I. Short Answer Questions DO ALL QUESTIONS

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

SAQ #2. Consider the simple exponential model of single species population growth.

$$\frac{1}{N} * \frac{\Delta N}{\Delta t} = r$$

(a). Describe this model. What do the terms to the left and right mean? (3 pts)
(b). What are the principal assumptions of this model? (3 pts)
(c). What is(are) the main prediction(s) of this model? (3 pts)
(d). What are the major problems with the assumptions and/or predictions of this model – in other words, what are the major ways in which this model clearly departs from ecological reality? (3 pts)

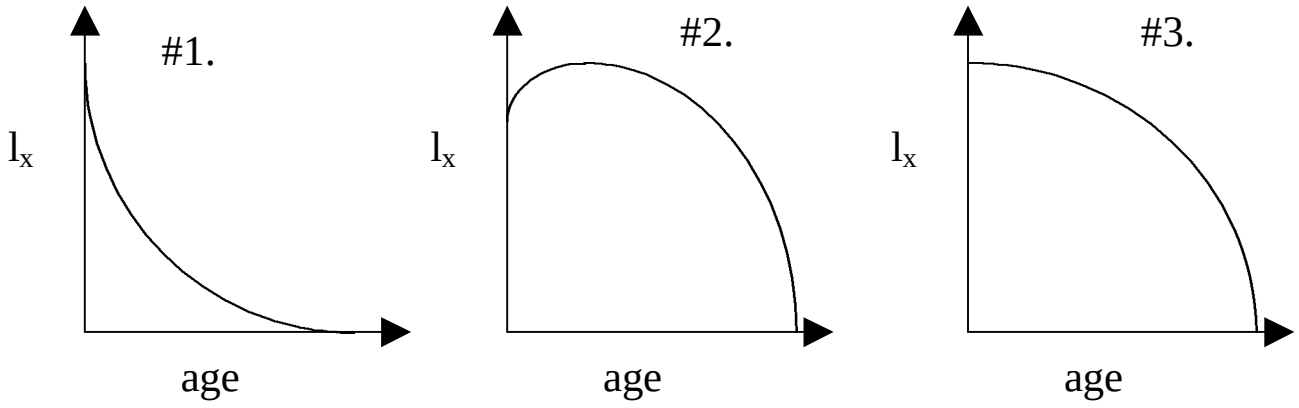
SAQ #3. According to your studies of a population of head lice on a randomly chosen seat in Kapelski room LC 1, each female has 10 female babies per week, 60 out of 100 adult females are killed by the impact of sleeping students' heads each week, half of <u>all</u> surviving adult females emigrate to Kirkbride each week, but none ever return since the asbestos there is toxic! Assume head lice can breed after only one week of life.

If there are 100 adult females alive and breeding now (N_0), how many would there be in one and two weeks from now? {Note 1: ignore the problem of males} {Note 2: you do not need a calculator to find the numerical values asked for. The calculations involve only simple arithmetic.}
how many in one week (N_1)? (3 pts)
how many in two weeks (N_2)? (3 pts)
{10 points extra credit: how many after a 14 week semester? email me the answer by Monday 10:30 (recall assumptions: each female has 10 female babies per week, 60 out of 100 adult females are killed by the impact of sleeping students' heads each week, half of all surviving adult females emigrate to Kirkbride each week, but none ever return. Assume head lice can breed after only one week of life. Assume that there are 100 adult females alive and breeding now, N_0). WORK ALONE PLEASE!!!}

SAQ #4. Please offer a brief, but precise definition of evolution.
SAQ #5. State what are the three conditions that are required for evolution to occur by natural selection?

SAQ #6. In addition to Natural Selection, Mutation, Immigration/Emigration, and Meiotic Drive, evolution can occur due to "Genetic Drift". Please briefly explain two different ways in which "Genetic Drift" can cause evolution.

SAQ #7. Examine the three graphs below, A, B, and C, that show the survivorship curves for hypothetical populations.



(a). The curve that shows low juvenile death rate is (circle one) #1 #2 #3 (1.5pts)

(b). The curve that shows high juvenile death rate is (circle one) #1 #2 #3 (1.5 pts)

(c). The curve that is impossible to obtain is (circle one) #1 #2 #3 (1.5 pts)

(d). Please briefly explain why the curve that you chose in part (c) above is impossible to obtain. (1.5 pts)

SAQ #8. 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.

Consider the simple logistic model of single species population growth.

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

SAQ #9. 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?

SAQ #10. Without using any symbols, what is the main prediction of this model?

SAQ #11. 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!

SAQ #12. 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!

SAQ #13. 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.

(c). Please briefly explain what are the advantages of using a diversity index, such as H', to estimate biodiversity rather than simply using the number of species censused?

I. Longer Answer Questions (15 points each) CHOOSE ANY 2 QUESTIONS and put a big "X" across the pages of the questions you do not want.

LAQ #1. Your job depends on successful management of a fishery for sport fishing. That means the fish population growth rate must not be negative despite predation by humans.

According to your computer simulations, if you were to impose a minimum catch age of 7 years (that is, all fish 6 years and younger must be thrown back), the fish population growth would be slightly positive (see table). Note that humans can only catch fish that are age 3 and older.

age x	survival px	survivorship lx	stable age dist., cx	fecundity mx
0	0.60	1.0000	0.4079	0.00
1	0.60	0.6000	0.2432	0.00
2	0.60	0.3600	0.1450	0.00
3	0.60	0.2160	0.0864	2.00
4	0.60	0.1296	0.0515	2.00
5	0.60	0.0778	0.0307	2.00
6	0.60	0.0467	0.0183	2.00
7	0.50	0.0233	0.0091	2.00
8	0.50	0.0117	0.0045	2.00
9	0.50	0.0058	0.0022	2.00
10	0.00	0.0029	0.0011	2.00

and the population is growing at a rate of little r = 0.0004

On average, how many fish would a fisherman have to throw back out of a day's catch of 10 fish?

a. Explain briefly **in words** how you would obtain this information from the table above:

b. Set up the problem and write out the equation that one would use a calculator to solve if you had one; however, I do not need for you to actually end up with a final number.

LAQ #2. This question will assess your understanding of the pros and cons of various fisheries management options that we discussed in class

(a) Please state two totally different and very important **long term** effects on a population of fish that you should anticipate with the "minimum catch size plan" in which fisherman only keep fish larger than a given size?

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

(b). Please state two totally different and very important **long term** effects on a population of fish that you should anticipate with the management plan to build a fish hatchery to offset the effects of fishing?

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

(c). Please describe the effects on a population of fish that you should anticipate with the management plan to reduce the number of fish taken by reducing the number of people and or times during which people can fish?

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

LAQ #3. This question will assess your understanding of the numerical methods involved in finding the growth rate of an age-structured population.

Age (X)	survival (Px)	fecundity (Mx)
age 0:	0.4	0
age 1:	0.5	1
age 2:	0.6	2
age 3:	0.7	3
age 4:	0.8	4
age 5:	0	5

At left is a table of typical survival (px) and fecundity (mx) values (the same ones we used in class).

(a). Please briefly explain in words WITHOUT USING ANY SYMBOLS OR MATH NOTATION how you would go about finding the number of individuals alive of each age as well as the total size of the population <u>in the next time interval</u> assuming that you knew the age-specific population numbers now and the survival and fecundity schedules (such as in the example at left).

(b). Please set up the actual equation to find the size of the population in the next time interval based on the table above and if initially there were 10 individuals alive in each of the age classes (x = 0 to 4). (Note: you do not need a calculator, I only want to see that you can set-up the equation correctly.)

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

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

Using simple algebra, please re-work the equation for logistic growth above into a form that you could input into a spreadsheet and solve numerically.

In other words, examine the table at right and note that "time" is in Column A, "N" is in Column B, "K" is in cell E1, and "r" is in cell E2.

Q - exactly what goes into cell B3 that should be copied to all B's below?

	A	B	C	D	E
1	time	N		K =	500
2	0	10		r =	0.5
3	1				
4	2				
5	3				
6	4				
7	5				

{Hints: recall that $\Delta N = N_{t+1} - N_t$, and $\Delta t = 1$}