

# Supplementary information:

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# 1 Hindcasting

## 1.1 MSE estimate

$$MSE_{estimate} = \frac{1}{n} \sum_{t=\text{last year}-n+1}^{\text{last year}} \left\{ \log I_t - \log \widehat{qB}_t \right\}^2$$

$n$  : Number of hinded years

$I_t$  : the biomass index in year  $t$

$\widehat{qB}_t$  : the estimated value of biomass index in year  $t$

	1year		2year		3years		4year		5years	
	NB1	NB2	NB1	NB2	NB1	NB2	NB1	NB2	NB1	NB2
MSE_CHN	0.399	0.405	0.677	0.672	0.155	0.161	0.270	0.275	0.149	0.163
MSE_JPN	0.991	1.021	0.179	0.161	0.427	0.448	0.444	0.470	0.387	0.443
MSE_KOR	0.182	0.183	0.749	0.732	0.058	0.067	0.080	0.087	0.065	0.080
MSE_RUS	1.047	1.081	0.331	0.327	0.518	0.539	0.504	0.524	0.413	0.454
MSE_CT	0.053	0.057	1.480	1.476	0.126	0.118	0.113	0.107	0.141	0.118
MSE_Bio	0.065	0.069	2.480	2.549	0.222	0.228	0.298	0.308	0.231	0.265
sum(CPUE)/5	0.534	0.549	0.683	0.674	0.257	0.267	0.282	0.293	0.231	0.252
(MSE_Bio+sum(CPUE)/5)/2	0.300	0.309	1.582	1.611	0.239	0.247	0.290	0.300	0.231	0.258

## 1.2 MSE MCMC sample mean

$$MSE_{mean} = \frac{1}{10000} \sum_{i=1}^{10000} \frac{1}{n} \sum_{t=\text{last year}-n+1}^{\text{last year}} \left\{ \log I_t - \log (q_i B_{ti}) \right\}^2$$

$n$  : Number of hinded years

$I_t$  : the biomass index in year  $t$

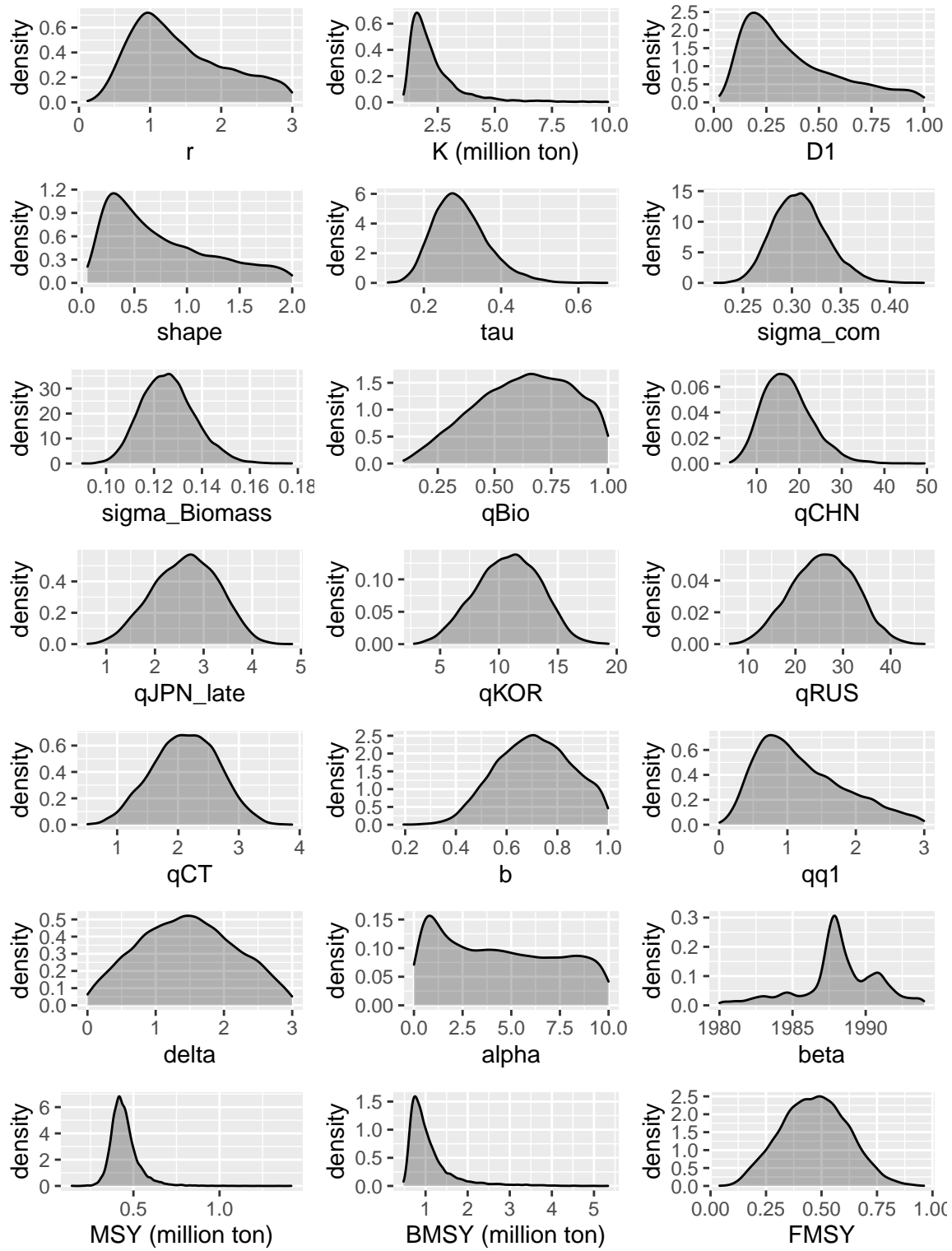
$q_i$  : the MCMC sample of catchability coefficient

$B_{ti}$  : the MCMC sample of biomass in year  $t$

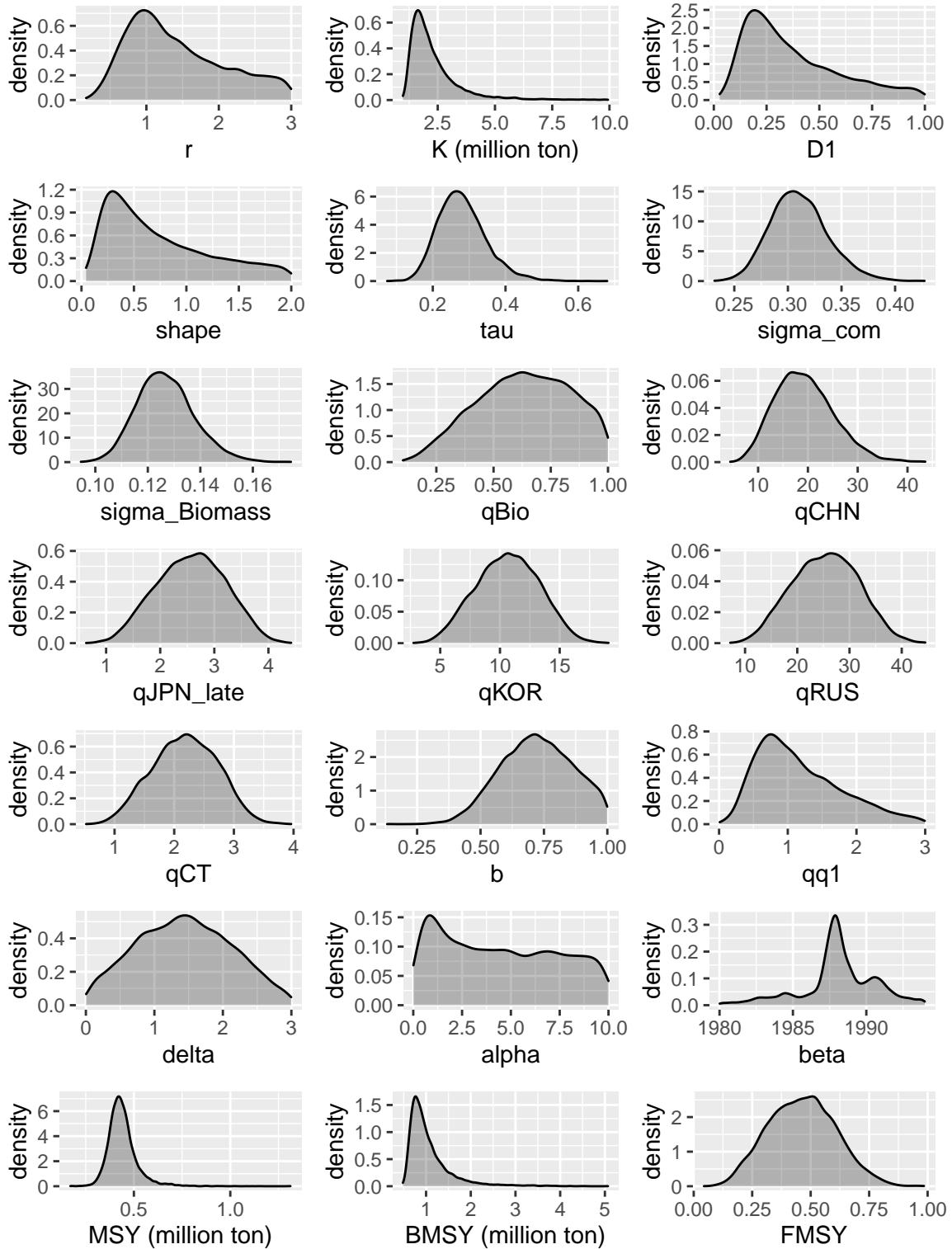
	1year		2year		3years		4year		5years	
	NB1	NB2	NB1	NB2	NB1	NB2	NB1	NB2	NB1	NB2
MSE_CHN	0.476	0.485	4.991	5.028	0.702	0.802	1.222	1.357	2.760	2.903
MSE_JPN	1.054	1.078	4.088	4.127	0.881	0.986	1.278	1.407	2.636	2.784
MSE_KOR	0.240	0.252	5.298	5.336	0.626	0.733	1.095	1.228	2.709	2.849
MSE_RUS	1.110	1.139	4.234	4.266	0.975	1.080	1.350	1.485	2.712	2.864
MSE_CT	0.115	0.126	6.287	6.322	0.746	0.850	1.241	1.380	3.134	3.252
MSE_Bio	0.223	0.251	14.691	15.016	1.420	1.656	2.180	2.462	4.951	5.328
sum(CPUE)/5	0.599	0.616	4.980	5.016	0.786	0.890	1.237	1.371	2.790	2.930
(MSE_Bio+sum(CPUE)/5)/2	0.411	0.433	9.835	10.016	1.103	1.273	1.709	1.917	3.870	4.129

### 1.3 Posterior distributions

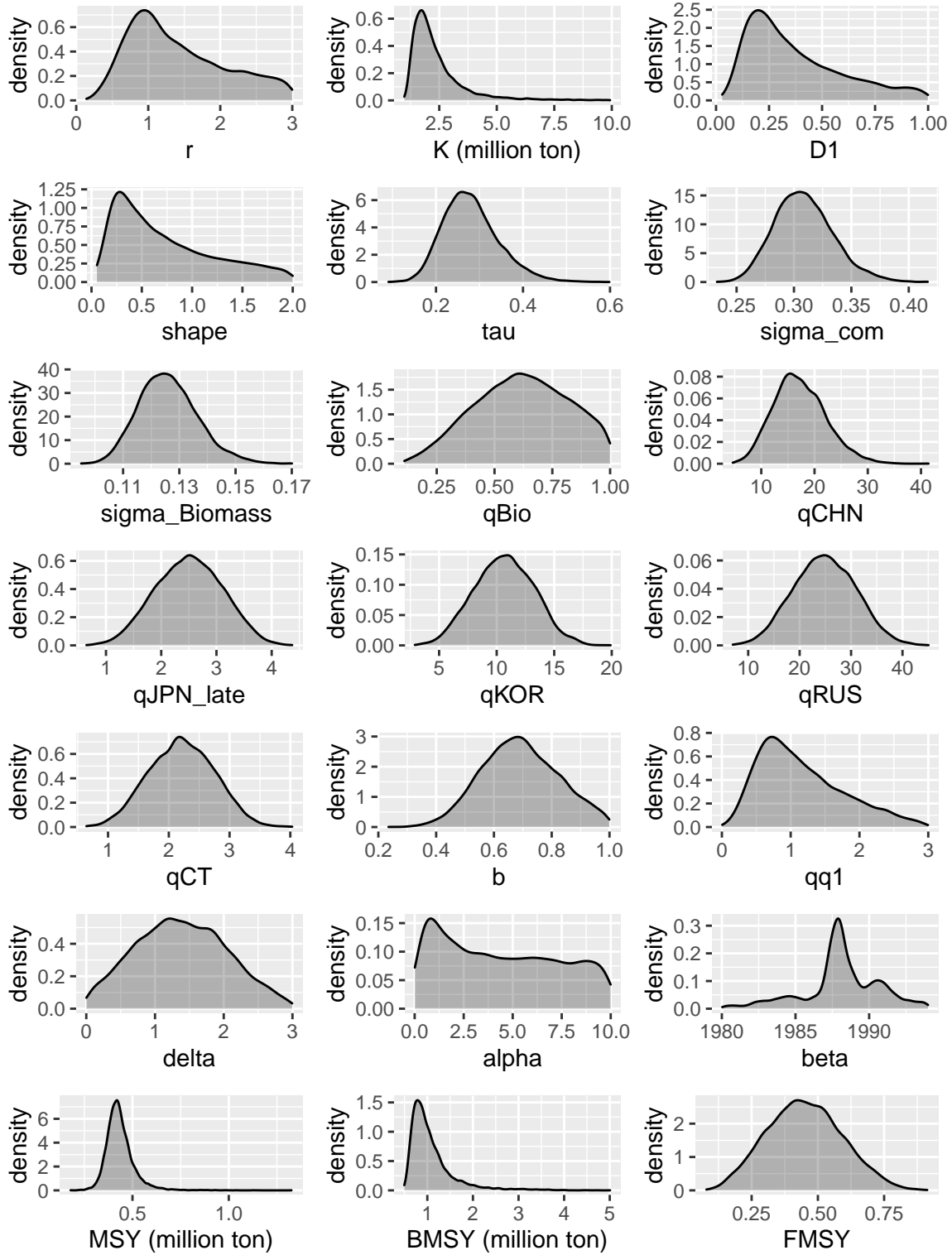
NB1 5 years



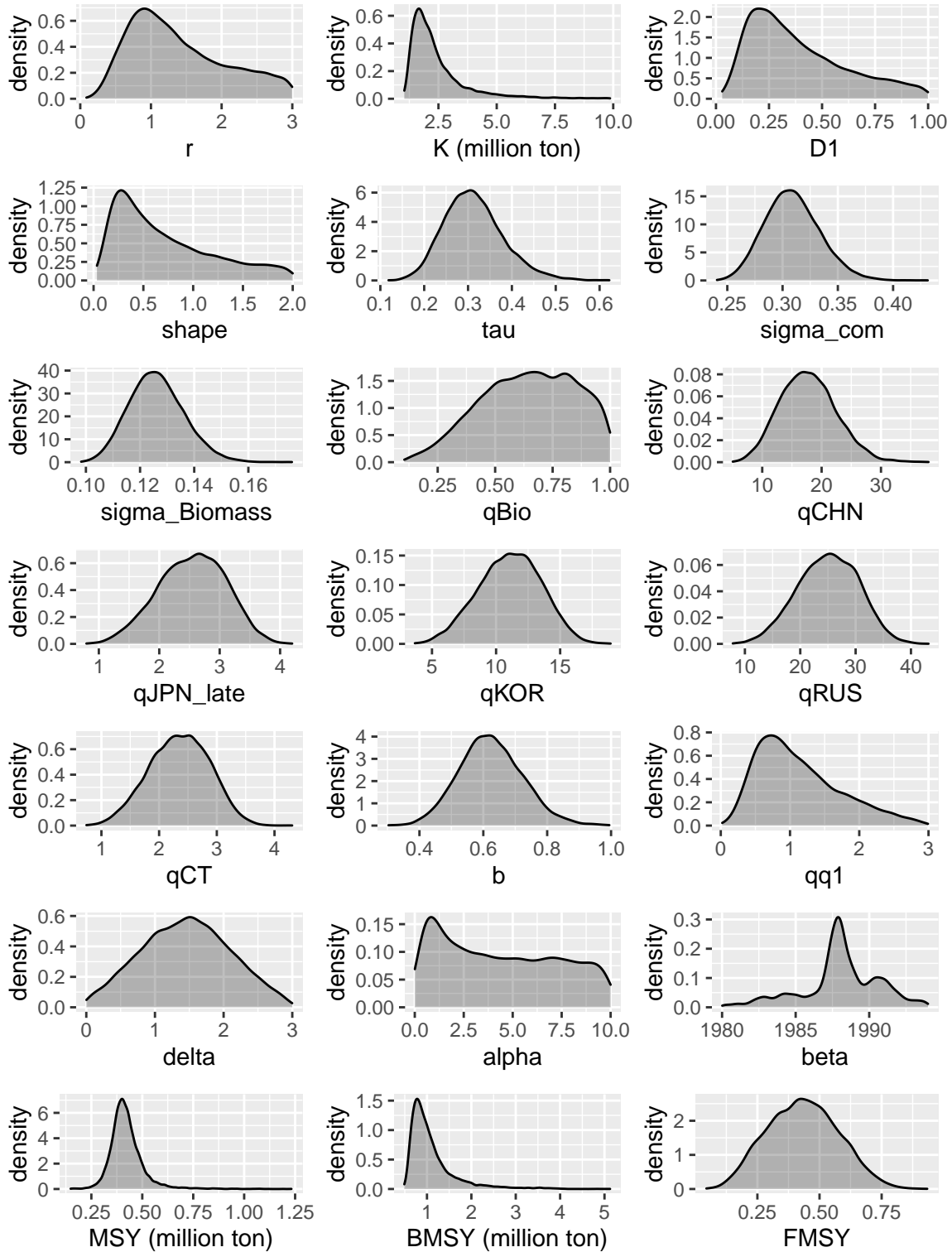
NB1 4 years



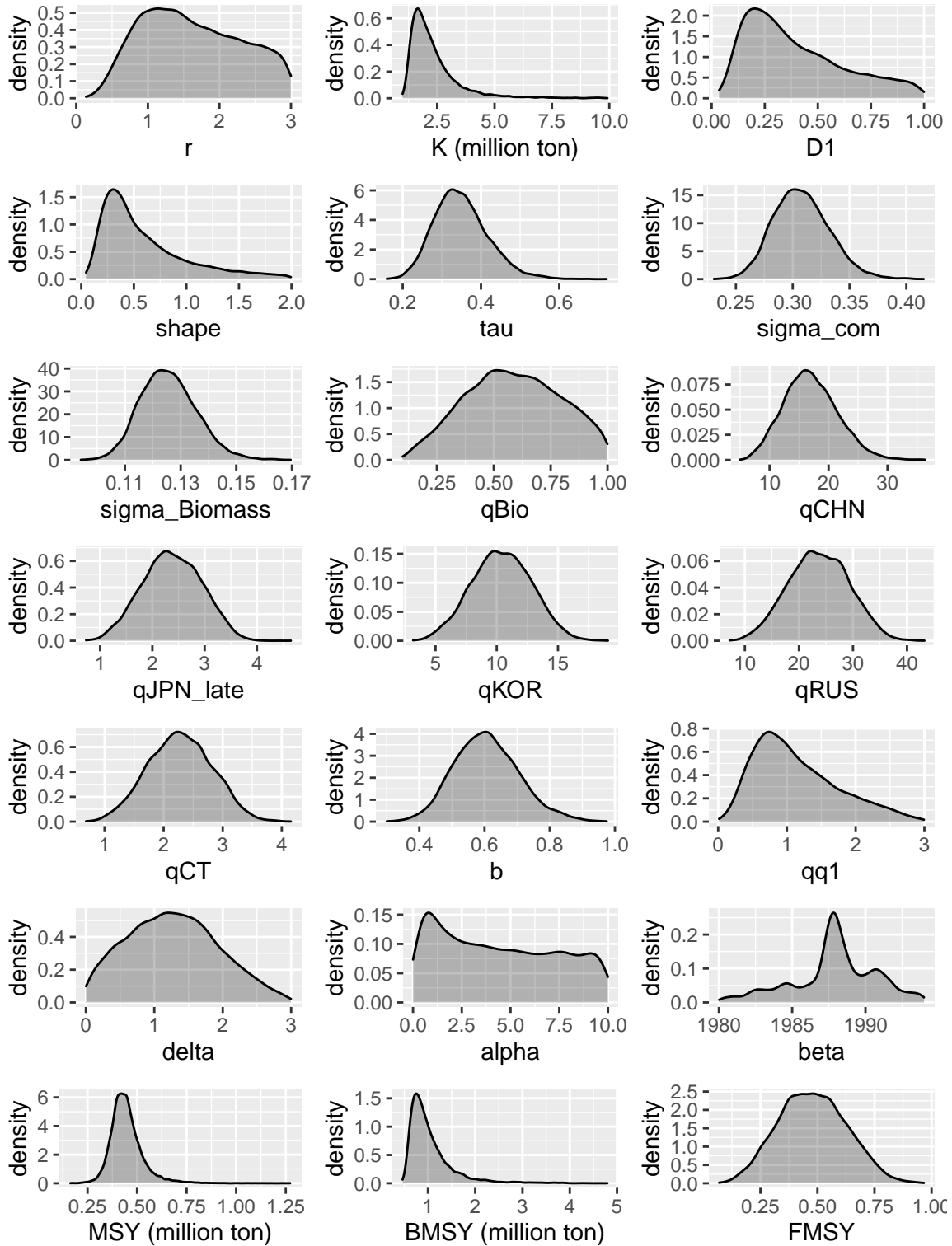
NB1 3 years



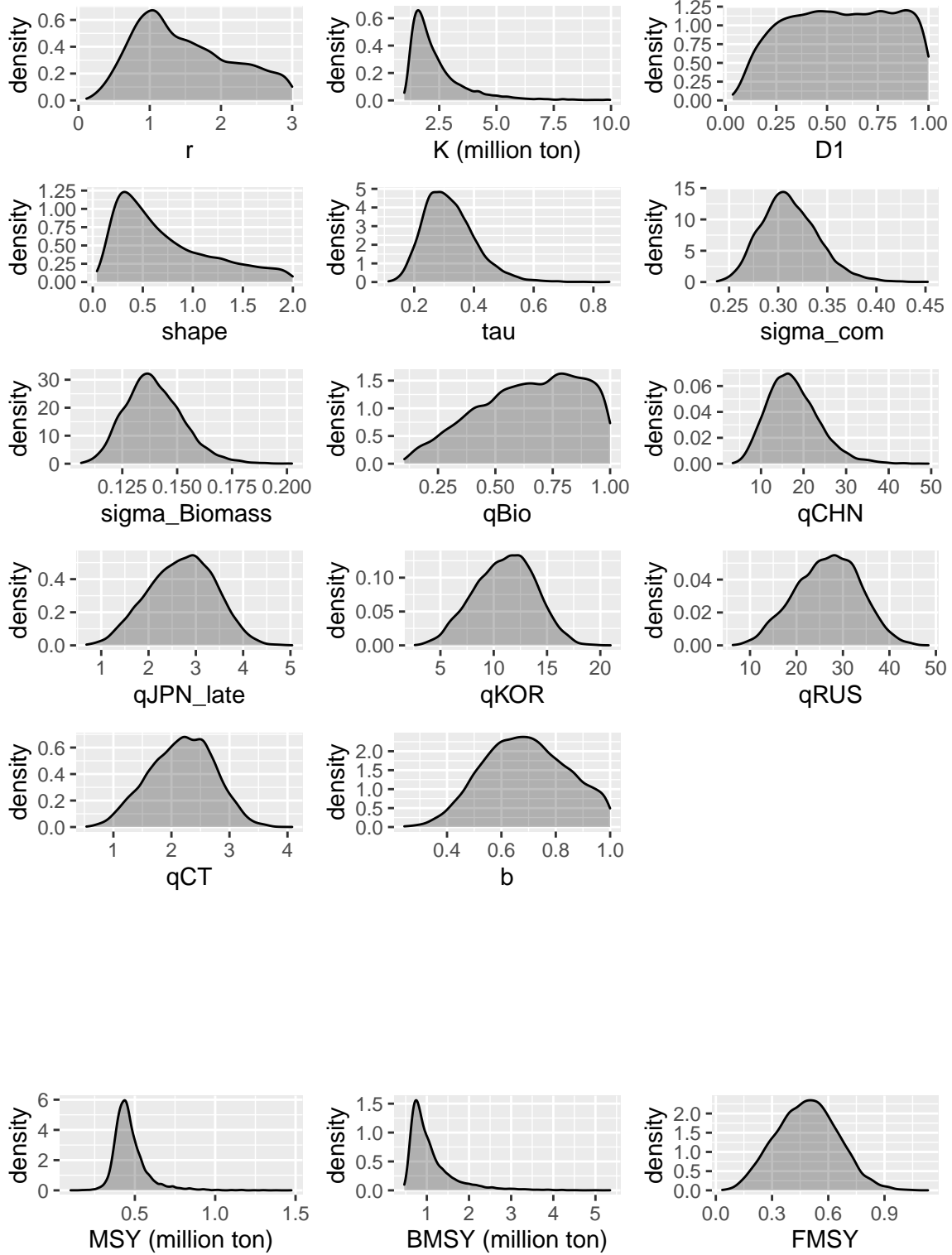
NB1 2 years



NB1 1 years

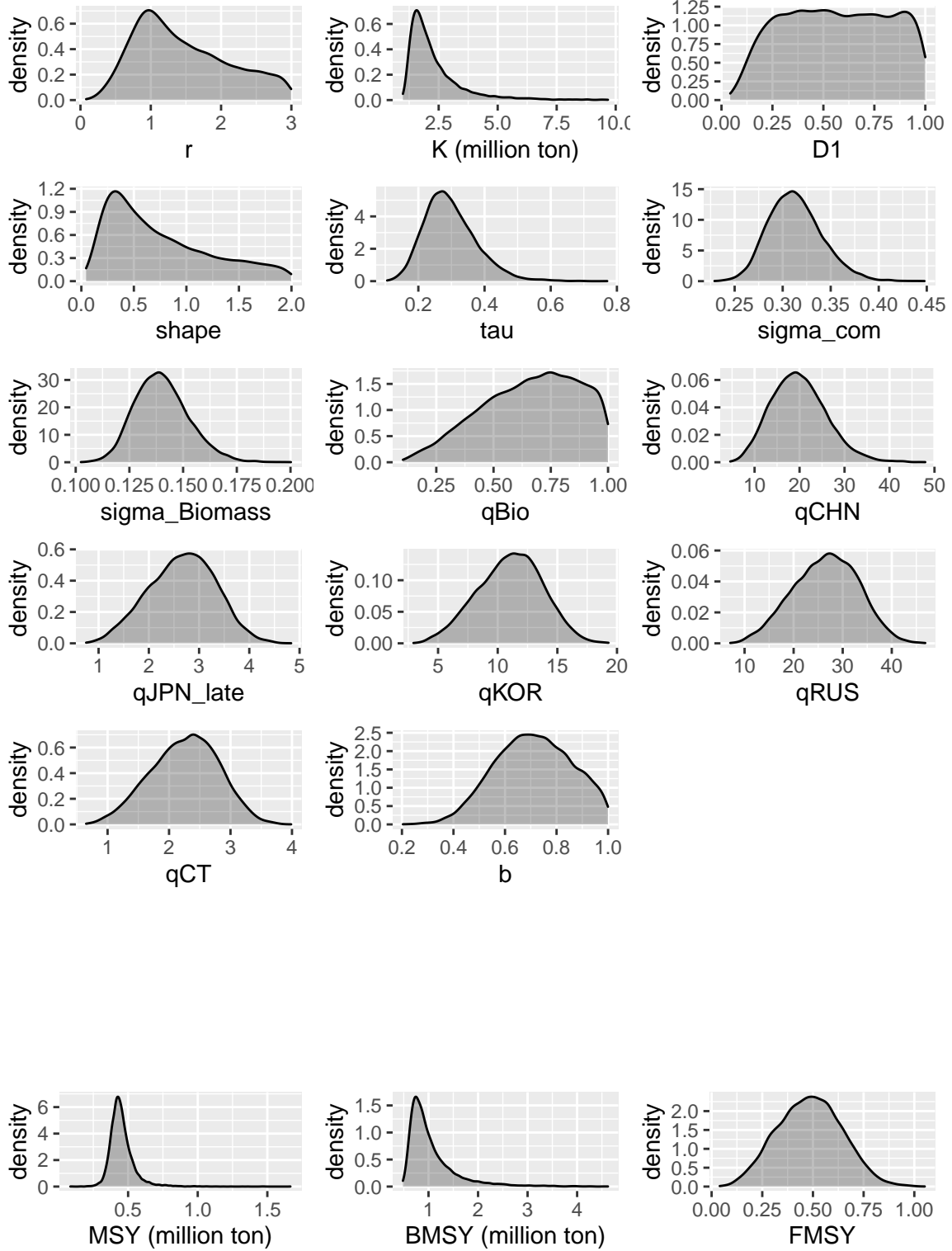


NB2 5 years

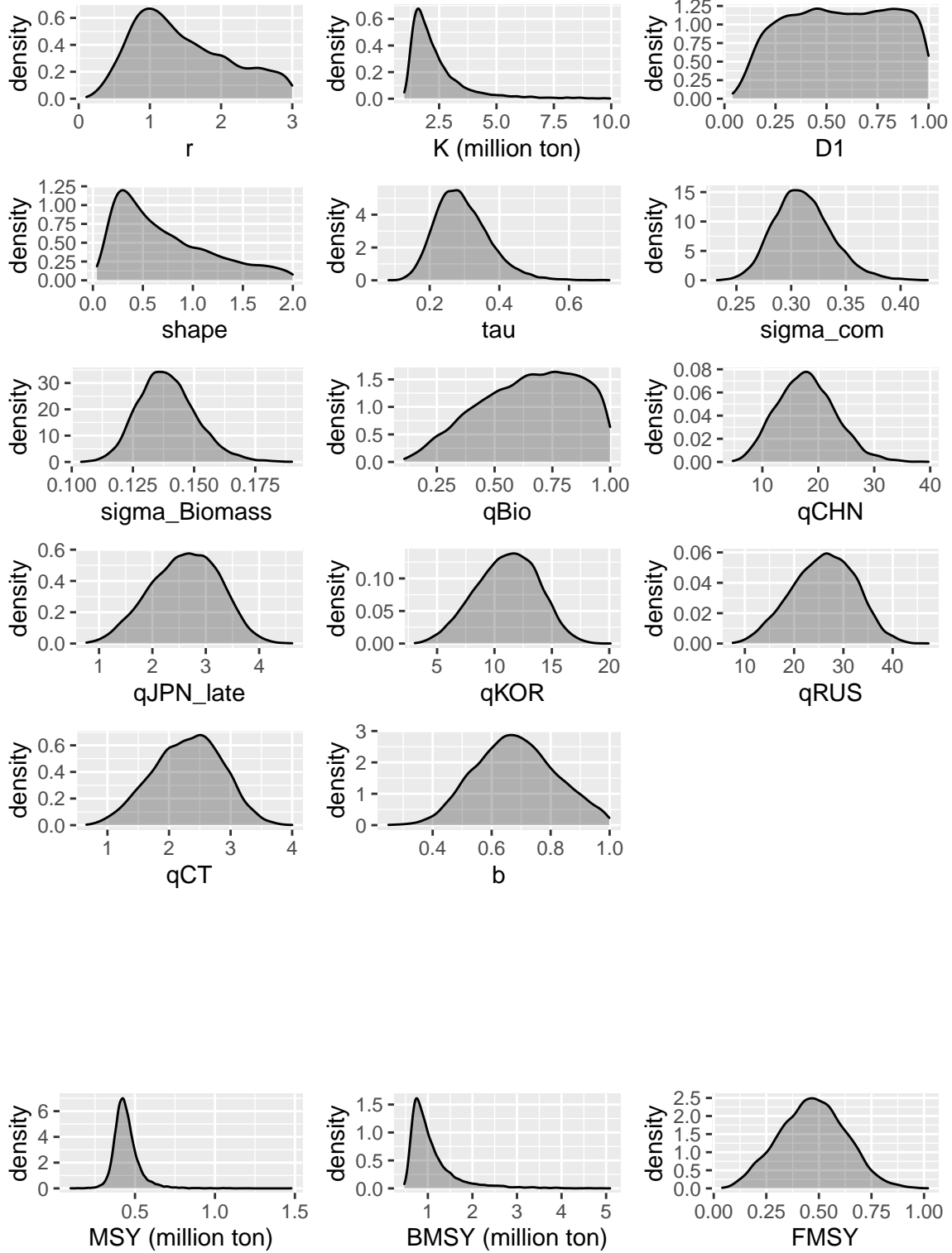




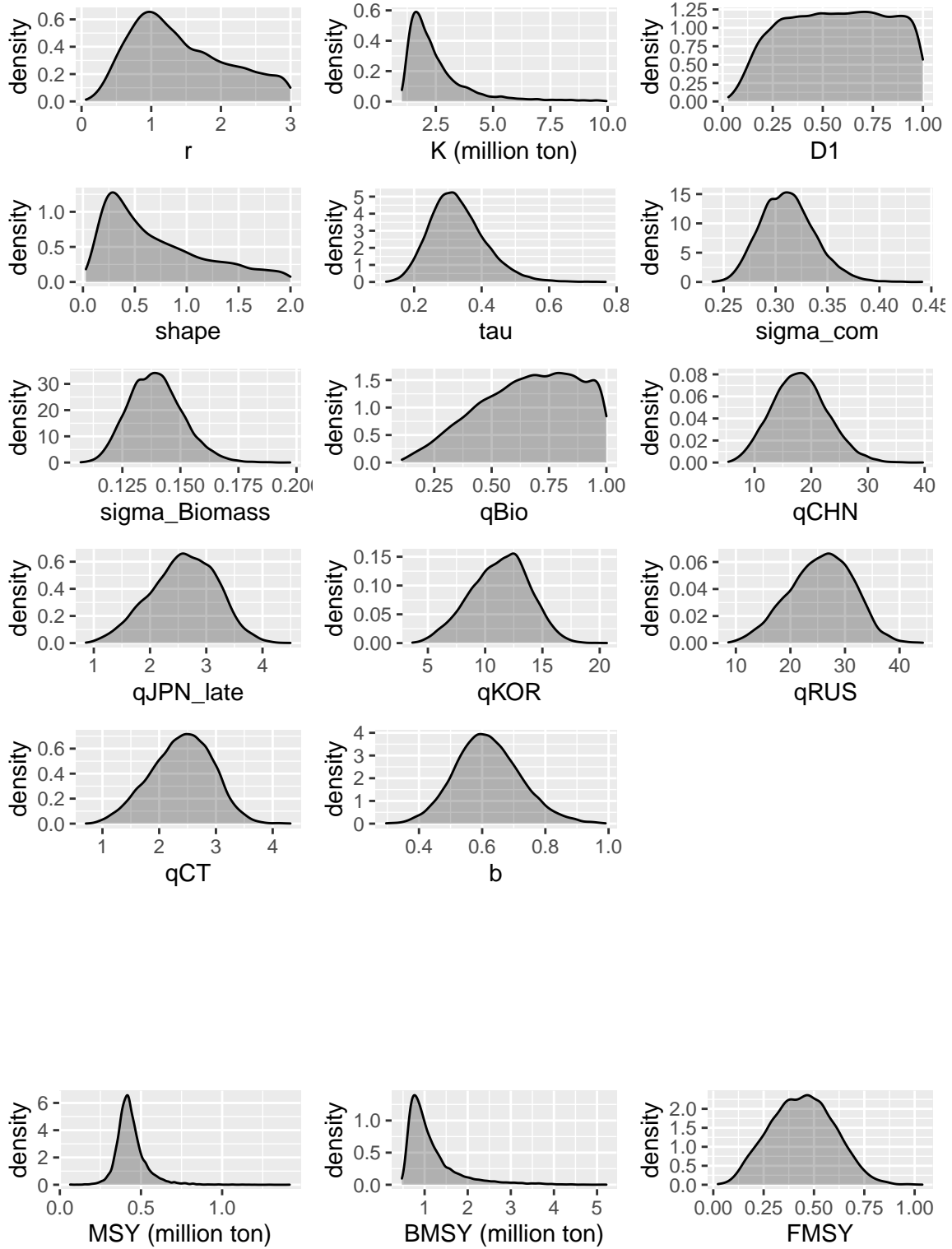
NB2 4 years



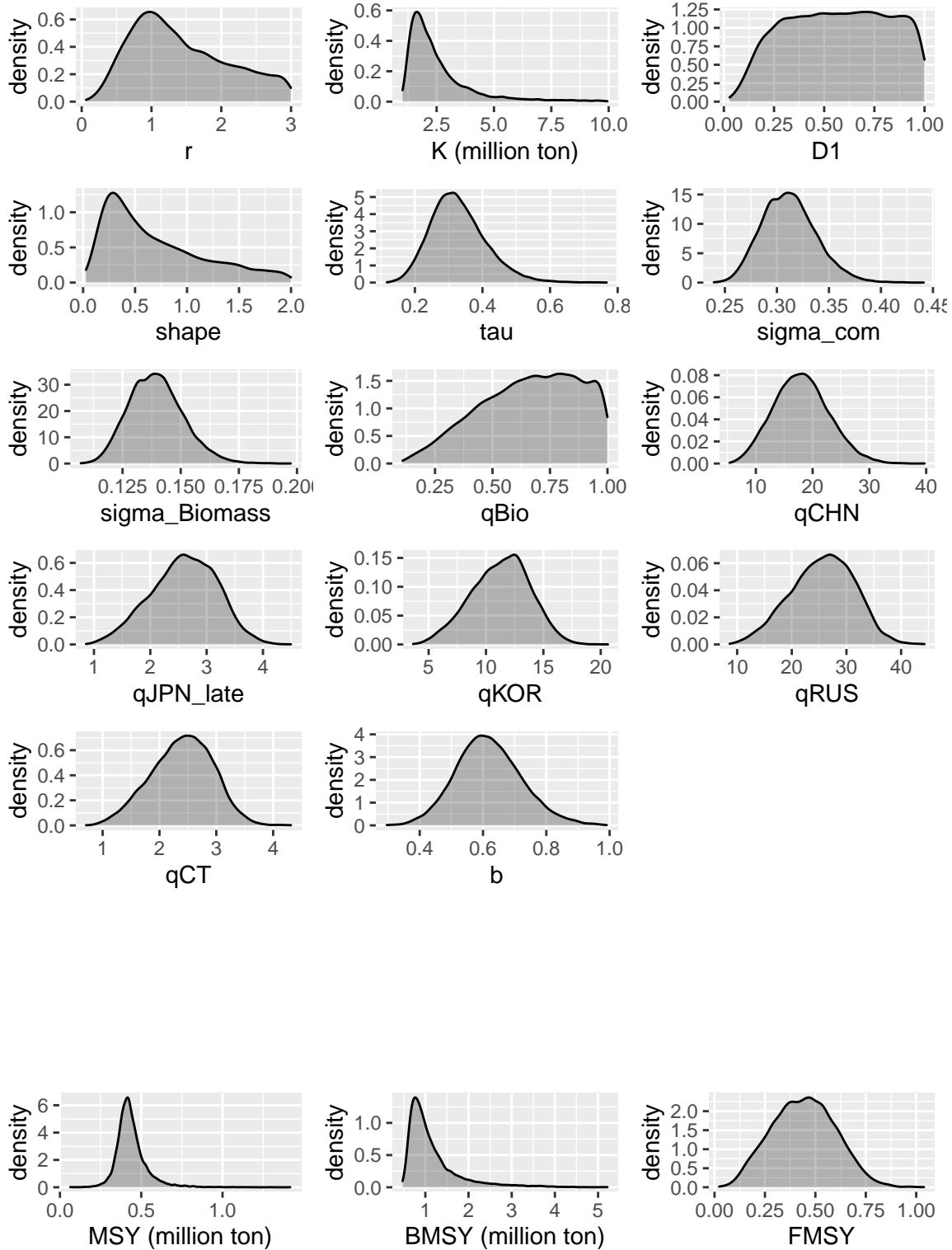
NB2 3 years



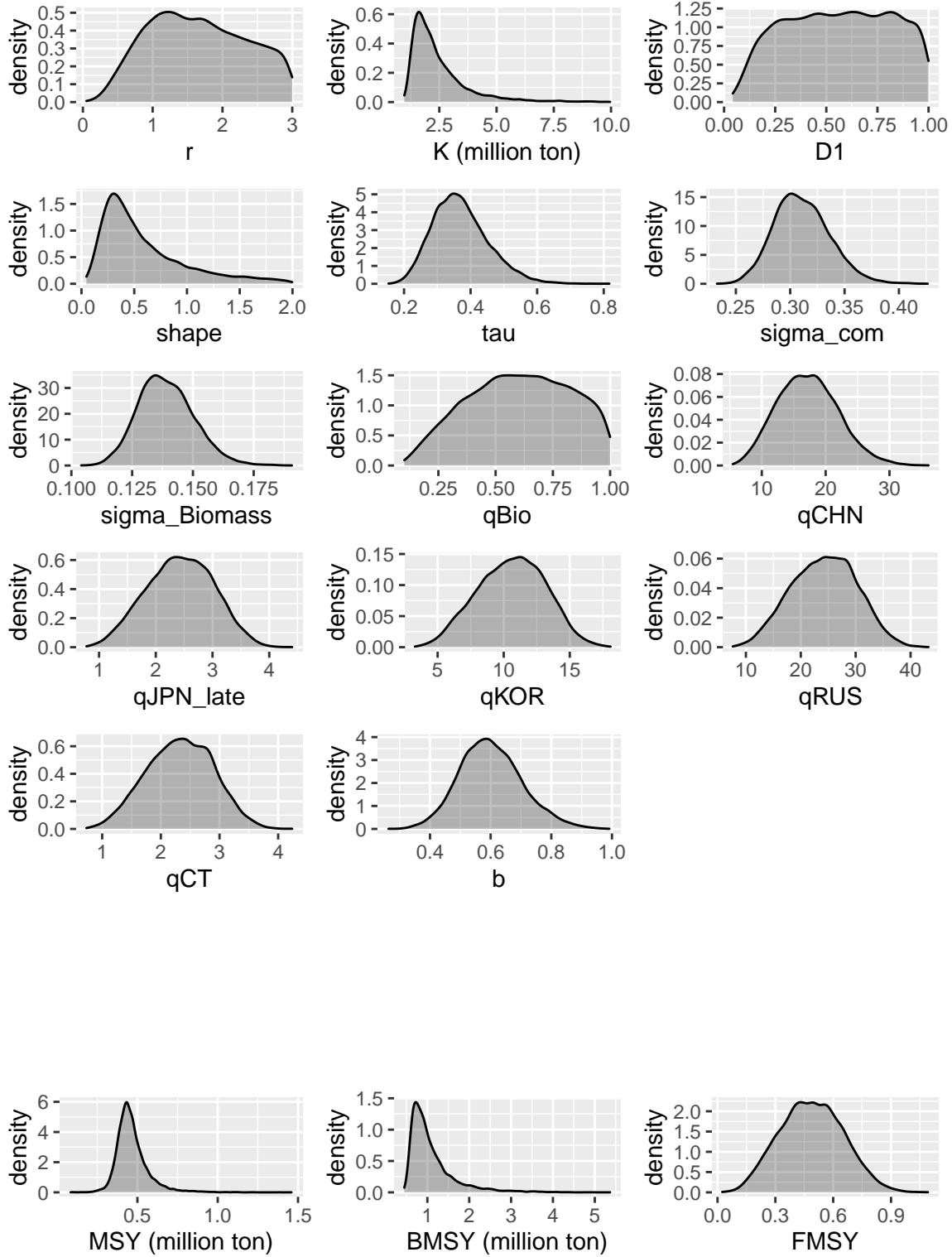
NB2 2 years



NB2 2 years



NB2 1 years

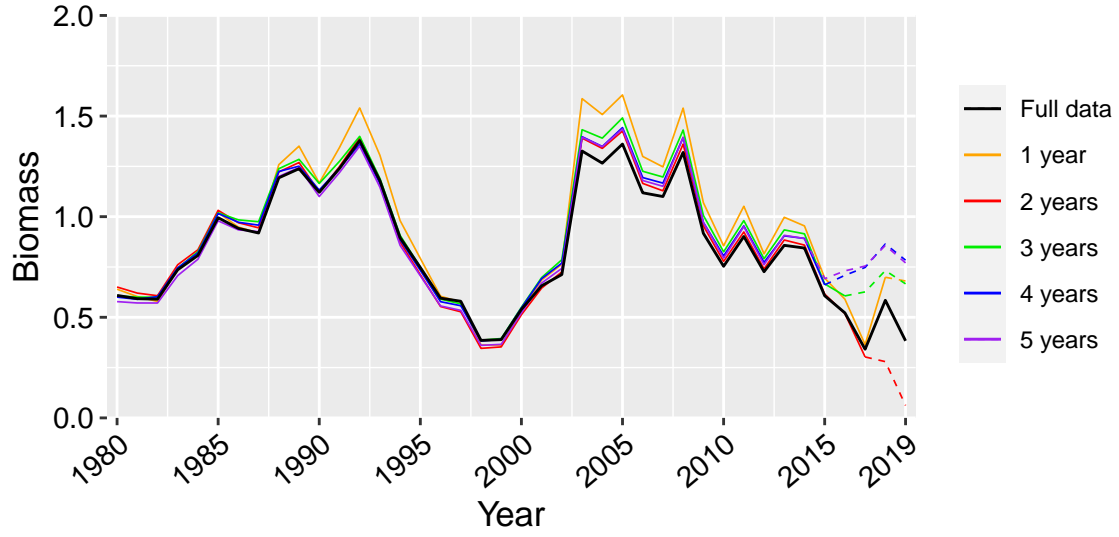


## 1.4 Results of parameters

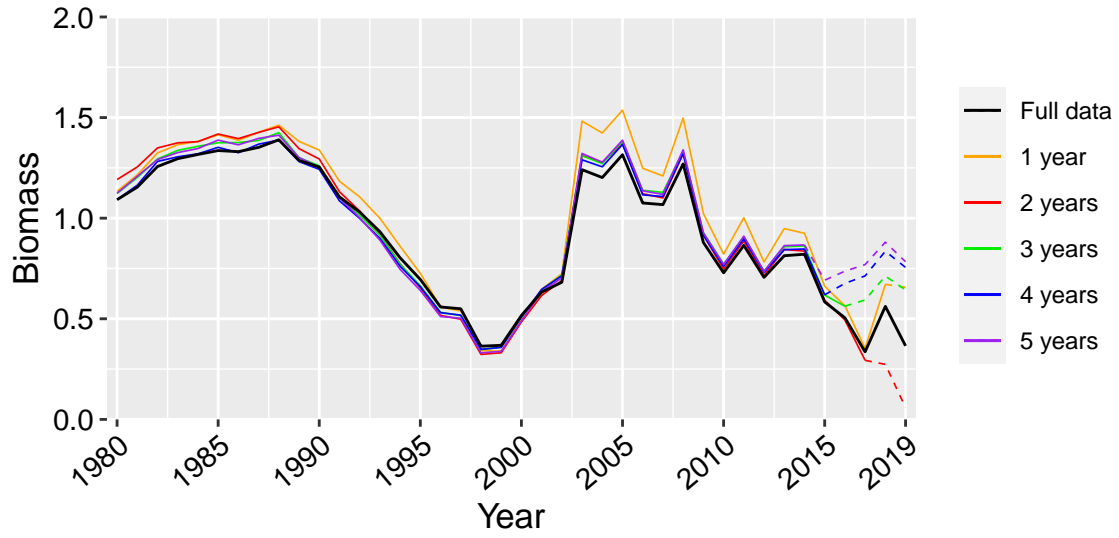
	1year		2years		3years		4years		5years	
	NB1	NB2	NB1	NB2	NB1	NB2	NB1	NB2	NB1	NB2
r	1.551	1.617	1.238	1.285	1.253	1.327	1.270	1.321	1.273	1.366
K (million ton)	2.036	2.084	2.056	2.108	2.033	2.002	1.990	1.952	1.977	1.999
qCHN	16.691	17.052	17.549	17.900	16.882	17.698	18.871	19.511	16.710	16.950
qJPN1	1.026		1.018		1.047		1.057		1.096	
qJPN2	2.369	2.439	2.567	2.617	2.506	2.636	2.587	2.690	2.656	2.730
qKOR	10.392	10.681	11.135	11.439	10.656	11.198	10.678	11.170	10.861	11.163
qRUS	23.665	24.378	25.171	25.916	24.824	26.246	25.527	26.795	26.037	26.986
qCT	2.275	2.336	2.361	2.421	2.211	2.323	2.185	2.283	2.131	2.201
qBio	0.581	0.611	0.657	0.683	0.621	0.671	0.640	0.683	0.646	0.671
Shape	0.464	0.461	0.570	0.551	0.586	0.588	0.599	0.610	0.608	0.579
sigma_com	0.306	0.309	0.308	0.311	0.307	0.309	0.309	0.311	0.307	0.309
sigma_Bio	0.125	0.138	0.126	0.139	0.125	0.138	0.126	0.139	0.125	0.138
tau	0.344	0.362	0.308	0.320	0.275	0.286	0.275	0.287	0.288	0.309
FMSY	0.475	0.488	0.432	0.443	0.447	0.471	0.463	0.484	0.469	0.487
BMSY (million ton)	0.911	0.929	0.948	0.965	0.943	0.922	0.921	0.906	0.921	0.924
MSY (million ton)	0.436	0.449	0.411	0.424	0.424	0.433	0.430	0.439	0.434	0.449
b	0.602	0.595	0.620	0.613	0.687	0.679	0.722	0.710	0.710	0.685

## 1.5 Biomass

NB1

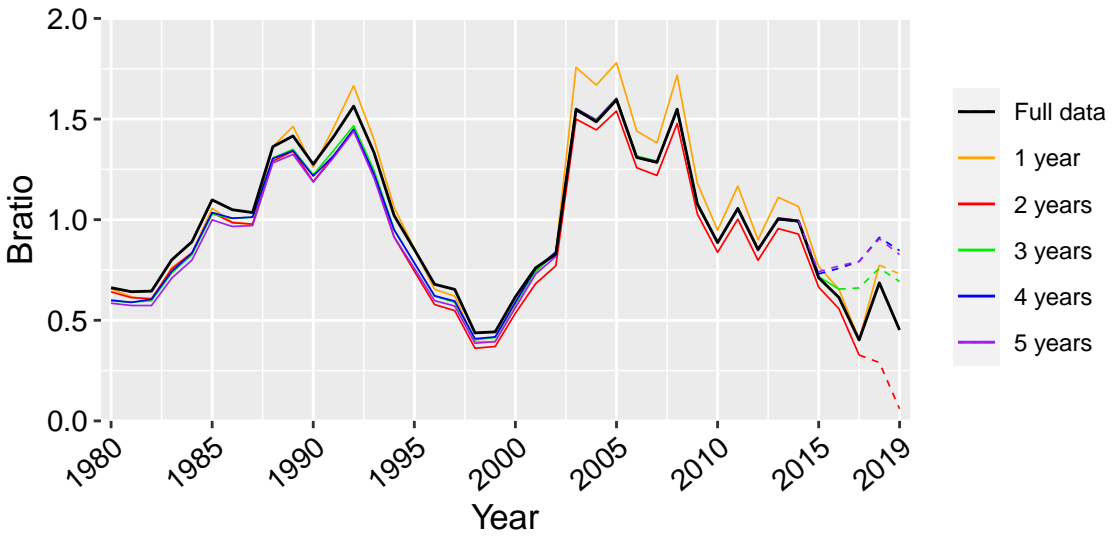


NB2

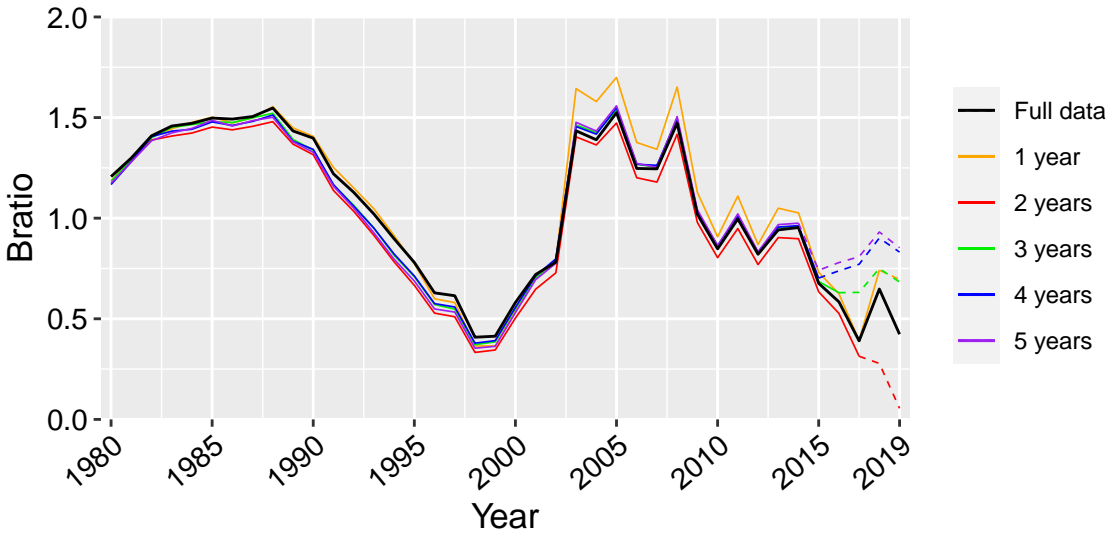


## 1.6 Bratio

NB1



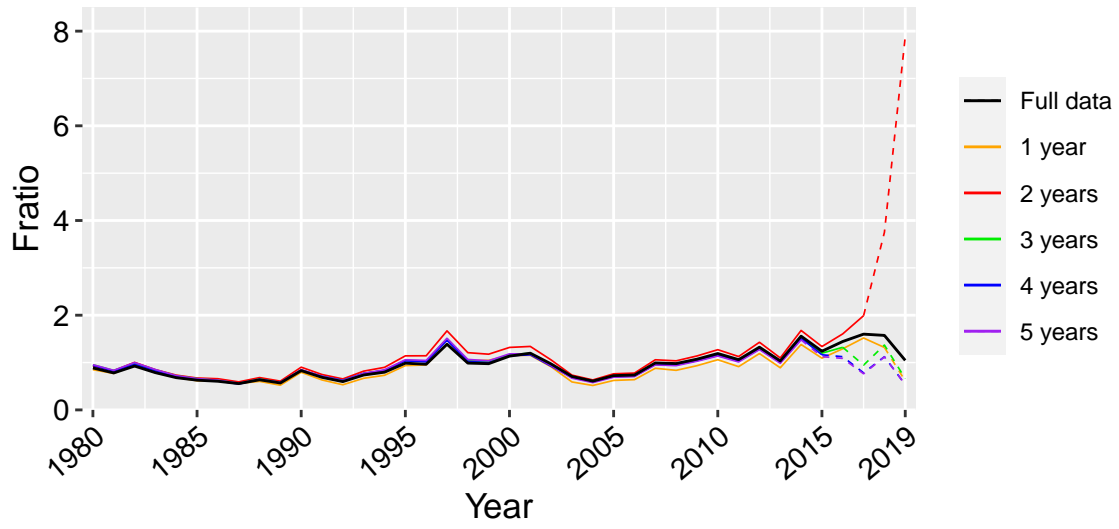
NB2



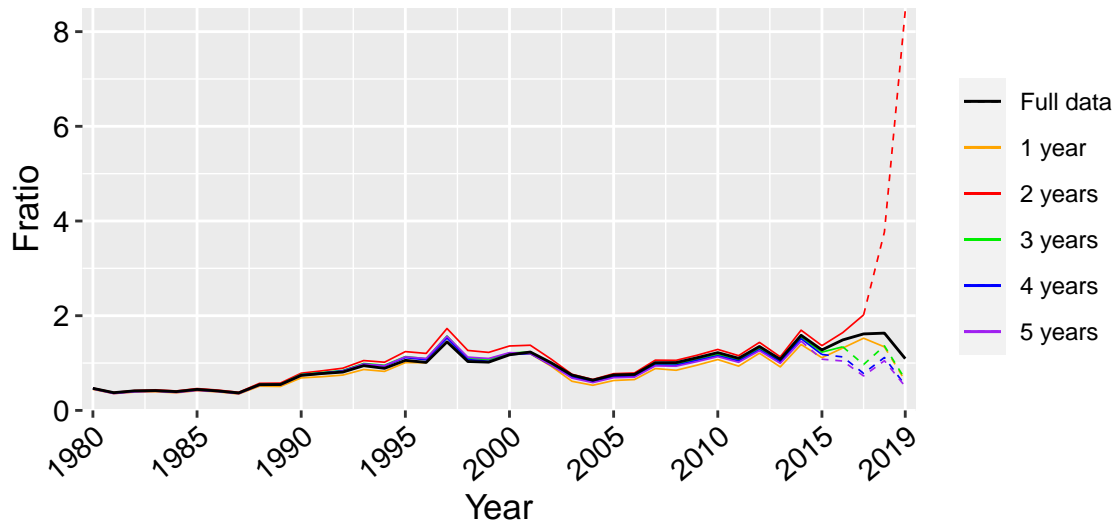


## 1.7 Fratio

NB1



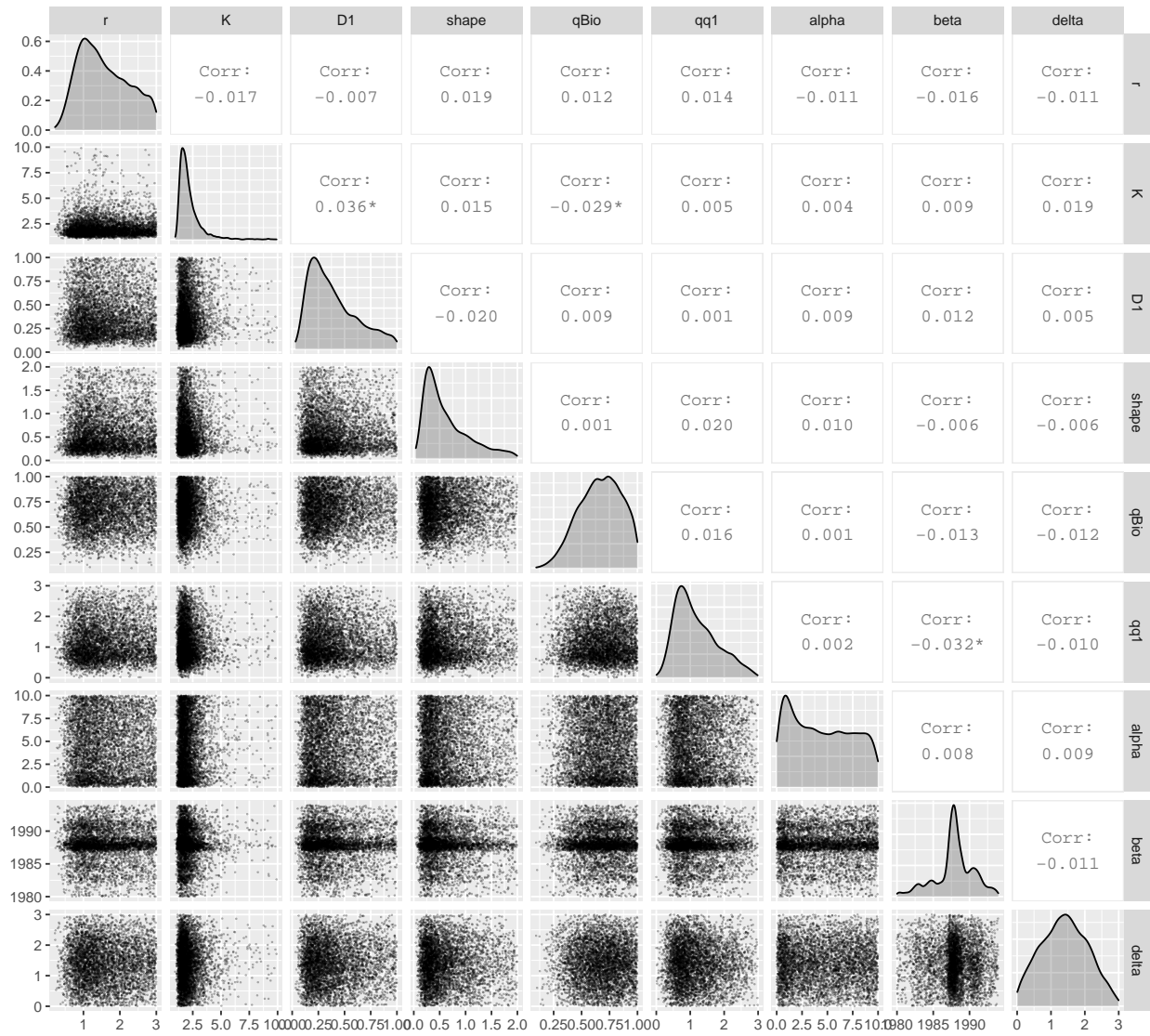
NB2



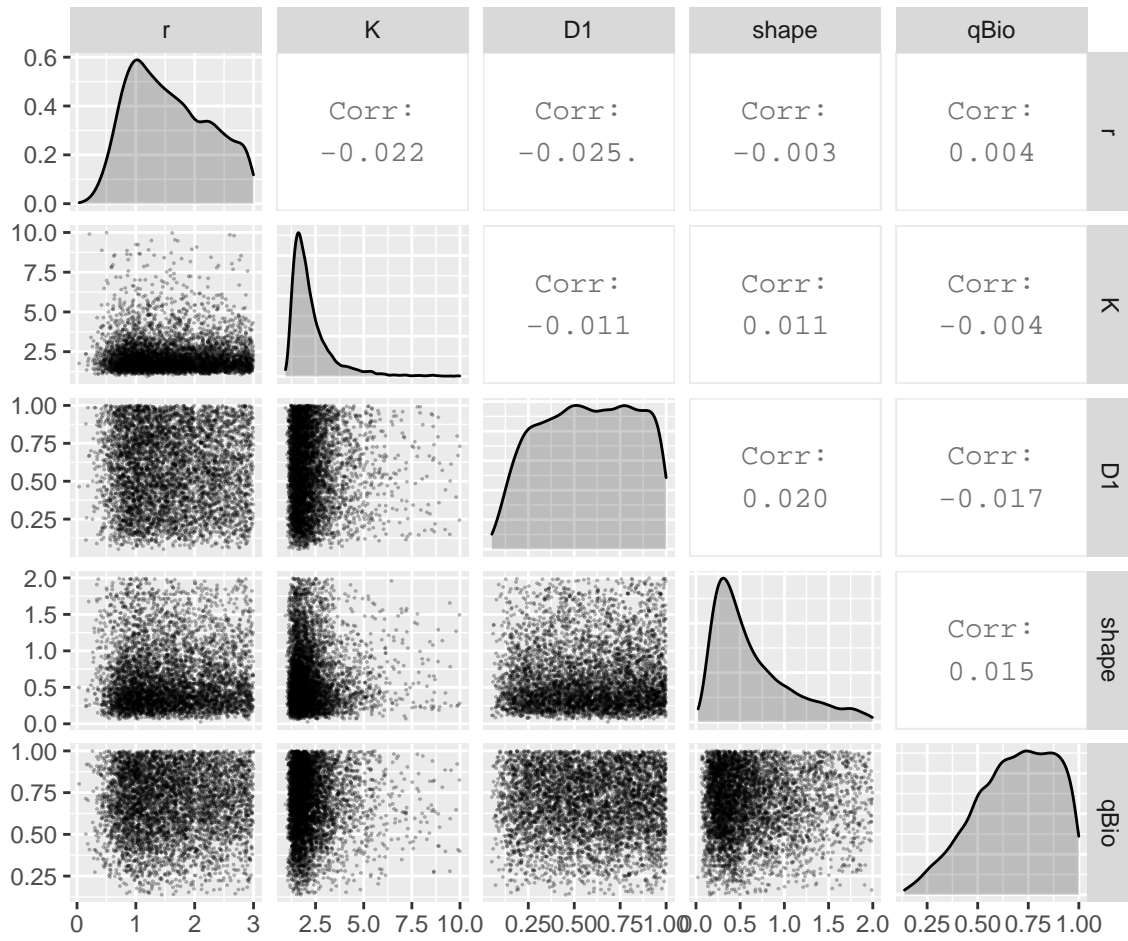
## 2 Correlation

1,000 MCMCsamples from a total of 10,000 samples

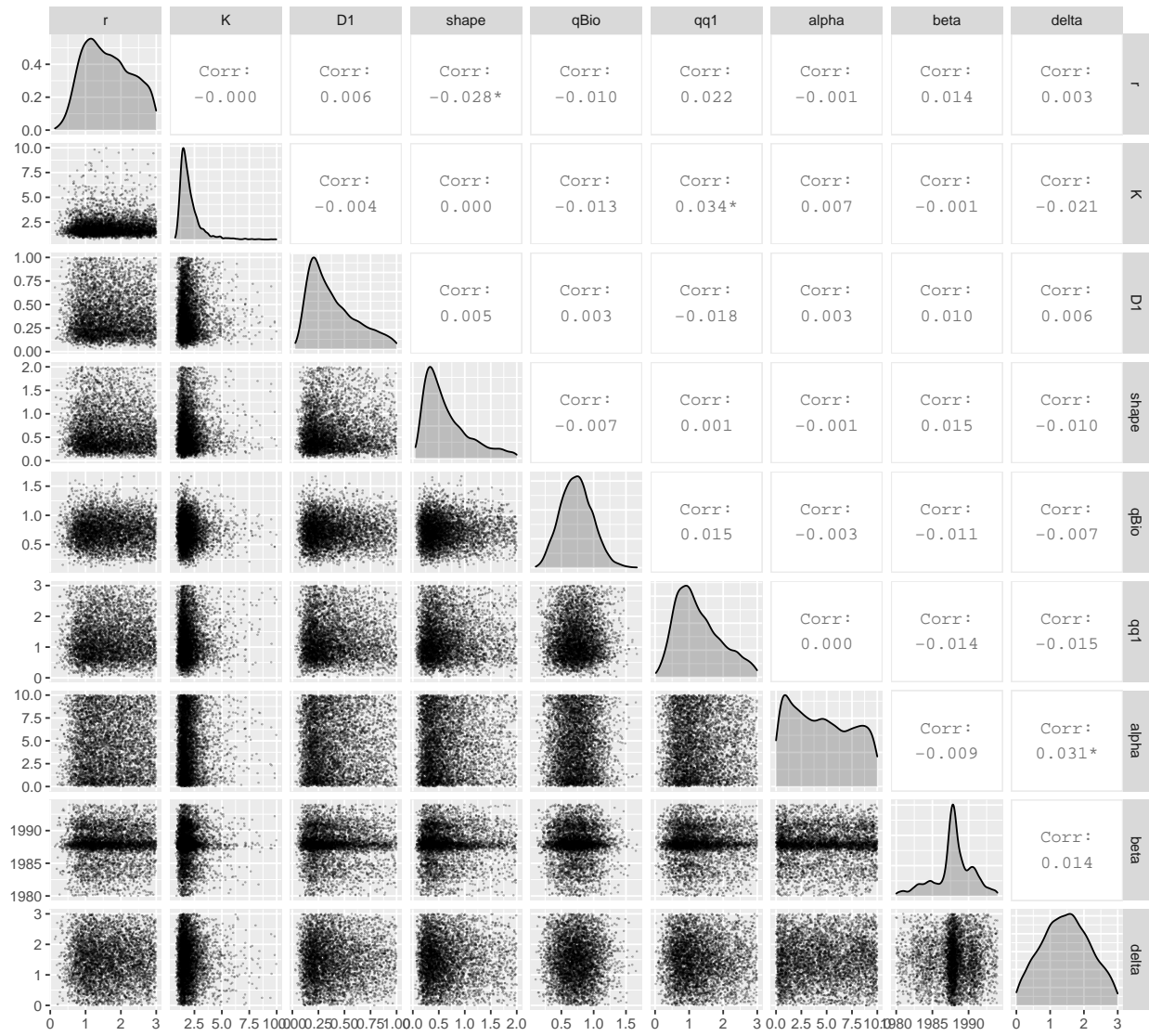
Base case 1



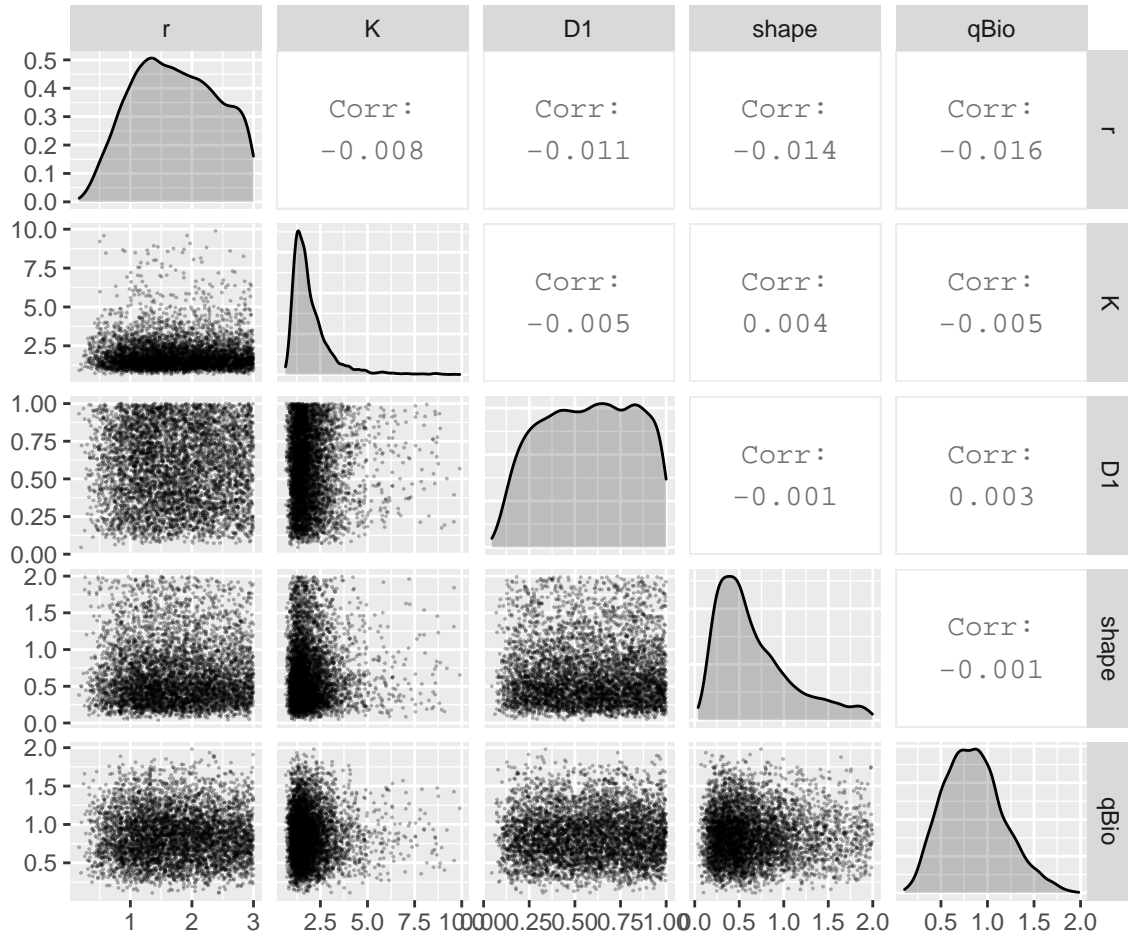
Base case 2



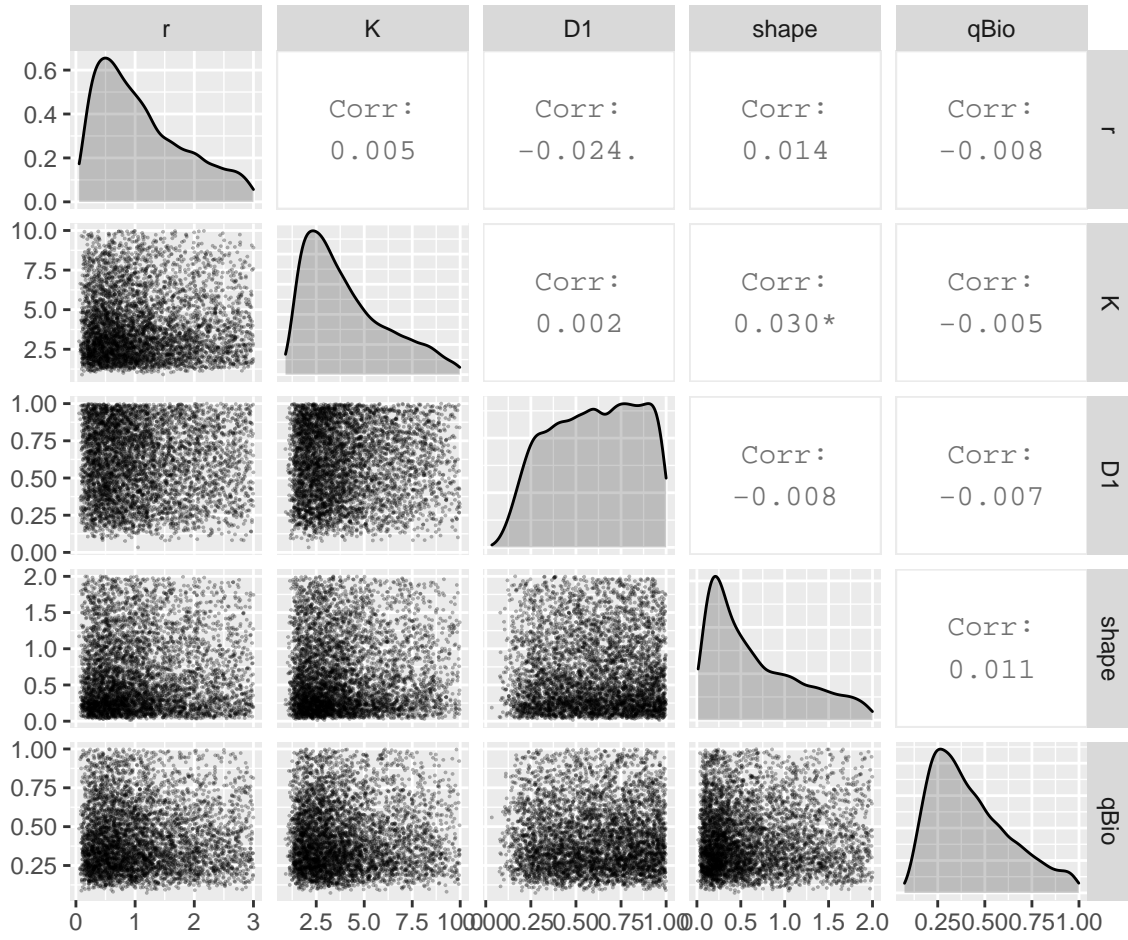
Sensitivity case 1



Sensitivity case 2



Sensitivity case 3



Sensitivity case 4

