Oikos

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Appendix 1

The metapopulation-source/sink continuum: theory

Given that patches are made up of particles (individuals, biomass units, etc., or in a discrete landscape, cells), the total number of particles in the system is given as,

$$p_T(c) = \int_1^{c_m} cac^{-b}\mathrm{dc} = \int_1^{c_m} ac^{1-b}\mathrm{dc} = \frac{a}{2-b}c_m^{2-b} - \frac{a}{2-b} \tag{A1}$$

which we assume is constant. The total number of patches is given as,

$$n_T(c) = \int_1^{c_m} ac^{-b}\mathrm{dc} = \frac{a}{1-b}c_m^{1-b} - \frac{a}{1-b} \tag{A2}$$

From Eq. 1 in the main text, we note that c_m occurs when $p(c) = 1$, i.e. the largest patch size has a frequency of one. Substituting this into Eq. 3 in the main text gives

$$a = c_m^b \tag{A3}$$

which, when substituted into Eq. A2, gives us,

$$n_T = \frac{c_m - c_m^b}{1-b} \tag{A4}$$

From Eq. A1, we write,

$$c_m^{2-b} = p_T\frac{2-b}{a} + 1 \tag{A5}$$

If we restrict our analysis to p_T large, Eq. A5 becomes,

$$c_m^{2-b} = p_T\frac{2-b}{a}$$

which, after substituting from Eq. A3 and rearranging, becomes,

$$b = 2 - \frac{c_m^2}{p_T} \tag{A6}$$

Substituting Eq. A6 into A4, we obtain,

$$n_T = \frac{c_m - c_m^{\left(2 - \frac{c_m^2}{p_T}\right)}}{\frac{c_m^2}{p_T} - 1} = h(c_m) \tag{A7}$$

which gives the total number of habitat patches, n_T, as a function of the largest patch size, c_m.

If we now assume linearity for the functions f and g, such that $e = a_e - b_e c_m$ and $m = a_m n_T$, and take the inverse of f, we have $c_m = (a_e - e) / b_e$. Substituting these linear terms to compute the composed function (Eq. A1), we obtain,

$$m = a_m \frac{\psi(e) - \psi(e)^{\left(2 - \frac{\psi(e)^2}{p_T}\right)}}{\frac{\psi(e)^2}{p_T} - 1} \tag{A8}$$

where,

$$\psi(e) = \frac{a_e - e}{b_e}$$

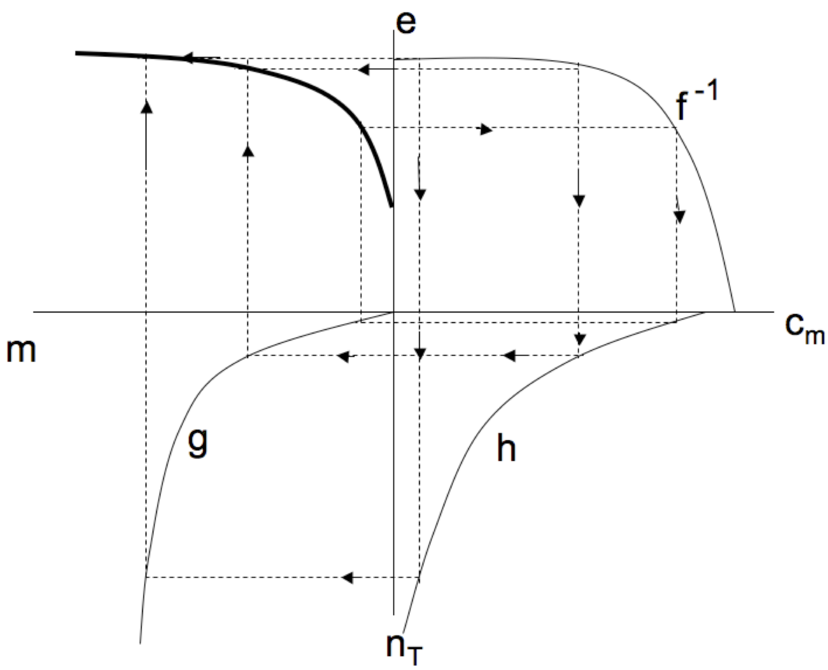

Figure A1. Graphical composition of the three essential functions to produce the relationship between migration rate (*m*) and extinction rate (*e*), based on the fundamental monotonic relationship between c_m and n_T. The final function gives a qualitative functional form to the relationship between migration (*m*) and extinction (*e*).

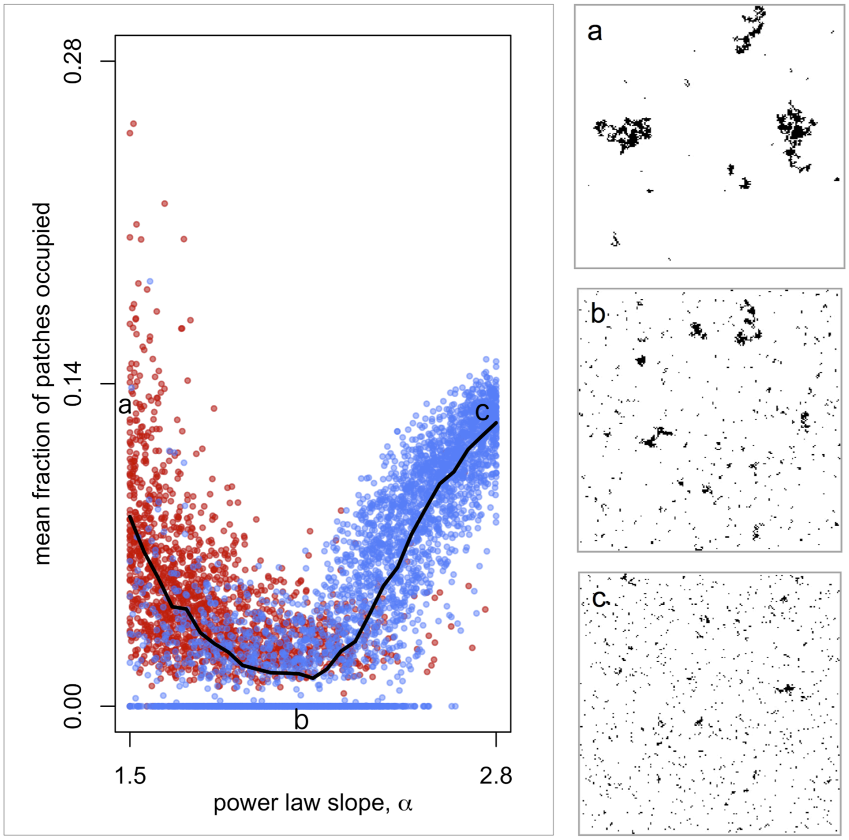

Figure A2. Average fraction of patches occupied as a function of the scaling parameter of the original 'self-organized' habitat distribution, from simulation experiments with migration from the nearest occupied patch only. Red points signify populations maintained as a source/sink populations. Blue points signify populations maintained as metapopulations.

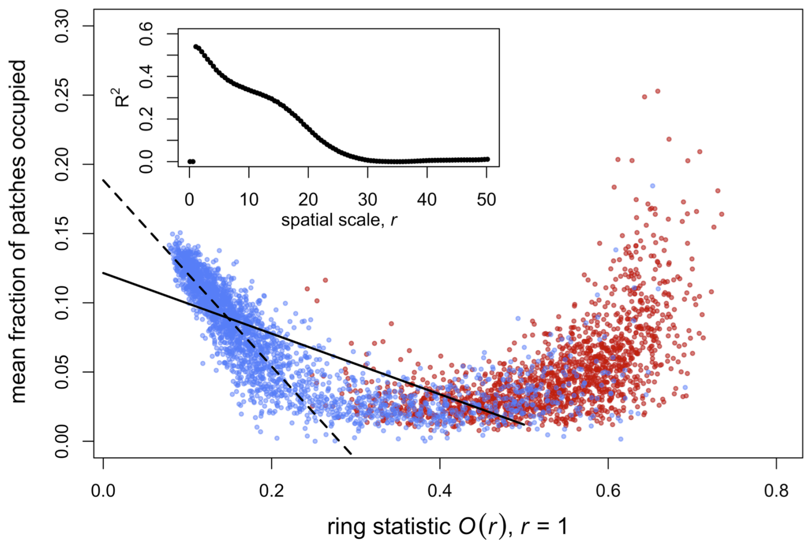

Figure A3. Mean fraction of patches occupied as a function of the O-ring statistic, a second-order measure of aggregation, from simulation experiments with migration from the nearest occupied patch only. Larger O(*r*) indicates greater aggregation (clustering). Red points signify populations maintained as source/sink populations. Blue points signify populations maintained as metapopulations. Results are for a spatial scale $r_{crit} = 1$ unit where the R^2 for a linear fit to the metapopulation data (blue points) is maximized ($R^2 = 0.54$, $p < 0.0001$; solid trendline and inset graph). The dashed line shows the fit if the minimum clump size for a source/sink population is defined to be 100 units instead of 250 ($R^2 = 0.73$, $p < 0.0001$).

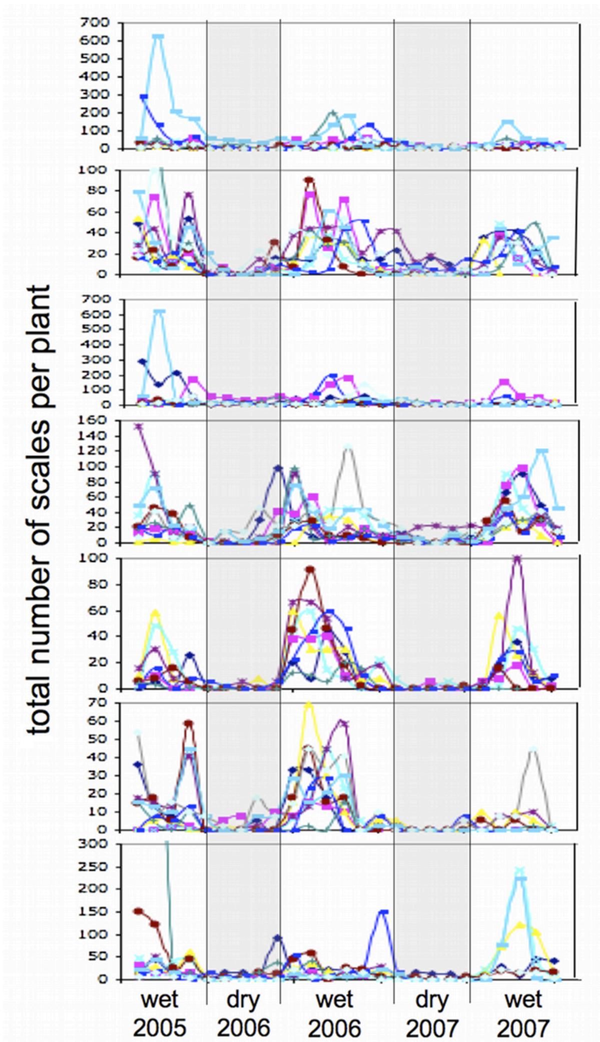

Figure A4. Time series of 35 populations of *Coccus viridis* at seven distinct locations in a 45 ha plot on an organic coffee farm in Chiapas, Mexico. Note the distinct decline to almost zero during each dry season for all populations.

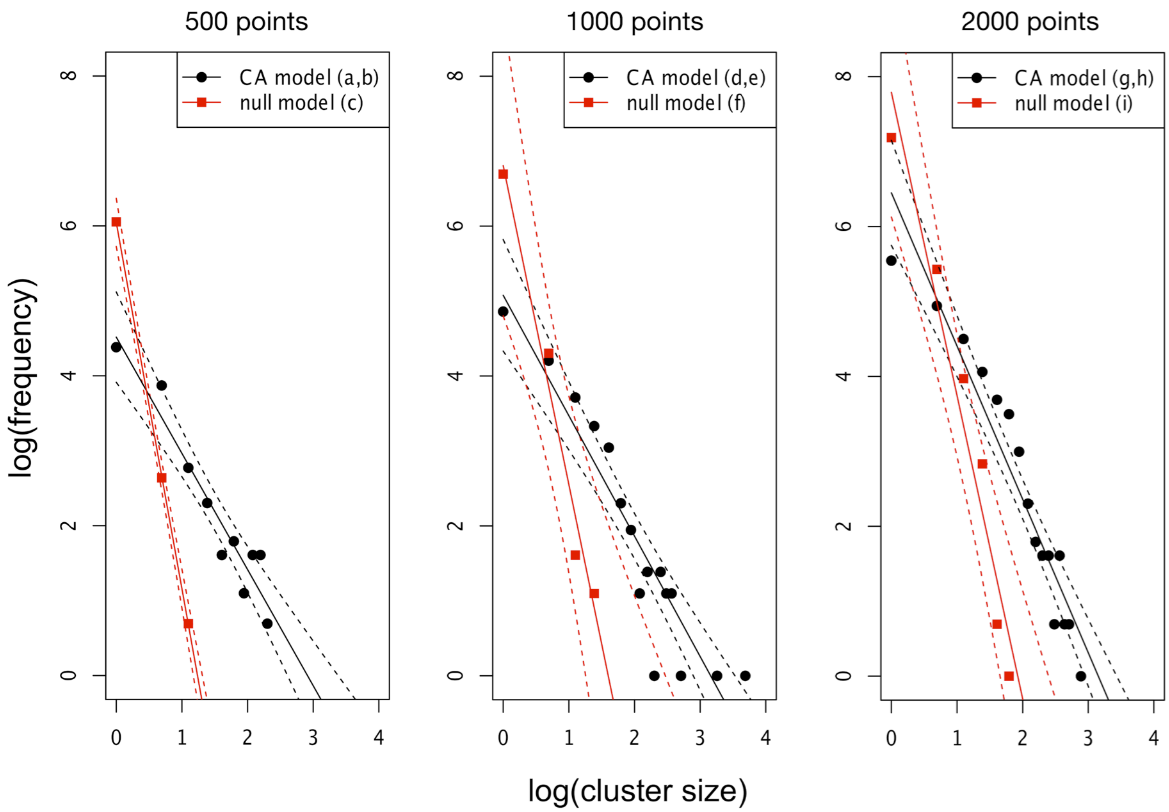

Figure A5. Cluster (patch) size distributions for the scenarios identified in Fig. 4–6. Dashed lines show 95% confidence intervals. 500 points: CA model R^2 = 0.91, p < 0.0001, null model R^2 = 0.99, p = 0.004; 1000 points: CA model R^2 = 0.87, p < 0.0001, null model R^2 = 0.96, p = 0.013; 2000 points: CA model R^2 = 0.92, p < 0.0001, null model R^2 = 0.93, p = 0.001

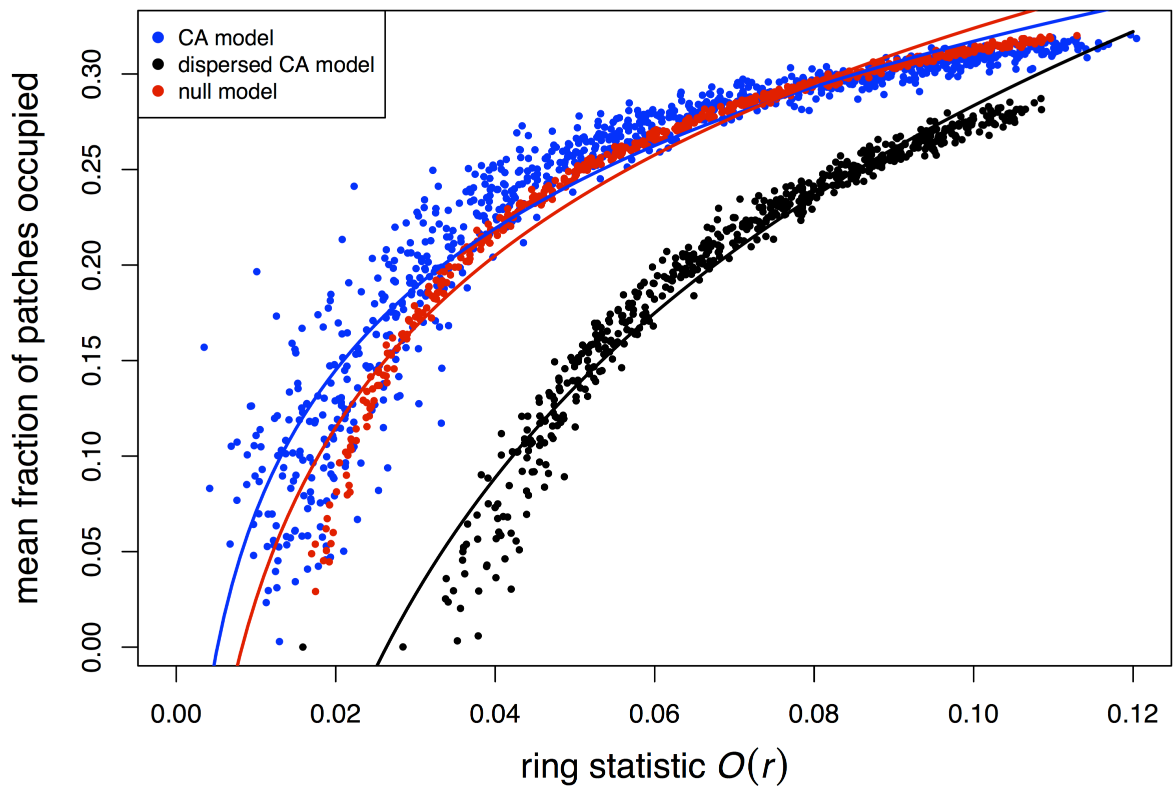

Figure A6. Mean fraction of patches occupied as a function of the O-ring statistic, a second-order measure of aggregation, for the CA, dispersed CA, and null scenarios. Larger O(r) indicates greater aggregation (clustering). Results are for spatial scales where the R^2 for logarithmic fits to the data, shown by the trendlines, are maximized, with r_{crit} = 23 units (R^2 = 0.79, p < 0.0001) for the CA; r_{crit} = 12 units (R^2= 0.91, p < 0.0001) for the dispersed CA; and r_{crit} = 4 units (R^2 = 0.84, p < 0.0001) for the null scenarios.