PBG 200A Notes

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1 From Last Time

- Pulliam 1988 - under equilibrium conditions, you get sources and sinks, or you get a balanced patch landscape (ideal free distribution (ex. ideal pike system))
- Levins - many patches (occupied patches, spacial heterogeneity)

"Should I Stay or Should I Go?" - The Clash

2 Background - Evolution of Dispersal

Basic result - spacial heterogeneity selects against dispersal. Temporal heterogeneity is neutral. Spacial AND temporal heterogeneity allows for possibility of selection *for* dispersal.

3 Levins' Model

Assumptions

- same size and quality patches
- dispersing randomly
- every patch is equally connected to every other patch
- infinite number of patches

4 Incidence Function Models (IFMs)

Finite number of patches, spacially explicit. Distance between patches i and j is d_{ij}. Patch i has area A_i. If patch i is occupied, it goes extinct at a rate A_i^{-x}. The larger the patch, the slower it goes extinct. Patch i becomes occupied at rate $\displaystyle\sum_{j \text{ occupied}} cA_j A_i \exp[-d_{ij}a]$. This is the net propagule pressure on the focal patch (patch i), and is the rate at which it becomes colonized.

4.1 Mean Field Model

p_i is the probability patch i is occupied at any particular point in time.

$$\frac{\mathrm{d}p_i}{\mathrm{d}t} = -p_i A_i^{-x} + (1 - p_i) \sum_{j \text{ occupied}} cA_j A_i \exp[-d_{ij}a] \tag{1}$$

Deterministic approximation of probabilistic model.

5 Rescue Effect

Let p be the fraction of occupied patches. Levins' Model is

$$\frac{\mathrm{d}p}{\mathrm{d}t} = cp(s-p) - \frac{ep}{1+ap} \tag{2}$$

where a is the strength of the rescue effect. Positive equilibria satisfy $c(s-p) = \dfrac{e}{1+ap}$ (colonization rate matches extinction rate). Thus,

$$\frac{c}{e} = \frac{1}{(1+ap)(s-p)} \tag{3}$$

Plot bifurcation diagram (p^* vs. $\frac{c}{e}$): 0 is always an equilibrim (plot $p^* = 0$). Horizontal asymptotes at s and $-\frac{1}{a}$. Sideways-facing parabola(ish) thing approaching the asymptotes. Get stable states for certain values of $\frac{c}{e}$.