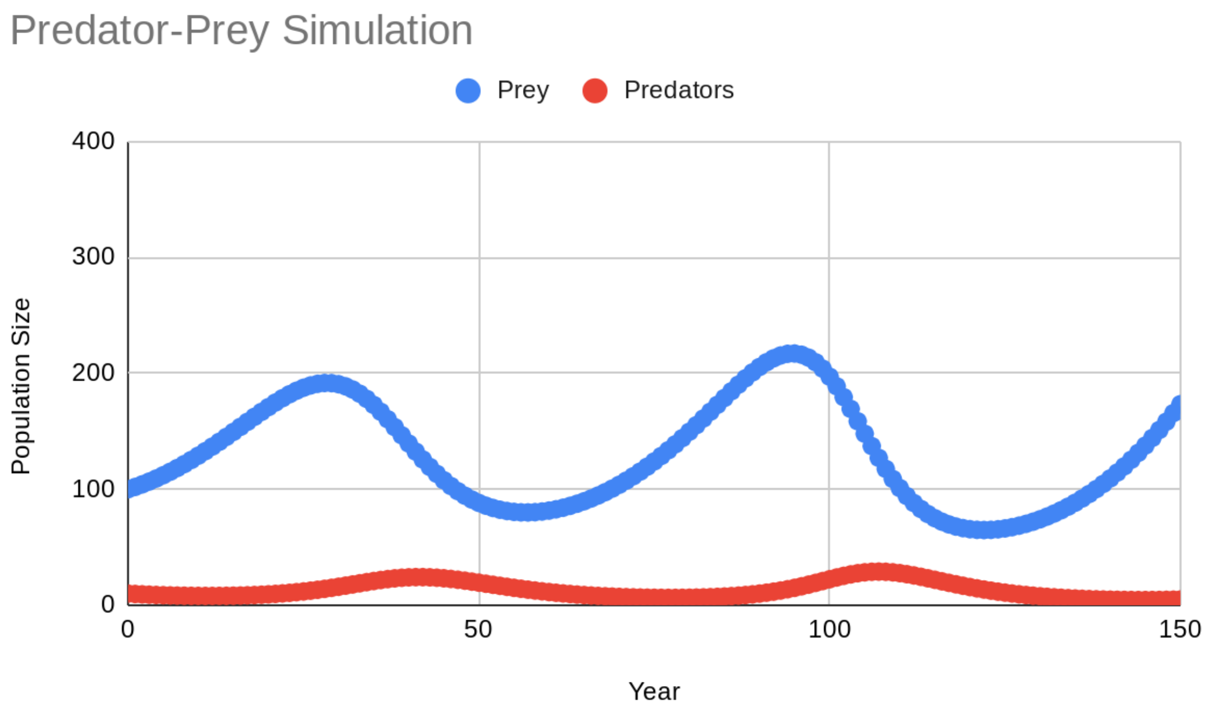
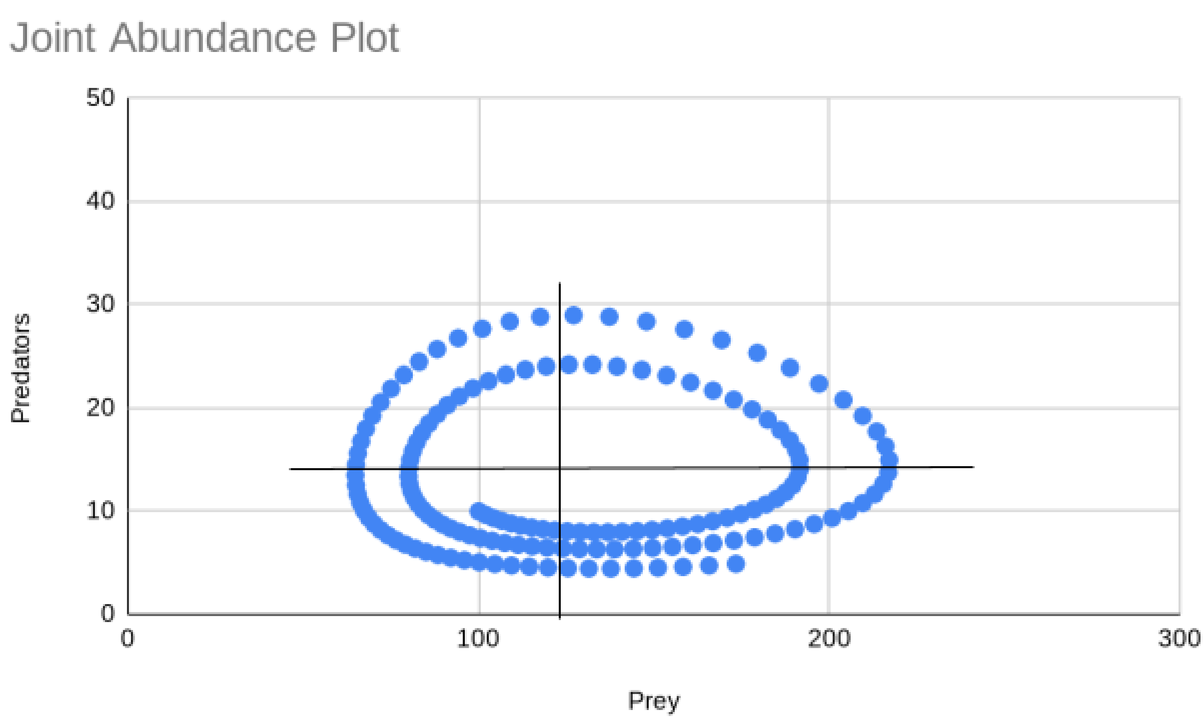
Predator-Prey Simulation

Group Members: Harrison Deitz, Thomas Keating, and Kenneth Lam

Graphs:



Predator-Prey Simulation
Prey
Predators
400
300
200
100
0
Population Size
0
50
100
150
Year



Joint Abundance Plot
50
40
30
20
10
0
Predators
0
100
200
300
Prey

Questions:

1. On your joint abundance use the values of the constants to calculate the positions of the isoclines and draw the isoclines with a pencil and ruler on top of your population curve. Does the curve seem to spiral around the point of intersection? Explain?

   Horizontal isocline: $\frac{r}{p} = \frac{0.07}{0.005} = 14$

   Vertical isocline: $\frac{d}{ap} = \frac{0.139}{((0.21)(0.005))} = 132.38$

   The curve does appear to spiral around the point of intersection. Our graph is an oval shape and the point of intersection lies around the center of the oval. Therefore, the graph spirals around it.

2. On a joint abundance plot of cycles near the stable limit condition, are the circles symmetrical around the intersection of isoclines as diagrammed in figure 11.10 or not? Describe the shape of the cycles on the joint abundance graph and reflect on why the increasing and decreasing parts of each cycle might be asymmetrical.

   The circles are not symmetrical around the isoclines. The shape of the cycles on the joint abundance graph is not symmetrical. They are asymmetrical because the population of predators is usually smaller than the population of prey.

3. During the 1920s, U.S. government policy encouraged extermination of predators such as wolves, mountain lions, and coyotes from large areas in the American West in order to maintain more abundant deer and antelope populations for hunters. Based on your model, what outcome would you expect from this effort to maintain prey in the absence of predators?

Based on the model, a decrease in a given predator population would cause an increase in the prey population.

Figure A:

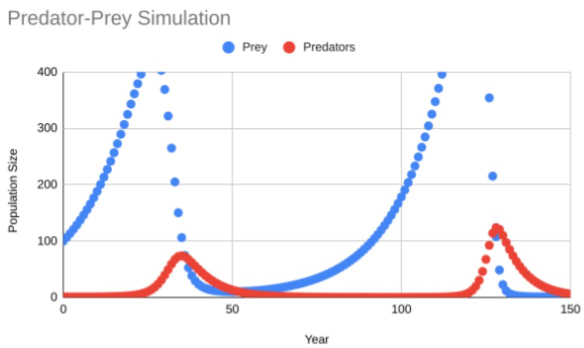
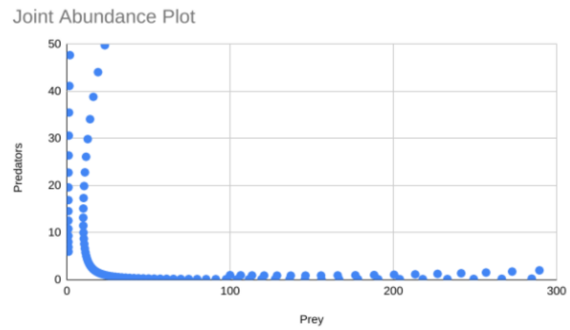


Figure B:



When changing the original number of predators from ten to one, the predator-prey simulation in figure A indicates larger peaks in the prey population size. Meanwhile, the predator population size has smaller peaks. In the joint abundance plot in figure B, The abundance of prey increases following a sharp decline in the predator population. Unlike the initial graph, there is no oval-shaped cycle. Increasing the number of predators causes the predator population size in figure A to have higher peaks and the prey population to have smaller peaks. In figure B, an oval shape begins to form indicating a more consistent population cycle.

4. If you adjust each of the four constants, one at a time by 10 percent, which seems to have the greatest impact on the simulation output? Examine the Lotka Volterra equations to explain why this constant makes such a big difference in the predator-prey system.

In the Lotka-Volterra model, the constant, p, represents the predator population. For finding the change in the prey population, the intrinsic growth rate is multiplied by the prey population, which is then subtracted by a product that is multiplied by the predator constant. Similarly, for finding the change in the predator population, the product of the measure of how many offspring the predators produce from one consumed prey is multiplied by the probability of the predator catching their prey. This is multiplied by the product of the predator and prey populations. Then, it is subtracted by the predator population multiplied by the mortality rate of predators. By increasing the predator constant by 10 percent, the predator and prey populations die off very quickly and they do not recover. When increasing the other constants by 10 percent, there are still visible population cycles present on the graph. With an increase in the predator population, there is less prey available to fulfill their needs. As a result of this, the predator population decreases from there being less food to eat, in addition to the prey population's decrease from the predators consuming them. This dynamic is shown in the equation, as the product including the predator population constant is subtracted.

5. Predator-prey systems are difficult to balance when there is only one predator and only one prey. Would you expect a system with multiple prey species to be more stable? Why?

   Yes, a system with multiple prey species would likely be more stable. This is because an increase in the number of prey populations allows the predator population to increase as well due to abundant resources. An increase in the predator population means a decrease in the prey populations. As a result, the decline in the prey populations would cause the predator population to decline. Therefore, the system would be stable because the populations would increase and decrease with each other.