Problems for Community Ecology Section of Principles of Ecology

For the upcoming exam I will likely choose questions directly for those below. If you have questions about any of these please see me during office hours, email me, and make an evening review session. I strongly recommend you work in groups to solve these problems. I highly recommend you use Ricklefs’ Living Graphs (http://www.whfreeman.com/ricklefs5e/index.htm)

Note: Analyze the graph. Recall that this means you need to identify all equilibria (circle them) and indicate whether they are stable or unstable. If stable, indicate whether they are locally stable or globally stable.

Predator-Prey Questions

1. Create a schematic drawing of the standard Lotka-Volterra predator-prey system. Include boxes and arrows and identify parameters. Assume that:

   - the herbivore per-capita growth rate = f
   - the herbivore-predator contact rate = g
   - the thermodynamics coefficient = j
   - the per-capita death rate of predators is z
   - the number of herbivores = X
   - the number of predators = Y

2. Write down the differential equations that correspond to the above model.
3. Draw a graph for the above equations. Label isoclines, axes, and the points where isoclines (equilibrium lines) meet the axes. Analyze the graph.
4. Assume you have twice as many herbivores as predators and you begin with the number of herbivores exceeding the equilibrium number that supports the predator population. Follow the dynamics of this system for one complete cycle (draw this on your graph).
5. Draw a companion graph to the above “phase-plane” graph but track N as a function of time for both populations.
6. Create a new predator-prey graph but assume density dependence and the Allee effect for herbivores and density dependent regulation for predators. Analyze the graph.
7. Based on the assumptions in 6 above assume the number of herbivores that just sustains the predator population (dP/dt = 0) is relatively low.
   a. Draw this graph
   b. Analyze it.
   c. Draw a graph for N vs. time for this system.
**Competition Questions**

1. What is a zero isocline?
2. If the isocline for species $N_1$ is greater (always higher and to the right) than the isocline for $N_2$ briefly describe what happens.
3. Draw the condition where the isoclines cross and $K_1$ (for $N_1$) is less than the point where the isocline for $N_2$ hits the x-axis. What happens? Why does this happen.
4. In your hand-drawn phase-plane graph above place a dot half way between the origin (the 0,0 point at the lower left) and the crossing of your isoclines. That dot represents the location of both populations of competitors simultaneously. Over time that point will move. Draw where it goes all the way to it’s ultimate resting point (the equilibrium to which it ultimately will reside).
5. Draw a new graph by hand of N versus time. Draw what both populations do over time if they start out at the dot in the previous question.
6. Draw the condition where the isoclines cross and $K_1$ for $N_1$ is greater than the point where the isocline for $N_2$ hits the x-axis. What happens? Why does this happen. Uniquely identify the isoclines for the two species. Indicate where $K_1$ and $K_2$ occur. Analyze the graph.
7. In your hand-drawn phase-plane graph above place a dot half way between the origin and the crossing of your isoclines. Again, over time that point will move. Draw where it goes all the way to it’s ultimate resting point (the equilibrium to which it ultimately will reside).
8. Draw a new graph by hand of N versus time. Draw what both populations do over time if they start out at the dot in the previous question.
1. What are the equilibria for $\frac{dN_1}{dt} = r_1 N_1 \left( \frac{K_1 - N_1 - \alpha_{12} N_2}{K_2} \right)$?

2. For $\frac{dN_2}{dt}$?

4. **Analyze** the following graphs:
5. In the following graphs indicate where the system will end up if it starts at the point provided. Graph $N$ vs. time for both species in the graphs on the right.

6. Determine the initial starting point (similar to above left graphs) and configuration of the isoclines given $N$ vs. time: