I. Short Answer 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.

diagram and explain objective 1 - 3 pts.
explain the key "emergent properties" that this objective aims at explaining - 3 pts.
diagram and explain objective 2 - 3 pts.
explain the key "emergent properties" that this objective aims at explaining - 3 pts.

SAQ #2. This question will assess your understanding of how to calculate and interpret human population growth rates using "crude" birth and death rates.

Please write down the basic equation used to perform this calculation including crude birth and death rates of "b" per 1000 and "d" per 1000. (Hint: recall that one begins with "size next time" equals the "size now" plus the "change in size"…)

(6 pts.)

SAQ #3. Consider the spreadsheet at right:

Q - exactly what formula goes into cell B3 that should be copied to all B's below to calculate the population size over the next century?

	A	B	C	D
1	time	n	# deaths per 1000	# births per 1000
2	2000	6,000,000,000	9	24
3	2001			
4	2002			

(4 pts.)

SAQ #4. Please offer a brief, but precise definition of evolution.

(4 pts.)

SAQ #5. 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?

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

(4 pts.)

SAQ #6. Consider the "minimum catch size plan" in which fisherman only keep fish larger than a given size. Please state two different biological effects on the fish that will likely affect the long term persistence of the population?

(4 pts.)

1- 2-

SAQ #7. Consider the management plan of building a fish hatchery to offset the mortality caused by fishing. Please state two different biological effects <u>on the fish</u> that will likely affect the long term persistence of the population?

1 - (4 pts.)

2 -

SAQ #8. When age-specific survival rates (p_x) and fecundities (m_x) are fixed, there is fixed survivorship curve, l_x, found from an equation described in lab. Please briefly explain what the survivorship curve, l_x, shows AND YOU MUST USE THE AXES BELOW TO DRAW REPRESENTATIVE SURVIVORSHIP CURVES FOR **<u>HIGH AND LOW</u>** JUVENILE SURVIVAL IN YOUR EXPLANATION.

(4 pts.)

SAQ #9. 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 TO DRAW A REPRESENTATIVE AGE STUCTURE CURVE IN YOUR EXPLANATION.

(4 pts.)

SAQ #10. According to your studies of a population of cockroaches in the cramped office of an unnamed Widener faculty member, each female cockroach has 8 female babies per month, 3 out of 4 adult females are killed by dropped books or spilled hot coffee each month, half of <u>all</u> surviving adult females emigrate to the adjacent offices each month, but none ever return because life is just too good over there! Assume cockroaches can breed after only one month of life.

If there are 20 adult female cockroaches alive and breeding now (N_0), how many would there be in one and two months 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.}

SHOW ALL OF YOUR WORK!!

how many in one month (N_1)? 5 pts.

how many in two months (N_2)? 4 pts.

I. Longer Answer Questions (15 points each)

LAQ #1. Consider the simple exponential model of single species population growth.

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

(a). What are the principal assumptions of this model? (2 pts.)

(b). What is the main prediction of this model? (please include a graph) (2 pts.)

(c). What are the major problems with the assumptions and predictions of this model – in other words, what are the major ways in which this model clearly departs from ecological reality?

(3 pts.)

(d). Please briefly explain the use of this model in the areas of theoretical and applied ecological research that we discussed in class.

theoretical – (4 pts.)

applied – (4 pts.)

LAQ #2. This question will assess your understanding of the causes of evolution.
(a) Please offer a brief, but precise explanation of how evolution can occur by natural selection.

(3 pts.)

(b) Please offer a brief, but precise explanation of how evolution can occur by mutation.

(3 pts.)

(c) Please offer a brief, but precise explanation of how evolution can occur by genetic drift.

(3 pts.)

(d) Please offer a brief, but precise explanation of how evolution can occur by immigration/ emigration (migration, but not related to genetic drift).

(3 pts.)

(e) Please offer a brief, but precise explanation of how evolution can occur by meiotic drive.

(3 pts.)

LAQ #3. This question will assess your understanding of current life history theory.
(a). Please briefly define a "life history phenotype."

(5 pts.)

(b). Current life history theory maintains that "the most fit organism should always adjust the allocation of its limited resources to to **G**, **S**, and **R** each year to maximize the sum of its present reproduction plus its expected future reproduction." Explain this concept in your own words. DO NOT SIMPLY RESTATE THE QUESTION. Please use a pie diagram of an individual energy budget in your response.

(10 pts.)

LAQ #4. This question will assess your understanding of the numerical methods involved in finding the growth rate of an age-structured population.

At left is a table of typical survival (px) and fecundity (mx) values.

	A	B	C
1	age(x)	px	mx
2	0	0.4	0
3	1	0.5	0
4	2	0.6	2
5	3	0.7	3
6	4	0	0

(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 (N1, N2, N3, N4 of 10 each) and the survival and fecundity schedules (such as in the example at left).

(7 pts.)

(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.)

(8 pts.)

ECOLOGY 301 – EXAM 2

LAQ #5. 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). What are the principal assumptions of this model? (4 pts.)

(b). **Without using any math symbols or notation**, explain in words what is the main prediction of this model?

(3 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!

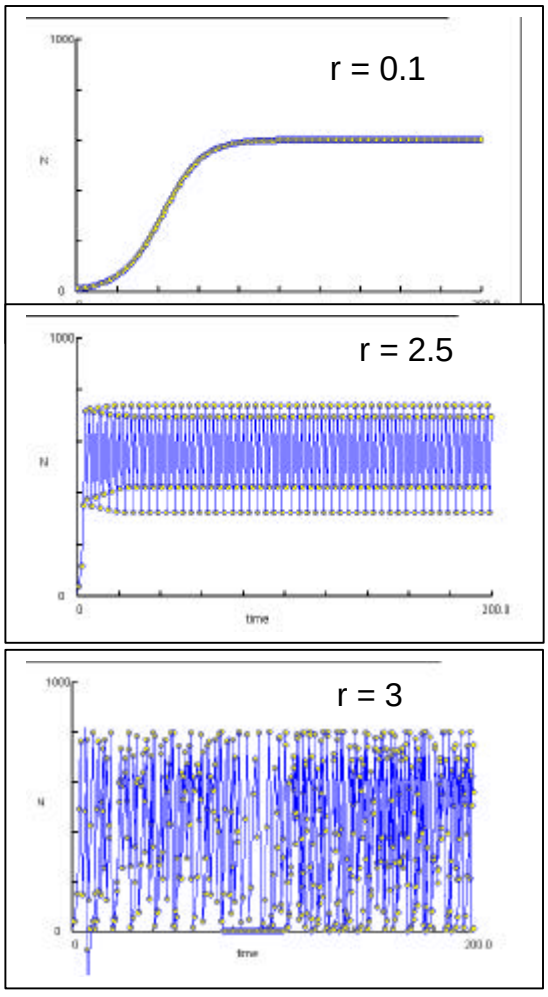
(4 pts.)

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

(4 pts.)

LAQ #6. Consider the simple logistic model of single species population growth above.

At right is a composite figure of three simulations using K = 600 and increasing the "intrinsic" growth rate parameter "r" from 0.1 to 3.



(a). Briefly describe what is happening as one increases "r" from 0.1 to 3?

(5 pts.)

(b). Recall that for the simple exponential model of population growth, the parameter "r" was a perfectly acceptable "fitness criterion." What was the argument for this point of view?

(5 pts.)

(c). Given the pattern we see at right that happens as one increases "r" in the logistic model, what implications does this have for our use of "r" as a "fitness criterion" now, and what should we do about it – i.e., what should we use as our criterion for fitness in a population that is growing logistically?

(5 pts.)