Mordecai et al., “Controls over native perennial grass exclusion and persistence in annual-invaded California grasslands”

Appendix B: Supplementary Figures.

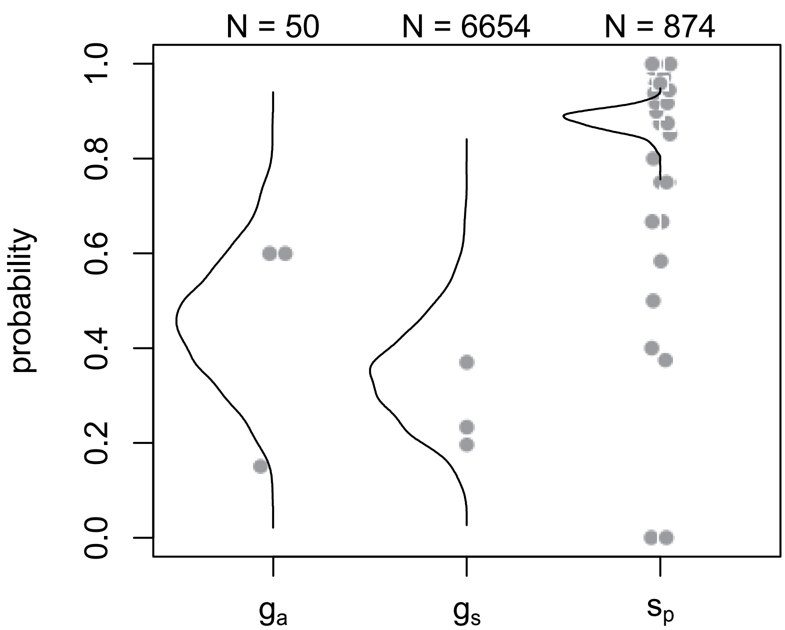
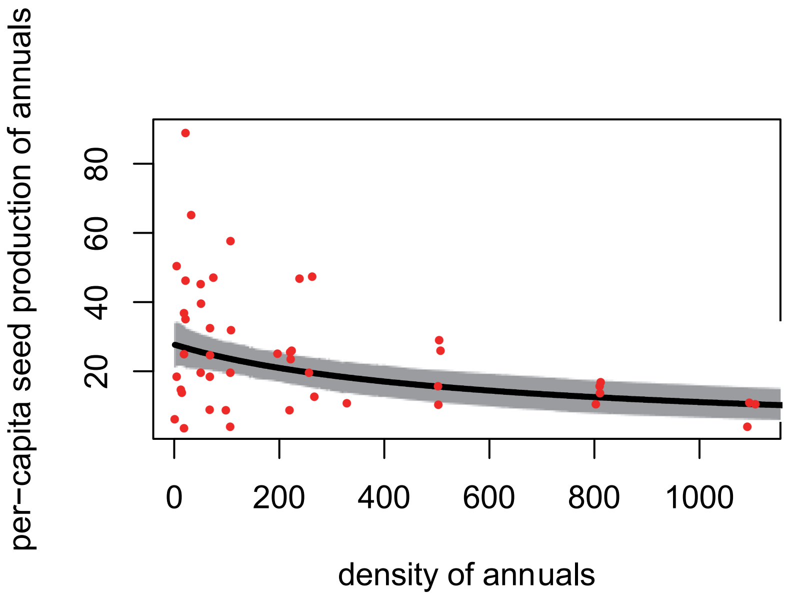


FIG. B1. Data (points) and posterior distributions (lines) for the parameters for germination (g_a and g_s) and adult survival (s_p). Data sources are listed in Table A1. Each data point represents multiple seeds or plants from an experimental trial. Total number of individuals included in each parameter estimate (sum across data points) is indicated above each parameter. Distributions represent uncertainty in the deterministic parameter value. The Bayesian model assumes that a beta-binomial probabilistic process with mean equal to the parameter value generates the observed data. As a result, the data themselves are expected to have a broader distribution than the posterior distribution on the parameter value.



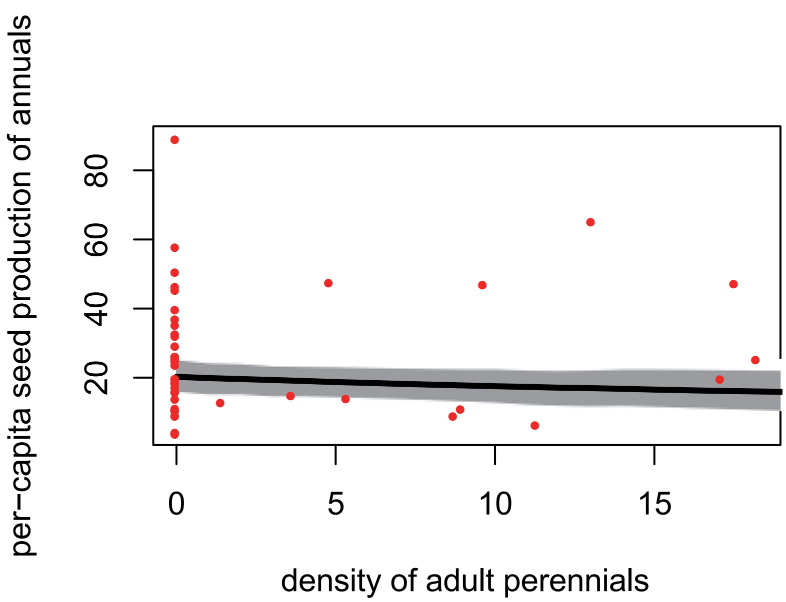


FIG. B2. Data (points) and posterior distribution for the function describing annual seed production (a function of the parameters λ_a, α_{aa}, α_{ap}). Black line is the mean and gray shaded area is the 95% highest posterior density (HPD) interval. Data were not available to estimate the competitive effect of perennial seedlings on annual seed production, α_{as}, so we estimated it based on α_{aa} as described in the text. The competition function was fitted for seed production as a function of annual and adult perennial density together, though plots show the marginal distribution for each density, evaluated at the mean density of the other species.

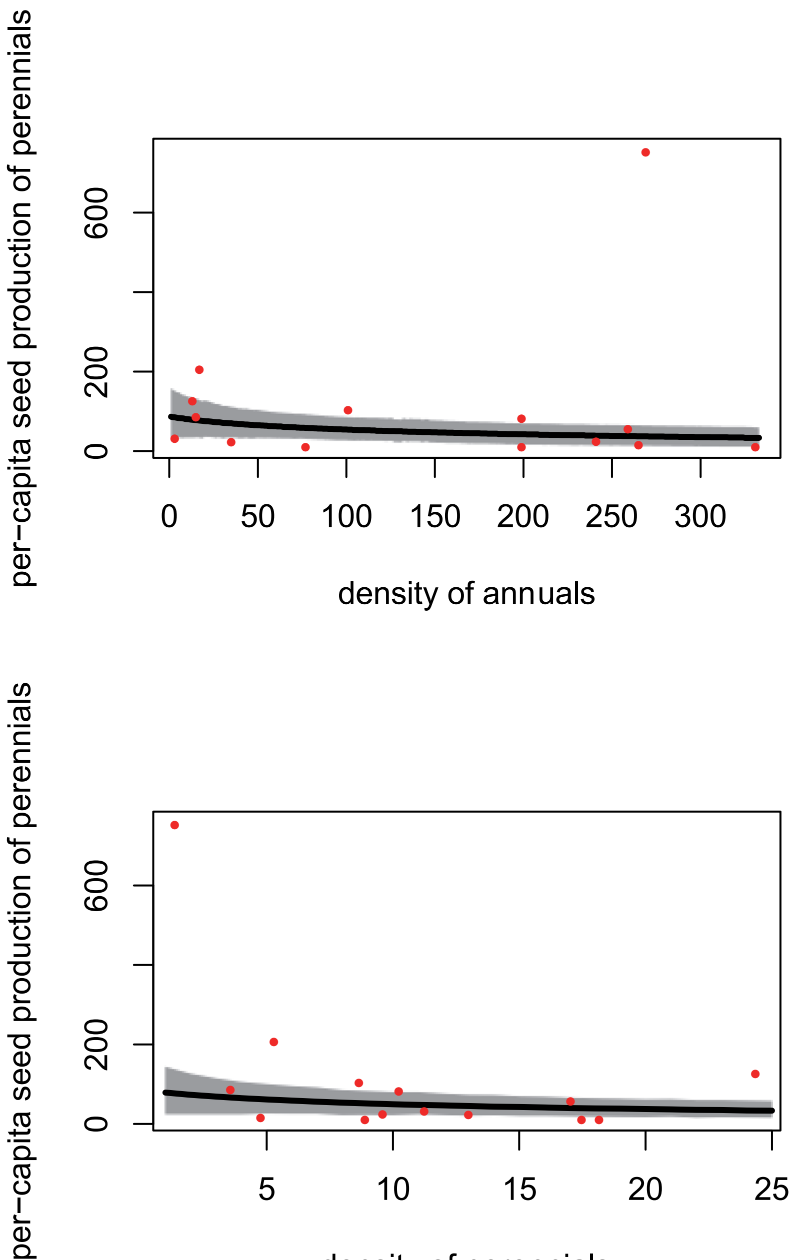


FIG. B3. Data (points) and posterior distribution for the function describing perennial seed production (a function of the parameters λ_p, α_{pa}, α_{pp}). Black line is the mean and gray shaded area is the 95% highest posterior density (HPD) interval. Data were not available to estimate the competitive effect of perennial seedlings on perennial seed production, α_{ps}, so we estimated it based on α_{pa} as described in the text. The competition function was fitted for seed production as a function of annual and adult perennial density together, though plots show the marginal distribution for each density, evaluated at the mean density of the other species.

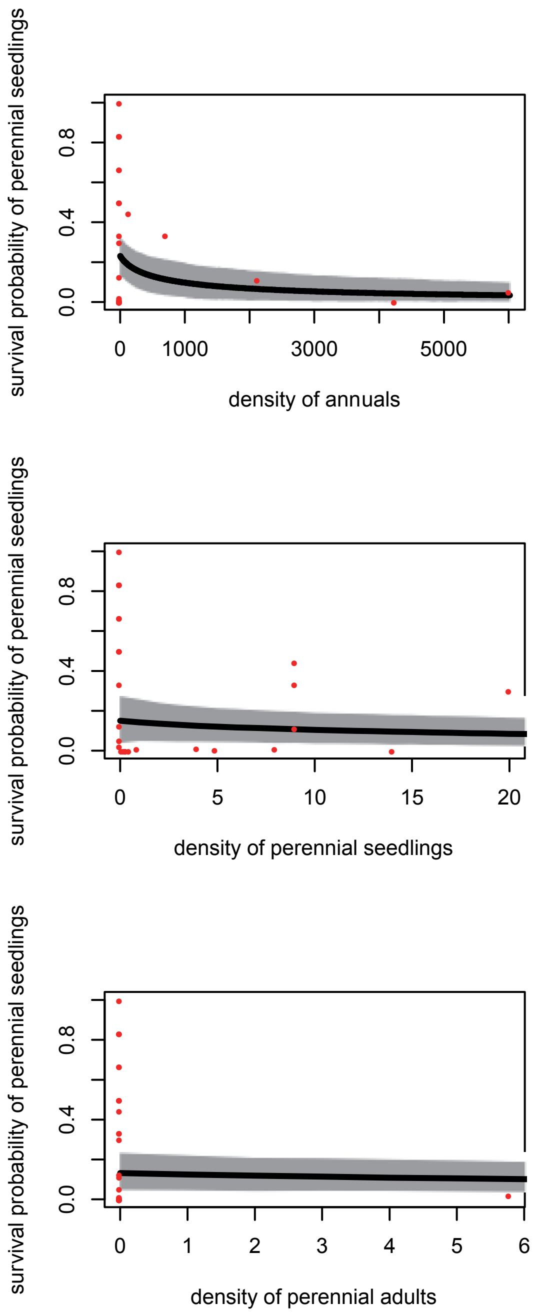


FIG. B4. Data (points) and posterior distribution for the function describing perennial seedling summer survival (a function of the parameters s_s, α_{sa}, α_{ss}, α_{sp}). Black line is the mean and gray shaded area is the 95% highest posterior density (HPD) interval. The competition function was fitted for survival as a function of annual and adult and seedling perennial density together, though plots show the marginal distribution for each density, evaluated at the mean density of the other species.

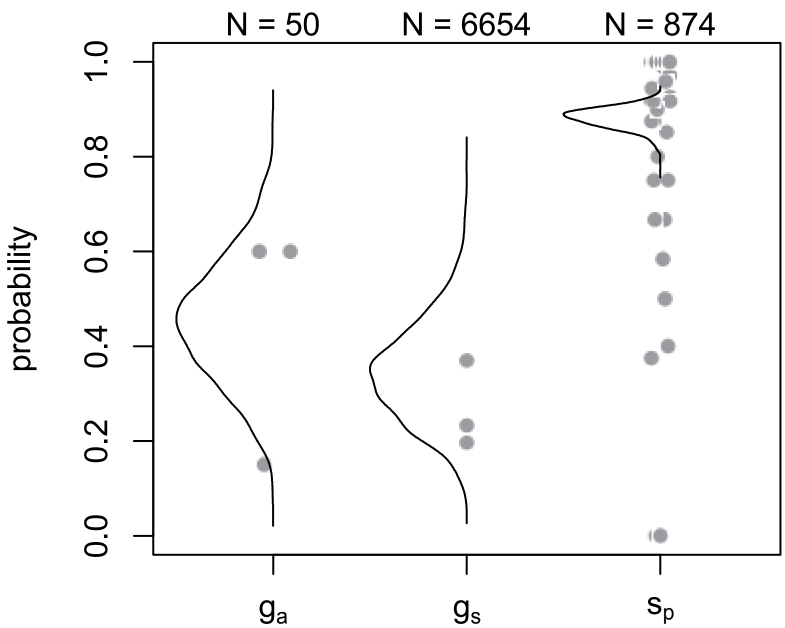


FIG. B5. Identical to Fig. B1 but using uninformative priors to derive posterior distributions.

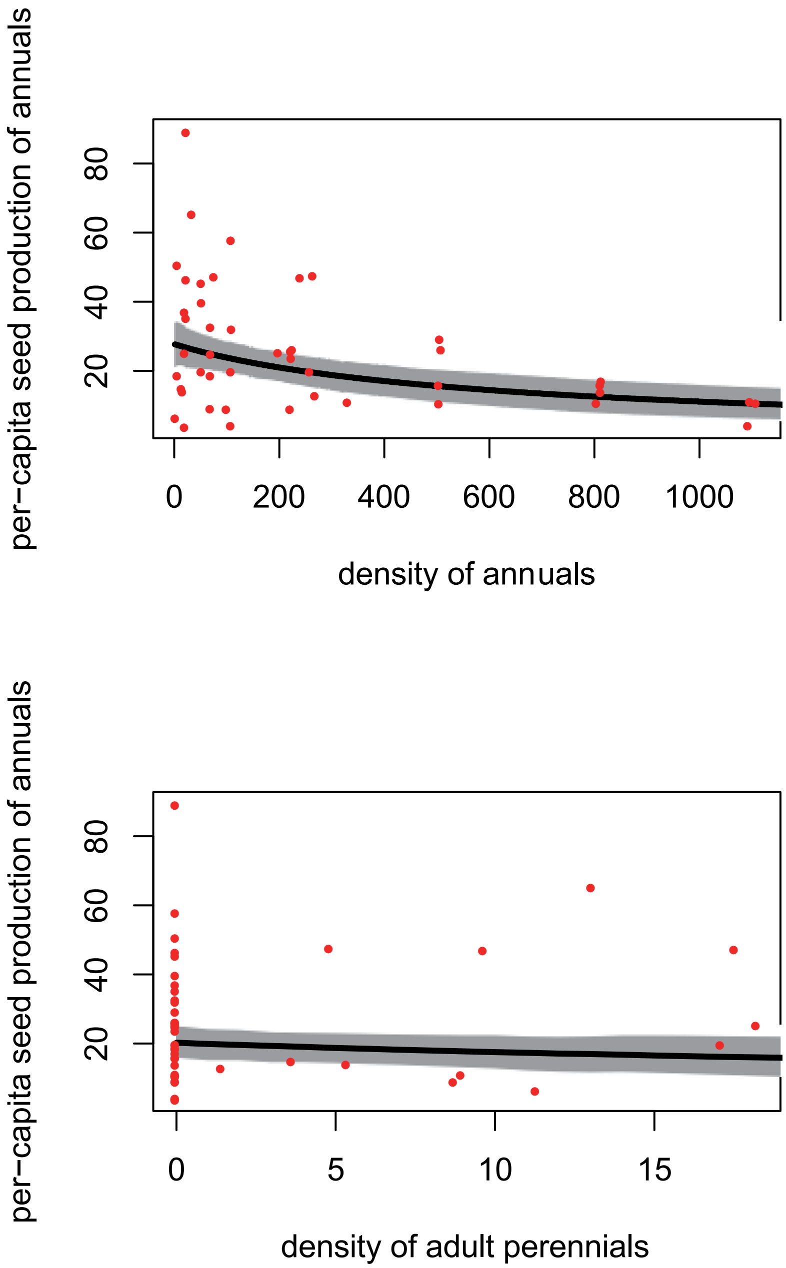


FIG. B6. Identical to Fig. B2 but using uninformative priors to derive posterior distributions.

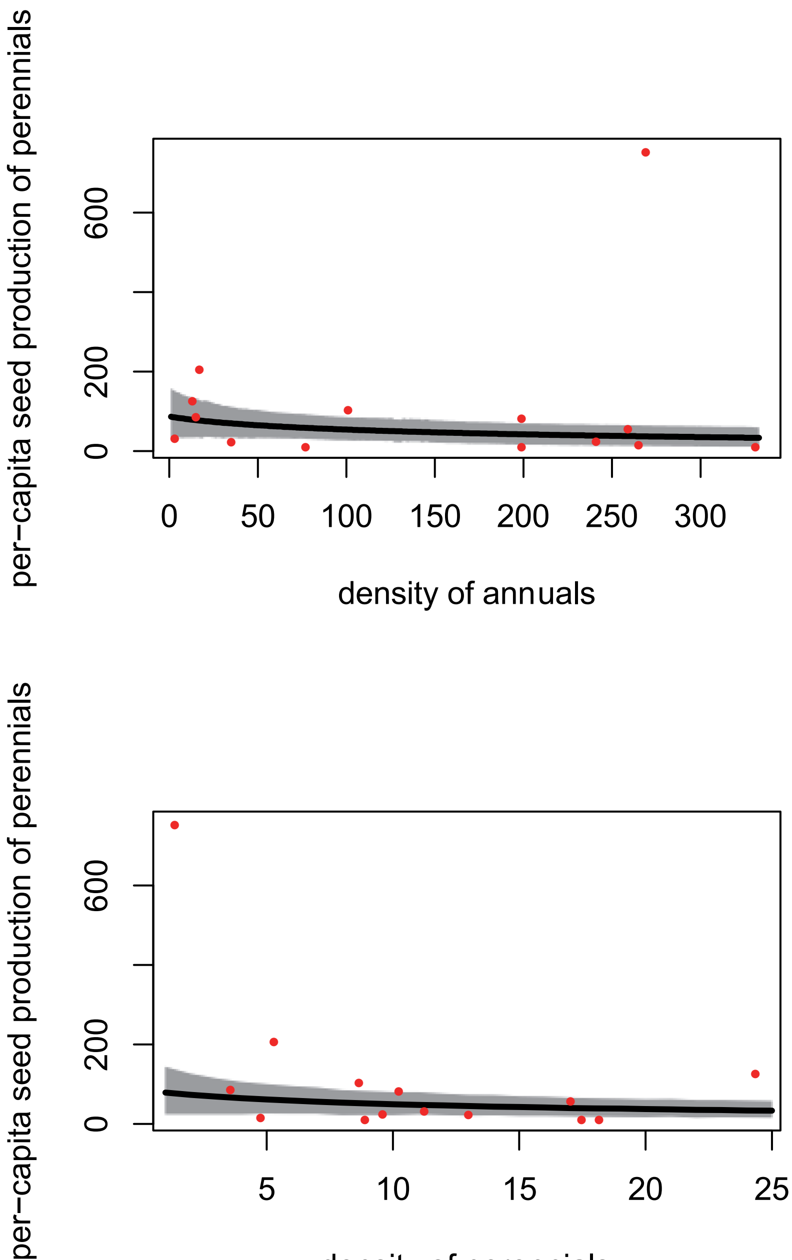


FIG. B7. Identical to Fig. B3 but using uninformative priors to derive posterior distributions.

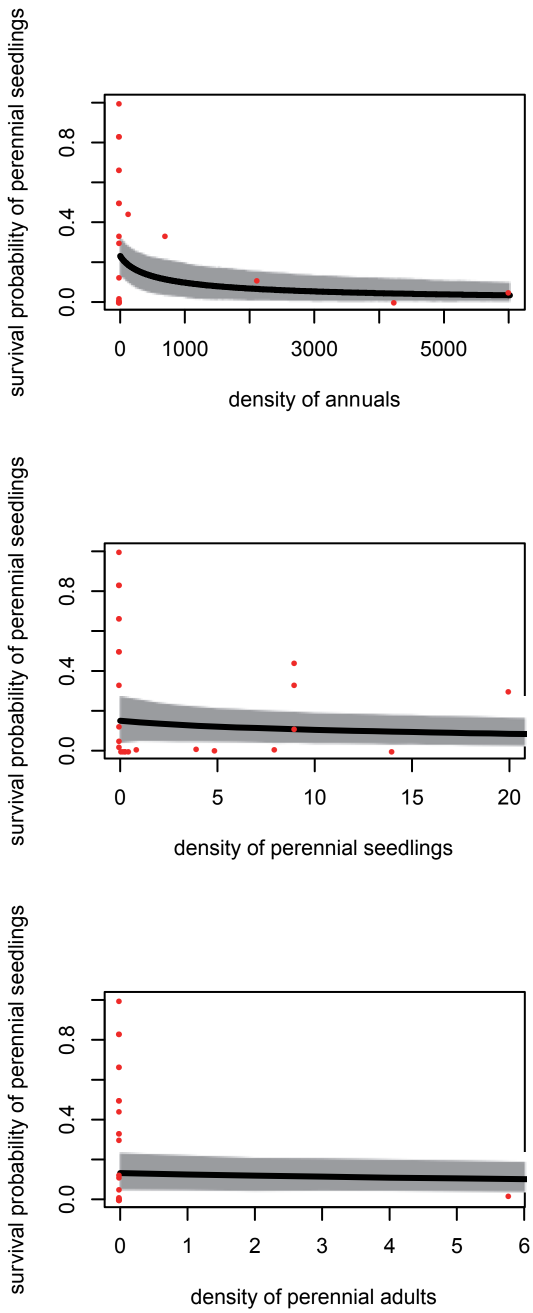


FIG. B8. Identical to Fig. B4 but using uninformative priors to derive posterior distributions.

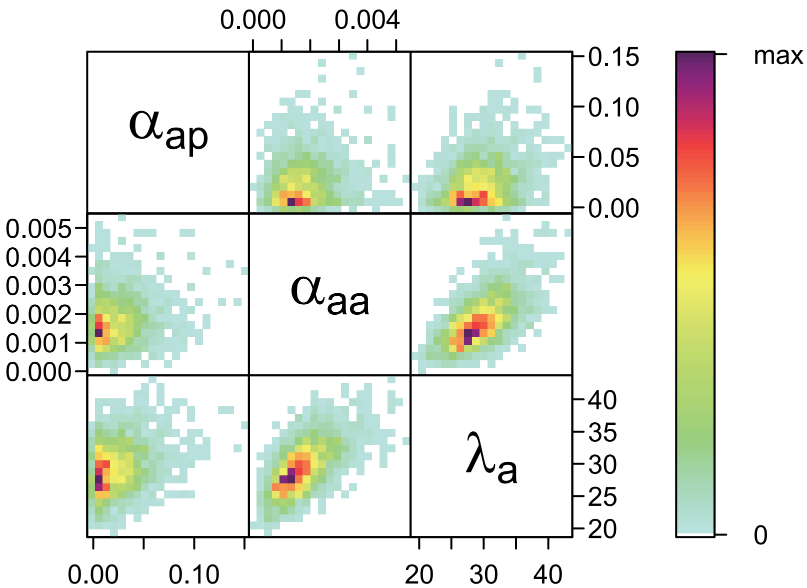


FIG. B9. Scatterplot showing the correlation between annual fecundity parameters fitted together, for 2000 samples from the posterior distribution of parameters. Warmer colors indicate a higher density of data points. Center diagonal indicates the parameters plotted; for example, the top right plot shows λ_a on the x-axis against α_{ap} on the y-axis.

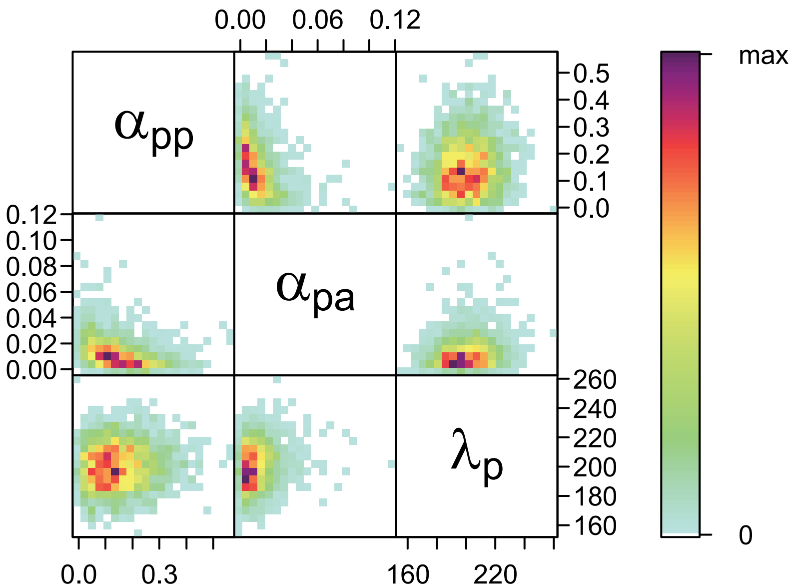


FIG. B10. Scatterplot showing the correlation between perennial fecundity parameters fitted together, for 2000 samples from the posterior distribution of parameters. Warmer colors indicate a higher density of data points.

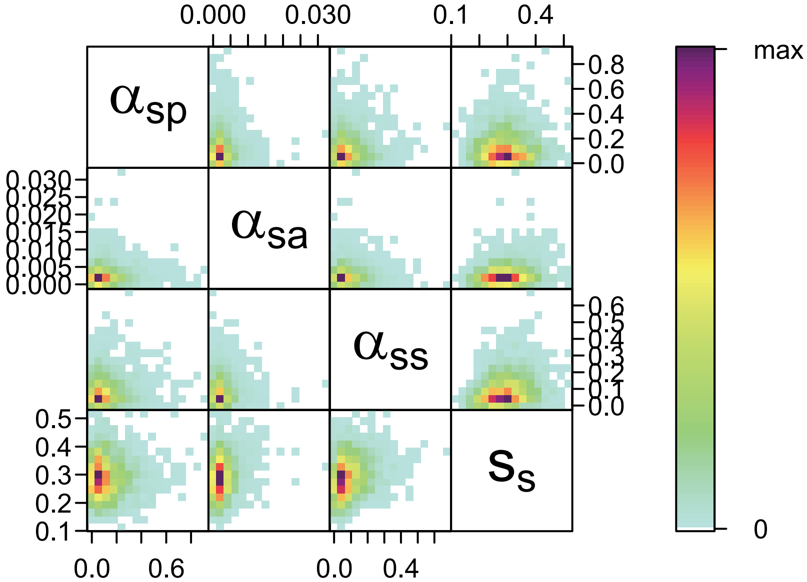


FIG. B11. Scatterplot showing the correlation between perennial seedling survival parameters fitted together, for 2000 samples from the posterior distribution of parameters. Warmer colors indicate a higher density of data points.

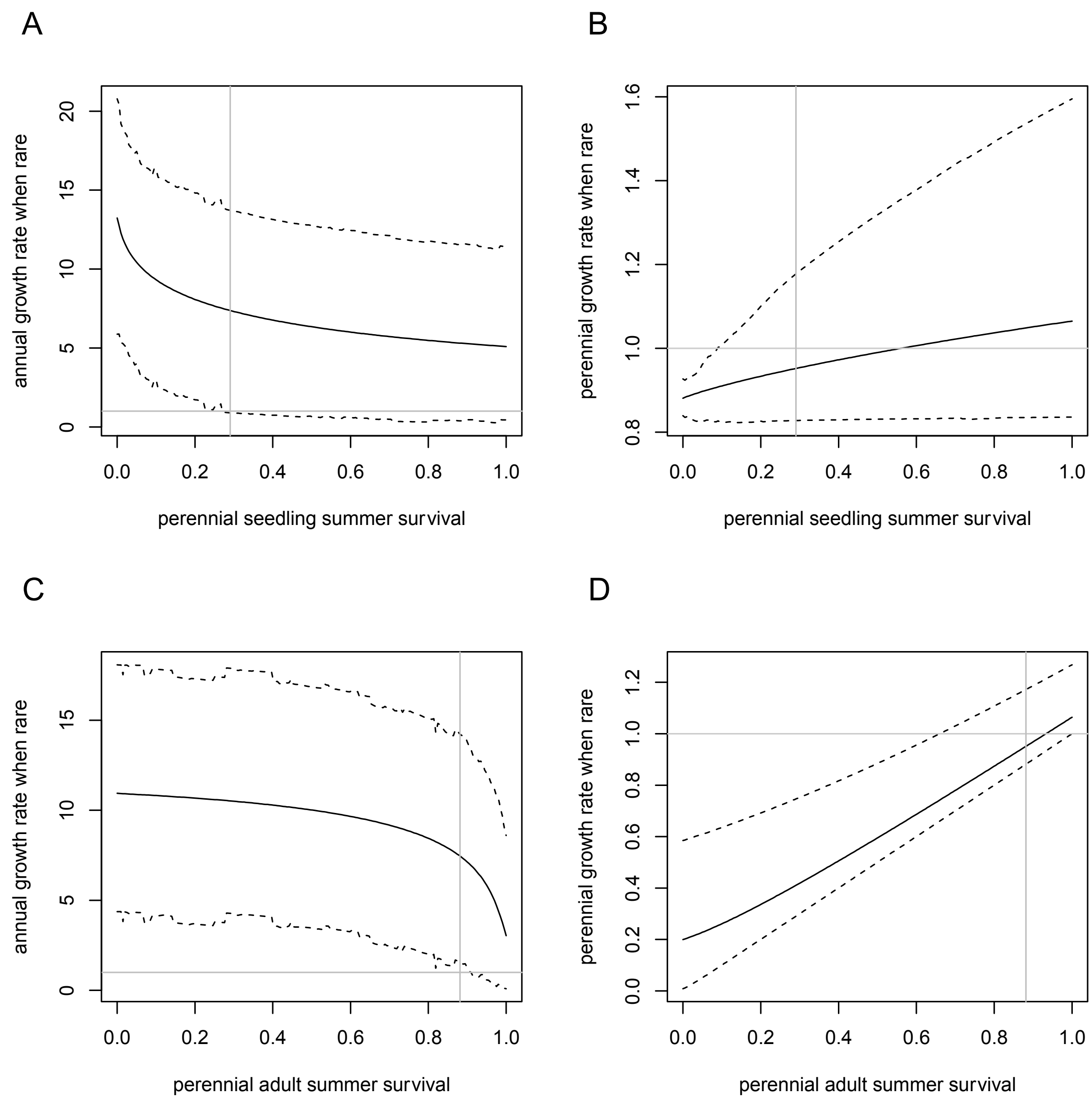


FIG. B12. Effect of perennial seedling and adult summer survival (s_s and s_p) on growth rates when rare. Seedling (A–B) and adult (C–D) summer survival varied across their entire domain (0, 1); growth rates when rare are calculated for each value for the annual (A and C), and the perennial (B and D) across all posterior samples of the remaining parameters. Solid lines are the means and dashed lines are the 95% HPD intervals. Gray horizontal lines show the threshold for invasion when rare (one), and gray vertical lines show the posterior mean value for perennial seedling and adult summer survival (s_2 and s_3, respectively).

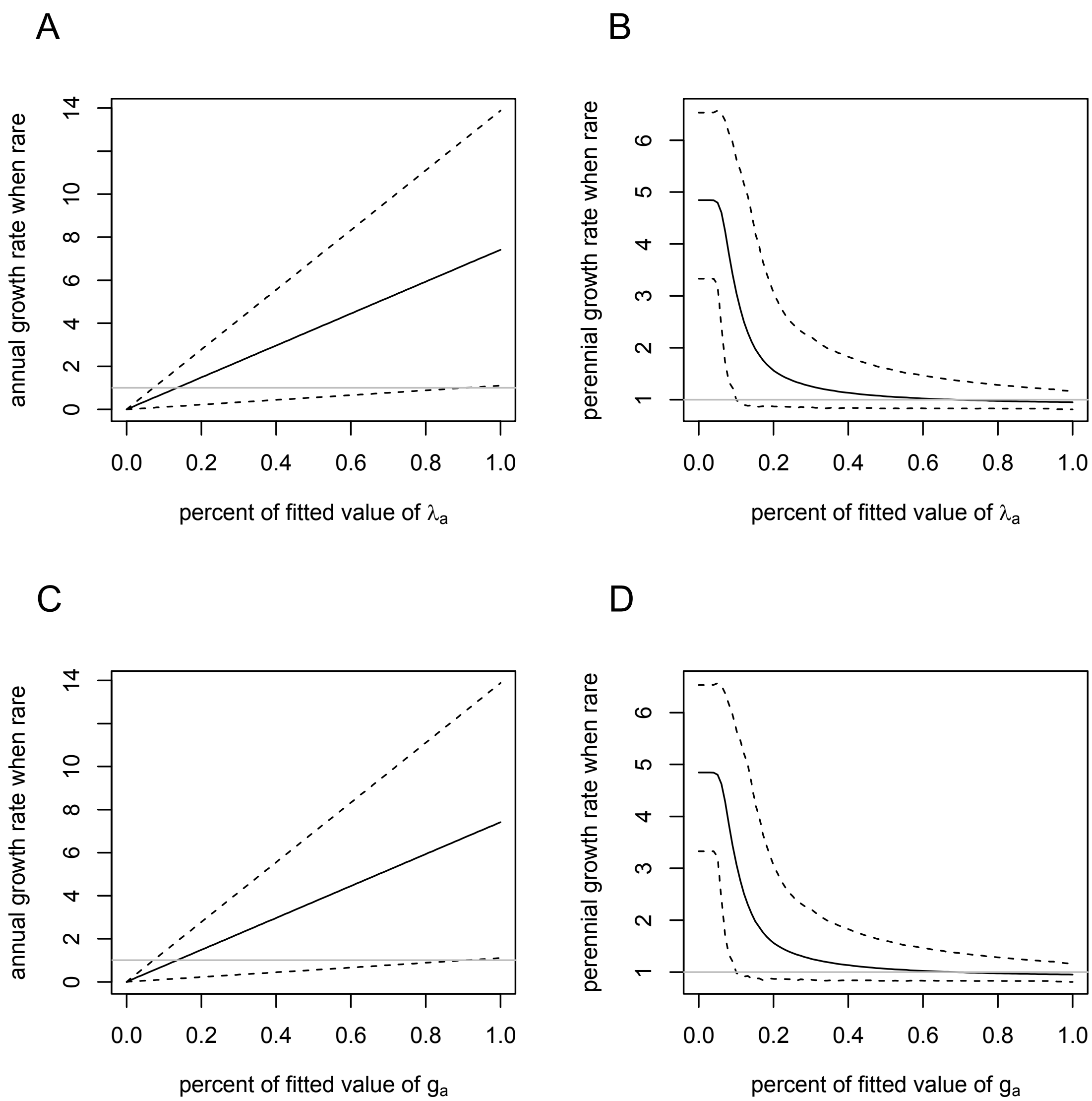


FIG. B13. Effect of λ_a and g_a on growth rates when rare for annuals (A and C) and perennials (B and D), respectively. The gray lines indicate the threshold value of one. Solid lines are the means, dashed lines are the 95% HPD intervals.

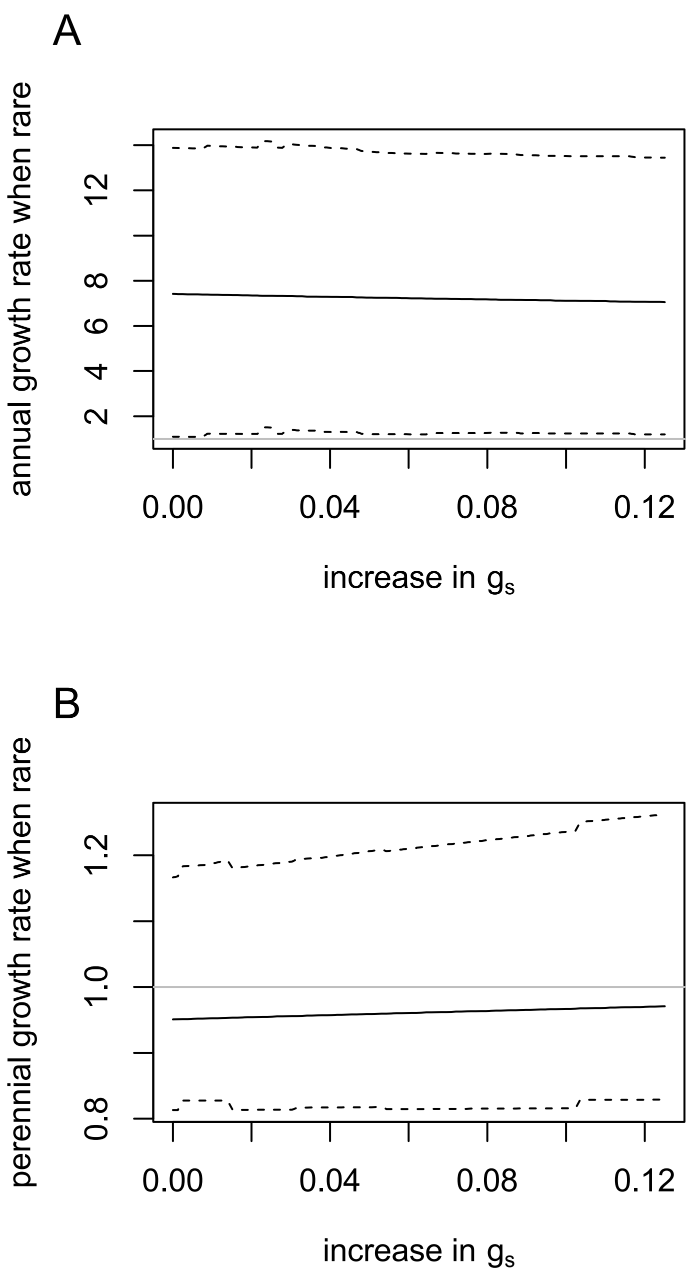


FIG. B14. Effect of increasing g_s on growth rates when rare for annuals (A) and perennials (B). The gray lines indicate the threshold value of one. Solid lines are the means, dashed lines are the 95% HPD intervals. Values on x-axis were added to the fitted value for each parameter sample. Range of values was selected to ensure that g_s, a proportion, remained below one.

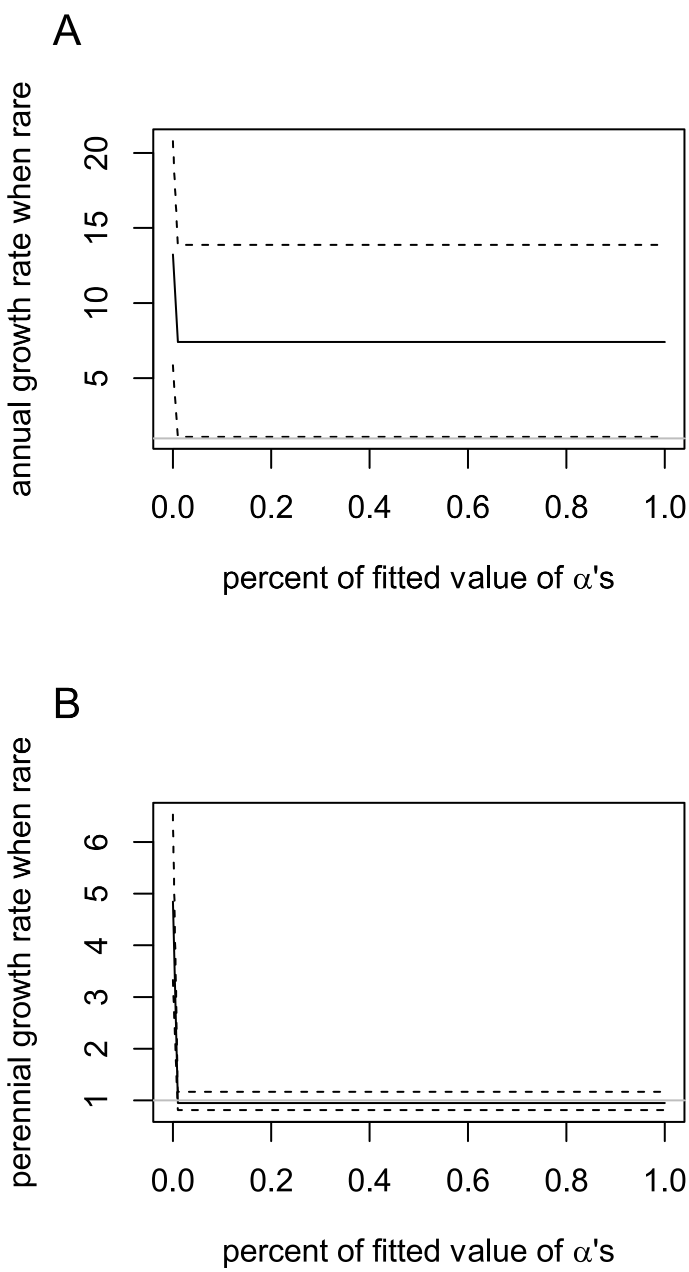


FIG. B15. Effect of α's on growth rates when rare of annuals (A) and perennials (B). The gray lines indicate the threshold value of one. Solid lines are the means, dashed lines are the 95% HPD intervals.

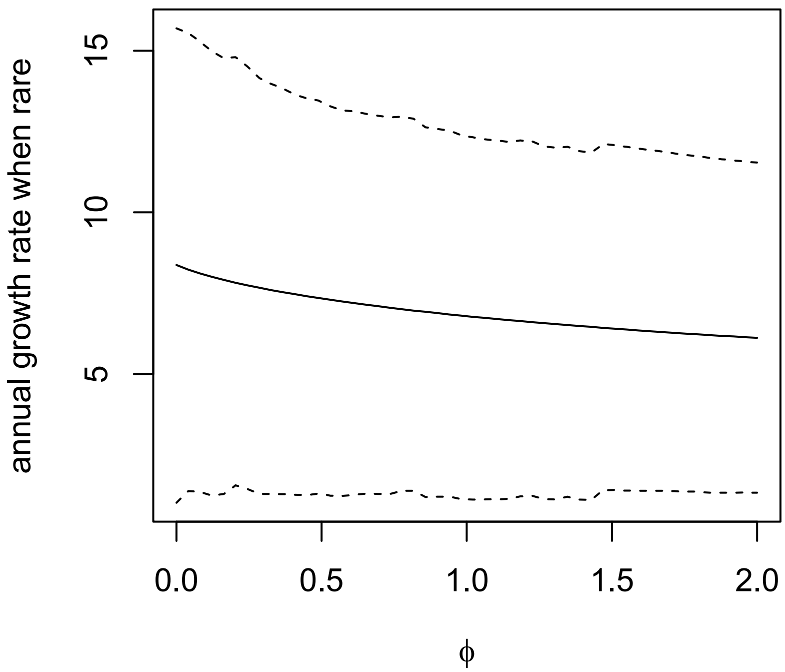


FIG. B16. Effect of ϕ on annual growth rate when rare. (ϕ has no effect on perennial growth rate when rare). Solid line is the mean, dashed lines are the 95% HPD interval. In the main model, ϕ ranged from zero to one. This parameter scales the perennial seedling competitive effects (α_{as} and α_{ps}) relative to annual competitive effects (α_{aa} and α_{pa}).

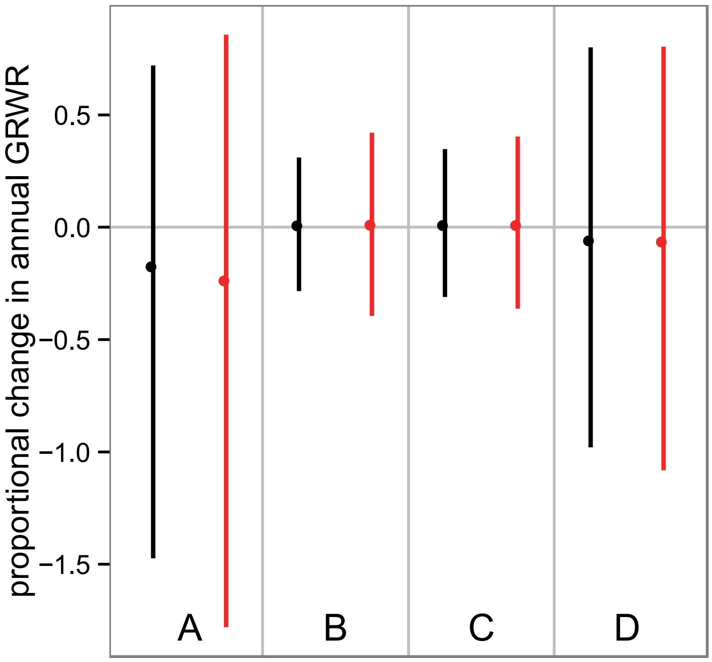


FIG. B17. Effect on annual growth rates when rare of positive (in black) and negative (in red) correlations between demographic rates, relative to baseline (uncorrelated) parameter sets. Correlated parameters are: A, annual fecundity (λ_a, α_{aa}, α_{as}, α_{ap}) and germination (g_a); B, perennial fecundity (λ_p, α_{pa}, α_{ps}, α_{pp}) and germination (g_s); C, perennial fecundity (λ_p, α_{pa}, α_{ps}, α_{pp}) and adult survival (s_p); and D, perennial germination (g_s) and seedling survival (s_s, α_{sa}, α_{ss}, α_{sp}). All other parameters are the same as in the main model (Fig. 1). For correlated parameters, distributions are the same as in the main model but they are resampled with a Spearman rank correlation 0.5 or -0.5 between the focal parameters. Focal traits affected by competition (fecundity and seedling survival) are correlated with the competition coefficients because they are derived from the same sets of data; such correlation structures are maintained by resampling these parameters as a group. Points: means; error bars: 95% highest posterior density intervals.

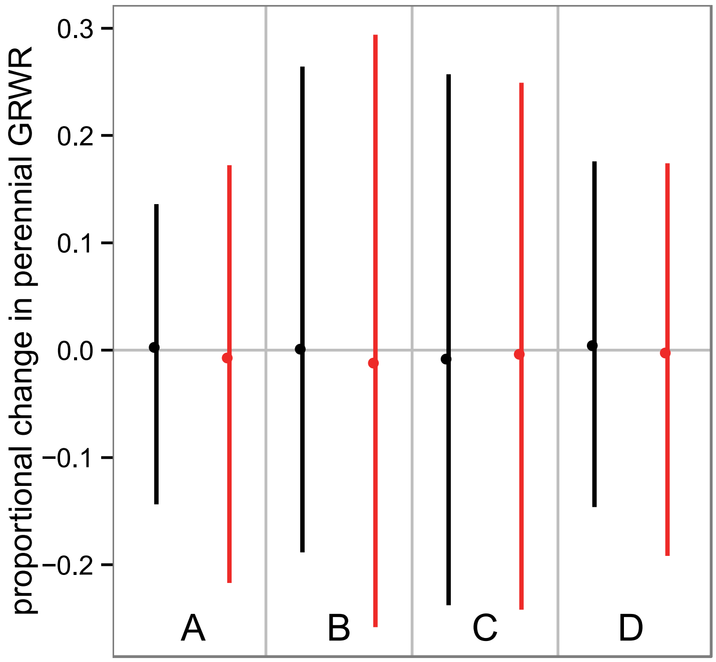


FIG. B18. Effect on perennial growth rates when rare of positive (in black) and negative (in red) correlations between demographic rates, relative to baseline (uncorrelated) parameter sets. Correlated parameters are: A, annual fecundity (λ_a, α_{aa}, α_{as}, α_{ap}) and germination (g_a); B, perennial fecundity (λ_p, α_{pa}, α_{ps}, α_{pp}) and germination (g_s); C, perennial fecundity (λ_p, α_{pa}, α_{ps}, α_{pp}) and adult survival (s_p); and D, perennial germination (g_s) and seedling survival (s_s, α_{sa}, α_{ss}, α_{sp}). All other parameters are the same as in the main model (Fig. 1). Other figure descriptions are as in Fig. B17. Note the difference in y-axis scales from Fig. B17.