ECOL 8310: POPULATION AND COMMUNITY ECOLOGY
HW 3

In lecture, we have covered the dynamics of closed populations, and we've also seen the Levins' model for meta-population dynamics. Here, I'd like use to start merging these concepts. I'd like you to take an approach in which we explicitly think about (or model) the within-patch dynamics (which was ignored in Levins' model) but couple the patches via migration (and hence, incorporate concepts of meta-population dynamics). The object of the exercise is two-fold: 1) it will prepare you for some issues we'll cover in the next class; and 2) it will facilitate your thinking about how migration can alter your intuition regarding the patterns we'd expect in systems that are influenced by migration (these patterns can be fundamentally different from what we'd expect closed systems).

We're going to make this as simple as possible, so let's assume we have only two patches.

In patch 1, population growth is logistic, with r_1=0.1 and K_1=100.
In patch 2, population growth is exponential with r_2=-.2 (i.e., the closed population will die out given sufficient time).

Ignore demographic and environmental stochasticity.

Now let the two patches be coupled via migration, governed by a rate of emigration of "m".

TO DO:

1) Write out a set of equations for the two patches when they are coupled by migration.
2) What are the equilibria (N_1* and N_2*) if the patches are uncoupled (i.e., set m=0 and solve; or just give the answer -- this one is simple, but establishes the baseline).
3) What do you think will happen to the equilibria in the presence of migration (m>0). If you can solve this analytically, wonderful, but what I'm looking for in this HW are qualitative answers in which you strive to clarify and justify how you think about the problem.
4) Draw out the qualitative relationships you expect between the equilibrium density in each patch and the magnitude of m (I.e., plot N_1* vs. m and N_2* vs. m). Pay particular attention to the equilibria as m tends towards 0 and infinite.
5) Now imagine that r_2=-0.05 (it is still negative and exponential, but the rate of decline is less); please answer parts 2-4 again.
6) Finally, let patch 2 improve even more, such that r_2=+0.1 (growth is now positive, but still exponential); answer parts 2-4 again. Justify your answer. Feel free to simulate this (e.g., in Excel or R), although you do not have to.