I. Short Answer Questions

SAQ #1. Please state and BRIEFLY explain the two major objectives of **community ecology**. Please use a diagram for each, AND write an explanation.

diagram and explain objective 1 - (2 pts)
explain the key “emergent properties” that this objective aims at explaining - (2 pts)
diagram and explain objective 2 - (2 pts)
explain the key “emergent properties” that this objective aims at explaining - (2 pts)

The next several questions will asses your understanding of the 2 species competition equations:

species 1:

$$\frac{1}{N_1} * \frac{\Delta N_1}{\Delta t} = r_1 * \left(1 - \frac{N_1}{K_1} - \frac{a * N_2}{K_1} \right)$$

species 2:

$$\frac{1}{N_2} * \frac{\Delta N_2}{\Delta t} = r_2 * \left(1 - \frac{N_2}{K_2} - \frac{b * N_1}{K_2} \right)$$

SAQ #2. One of the principal mathematical **assumptions** of this model is the constancy of its parameters. What are these constants and what are the ecological implications of assuming that these are constants? (3 pts)

SAQ #3. Another assumption is about how the model includes density dependence. Please use the axes below AND explain how this model includes density dependence. (4 pts)

SAQ #4. Please explain <u>in words</u> without using any symbols or notation what is the principal <u>prediction</u> of the 2 species competition model above. (3 pts)

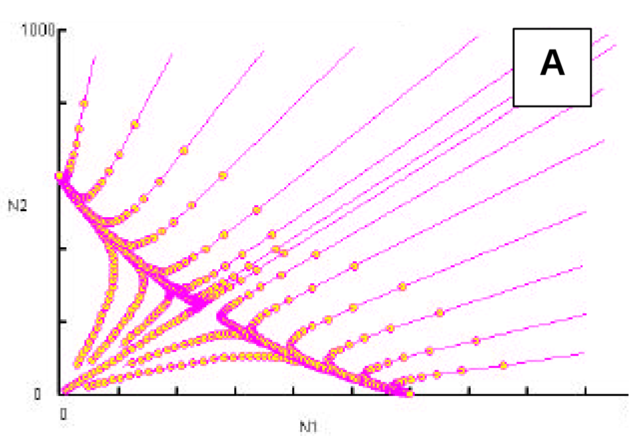
SAQ #5. It can be shown that stable competitive coexistence will always occur if two inequalities are true:

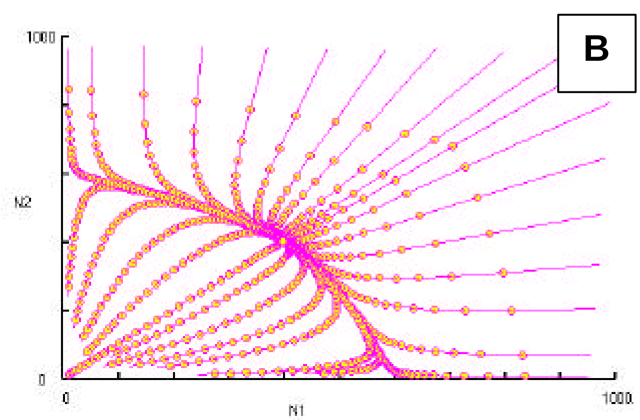
$$\frac{1}{K_2} > \frac{a}{K_1} \quad \text{and} \quad \frac{1}{K_1} > \frac{b}{K_2}$$

Show how EITHER ONE of these inequalities results directly from the 2 species competition equations above. (4 pts)

SAQ #6. Consider the two figures below that show the N_1 vs. N_2 solutions for simulations of competition with two different sets of model parameters.

{$K_1 = K_2 = 600$, alpha = 1.5, beta = 1.5} {$K_1 = K_2 = 600$, alpha = beta = 0.5}





For which one is there stable coexistence? A or B (circle one, 1 pt)

Please explain why does one lead to stable competitive coexistence but the other does not? (3 pts)

SAQ #7. Thomas Park's laboratory studies on competition between two species of flour beetles found that the winner in competition depended on the temperature, humidity, and genetic strain of individual beetles.

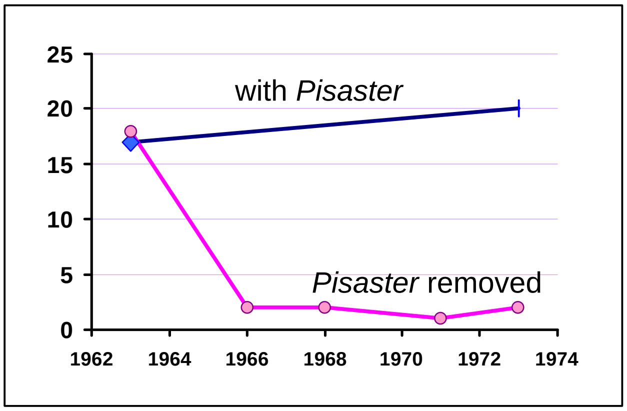
(a). What are the specific conclusions we can safely draw from Park's studies about the assumptions of our two species competition model above?

(2 pts)

(b) What are the main generalizations we can draw from Park's studies about the use of lab experiments to understand competition in nature?

(2 pts)

SAQ #8. At right is a plot of invertebrate species diversity among a rocky intertidal habitats where the predatory sea star, *Pisaster*, is present (top) versus where it has been experimentally removed. Please briefly explain this pattern.



(3 pts)

SAQ #9. Consider the simplest possible model of the **predator/prey interaction** below:

for prey: for predator:

$$\frac{1}{\text{Prey}} * \frac{\Delta \text{Prey}}{\Delta t} = r_1 - a * \text{Predator} \qquad \frac{1}{\text{Predator}} * \frac{\Delta \text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

(a). Please list two of the principal mathematical **assumptions** of this model (select two different ones!), and in addition, state the main ecological implications of each of these math assumptions.

mathematical assumptions: ecological implications:

(2 pts)

SAQ #10. Draw a little graph below showing the **prey per capita population growth rate** vs. the **predator population size** for this model. Indicate ALL relevant constants, and LABEL THE AXES!

(2 pts)

SAQ #11. Draw a little graph below showing the **predator per capita population growth rate** vs. the **prey population size** for this model. Indicate ALL relevant constants, and LABEL THE AXES!

(2 pts)

SAQ #12. Consider the simplest possible model of the **predator/prey interaction** below:

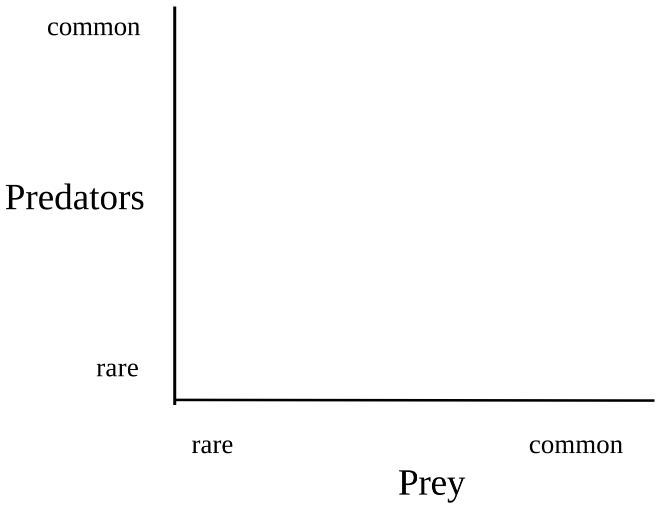
for prey:

$$\frac{1}{\text{Prey}} * \frac{\Delta \text{Prey}}{\Delta t} = r_1 - a * \text{Predator}$$

for predator:

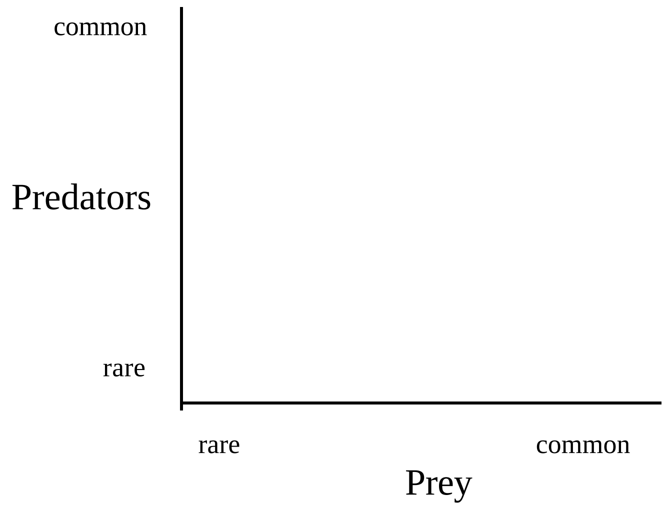
$$\frac{1}{\text{Predator}} * \frac{\Delta \text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

a. In the graph below, plot the change in the population size of **Prey** using four little arrows corresponding to when Prey and Predators are common and rare.



(1 pt.)

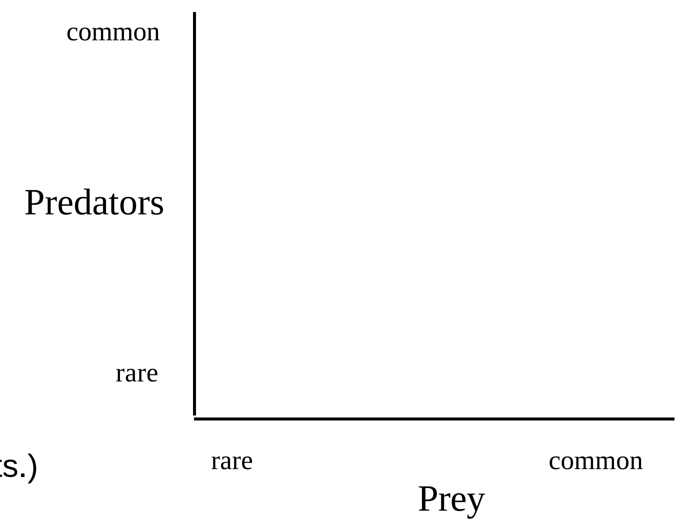
b. In the graph below, plot the change in the population size of **Predators** using four little arrows corresponding to when Prey and Predators are common and rare.



(1 pt.)

c. In the graph at right, combine the arrows from the two plots above...

(2 pts)



d. Does this model lead to stable predator prey coexistence?

Yes or No ??? (2 pts.)

e. Briefly explain why or why not. (2 pts)

Consider again the simplest possible model of the **predator/prey interaction** below:

for prey:

$$\frac{1}{\text{Prey}} * \frac{\Delta\text{Prey}}{\Delta t} = r_1 - a * \text{Predator}$$

for predator:

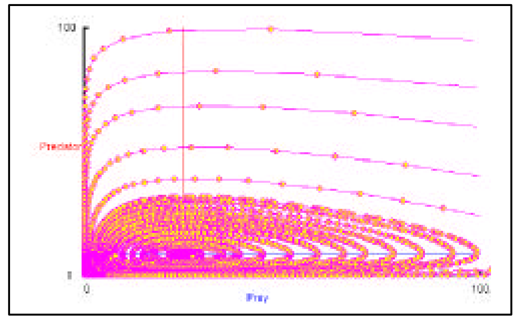
$$\frac{1}{\text{Predator}} * \frac{\Delta\text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

SAQ #13. (a). What is the ecological interpretation of the alpha (α)? (2 pts.)

(b). Why might natural selection favor a higher alpha (α)? (1 pt.)

(c). At right is a plot of Predator vs. Prey for an elevated alpha (α) (recall that we did this example in class). Briefly explain what this simulation predicts about coexistence due to the effects of increasing alpha (α).

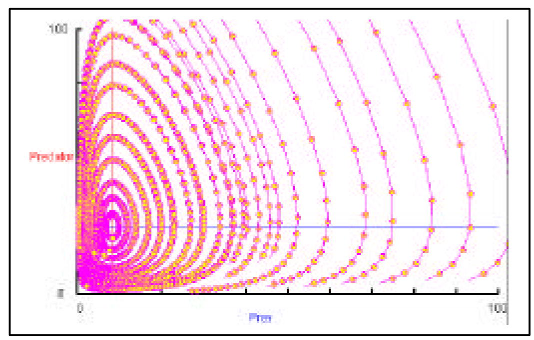
(1 pt.)



SAQ #14. (a). What is the ecological interpretation of the beta (β)? (2 pts.)
(b). Why might natural selection favor a higher beta (β)? (1 pt.)

(c). At right is a plot of Predator vs. Prey for an elevated beta (β) (recall that we did this example in class). Briefly explain what this simulation predicts about coexistence due to the effects of increasing beta (β).

(1 pt.)



I. Longer Answer Questions (15 points each)

LAQ #1. Consider the simplest possible model of two species **competition** below:

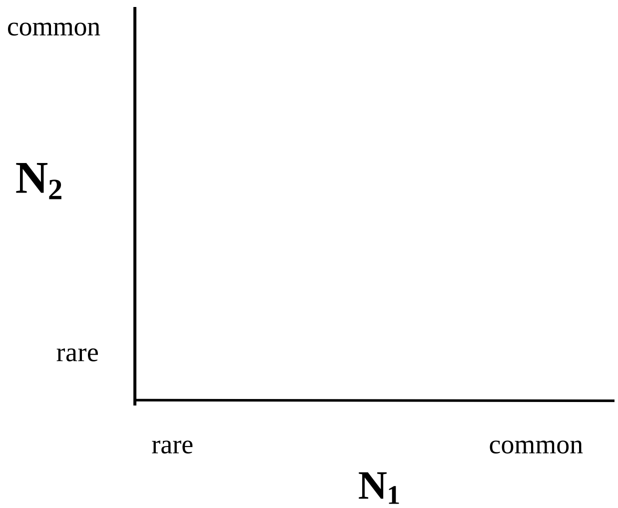
for species 1:

$$\frac{1}{N_1} * \frac{\Delta N_1}{\Delta t} = r_1 - a * N_2$$

for species 2

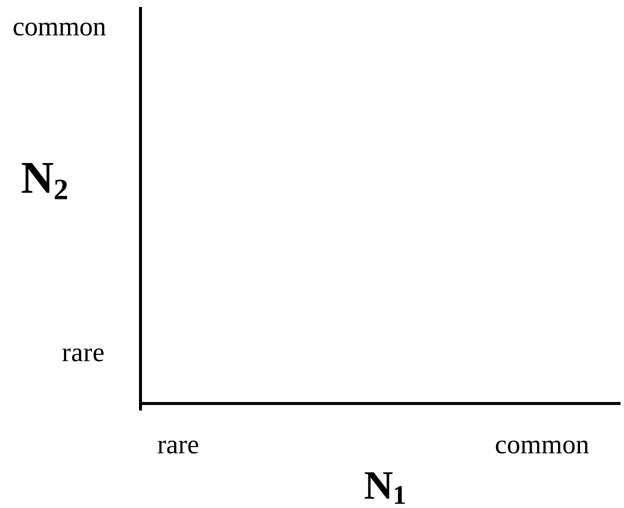
$$\frac{1}{N_2} * \frac{\Delta N_2}{\Delta t} = r_2 - b * N_1$$

a. In the graph below, plot the change in the population size of **species N1** using four little arrows corresponding to when N1 and N2 are common and rare.



(3 pts.)

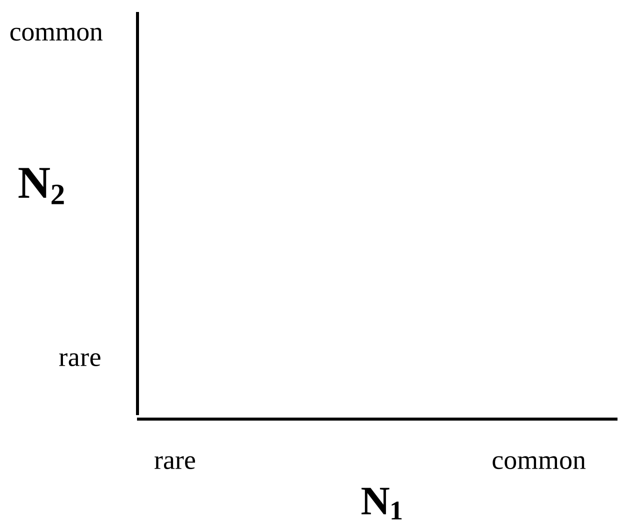
b. In the graph below, plot the change in the population size of **species N2** using four little arrows corresponding to when N1 and N2 are common and rare.



(3 pts.)

c. In the graph at right, combine the arrows from the two plots above...

(3 pts)

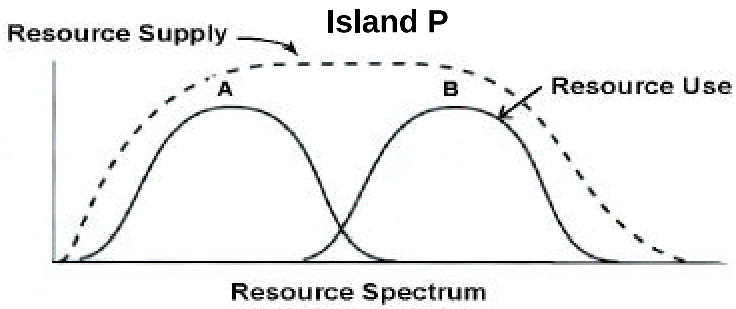


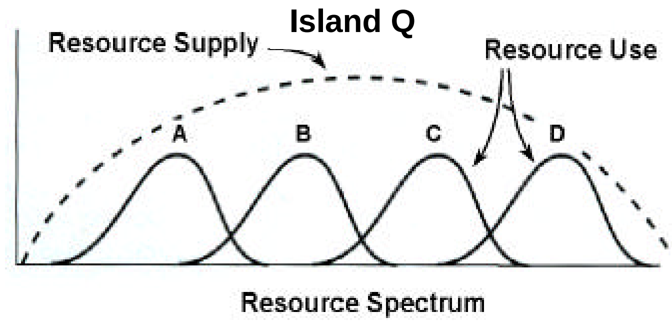
d. Does this model ever lead to stable competitive coexistence?

Yes or No ??? (3 pts.)

e. Briefly explain why or why not. (3 pts)

LAQ #2. Consider the hypothetical case of two identical islands (call them P and Q) upon which a number of similar species of lizards live (two species, A & B, occur on Island P, and four species, A-D, occur on Island Q).





a. Please explain how competition theory would account for the differences we see in species diversity and the breadth of resource use by the component species.

(9 pts)

b. Please offer one **clear alternative explanation** for the differences we see in species diversity and the breadth of resource use by the component species. In other words, how would one account for the observed differences without invoking competition theory?

(6 pts)

LAQ #3. What did Joe Connell (1961) <u>observe</u> about the distribution of two barnacle species in the Scottish rocky inter-tidal? What exactly did Joe Connell (1961) <u>do</u> to understand what caused the barnacle distribution pattern in the Scottish rocky inter-tidal? What were the causes of the distribution pattern observed? Please use diagrams, sketches, etc., in your answer and explain the experimental design and experimental results.

Connell's observations: (5 pts)
Connell's experimental design and results: (5 pts)
Connell's interpretation of his results: (5 pts)

LAQ #4. According to Dr. David Reznick, who has studied life history evolution in guppies that live in streams on the Caribbean Island of Trinidad, there are major differences in guppy life history for mountain vs. lower elevation populations.

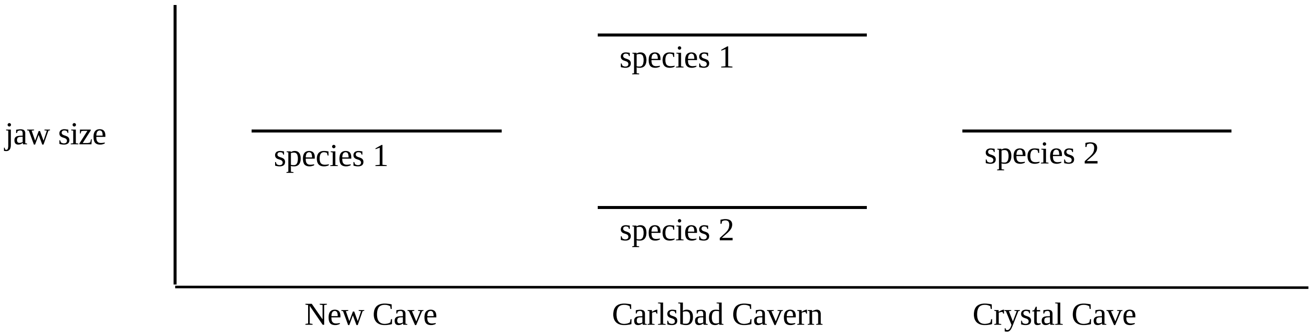
Reznick found that <u>at upstream sites</u> a small predatory fish is very common and is a voracious predator of smaller guppies, and that larger guppies have few predators. In contrast, <u>at downstream sites</u>, a different species of large-bodied predatory fish is very common and is a voracious predator of larger guppies, but that smaller guppies are not eaten. Given these different predation regimes, what life history characteristics would you expect to evolve in the <u>guppies</u> at the high and the low elevation sites regarding:

juvenile and adult mortality – (3pts)
at high elevation: at low elevation:
body size and age at sexual maturity – (3pts)
at high elevation: at low elevation:
egg size and number of eggs per reproductive event – (3pts)
at high elevation: at low elevation:
adult reproductive life span – (3pts)
at high elevation: at low elevation:

At which site would you expect to see elaborate secondary sexual characteristics (bright colors, enlarged fins, courtship displays, etc.) among reproductively active adults? Why?

(3 pts)

LAQ #5. Below shows the jaw sizes of 2 species of blind salamanders from three different caves in southeastern New Mexico. Species 1 occurs in the left two caves and species 2 occurs in the right two caves. Note that in Carlsbad Cavern, where they co-occur, their jaws are different sizes.



(a). Please explain how the phenomenon of "Competitive Character Displacement" could account for this pattern.

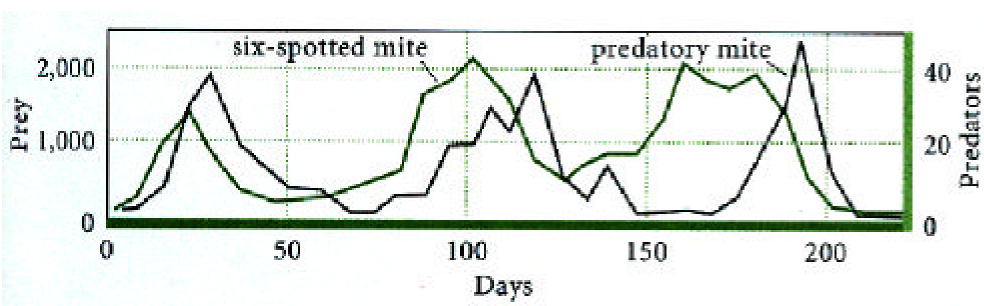
(5 pts)

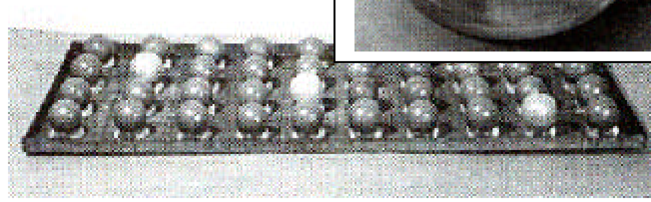
(b). Please explain how the phenomenon of "Reproductive Character Displacement" could account for this pattern.

(5 pts)

(c). Is it essential and required to explain the pattern observed above using an hypothesis based on "coevolution" or is it possible to account for this pattern using ordinary evolution? State your position and then provide a brief supporting argument.

(5 pts)





LAQ #6. This question will assess your understanding of some of the issues surrounding coexistence of interacting species in ecological communities.

One of the most important lab studies of predator prey dynamics was Huffaker's (1957) study of predator and prey mites living in trays of rotting oranges. WHY exactly did the predators coexist with their prey (as opposed to hunting their prey to extinction) **and** what are the general conclusions we can draw from Huffaker's research about ecological interactions in our ever fragmenting human-impacted landscapes?

- exactly why did they coexist? (7 pts)
- general conclusions? (8 pts)

LAQ #7. Consider a more complex model of the **predator/prey interaction** that includes a prey density-dependent predator attack rate:

for prey:

$$\frac{1}{Prey} * \frac{\Delta Prey}{\Delta t} = r_1 - (\alpha * Prey) * Predator$$

for predator:

$$\frac{1}{Predator} * \frac{\Delta Predator}{\Delta t} = -r_2 + ß * Prey$$

(a). For this model, please plot the relationship between prey density (x) and the predator attack rate (y) using the axes at right. Please label the axes and all relevant constants.

(5 pts)

(b). What is the ecological interpretation of a prey density dependent attack rate? Please offer at least one specific realistic example (from class, the text, etc.) in which this might be a reasonable assumption.

(5 pts)

(c). The solution for this model, in a plot of Predator (Y) versus Prey (x) appears at right. What is the prediction of this model?

(5 pts)