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

<u>mathematical assumptions:</u> <u>ecological implications:</u>

(6 pts)

SAQ #3. Draw a little graph below showing the **per capita population growth rate of species 1** vs. the **population size of species 2** for this model. Indicate ALL relevant constants, and LABEL THE AXES!

(3 pts)

SAQ #4. What are the major problems with the **assumptions** of this model – in other words, what are the major ways in which the **assumptions** of this model clearly depart from ecological reality?

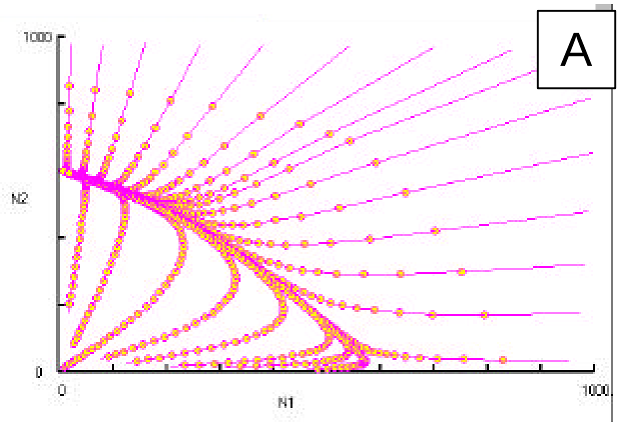
(3 pts)

SAQ #5. **Without using any math symbols or notation**, explain in words what is the main prediction of this model?

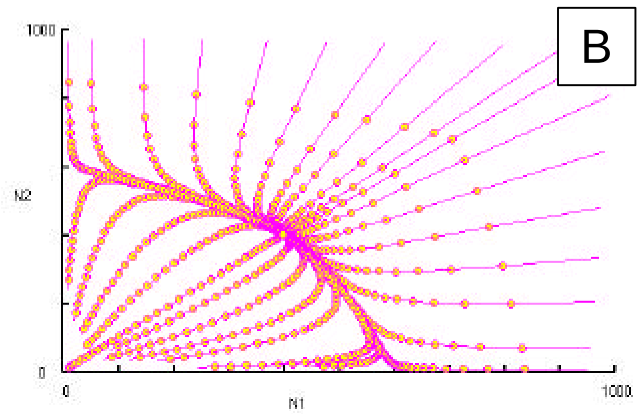
(3 pts)

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, beta = 0.5}



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



For which one is there stable coexistence? A or B (circle one) (2 pts)

SAQ #7. Please briefly explain why does one lead to stable competitive coexistence whereas the other does not? (hint: take a look at the alpha's)

(3 pts)

SAQ #8. What are the strengths and weaknesses of using laboratory experimental studies to advance our understanding of the importance of competition in nature? Please use specific examples from class and/or the text to support your arguments.

(4 pts)

SAQ #9. What are the strengths and weaknesses of using comparative "natural experiment" studies to advance our understanding of the importance of competition in nature? Please use specific examples from class and/or the text to support your arguments.

(4 pts)

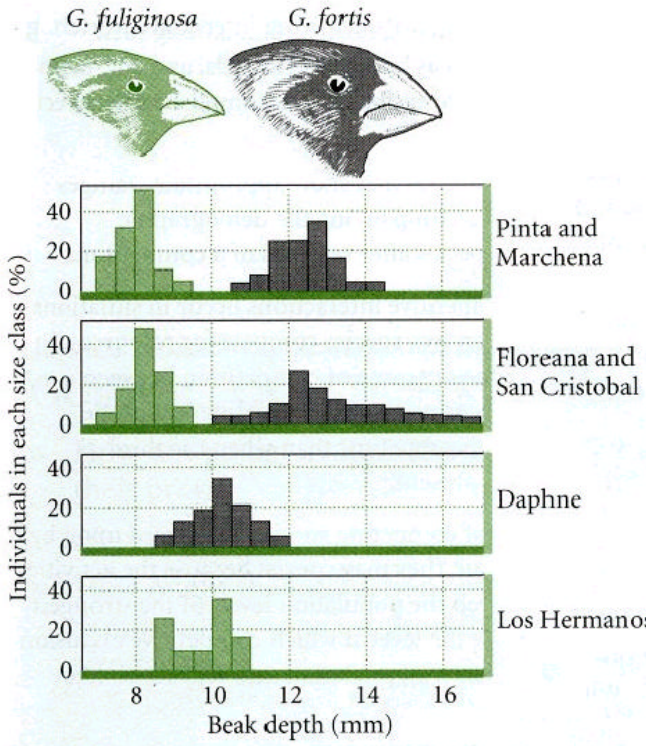
SAQ #10. What did Joe Connell (1961) <u>observe</u> about the distribution of two barnacle species in the Scottish rocky inter-tidal? What exactly did Joe Connell (1961) <u>do</u> to understand what caused the barnacle distribution pattern in the Scottish rocky inter-tidal? What were the causes of the distribution pattern observed? Please use diagrams, sketches, etc., in your answer and explain the experimental design and experimental results.

Connell's observations: (2 pts)

Connell's experimental design and results: (4 pts)

Connell's interpretation of his results: (2 pts)

SAQ #11. The figure at right shows the distributions of beak sizes for two species of finches on four different Galapagos Islands (on the top two islands the species co-occur, and on the bottom two, the species are alone).



(a). Please explain how the phenomenon of "Competitive Character Displacement" could account for the differences in beak size distributions among species and islands.

(3 pts)

(b). Please explain how the phenomenon of "Reproductive Character Displacement" could account for the differences in beak size distributions among species and islands.

(3 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.

(3 pts)

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

for prey: for predator:

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

(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.

<u>mathematical assumptions:</u> <u>ecological implications:</u>

(3 pts)

SAQ #13. 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 #14. 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 #15. Consider the simplest possible model of the **predator/prey interaction** below:

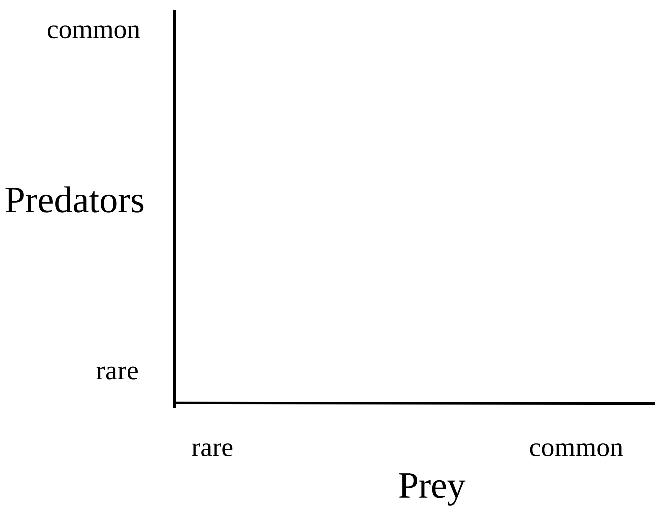
for prey:

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

for predator:

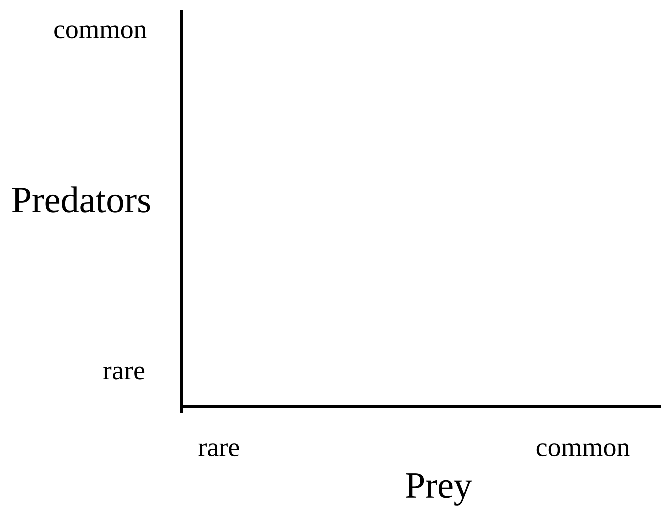
$$\frac{1}{\text{Predator}} * \frac{\Delta \text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

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.



(2 pts.)

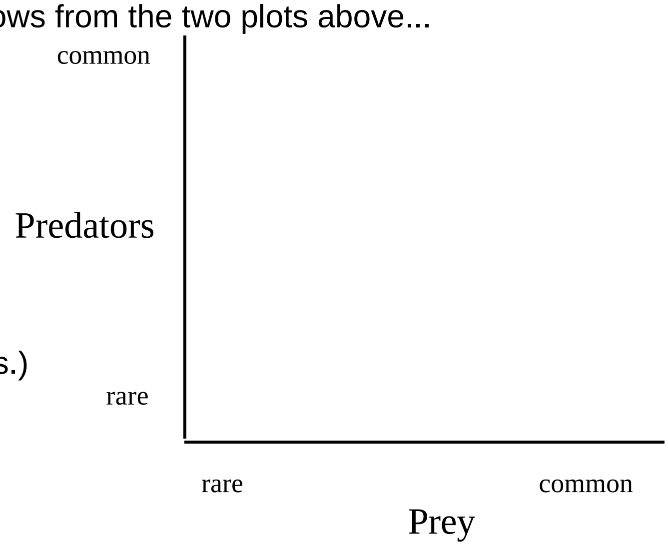
b. In the graph below, plot the change in the population size of **Predators** using four little arrows corresponding to when Prey and Predators are common and rare.



(2 pts.)

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

(2 pts)



(2 pts)

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

Yes or No ??? (2 pts.)

e. Briefly explain why or why not.

Longer Answer Questions

LAQ #1. This question will assess your understanding of **evolution** and its causes.

(a). Please offer a brief, but precise definition of evolution. (3 pts)

(b). Please offer a brief, but precise, explanation for how evolution can occur by Natural Selection? (3 pts)

(c). Please offer a brief, but precise, explanation for how evolution can occur by Mutation? (3 pts)

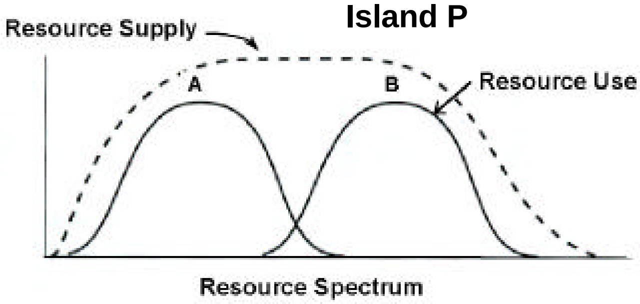
(d). Please offer a brief, but precise, explanation for how evolution can occur by Migration (Immigration/Emigration)? (2 pts)

(e). Please offer a brief, but precise, explanation for how evolution can occur by Genetic Drift? (2 pts)

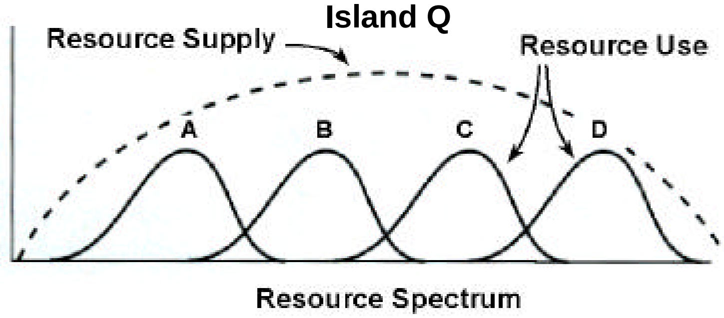
(f). Please offer a brief, but precise, explanation for how evolution can occur by Meiotic Drive? (2 pts)

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).

Island P



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 at least 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. Thomas Park and his colleagues studied competition in lab among species and strains of flour beetles for several decades. Two tables summarizing their results appear below.

TEMP. °C	RELATIVE HUMIDITY %	CLIMATE	SINGLE SPECIES NUMBERS	MIXED SPECIES (% WINS) *T. confusum*	*T. castaneum*
34	70	Hot-moist	conf = cast	0	100
34	30	Hot-dry	conf > cast	90	10
29	70	Temperate-moist	conf < cast	14	86
29	30	Temperate-dry	conf > cast	87	13
24	70	Cold-moist	conf < cast	71	29
24	30	Cold-dry	conf > cast	100	0

T. castaneum STRAIN	*T. confusum* STRAIN	# *castaneum* WINS	# *confusum* WINS
CI	bI	10	0
	bII	10	0
	bIII	10	0
	bIV	10	0
CII	bI	1	8
	bII	0	10
	bIII	0	10
	bIV	4	6
CIII	bI	0	10
	bII	0	9
	bIII	0	10
	bIV	0	10
CIV	bI	9	1
	bII	9	0
	bIII	9	1
	bIV	8	2

According to Stiling and your own understanding of ecological competition, what are the important messages we should learn from Park's landmark studies? Please address implications not only to advancing the theory of competition, but also include implications about what Park's data reveal about the importance of competition in nature. (15 pts)

LAQ #3. Below is a summary table from Stiling of a review paper of 72 studies of competition by Joe Connell (1983). According to Stiling, Connell found competition "in 55% of the 215 species and in 40% of the 527 experiments involved" (p. 255).

	TERRESTRIAL NO. EXP.	%	MARINE NO. EXP.	%	FRESHWATER NO. EXP.	%	TOTAL NO. EXP.	%
Plants	205	30	31	68	2	50	238	35
Herbivores	45	20	13	69	0	—	58	31
Carnivores	36	11	5	60	3	67	44	20
Total	286	26	49	67	5	60	340	32
Invertebrates	57	16	37	32	0	—	94	22
Vertebrates	47	23	10	90	3	67	60	37

According to Stiling and your own understanding of ecological competition, what are the important messages we should learn from Connell's (and others') reviews of this type about the prevalence and importance of competition in nature? (15 pts)

LAQ #4. This question will asses your understanding of the conditions for stable coexistence from the 2 species competition equations:

species 1:

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

species 2:

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

(a). It can be shown that stable competitive coexistence will always occur if two inequalities are true:

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

Show how EITHER ONE of these inequalities results directly from the 2 species competition equations above. (10 pts)

(b). 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." (5 pts)

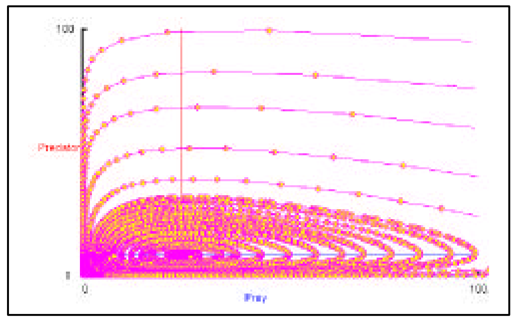
LAQ#5. Consider again the simplest possible model of the **predator/prey interaction** below:

for prey:

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

for predator:

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



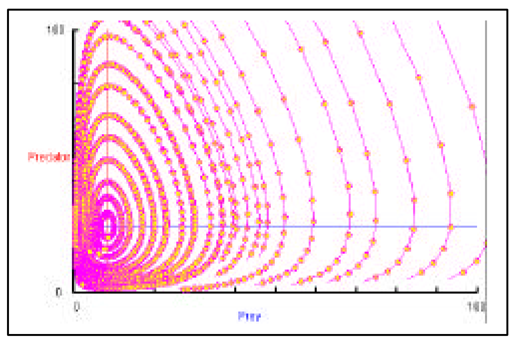
(a). What is the ecological interpretation of the alpha (α)? (3 pts.)

(b). Why might natural selection favor a higher alpha (α)? (2 pts.)

(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 the effects of increasing alpha (α). (3 pts.)

(d). What is the ecological interpretation of the beta (β)? (2 pts.)

(e). Why might natural selection favor a higher beta (β)? (2 pts.)



(f). 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 the effects of increasing beta (β). (3 pts.)