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BI 471/571: Population Ecology

Problems 4: competition

1. Hastings Problems 7.1, 7.2, 7.4

$$\frac{dN_1}{dt} = R_1 N_1 (1 - a_{11} N_1 - a_{12} N_2)$$

$$\frac{dN_2}{dt} = R_2 N_2 (1 - a_{21} N_1 - a_{22} N_2)$$

$$= (R_1 N_1 - m N_{1i})(1 - a_{11} N_1 - a_{12} N_2)$$

$$= (R_2 N_2 - m N_{2i})(1 - a_{21} N_1 - a_{22} N_2)$$

7.1)

In order for it to be impossible for coexistence the signs of the variables in the equation should be negative, representing a competitive interaction between the species. When adding in this new term ($-mN_i$), it must make the signs positive in order for coexistence to occur.

7.2)

$$\frac{dp_1}{dt} = m_1 p_1 (1-p_1) - ep_1$$

$$= m_1 p_1 - m_1 p_1^2 - ep_1$$

$$0 = m_1 - 2m_1 p_1 - e$$

Solve for p_1:

$$2m_1 p_1 = m_1 - e$$

$$p_1 = \frac{m_1 - e}{2m_1}$$

In order for the equilibrium to be positive, the colonization rate of species 1 would need to be positive and larger than the extinction rate. Meaning, this population would need to be viable with a well established population that is not on the break of extinction.

$$\frac{dP_2}{dt} = m_2 P_2 (1 - P_1 - P_2) - m_1 P_1 P_2 - eP_2$$

$$= m_2 P_2 \left(1 - \frac{m_1 - e}{2m_1} - P_2\right) - m_1 \left(\frac{m_1 - e}{2m_1}\right) P_2 - eP_2$$

$$= m_2 P_2 - \frac{m_2 P_2 m_1 - m_2 P_2 e}{2m_1} - m_2 P_2^2 - \left(\frac{m_1 - e}{2}\right) P_2 - eP_2$$

$$= m_2 P_2 - \frac{m_2 P_2}{2} - \frac{m_2 P_2 e}{2m_1} - m_2 P_2^2 - \frac{P_2 m_1 - eP_2}{2} - eP_2$$

$$0 = m_2 - \frac{1}{2} m_2 - \frac{m_2 e}{2m_1} - 2m_2 P_2 - \frac{m_1 - e}{2} - e \, ?$$

I think both m1 and m2 have to be positive in order for both species to survive.

7.4) Competition in the lab versus the field using Lotka Volterra equations would differ. In a lab setting these equations could help infer species interactions and relationships. In a field setting more detail can be observed in the surroundings of the species and other environmental factors. Looking at two species grown together in a lab setting will focus mainly on a smaller scale interaction (controlled setting), while in the field the natural interaction of these two species can be studied. Looking at overlap in resources between competitive species can give insight into how species interact with one another and how they compete for those resources. Experiments in the field can manipulate populations by creating controlled areas. An example of this could be a planted plot of a plant species and its interaction with the organisms that pollinate it. The manipulated aspect of this study being the planted plots.

2.

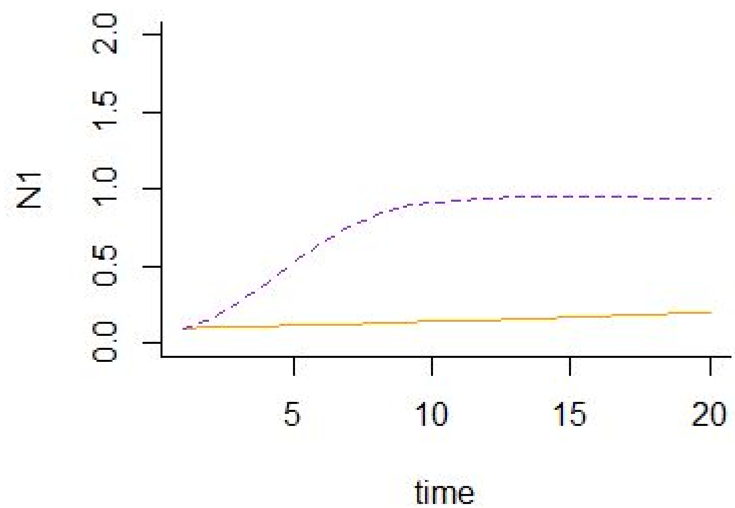

Figure 1: Orange solid line represents species 1, purple dotted line represents species 2, short term: 20 days

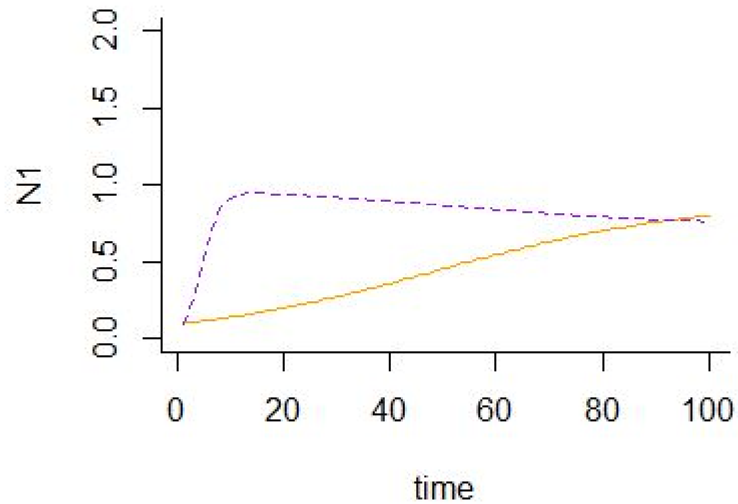

Figure 2: Species 1 (orange) and Species 2 (purple) populations, long term: 100 days

After 20 days both species coexisting together. In the first figure I have attached species 1 seems to have a constant population over the 20 days, while species 2 has an increase followed by a flattening out (possibly the population capacity?). After performing the same study for 100 days would show different results than the 20 day study and this can be seen in figure 2. Species 1 steadily increases over time and eventually crosses over species 2's line. Species 2 sharply increases and then proceeds to gradually decrease. The short and long term studies are different and should be interpreted differently. When comparing the two graphs representing these two studies, it is clear that the short term study fails to show the bigger picture (the interaction of these two species).

3. Plant-Pollinator Networks or Invasive species Emerald Ash Borer