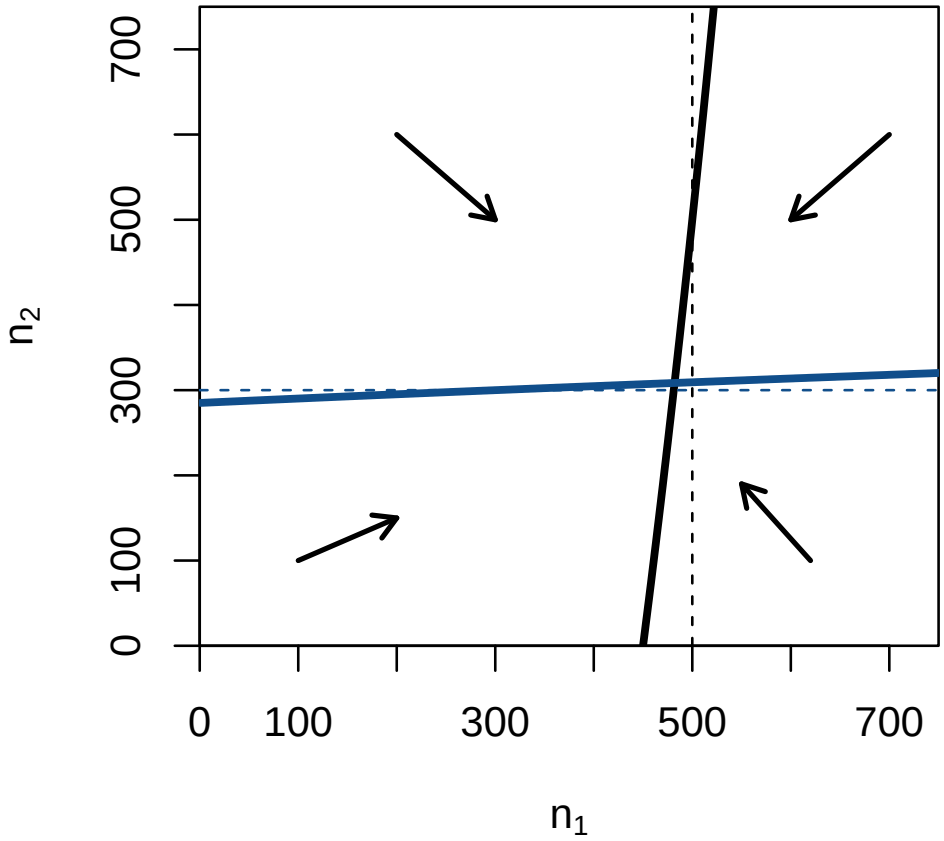
# Metapopulation Homework Solutions

1. Sketch nullclines for a two-patch model with very small $\epsilon$ and very large $\epsilon$. How do these plots differ from Figure 3?

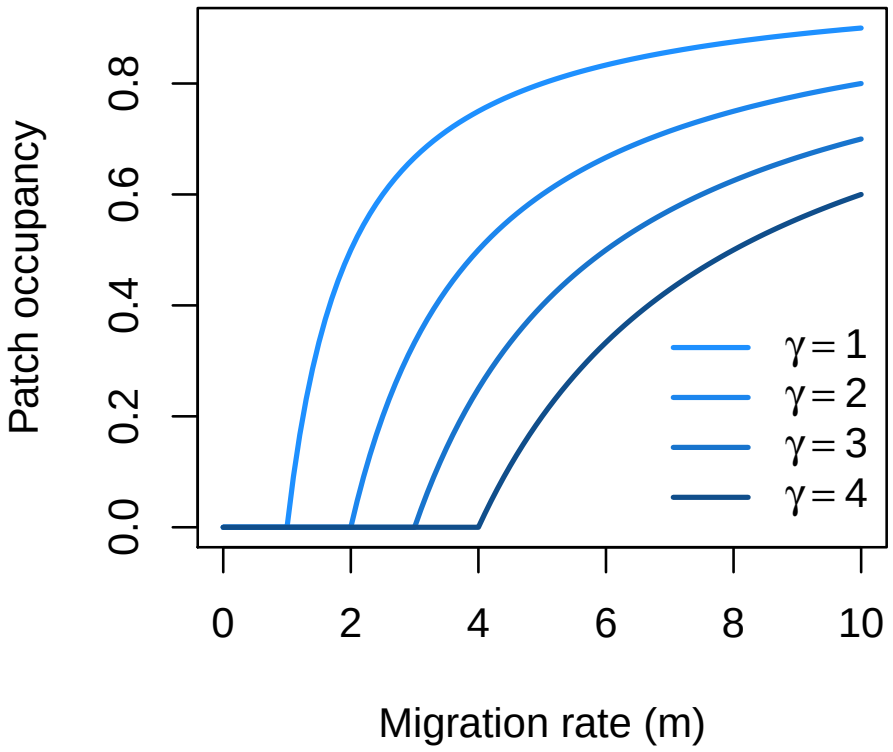



Nullclines of the two-patch model. Black designates the nullcline of $n_1$ while blue designates the nullcline of $n_2$ where $r_1 = 1$, $r_2 = 2$, $k_1 = 500$, $k_2 = 300$, and $\epsilon = 0.1$. As the degree of coupling ($\epsilon$) decreases, the sub-populations approach their independent carrying capacities. Thus, this plot is intermediate between the highly connected model in Figure 3 and the completely uncoupled population dynamics.

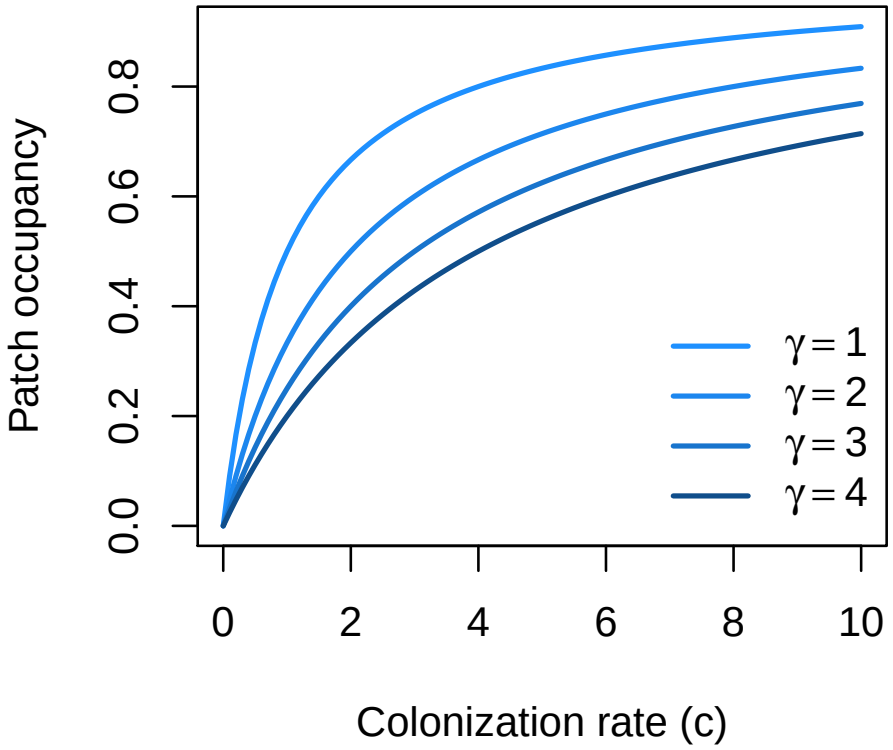
2. Sketch the curves describing eqilibrium patch occupancy of the classical and mainland-island metapopulations (equations 10 and 16). How does patch occupancy depend on

such parameters as $m$, $\gamma$, and $c$?

Equilibrium patch occupancy for the classical (Levins) metapopulation model is $p^*_{Levins} = 1 - \gamma/m$ where $\gamma$ is the extinction rate and $m$ is the migration rate. This formula gives the patch occupancy where $\gamma < m$. Here we plot patch occupancy as a function of $m$ for a range of $\gamma$ values.




Similarly, for the mainland-island model, equilibrium patch occupancy $p^*_{Mainland-island} = c/(c + \gamma)$ where $\gamma$ is the extinction rate and $c$ is the colonization rate. This formula gives a valid patch occupancy anywhere $c > 0$. Here we plot patch occupancy as a function of $c$ for a range of $\gamma$ values.




3. Are the data in Figure 2 more consistent with a classical or mainland-island metapopulation model?

   Evidently, the dynamics of the Glanville Fritillary butterfly behave more like the mainland-island model than the Levins model. According to the mainland-island model, the rate of colonization declines with the fraction of patches occupied because as this fraction increases the number of available patches goes down while there is no change in the propagule pressure. By contrast, the Levins model predicts that the colonization rate would increase with fraction of populations colonized for values of $p$ less than 0.5.