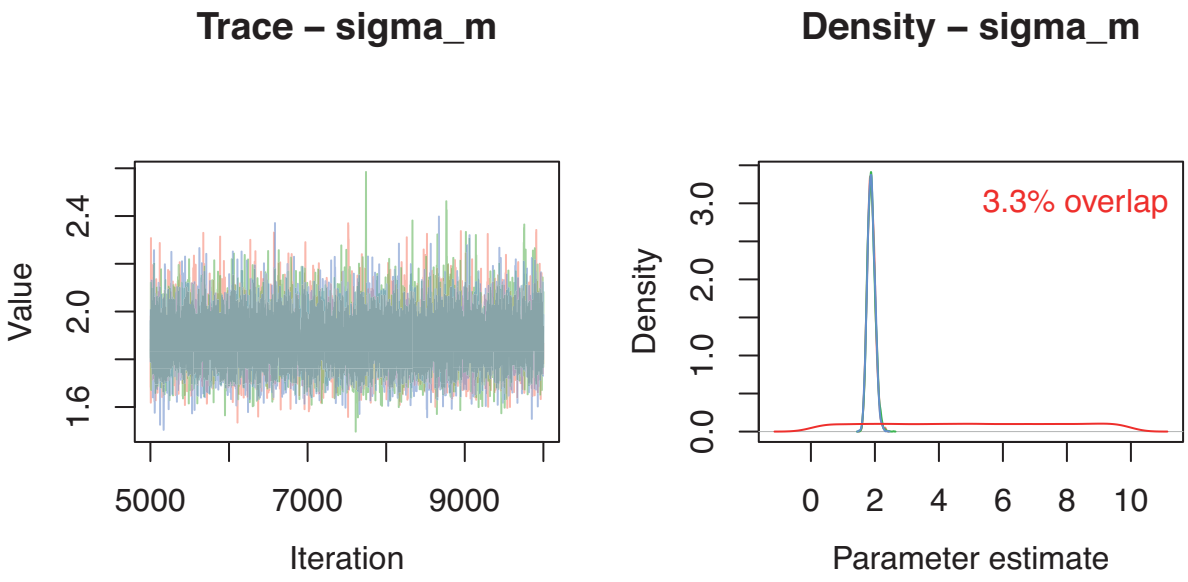

Figure A10-34: Posterior trace plot (left) and prior posterior overlap (right) for σ_m

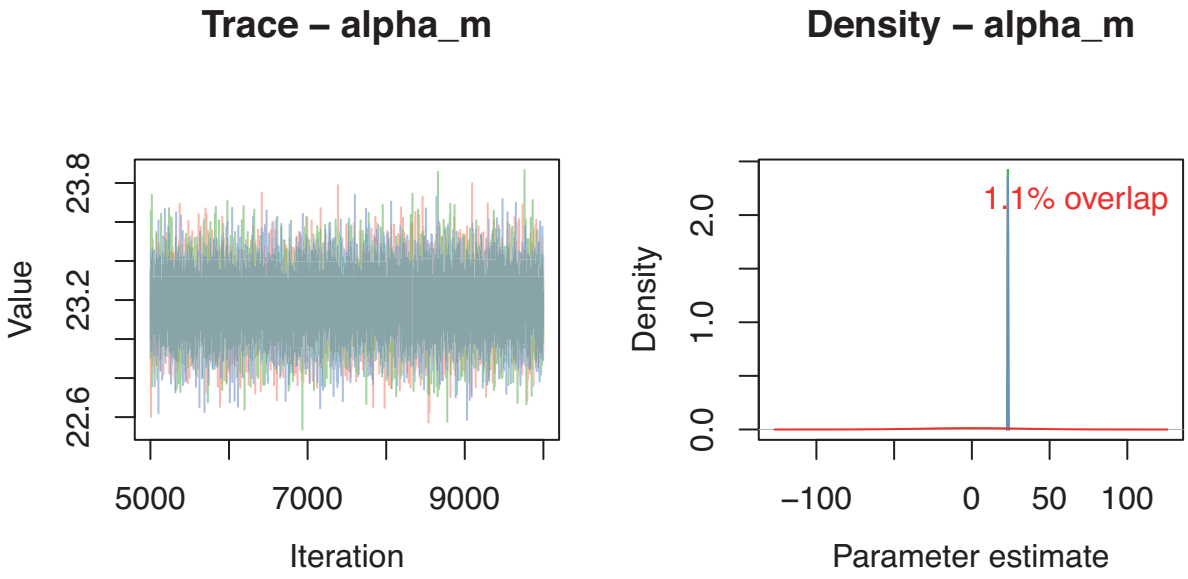

Figure A10-35: Posterior trace plot (left) and prior posterior overlap (right) for α_m

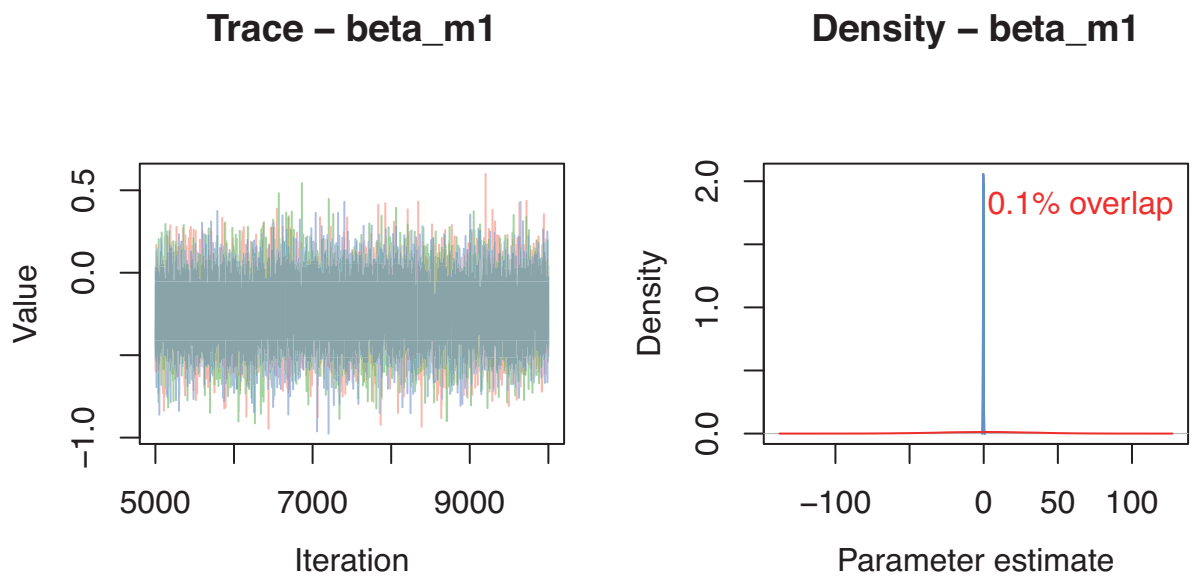

Figure A10-36: Posterior trace plot (left) and prior posterior overlap (right) for β_{m_1}

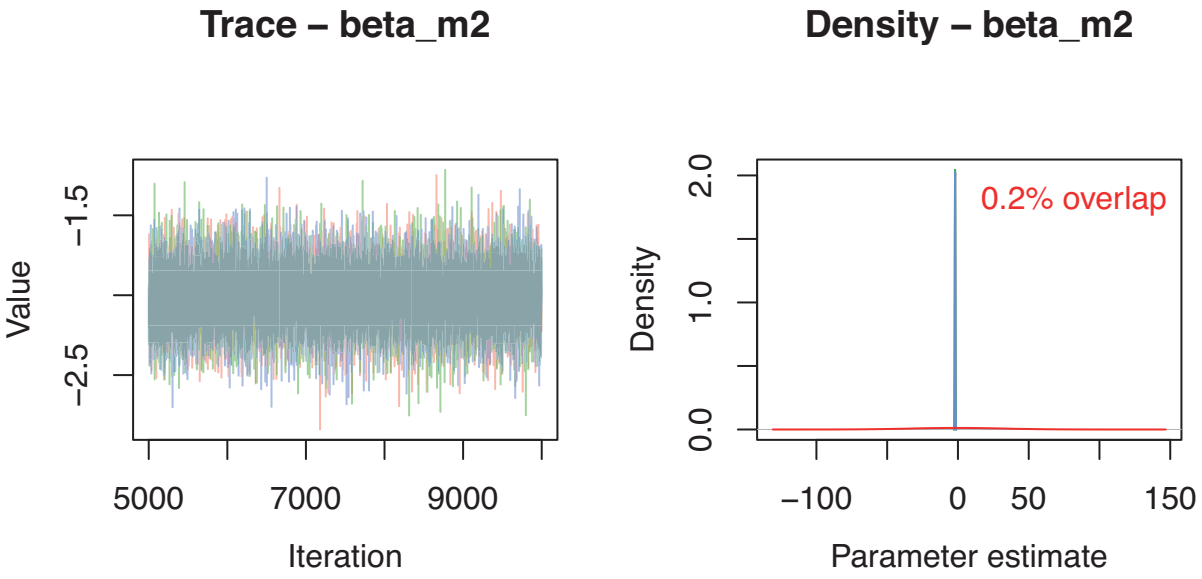

Figure A10-37: Posterior trace plot (left) and prior posterior overlap (right) for β_{m_2}

Model summary - Population growth rate ~ $\delta^{15}N$

All parameters converged and had acceptable effective sample sizes (n.eff) and PPO.

Table A10-5: Model summary table. For each parameter, the posterior mean; sd; 2.5%, 50%, and 97.5% quantiles; Rhat; and number of effective samples are shown.

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
alpha_p	0.886	0.034	0.821	0.885	0.952	1.01	624
beta_p	0.006	0.001	0.003	0.006	0.009	1.01	622

Trace plots and prior posterior overlap - Population growth rate $\sim \delta^{15} N$

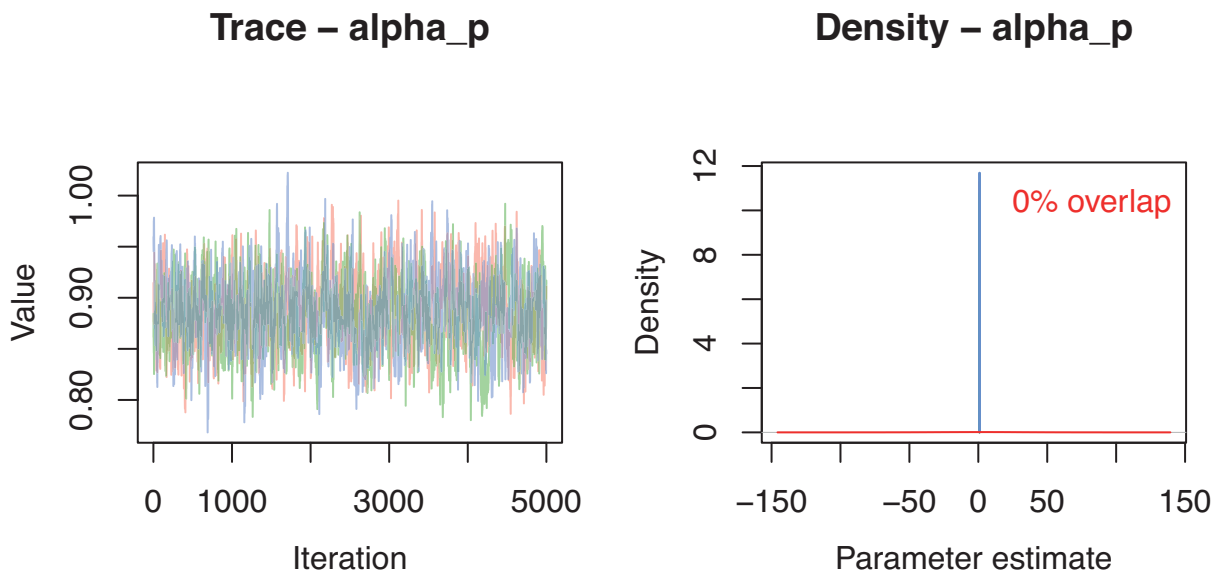

Figure A10-38: Posterior trace plot (left) and prior posterior overlap (right) for α_p

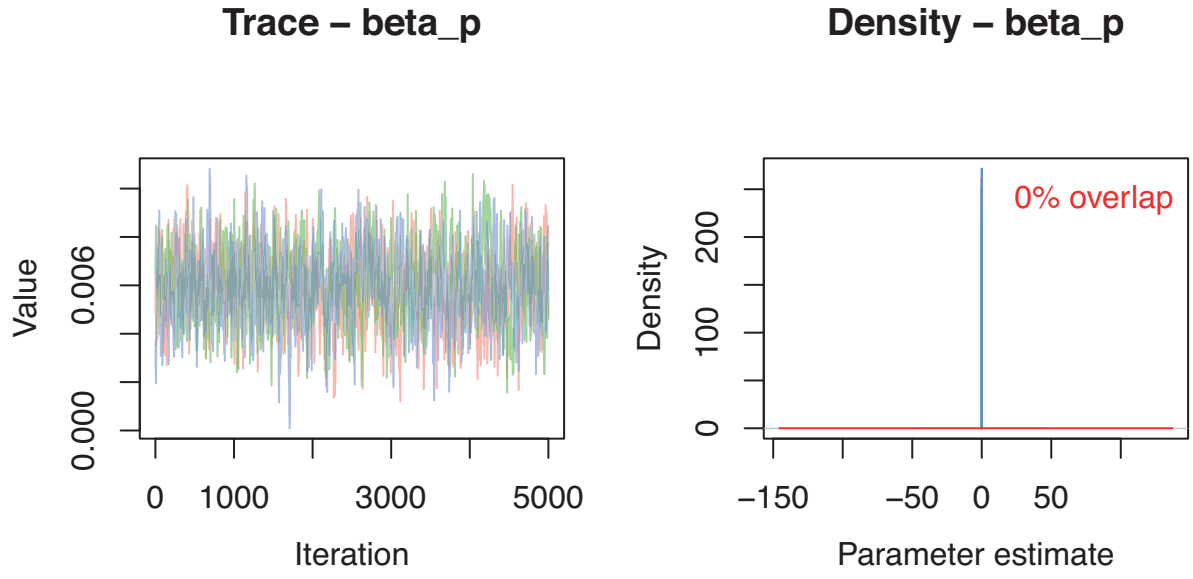

Figure A10-39: Posterior trace plot (left) and prior posterior overlap (right) for β_p

Temporal changes in $\delta^{15}N$

Posterior estimates for β parameters

The β parameters from Equation A10-1 represent the change in $\delta^{15}N$ over time, at each breeding colony.

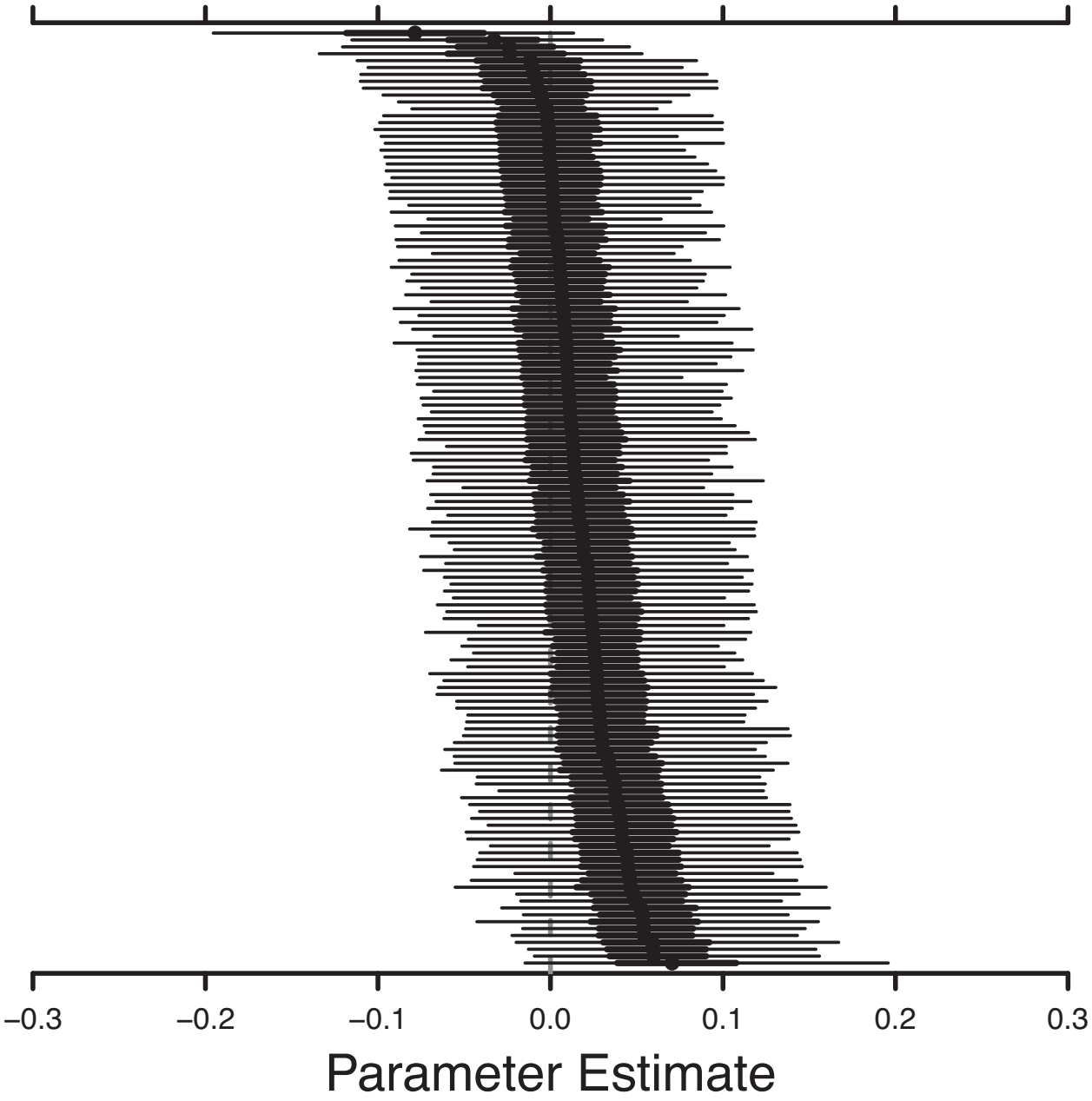

Figure A10-40: Posterior estimates for all β parameters for model. Black circles represent posterior medians. Thicker lines represent 50% credible intervals while thinner lines represent 95% credible intervals. Each parameter represents the change in $\delta^{15}N$ over time at a given site.

Spatial differences in $\delta^{15}N$

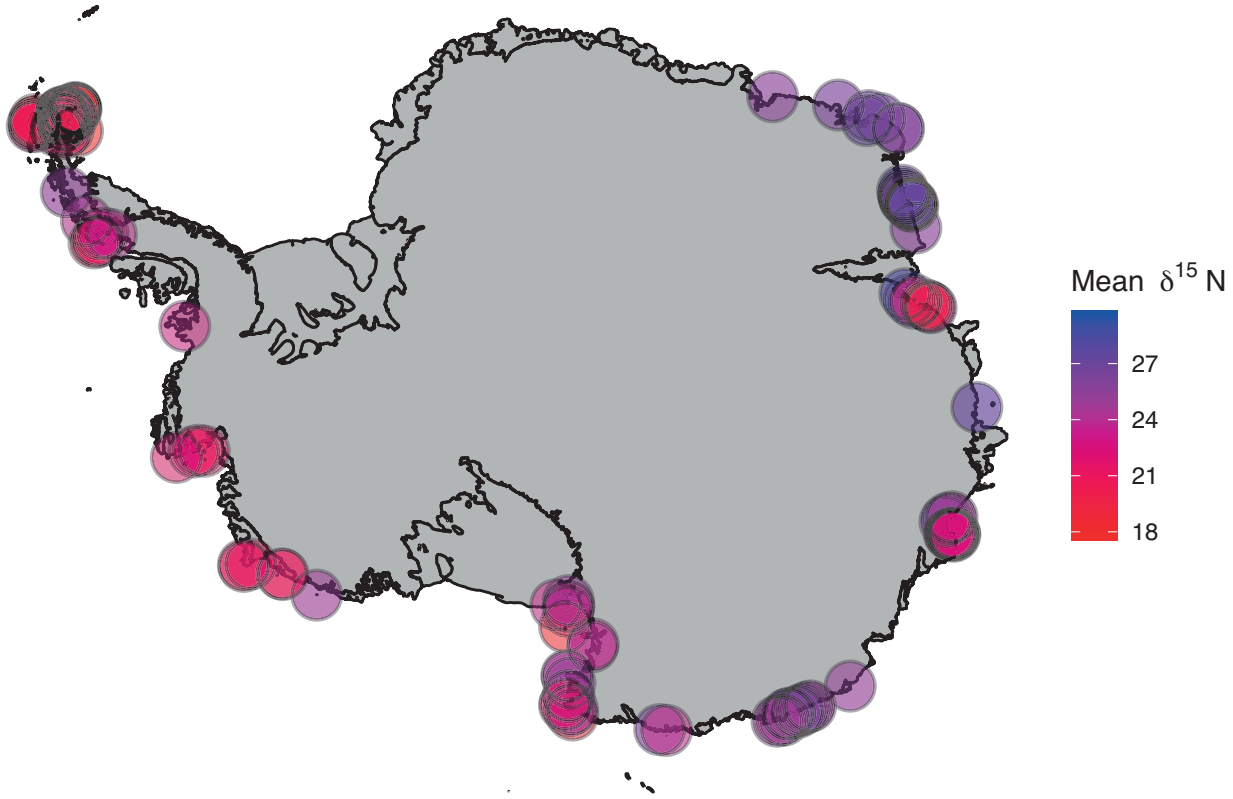

Figure A10-41: Map of estimated colony mean $\delta^{15}N$ values

Degree of regional variation in $\delta^{15}N$

Posterior chains for estimates of z_{site} parameters (site average for estimated $\delta^{15}N$) were used to determine whether a regional difference in penguin diet was apparent. To account for the uncertainty in these estimates, at each iteration of the posterior chain, the site average for estimated $\delta^{15}N$ was calculated. The Antarctic Peninsula (AP) was found to have a lower estimated $\delta^{15}N$ than East Antarctica (EA). The distribution of differenced values does not overlap 0 (Figure A10-42), suggestion this is a robust conclusion.

Mean estimated $\delta^{15}N$ for AP: 20.99

Mean estimated $\delta^{15}N$ for EA: 24.637

Mean difference between $\delta^{15}N$ values for AP and EA: 3.647

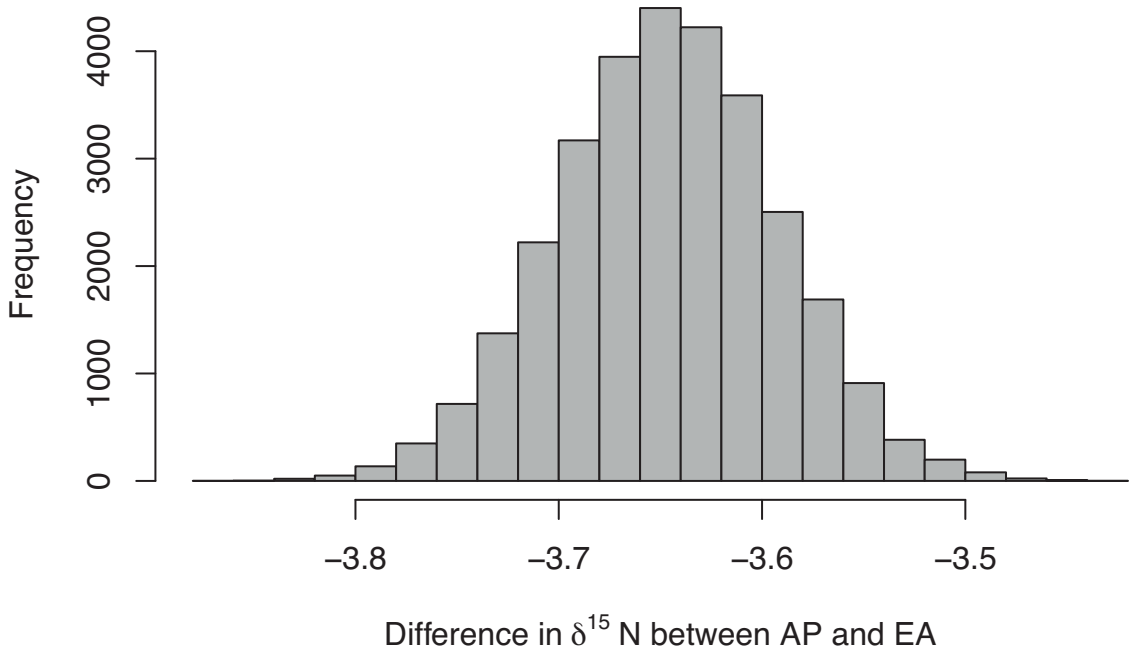

Figure A10-42: Histogram of differences in posterior chains of AP and EA $\delta^{15}N$

Effect of SIC and SA on $\delta^{15}N$

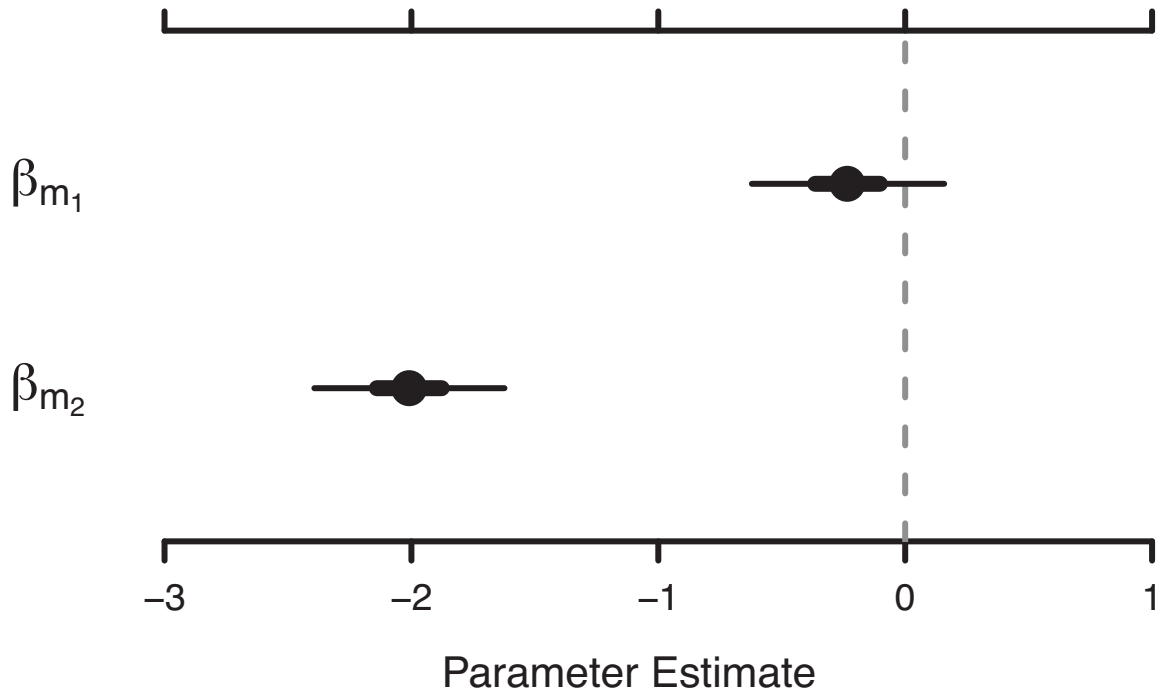

Figure A10-43: Posterior estimates for β_{m_1} (SIC effect) and β_{m_2} (Shelf Area effect) parameters. Black circles represent posterior medians. Thicker lines represent 50% credible intervals while thinner lines represent 95% credible intervals.

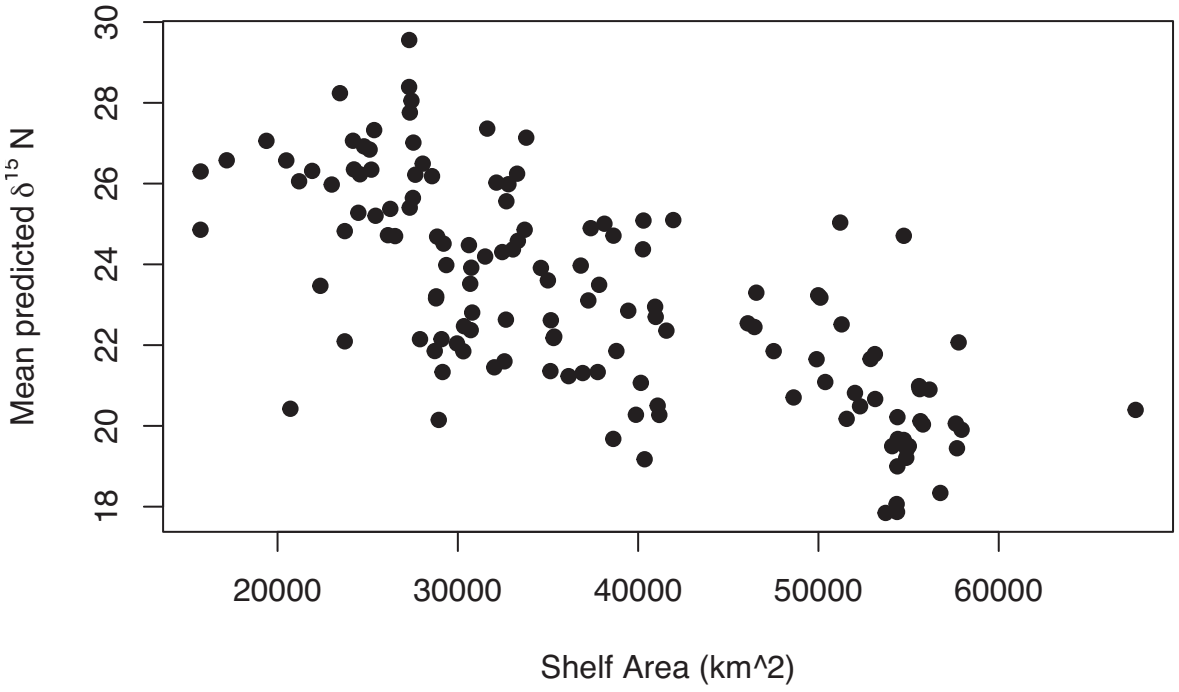

Figure A10-44: Site mean predicted $\delta^{15}N$ vs. Shelf Area

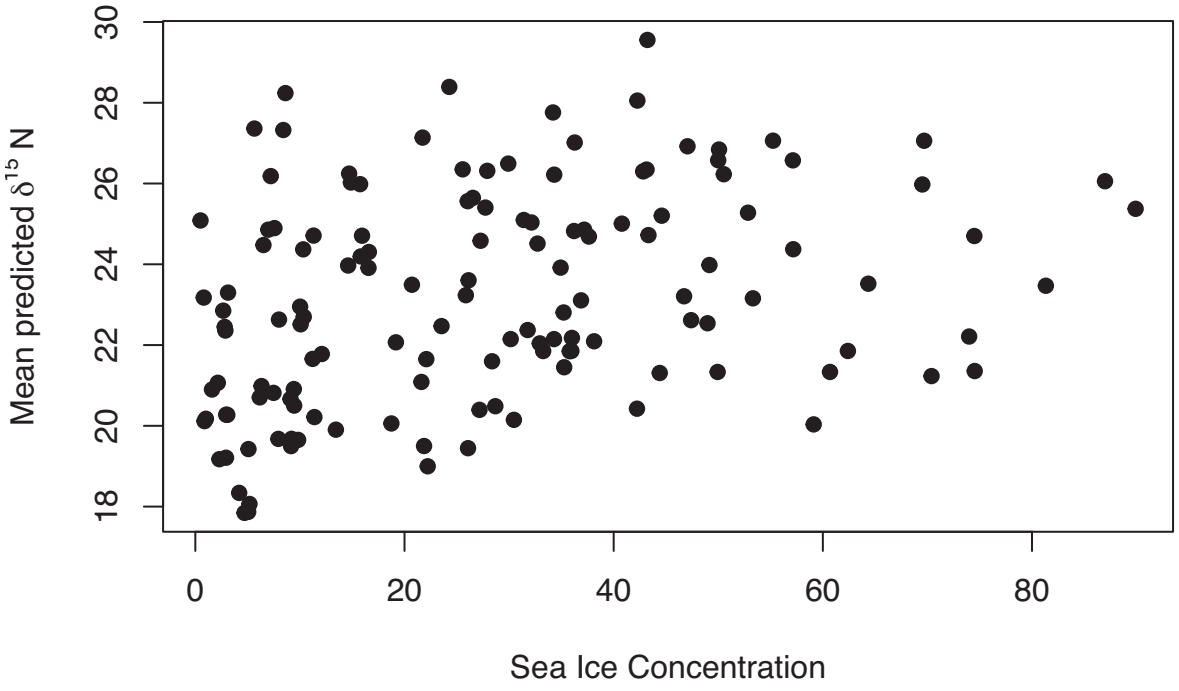

Figure A10-45: Site mean predicted $\delta^{15}N$ vs. SIC

Effect of $\delta^{15}N$ on growth rate

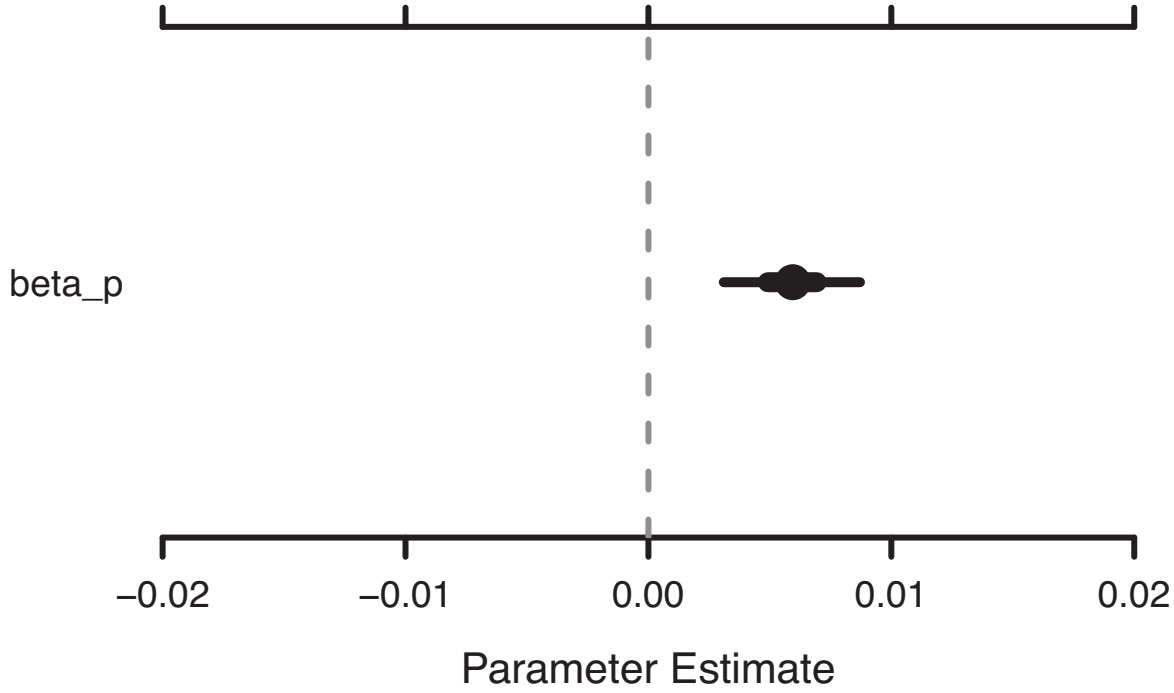

Figure A10-46: Posterior estimate for β_p, the strength of the relationship between $\delta^{15}N$ and population growth rate. Black circles represent posterior medians. Thicker lines represent 50% credible intervals while thinner lines represent 95% credible intervals.

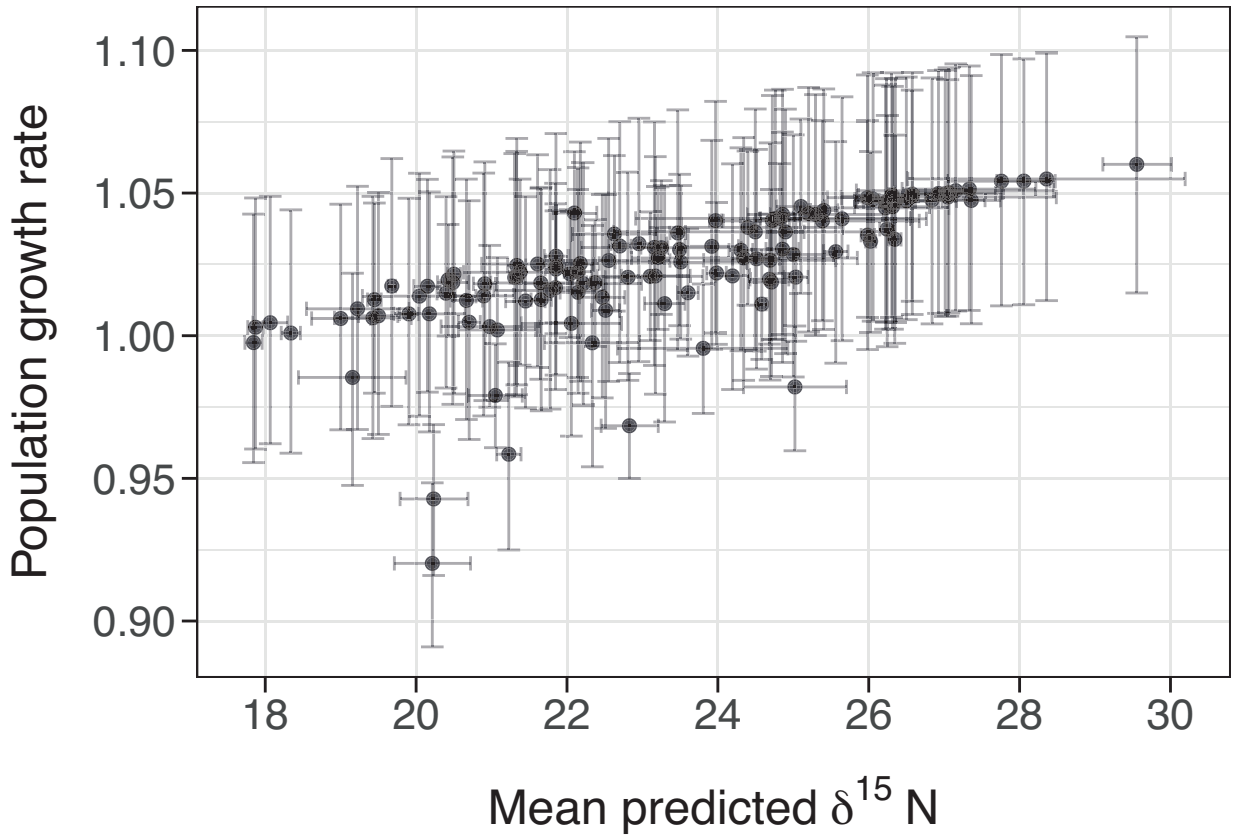

Figure A10-47: Estimated penguin colony population growth rates plotted against mean site predicted $\delta^{15}N$ values for each breeding colony. Error bars represent 95% credible intervals for growth rate and predicted $\delta^{15}N$ values.