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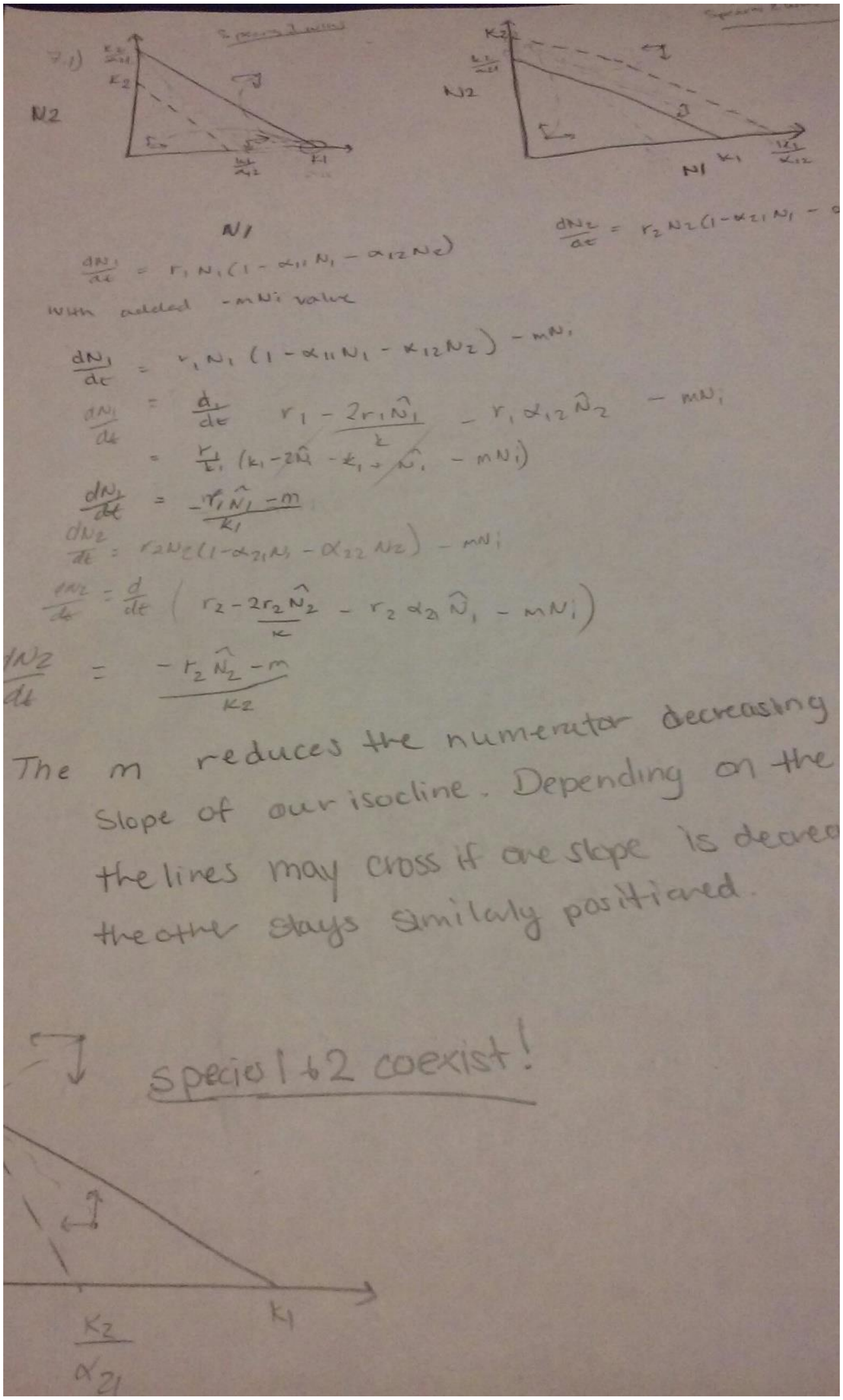
BI 471 Population Ecology

HW 4

1. 7.1:


7.1)

$$\frac{dN_2}{dt} = r_2 N_2 (1 - \alpha_{21} N_1 - $$

$$\frac{dN_1}{dt} = r_1 N_1 (1 - \alpha_{11} N_1 - \alpha_{12} N_2)$$

with added $-mN_i$ value

$$\frac{dN_1}{dt} = r_1 N_1 (1 - \alpha_{11} N_1 - \alpha_{12} N_2) - mN_i$$

$$\frac{dN_1}{dt} = \frac{d}{dt} \quad r_1 - \frac{2 r_1 \hat{N}_1}{k} - r_1 \alpha_{12} \hat{N}_2 - mN_i$$

$$= \frac{r_1}{k_1} (k_1 - 2\hat{N}_1 - k_1 + \hat{N}_1 - mN_i)$$

$$\frac{dN_1}{dt} = \frac{-r_1 \hat{N}_1 - m}{k_1}$$

$$\frac{dN_2}{dt} = r_2 N_2 (1 - \alpha_{21} N_1 - \alpha_{22} N_2) - mN_i$$

$$\frac{dN_2}{dt} = \frac{d}{dt} \left(r_2 - \frac{2 r_2 \hat{N}_2}{k} - r_2 \alpha_{21} \hat{N}_1 - mN_i \right)$$

$$\frac{dN_2}{dt} = \frac{-r_2 \hat{N}_2 - m}{K_2}$$

The m reduces the numerator decreasing Slope of our isocline. Depending on the the lines may cross if one slope is decrea the other stays similarly positioned.

species 1 + 2 coexist!

7.2:

7.2) a) $\frac{dp_1}{dt} = m_1 p_1 (1-p_1) - e p_1$

$0 = m_1 p_1 (1-p_1) - e p_1$

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

$0 = p_1 (m_1 - m p_1 - e)$ $\quad \boxed{0 = p_1}$

$0 = m_1 - m_1 p_1 - e$

$m_1 p_1 = m_1 - e$

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

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

For this to be positive e must be less than m_1. The extinction rate must be less than the colonization rate in order for the # of patches colonized to increase.

b) $\frac{dp_2}{dt} = m_2 p_2 (1 - p_1 - p_2) - m_1 p_1 p_2$

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

$\frac{dp_2}{dt} = m_2 p_2 \left(1 - \frac{m_1 - e}{m_1} - p_2\right) - m_1 \left(\frac{m_1 - e}{m_1}\right) p_2 - e p_2$

$\frac{dp^2}{dt} = \frac{d}{dt} \quad m_2 p_2 - \frac{(m_2 p_2)(m_1 - e)}{m_1} - m_2 p_2^2 - m_1 p_2 \left(\frac{m_1 - e}{m_1}\right) - e p_2$

$= m_2 p_2 - \frac{m_2 p_1 \ldots}{m_1} \; 2 m_2 p_2 - m_1 - e - e \ldots$

$= m_2 e - 2 m_1 m_2 p_2 - m_1^2$

M2 must be greater than m_1 in order for both to survive since it has its survival multiplied by extinction rate.

c) If the extinction rate were increased, m_2 would be most likely to lose in competition

If the e is at its highest level, we are likely to see extinction of species 2.

If e is increased then species 2 goes extinct. I don't think it makes sense because species 1 would have a negative growth rate. Both must live so rather than competition, this models mutualism.

7.4:

a. In the laboratory, the Lotka-Volterra equations serve to show how one species affects another based on their respective initial starting conditions and populations. In the field, it is a bit harder to control for other factors that influence survival of different species.

b. In the competition experiment using Paramecium, when the two species were grown together, it was shown that every time the two were grown together, they did not get to as high of population levels as they did when they grew by themselves.

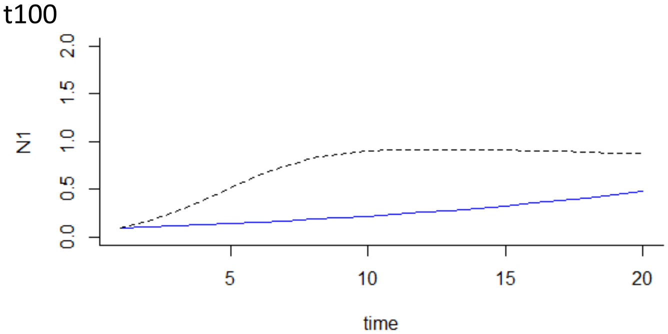
c. It would be important to note the effect of resources on the systems that we model. I find my understanding of the equations a bit vague, but I do think that one important one is looking at patches of space which is even available for colonization. We would have to look at how different species are able to compete for space versus nutrients.

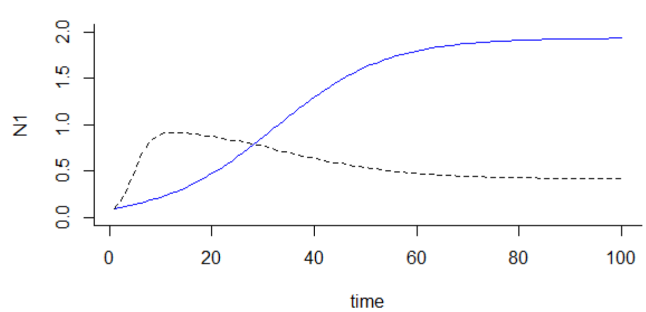
d. Field manipulations of populations that were discussed were those of refraction in which a part of the population is removed and is modeled by including an –mNi term in the equations on rate of population over time using logistic growth.

2. From the graph, we can conclude that over time, species 1 will begin to grow while species 2 starts a slow decline even though initial growth for species 2 was much faster. When I then plotted it for t = 1:100, the plot showed a bit of a different picture. Species 2 enjoyed an extremely brief point of moderate growth in comparison to the very slow rise in species 1, but then species 2 experienced a rapid decline in population reaching a low, but respectable, population size. Species 1, on the other hand, did much better as its population continued to grow throughout the time scale observed.

   What this might suggest, is that populations are dynamic and it may take time for the factors affecting population size to kick in and give us a big picture idea of what is occurring. In this case, between short and long-term experiments, we see very different things happening to each population.

   Plots: t20 and t100





R Script:

```
library(deSolve)
## 2species
comp <- function(t, y, p) {
  N1 <- y[1]
  N2 <- y[2]
  with(as.list(p), {
    dN1.dt <- (r1 * N1 / K1) * (K1 - N1 - a12 * N2)
    dN2.dt <- (r2 * N2 / K2) * (K2 - N2 - a21 * N1)
    return(list (c(dN1.dt, dN2.dt)))
  })
}
## Name parameters
t <- 1:100
y0 <- c('N1' = 0.1, 'N2' = 0.1)
p <- c('r1' = 0.1, 'r2' = 0.6,
       'K1' = 2, 'K2' = 1,
       'a12' = 0.15, 'a21' = 0.3)

sim <- ode(y = y0, times = t, func = comp, parms = p, method = 'lsoda')
sim <- as.data.frame (sim)
## Now we have a three column data frame. Data frame is essentially a table.

plot(N1 ~ time, type = 'l', col = 'blue', bty = 'l', data = sim, ylim = c(0, 2))
points(N2 ~ time, type = 'l', lty = 2, data = sim)
```

3. I would like to contribute to the project on Amur Leopards.