SAQ #1. **I**Please state and briefly explain the three major objectives of this course (listed on page two of the syllabus).

state and explain objective 1 - (3 pts)
state and explain objective 2 - (3 pts)
state and explain objective 3 - (3 pts)

SAQ #2. In what ways does the problem of temporal or time scale pose such a challenge to ecosystem modeling? Please offer two different examples. 1 – 2 – (5 pts)

SAQ #3. In what ways does detritus pose such a challenge to ecosystem modeling? Please offer two different examples. 1 – 2 – (5 pts)

SAQ #4. In the example in class of the car not starting, numerous hypotheses were raised to explain the phenomenon. Why exactly isn't this an example of "multiple causality?" (5 pts)

SAQ #5. According to your field notes on a population of squirrels in southeastern PA, each female has five female babies per year, six out of ten adult females are killed by hawks each year, four out of ten adult females are killed by snakes each year, none leave per year and none emigrate from elsewhere per year. Assume squirrels can breed as one year olds.

If there are 100 adult females alive and breeding now (N_0), how many would there be in one and two years from now? {Note 1: ignore the problem of males} {Note 2: you do not need a calculator to find the numerical values requested.}

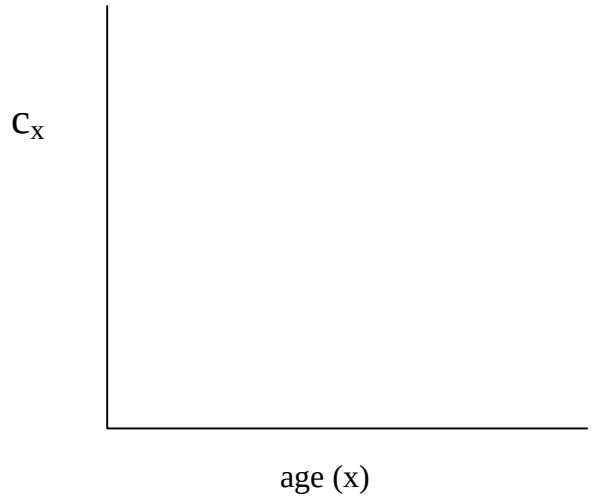
SHOW ALL OF YOUR WORK!!

how many in one year (N_1)? (4 pts)
how many in two years (N_2)? (4 pts)

SAQ #6. Explain briefly what are the **three conditions that are required for evolution to occur by natural selection**?

condition #1 - (2 pts)
condition #2 - (2 pts)
condition #3 - (2 pts)

SAQ #7. When age-specific survival rates (p_x) and fecundities (m_x) are fixed, there is fixed age structure, c_x, found from a lengthy equation described in lab. **Please briefly explain** what the age structure curve, c_x , shows AND YOU MUST USE THE AXES BELOW SOMEHOW IN YOUR EXPLANATION.



(5 pts)

SAQ #8. Data from a recent census of tree species from a woodlot include 45 individuals of species 1, 35 of species 2, and 10 each of species 3 and 4 (note that the total number of individuals is 100).

(a). What is the total number of species present? _____ ← (1 pt)

(b). According to the equation for the Shannon Diversity Index, H',

$$H' = -\sum_{i}^{S} p_i * \ln(p_i)$$

(for which p_i is the proportion of data from the ith species, and S is the total number of species)

...what is the diversity of species present? Please set up the problem, i.e. write out the equation for diversity, but you need not solve it numerically. (3 pts)

SAQ #9. Please state two totally different and very important **long term** effects <u>on a population of fish</u> that you should anticipate with the management plan to build a fish hatchery to offset the effects of fishing? (5 pts)

Q – Is this management plan sustainable? Why or why not?

SAQ #10. What are the essential and necessary conditions for competition to occur between two species? (4 pts)

SAQ #11. When is it coevolution versus ordinary evolution? In your answer, please offer a definition of coevolution and describe exactly how this phenomenon differs from evolution. (5 pts)

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

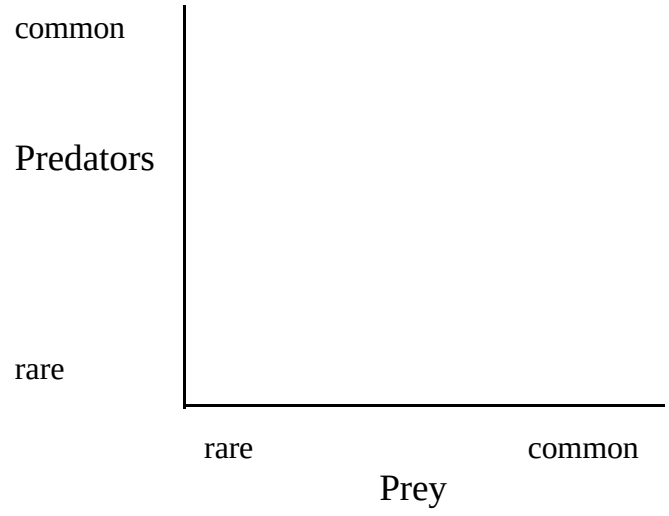
for prey:

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

for predator:

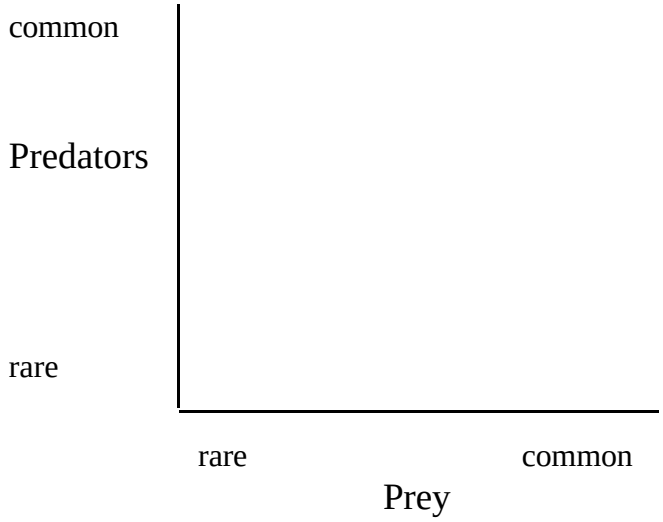
$$\frac{1}{\text{Predator}} * \frac{\Delta\text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

a. In the graph at right, plot the change in the population size of **Predators** using four little arrows corresponding to when Prey and Predators are common and rare. (3 pts)



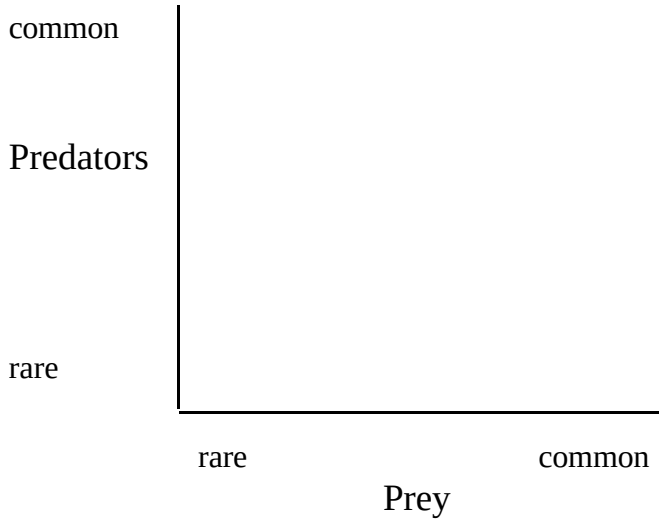
b. In the graph at right, plot the change in the population size of **Prey** using four little arrows corresponding to when Prey and Predators are common and rare.

(3pts)



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

(3 pts)



II. Longer Answer Questions (15 points each)

Remember, please answer: (#1 or #2 or #3) AND (#4 or #5 or #6).

LAQ #1. This question will assess your understanding of inquiry methods in ecology.

(a). Please list the principal strengths and weaknesses of **controlled laboratory experiments** to understand ecological phenomena. (please avoid unnecessary repetition)
strengths: weaknesses: (5 pts)

(b). Please list the principal strengths and weaknesses of **controlled field experiments** to understand ecological phenomena. (please avoid unnecessary repetition)
strengths: weaknesses: (5 pts)

(c). Please list the principal strengths and weaknesses of **"natural experiments"** to understand ecological phenomena. (please avoid unnecessary repetition)
strengths: weaknesses: (5 pts)

LAQ #2. (a). Please state what are the two principal objectives of individual ecology.
state objective 1 - (4 pts)
state objective 2 - (4 pts)

(b). Please briefly explain the basic design features of a "wait-ambush" vs. a "wide foraging" snake (I used a rattlesnake and whipsnake in class), and explain how this anecdote applies to the objectives of individual ecology. (7 pts)

LAQ#3. (a). Please state why the concept of the "ecological energy budget" is critical to so many research questions in individual ecology. (3 pts)

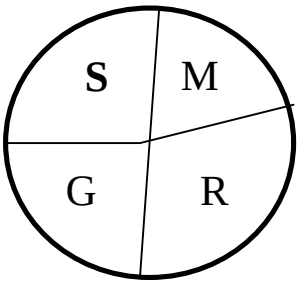
b. Please define the components of an individual energy budget. [hint: what do M, G, S, and R represent in the figure below.] (4 pts)

M =

G =

S =

R =



c. For an ectothermic animal such as a lizard, how might environmental constraints and limitations affect the total **size** of its energy budget (EB) from the environmental types listed below?

how might the resource environment limit total EB size? - (2 pts)

how might the biophysical environment limit total EB size? - (2 pts)

how might the social/demographic environment limit total EB size? - (2 pts)

how might the predation environment limit total EB size? - (2 pts)

LAQ #4. Consider the simple logistic model of single species population growth.

$$\frac{1}{N} * \frac{\Delta N}{\Delta t} = r * \left[1 - \frac{N}{K} \right]$$

a. Describe this model by explaining what <u>all</u> of the terms mean to the left and right of the equals sign, and list what are the principal ecologically relevant assumptions? (5 pts)

b. Without using any symbols, what is the main prediction of this model? (4 pts)

c. Draw a little graph below showing the per capita population growth rate vs. the population size for this model. Indicate ALL relevant constants, and LABEL THE AXES! (3 pts)

d. Draw a little graph below showing the population size vs. time beginning with an initially large (N >> K) <u>and</u> with an initially small (N << K) population size for this model. LABEL THE AXES AND ALL CONSTANTS! (3 pts)

LAQ #5. This question will asses your understanding of the conditions for stable coexistence from the 2 species competition equations:

species 1: species 2:

$$\frac{1}{N_1} * \frac{\Delta N_1}{\Delta t} = r_1 * \left(1 - \frac{N_1}{K_1} - \frac{a * N_2}{K_1} \right) \qquad \frac{1}{N_2} * \frac{\Delta N_2}{\Delta t} = r_2 * \left(1 - \frac{N_2}{K_2} - \frac{b * N_1}{K_2} \right)$$

(a). 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.

(b). It can be shown that stable competitive coexistence always occurs if two inequalities are true:

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

Using simple algebra, show how EITHER ONE of these inequalities results directly from the 2 species competition equations above.

(c). Please briefly explain how the conditions for stable coexistence (stemming from the inequalities above) validate the “competitive exclusion principle”" which states simply that "complete competitors cannot coexist."

LAQ #6. This question will test your knowledge of the consequences of trophic interactions at the community level on the evolution of individual life histories.

a. Assume for a moment that resource supply/demand ratios completely determined the evolution of life history characters. Describe at least 5 individual life history characteristics in a population for which <u>resource supply equals demand</u>, (i.e. competition was at a maximum). 1 - 2 - 3 - 4 - 5 - (5 pts)

b. Assume for a moment that the environment were variable and unpredictable and that the relationship between juvenile and adult mortality completely determined the evolution of life history characters. Describe at least 5 individual life history characteristics in a population for which <u>juvenile mortality were relatively high and unpredictable</u>, (because of either competition for food or due to intense predation on juveniles by small bodied predators with bottomless appetites). 1 - 2 - 3 - 4 - 5 - (5 pts)