

Appendix 1–3

Appendix 1

Effect of habitat density on viability

The joint effects of environmental correlation and inter-patch distance were investigated with a general model assuming no dispersal cost. The figure (Fig. A1) illustrates the effect of habitat density on metapopulation viability, for a constant number and capacity of patches (i.e. habitat density depends on the species range size only). In the absence of explicit spatial effect (i.e. local growth rate is independent of the distance to perturbations, and dispersal among patches is independent of distance, Fig. A1a), metapopula-

tion viability is independent of habitat density. If local growth rate is assumed to depend on the distance to perturbations, viability decreases with increasing habitat density (i.e. viability increases with species range), as local environments and population dynamics become more correlated, which inflates the risk of global extinction (Harrison and Quinn 1989) (Fig. A1c). If dispersal among two patches is inversely proportional to their distance, viability increases with habitat density, because the effective dispersal rate (and hence the possibility of recolonization after a local extinction event) increases (Fig. A1b). Finally, if both local growth rate and dispersal depend on patch location, maximal viability is obtained for an intermediate habitat density (Fig. A1d), allowing sufficient dispersal without strong environmental correlation (Hanski 1998, Shafer 2001, Williams et al. 2005).

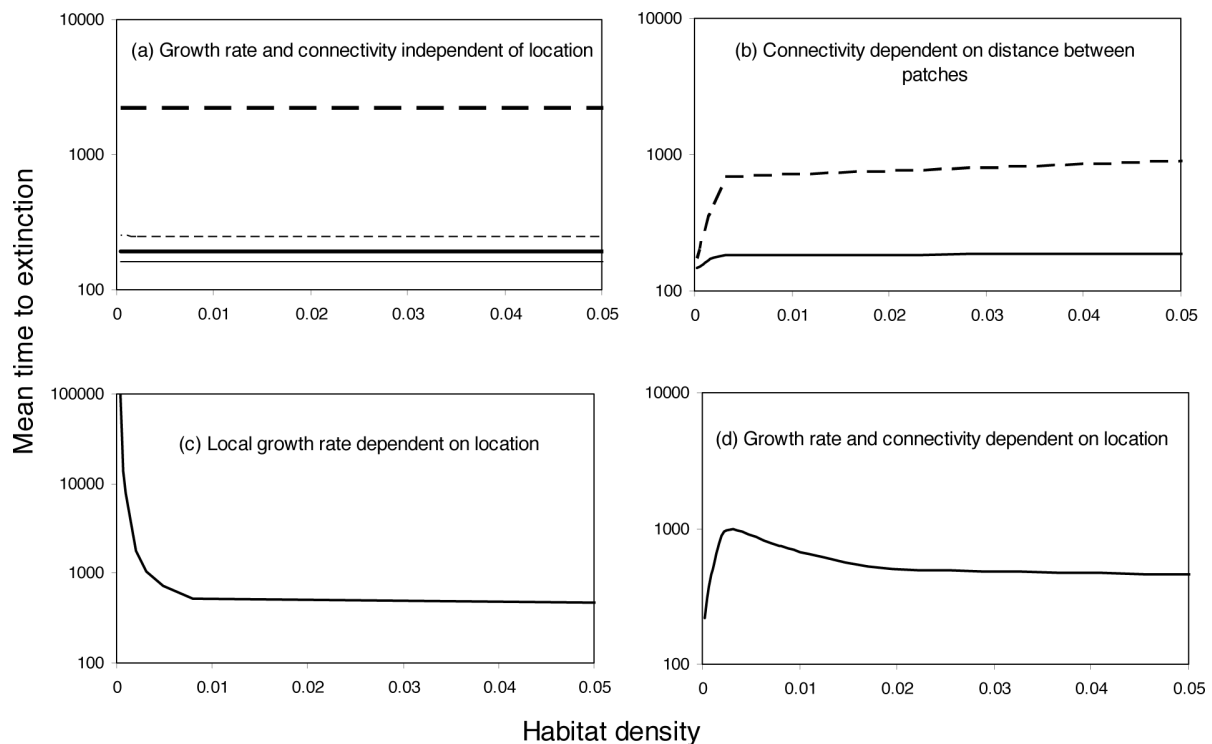
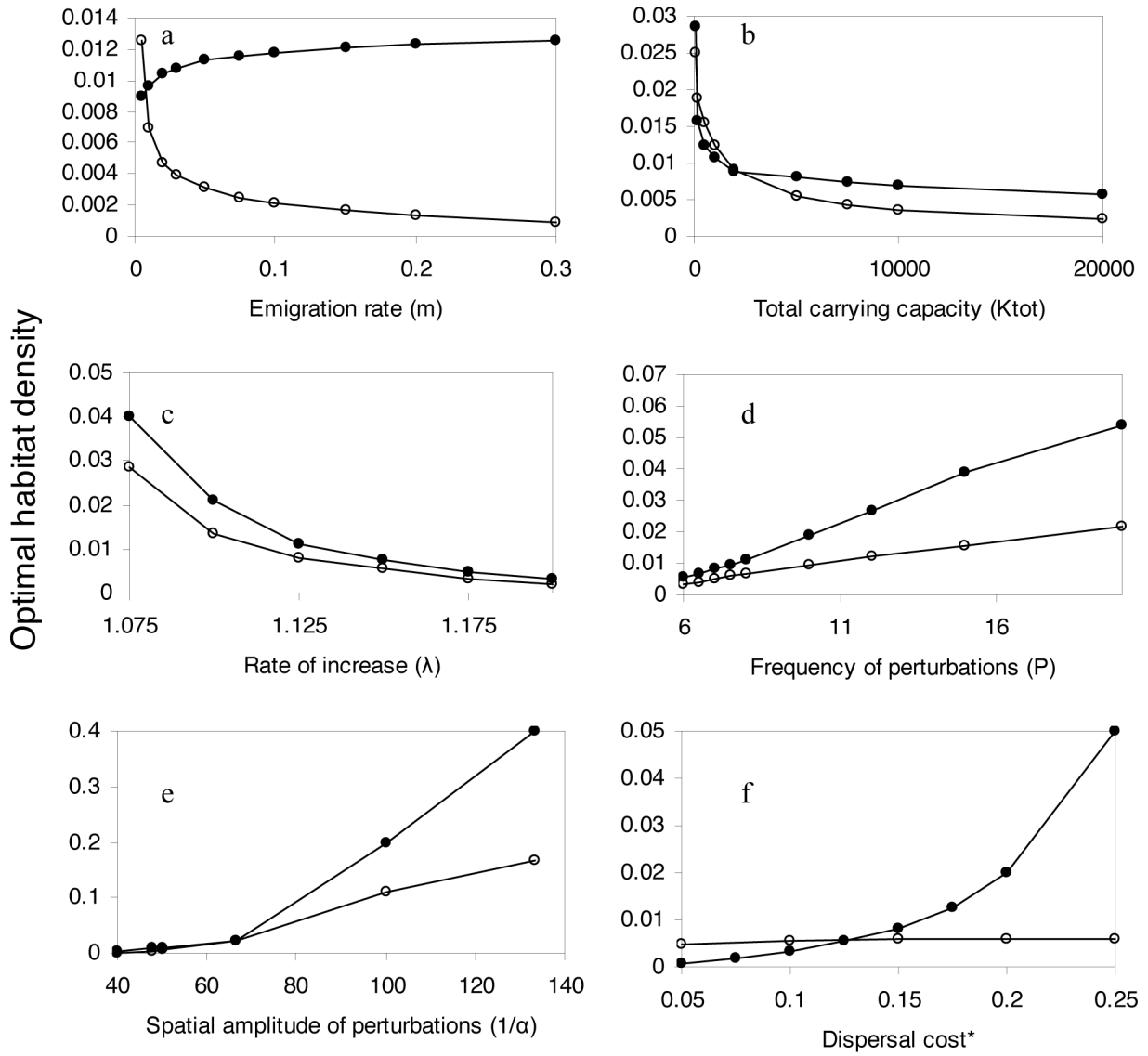


Figure A1. Relationship between metapopulation viability and habitat density. Patches are randomly distributed within the species range (A). Habitat density is defined as B/A and varies only with A (the total number of patches B is fixed to 20 in all cases). $K = 250$, $\lambda = 1.15$. (a) Instantaneous local growth rate is independent of patch location. In each year, the relative quality of the environment in patch i (q_i) is drawn from a Beta distribution with mean 0.875 and variance 0.02. Values of q_i are either drawn independently for all patches (independent local environments, dashed lines) or assumed equal in all patches (correlated local environment, solid lines). All patches are equally connected to each other without dispersal cost (constant emigration rates $m = 0.01$ (thin lines) or $m = 0.1$ (thick lines)). (b) Instantaneous local growth rate is independent of patch location (same as (a)), but the amount of dispersal is dependent on the distance among patches. Dispersal occurs according to the conditional dispersal scenario (without cost: $c = 0.0$) presented in methods with parameters $m = 0.1$, $\beta = 0.15$. (c) Instantaneous local growth rate in each patch is affected by the distance to perturbations, as presented in methods, with $p = 7.0$ and $\alpha = 0.021$. Dispersal occurs as in (a) (all patches equally connected to each other). (d) Instantaneous local growth rate in each patch is affected by the distance to perturbations (same as (c)). Dispersal is dependent on the distance among patches (same as (b)).

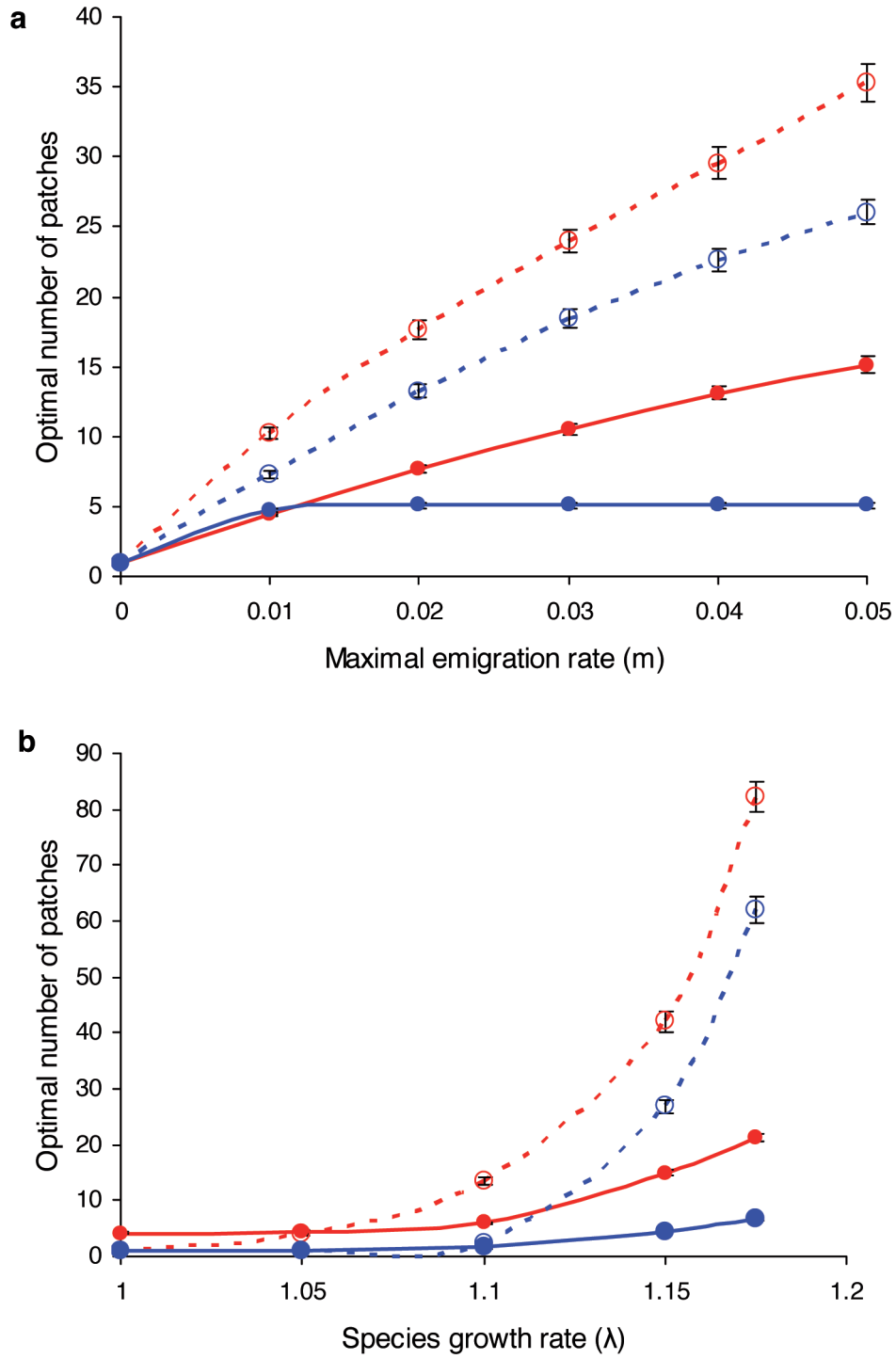
Appendix 2



Optimal habitat densities for different species and landscape characteristics, obtained under the conditional (open circles) and unconditional (filled circles) dispersal scenarios. Patches are randomly distributed within the species range (A). Habitat density is defined as B/A and varies only with A (the total number of patches B is fixed to 20 in all cases). All results were obtained by incrementally increasing A from 100 to 40,000.

- a) $\lambda = 1.15$, $K_{\text{tot}} = 5000$, $P = 7$, $\alpha = 0.021$, $\beta = 0.15$, $c = 0.1$ (c is defined for conditional dispersal only).
- b) $\lambda = 1.15$, $K_{\text{tot}} = 5000$, $m = 0.025$, $P = 7$, $\alpha = 0.021$, $\beta = 0.15$, $c = 0.1$ (c is defined for conditional dispersal only).
- c) $K_{\text{tot}} = 5000$, $m = 0.025$, $P = 7$, $\alpha = 0.021$, $\beta = 0.15$, $c = 0.1$ (c is defined for conditional dispersal only).
- d) $\lambda = 1.15$, $K_{\text{tot}} = 5000$, $m = 0.025$, $P = 7$, $\alpha = 0.021$, $\beta = 0.15$, $c = 0.1$ (c is defined for conditional dispersal only).
- e) $\lambda = 1.15$, $K_{\text{tot}} = 5000$, $m = 0.025$, $P = 7$, $\beta = 0.15$, $c = 0.1$ (c is defined for conditional dispersal only).
- f) $\lambda = 1.15$, $K_{\text{tot}} = 5000$, $m = 0.025$, $\alpha = 0.021$, $P = 7$, * The dispersal cost is defined by parameter β in the unconditional dispersal scenario and by parameter c in the conditional dispersal scenario. β is fixed to 0.15 in the conditional dispersal scenario.

Appendix 3



Optimal levels of fragmentation obtained for different growth and dispersal rates. All results were obtained by starting from a situation with a single patch ($B = 1$) and a species range of area $A = 400$. The number of patches was incrementally increased to 150 either by increasing patch density with constant area size (density option, solid circles, continuous lines) or by increasing both the number of patches and the species range to keep a constant density of patches (range option, open circles, dashed lines). In all cases, $K_{\text{tot}} = 5000$. Blue symbols and lines: model with conditional dispersal ($\beta = 0.15$, $c = 0.1$); Red symbols and lines: model with unconditional dispersal ($\beta = 0.15$). Bars indicate standard errors of the mean computed on 10 000 independent trajectories. (a) $\lambda = 1.15$, $P = 7.0$, $\alpha = 0.021$. (b) $m = 0.05$, $P = 7.0$, $\alpha = 0.021$.