

Jacquemyn, H., Brys, R., Davison, R., Tuljapurkar, S. and Jongejans, E. 2012. Stochastic LTRE analysis of the effects of herbivory on the population dynamics of a perennial grassland herb. – *Oikos* 121: 211-218.

Appendix A1

Vital rates used to construct matrix models of mown and grazed *Primula veris* populations. Data were collected in two sites during ten consecutive years (1999–2008). Sigma refers to survival, gamma to growth conditional on survival, and phi refers to the probability of a plant flowering in the next year. Mu represents the average number of flowers, pi the average number of seeds per fruit and epsilon the proportion of seeds that germinate and successfully establish as a seedling.

	sigmaL	sigmaJ	sigmaV	sigmaF	gammaL	gammaJ	phiJ	phiV	phiF	mu	pi	epsilon
1G99	0.86956522	0.8461538	0.8000000	0.7428571	0.0000000	0.9090909	0.0000000	0.11764706	0.2692308	5.54	22.77	0.004076915
1G00	0.72222222	0.8181818	0.7373737	0.8666667	0.0000000	0.9444444	0.0000000	0.08219178	0.3076923	3.44	13.56	0.024296266
1G01	0.82352941	1.0000000	0.9569892	1.0000000	0.0000000	0.9285714	0.15384615	0.12359551	0.0000000	3.94	12.45	0.032617781
1G02	0.75000000	1.0000000	0.9595960	1.0000000	0.0000000	0.8000000	0.0000000	0.14736842	0.1538462	4.22	6.36	0.054455366
1G03	0.36842105	0.8000000	0.8557692	1.0000000	0.0000000	0.8333333	0.0000000	0.03370787	0.1875000	5.60	9.71	0.016091658
1G04	0.28571429	0.6666667	0.9174312	1.0000000	0.0000000	1.0000000	0.0000000	0.1500000	0.1666667	4.54	12.17	0.030164930
1G05	0.20000000	0.7500000	0.9270833	0.9375000	0.0000000	0.3333333	0.0000000	0.17977528	0.0000000	5.02	15.18	0.027065650
1G06	0.30303030	1.0000000	0.9550562	0.9375000	0.0000000	1.0000000	0.2500000	0.31764706	0.2000000	4.67	21.30	0.032044515
1G07	0.27450980	0.9000000	0.9726027	1.0000000	0.0000000	1.0000000	0.11111111	0.32394366	0.5483871	5.67	26.73	0.016175953
1M99	0.61538462	0.8148148	0.8596491	0.9047619	0.0000000	1.0000000	0.0000000	0.30612245	0.4210526	5.53	22.72	0.006190448
1M00	0.51020408	0.8750000	0.9325843	0.8974359	0.0000000	1.0000000	0.0000000	0.16867470	0.2857143	6.04	41.80	0.003351476
1M01	0.54545455	0.6400000	0.9405941	0.9166667	0.0000000	1.0000000	0.3750000	0.47368421	0.6818182	10.56	34.75	0.002952184
1M02	0.80769231	0.6111111	0.9701493	1.0000000	0.0000000	1.0000000	0.0000000	0.38461538	0.3787879	12.15	52.48	0.001568303

1M03	0.40909091	0.7619048	0.9347826	1.0000000	0.00000000	0.8750000	0.21428571	0.44186047	0.8400000	8.59	33.12	0.011669563
1M04	0.10240964	0.5862069	0.9253731	0.9540230	0.00000000	0.7647059	0.15384615	0.48387097	0.8915663	8.02	35.16	0.008478536
1M05	0.11057692	0.7142857	0.9807692	0.9622642	0.00000000	1.0000000	0.20000000	0.27450980	0.3823529	9.12	38.12	0.005074439
1M06	0.12299465	0.6956522	0.9553571	0.9642857	0.00000000	0.8750000	0.21428571	0.66355140	0.5555556	8.89	34.67	0.005156397
1M07	0.19101124	0.6800000	0.9577465	0.9615385	0.00000000	0.9411765	0.00000000	0.72058824	0.5300000	10.07	40.93	0.002776147
2G99	0.76363636	0.7948718	0.8909091	0.9473684	0.19047619	0.5806452	0.02777778	0.25510204	0.1111111	5.00	22.66	0.019510382
2G00	0.43181818	0.4583333	0.6126761	0.6896552	0.10526316	0.8787879	0.03448276	0.16091954	0.2000000	4.56	18.46	0.004506072
2G01	0.54545455	0.5714286	0.9480519	1.0000000	0.00000000	0.9166667	0.09090909	0.30136986	0.2857143	4.12	15.67	0.086297925
2G02	0.58974359	1.0000000	0.9878049	1.0000000	0.00000000	0.8571429	0.00000000	0.02469136	0.0400000	3.89	14.89	0.022098646
2G03	0.34375000	0.7500000	0.8897638	1.0000000	0.00000000	0.7777778	0.00000000	0.02654867	0.0000000	4.89	13.67	0.069811892
2G04	0.28571429	0.4666667	0.8677686	1.0000000	0.00000000	0.8571429	0.00000000	0.06666667	0.0000000	5.23	17.89	0.046313763
2G05	0.23076923	1.0000000	0.9279279	0.8571429	0.00000000	0.8000000	0.00000000	0.16504854	0.1666667	4.82	21.67	0.025986609
2G06	0.31578947	1.0000000	0.9494949	0.9444444	0.00000000	1.0000000	0.00000000	0.28723404	0.6470588	5.01	18.18	0.028667759
2G07	0.25531915	0.8333333	0.9358974	0.9743590	0.00000000	1.0000000	0.20000000	0.12328767	0.3684211	5.12	21.63	0.027783705
2M99	0.84615385	0.9200000	0.9333333	0.8518519	0.03030303	0.8260870	0.13157895	0.35714286	0.6086957	5.47	23.71	0.010851779
2M00	0.52631579	0.8604651	0.9560440	0.9772727	0.00000000	0.8918919	0.00000000	0.21839080	0.2093023	6.04	34.57	0.001959221
2M01	0.66666667	0.9583333	0.9851852	1.0000000	0.00000000	0.9565217	0.18181818	0.44360902	0.6551724	9.58	37.46	0.005669186
2M02	0.72881356	0.9230769	0.9619048	0.9523810	0.04651163	0.7500000	0.00000000	0.47524752	0.5875000	9.60	45.37	0.003525903
2M03	0.48062016	0.9318182	0.9387755	0.9690722	0.01612903	0.8536585	0.11428571	0.28260870	0.4255319	9.67	36.75	0.007832641
2M04	0.12222222	0.5810811	0.9415584	1.0000000	0.00000000	0.6976744	0.13333333	0.33793103	0.5571429	8.54	34.68	0.013505885
2M05	0.09642857	0.5217391	0.9215686	0.9456522	0.00000000	0.6666667	0.06250000	0.19148936	0.3678161	8.99	39.36	0.007157367
2M06	0.22317597	0.6857143	0.9567568	0.9677419	0.00000000	0.8750000	0.14285714	0.50847458	0.5500000	9.23	36.76	0.004706156
2M07	0.19191919	0.6181818	0.9166667	0.9682540	0.00000000	0.8823529	0.06666667	0.38842975	0.3606557	9.66	40.86	0.003217170

Appendix A2

Contributions of mean vital rates, variance in vital rates, vital rate elasticities and correlations

between vital rates to differences in the stochastic growth rate of grazed and mown sites.

Sigma refers to survival, gamma to growth conditional on survival, and phi refers to the

probability of a plant flowering in the next year. Mu represents the average number of

flowers, pi the average number of seeds per fruit and epsilon the proportion of seeds that

germinate and successfully establish as a seedling.

a. contributions of changes in mean vital rates

```
sigmaL 0.0135276913
sigmaJ 0.0098908769
sigmaV -0.0263700967
sigmaF -0.0033853494
gammaL 0.0003816191
gammaJ -0.0008416968
phiJ -0.0038412609
phiV -0.0643659036
phiF -0.0338492888
mu -0.0599747165
pi -0.0773725207
epsilon 0.1674834566
```

b. contributions of changes in mean vital rate elasticity values

```
          sigmaL      sigmaJ      sigmaV      sigmaF      gammaL      gammaJ
sigmaL  3.895956e-04  4.819036e-05  4.430658e-05 -9.640628e-05 -3.037239e-06  1.344498e-05
sigmaJ  4.819036e-05  3.012401e-05 -4.374052e-05  4.987965e-06 -6.337593e-08  2.676209e-06
sigmaV  4.430658e-05 -4.374052e-05 -5.391553e-04  8.030200e-05  4.443426e-06  4.073886e-07
sigmaF -9.640628e-05  4.987965e-06  8.030200e-05  1.357137e-04 -1.086563e-06  5.519632e-06
gammaL -3.037239e-06 -6.337593e-08  4.443426e-06 -1.086563e-06 -1.443056e-07 -2.595598e-08
gammaJ  1.344498e-05  2.676209e-06  4.073886e-07  5.519632e-06 -2.595598e-08  7.933563e-06
phiJ -8.933959e-06  2.540050e-06 -5.521959e-06  8.969481e-06  7.519433e-08  3.811647e-06
phiV  1.388858e-05 -6.174172e-06 -1.052017e-04 -1.374862e-06  2.293494e-08  4.278729e-06
phiF -8.294780e-05  3.382508e-05  6.767143e-06 -1.747611e-05  1.086377e-07  2.660033e-05
mu -2.763332e-05 -6.745203e-06 -1.943754e-05  3.096792e-05 -8.453858e-08 -1.978661e-06
pi -1.613920e-05 -4.838568e-07 -1.129961e-05 -1.979289e-05 -5.468113e-07  1.567598e-06
epsilon -5.193293e-05 -5.390856e-06 -6.332170e-05  1.417142e-04  1.442312e-06 -7.830229e-06
          phiJ      phiV      phiF      mu      pi      epsilon
sigmaL -8.933959e-06  1.388858e-05 -8.294780e-05 -2.763332e-05 -1.613920e-05 -5.193293e-05
sigmaJ  2.540050e-06 -6.174172e-06  3.382508e-05 -6.745203e-06 -4.838568e-07 -5.390856e-06
sigmaV -5.521959e-06 -1.052017e-04  6.767143e-06 -1.943754e-05 -1.129961e-05 -6.332170e-05
sigmaF  8.969481e-06 -1.374862e-06 -1.747611e-05  3.096792e-05 -1.979289e-05  1.417142e-04
gammaL  7.519433e-08  2.293494e-08  1.086377e-07 -8.453858e-08 -5.468113e-07  1.442312e-06
gammaJ  3.811647e-06  4.278729e-06  2.660033e-05 -1.978661e-06  1.567598e-06 -7.830229e-06
phiJ  6.292202e-06 -5.912207e-07  4.684835e-05  2.487288e-06  5.423339e-06  1.079871e-05
phiV -5.912207e-07 -2.302138e-04  1.445882e-04 -1.002265e-05 -2.371794e-05  1.375768e-05
phiF  4.684835e-05  1.445882e-04  3.801309e-04  3.982705e-05  1.209168e-04 -4.002477e-05
mu  2.487288e-06 -1.002265e-05  3.982705e-05  3.374414e-05  2.762547e-05 -3.054864e-05
pi  5.423339e-06 -2.371794e-05  1.209168e-04  2.762547e-05  6.470503e-05 -8.766888e-05
epsilon 1.079871e-05  1.375768e-05 -4.002477e-05 -3.054864e-05 -8.766888e-05  3.064777e-04
```

c. contributions of changes in coefficients of variance

```
          sigmaL      sigmaJ      sigmaV      sigmaF      gammaL      gammaJ
sigmaL  1.008092e-03  2.819679e-05  1.443885e-04  6.899048e-05  1.103360e-06 -9.841795e-06
sigmaJ  2.819679e-05 -5.831310e-05 -8.271952e-05  1.383050e-05 -2.340121e-07 -8.022575e-06
sigmaV  1.443885e-04 -8.271952e-05 -1.314633e-03 -2.786340e-04  5.923992e-06 -7.351987e-06
sigmaF  6.899048e-05  1.383050e-05 -2.786340e-04 -1.439009e-04  1.819318e-06  1.985776e-06
gammaL  1.103360e-06 -2.340121e-07  5.923992e-06  1.819318e-06 -8.804769e-08  7.565956e-08
```

gammaJ	-9.841795e-06	-8.022575e-06	-7.351987e-06	1.985776e-06	7.565956e-08	-9.463779e-06
phiJ	4.226581e-06	-2.842241e-06	-4.318806e-05	-1.081691e-05	3.783822e-07	-3.437364e-06
phiV	1.342043e-05	-6.635841e-06	-2.294759e-04	-2.935225e-05	9.038257e-08	-9.521280e-06
phiF	3.965884e-05	-1.129107e-05	2.610662e-07	-2.102133e-05	-1.445701e-07	-7.699733e-06
mu	-1.213441e-04	-9.458795e-06	-8.907478e-05	-1.551072e-05	1.112577e-07	4.065540e-07
pi	6.641386e-06	8.950380e-06	-2.442918e-04	-3.033946e-05	-1.141724e-06	-1.095220e-06
epsilon	-8.143906e-05	1.333496e-06	1.966440e-05	-8.430983e-05	4.849361e-07	1.213233e-05
	phiJ	phiV	phiF	mu	pi	epsilon
sigmaL	4.226581e-06	1.342043e-05	3.965884e-05	-1.213441e-04	6.641386e-06	-8.143906e-05
sigmaJ	-2.842241e-06	-6.635841e-06	-1.129107e-05	-9.458795e-06	8.950380e-06	1.333496e-06
sigmaV	-4.318806e-05	-2.294759e-04	2.610662e-07	-8.907478e-05	-2.442918e-04	1.966440e-05
sigmaF	-1.081691e-05	-2.935225e-05	-2.102133e-05	-1.551072e-05	-3.033946e-05	-8.430983e-05
gammaL	3.783822e-07	9.038257e-08	-1.445701e-07	1.112577e-07	-1.141724e-06	4.849361e-07
gammaJ	-3.437364e-06	-9.521280e-06	-7.699733e-06	4.065540e-07	-1.095220e-06	1.213233e-05
phiJ	-1.231620e-05	-3.609319e-05	-4.825491e-05	5.613029e-07	-4.673539e-06	-1.143119e-05
phiV	-3.609319e-05	-3.949058e-04	-2.047478e-04	9.638121e-06	-1.229304e-04	3.281201e-05
phiF	-4.825491e-05	-2.047478e-04	-3.534037e-04	-1.374693e-05	-5.950966e-05	-3.750041e-05
mu	5.613029e-07	9.638121e-06	-1.374693e-05	1.443077e-04	1.630763e-05	-8.781959e-05
pi	-4.673539e-06	-1.229304e-04	-5.950966e-05	1.630763e-05	-2.153610e-04	1.036724e-04
epsilon	-1.143119e-05	3.281201e-05	-3.750041e-05	-8.781959e-05	1.036724e-04	3.431485e-04

d. contributions of changes in correlation coefficients

	sigmaL	sigmaJ	sigmaV	sigmaF	gammaL	gammaJ
sigmaL	0.000000e+00	3.959845e-04	1.106629e-04	-3.908995e-05	1.666587e-06	6.126573e-05
sigmaJ	3.959845e-04	0.000000e+00	-2.523277e-04	-7.388602e-05	3.558012e-06	2.648334e-05
sigmaV	1.106629e-04	-2.523277e-04	0.000000e+00	-2.020807e-05	5.296889e-06	4.936679e-06
sigmaF	-3.908995e-05	-7.388602e-05	-2.020807e-05	0.000000e+00	2.034930e-06	-1.769552e-05
gammaL	1.666587e-06	3.558012e-06	5.296889e-06	2.034930e-06	0.000000e+00	2.749011e-07
gammaJ	6.126573e-05	2.648334e-05	4.936679e-06	-1.769552e-05	2.749011e-07	0.000000e+00
phiJ	-1.281698e-05	-2.151754e-05	-1.513413e-05	-5.636850e-07	-2.615332e-07	-7.017861e-06
phiV	-8.188845e-05	-2.053849e-04	-5.118243e-05	8.902800e-05	-6.606295e-07	-1.790123e-05
phiF	7.666012e-05	-8.704408e-05	-2.621554e-05	7.146379e-05	-1.148363e-07	-4.309880e-05
mu	1.505158e-04	-6.630922e-05	1.151587e-04	5.649653e-05	-6.797636e-08	1.596876e-06
pi	6.866067e-05	-8.991239e-05	3.211381e-04	1.586739e-04	-1.881544e-06	-5.302645e-06
epsilon	-3.198378e-04	-6.349895e-05	-8.171297e-04	-2.412886e-04	1.002891e-05	-7.464899e-05
	phiJ	phiV	phiF	mu	pi	epsilon
sigmaL	-1.281698e-05	-8.188845e-05	7.666012e-05	1.505158e-04	6.866067e-05	-3.198378e-04
sigmaJ	-2.151754e-05	-2.053849e-04	-8.704408e-05	-6.630922e-05	-8.991239e-05	-6.349895e-05
sigmaV	-1.513413e-05	-5.118243e-05	-2.621554e-05	1.151587e-04	3.211381e-04	-8.171297e-04
sigmaF	-5.636850e-07	8.902800e-05	7.146379e-05	5.649653e-05	1.586739e-04	-2.412886e-04
gammaL	-2.615332e-07	-6.606295e-07	-1.148363e-07	-6.797636e-08	-1.881544e-06	1.002891e-05
gammaJ	-7.017861e-06	-1.790123e-05	-4.309880e-05	1.596876e-06	-5.302645e-06	-7.464899e-05
phiJ	0.000000e+00	-3.940798e-05	-5.391617e-06	7.967399e-06	-4.825123e-05	2.792318e-05
phiV	-3.940798e-05	0.000000e+00	-5.764093e-05	1.054188e-04	-1.936819e-04	1.613018e-05
phiF	-5.391617e-06	-5.764093e-05	0.000000e+00	9.942797e-06	-2.231707e-04	4.799230e-04
mu	7.967399e-06	1.054188e-04	9.942797e-06	0.000000e+00	2.407896e-05	1.871958e-05
pi	-4.825123e-05	-1.936819e-04	-2.231707e-04	2.407896e-05	0.000000e+00	2.394632e-05
epsilon	2.792318e-05	1.613018e-05	4.799230e-04	1.871958e-05	2.394632e-05	0.000000e+00

Appendix A3

SNA-LTRE analysis of the difference in stochastic population growth rate between site 2 and site 1. σ refers to survival, γ to growth conditional on survival, and ϕ refers to the probability of a plant flowering in the next year. μ represents the average number of flowers, π the average number of seeds per fruit and ε the proportion of seeds that germinate and successfully establish as a seedling.

