Before starting WRITE YOUR NAME ON EACH PAGE!

You have tons of time. **Take your time** and **read each question carefully** to ensure you fully understand **exactly** what we are after and don't jump to conclusions too quickly.

SCRATCH PAPER AT END: There is a page of scratch paper for you to use to organize your thoughts, make outlines for the essay questions, etc...

Good luck and impress us with your toolkit of ecological knowledge and concepts!

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PART A. Short answers, graphs and calculations

1. You have just completed your study of a cohort of your favorite organism, the Surfing Cruz-Dude. You began your study by ear-tagging 1000 females, followed the entire cohort until the last one died, and noted the number of babies each female produced, on average, at each age. You just compiled all of your data and found the following: of the original 1000 newborns (i.e. age 0) you followed, 500 survived to year 1 where they had (on average) 1 baby each, 150 survived to year 2, where they had 2 babies each, and none survived to year 3.

Age	Number alive	Babies/ female		
X	s_x	b_x		
0				
1				
2				
3				

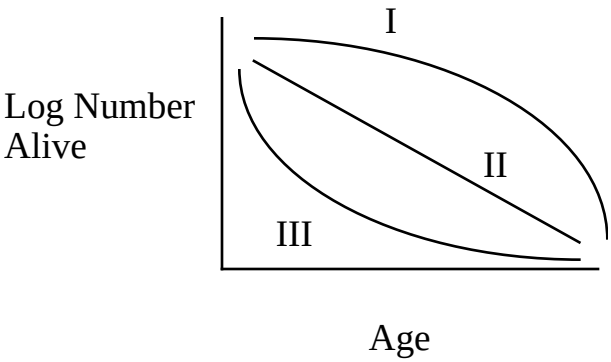
(a) Is this population growing, declining or stable? To answer, complete the life table, calculate R_o and tell us why the population is changing in the direction it is. (4 points)

(b) Why does the value of R_o tell you whether the population is stable, increasing or decreasing? (tell us in words what R_o represents biologically). (2 points)

(c) In what basic way does R_o differ from r or λ? (1 point)

(d) Why do we look at females in the life table? (1 point)

2. Three basic patterns of survivorship, or survivorship curves, are recognized, as illustrated in the graph immediately below.



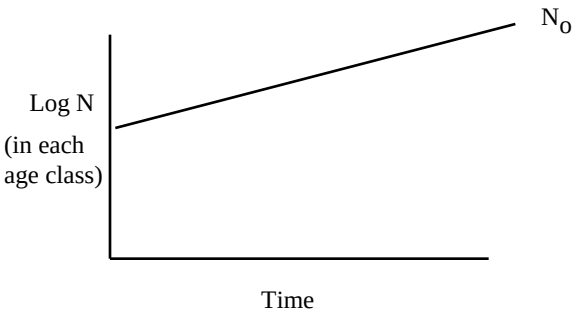
(a) Provide an example organism that would have Type I curve and Type III curve. (2 points)

Type I _____

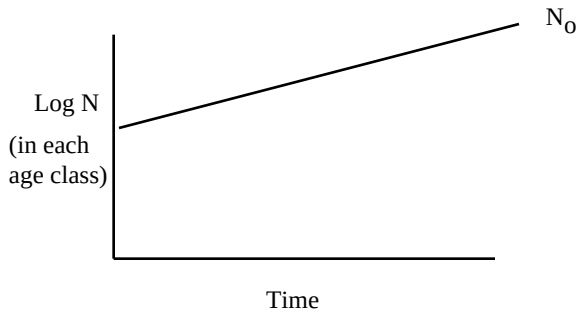
Type III _____

(b) If the life table of a population remains the same over time (i.e., across generations), 'stable age distributions" will form over time. Consider two species: species A has a type I pattern of survival while species B has a type III pattern of survival. Each species has three age classes – newborns, yearlings, and two year olds. If each species does show a stable age distribution draw in the lines for the number of yearlings (N_1) and number two year olds (N_2) for each species, relative to the number of newborns (N_o) shown. Your lines must clearly show the difference between the two species that would result from their different patterns of survival. (4 points)

Species A Type I



Species B Type III



3. The population dynamics of infectious disease can be represented with a simple model: $R_p = S\beta L$, where R_p = is the rate at which the disease spreads from one host to another and S is the number of individuals in a population who are susceptible to the disease.

(a) What do the other two symbols represent? (2 points)

β _____

L _____

(b) At what value of R_p does the disease begin to spread and an epidemic start? (1 point)

(c) This model can explain why cases of measles show population cycles. With reference to the model, explain what causes the two phases of a cycle, an **epidemic** whereby measles begins to spread, and the **crash**, where the cases of new infections drops. Explain what causes the number of susceptibles to change in each phase. (4 points)

(d) How can we prevent measles from cycling in epidemics and why, specifically does this approach work? (2 points)

4. Human destruction of habitats like forests often leave us with islands of suitable habitat in a sea of unsuitable habitat. This scenario describes what happens when we set aside areas of habitat as reserves or parks. The application of the theory of island biogeography to human-created islands of habitat led to an important debate over the design of reserves: for a given total area that can be preserved, is it better to save a **S**ingle **L**arge **O**r **S**everal **S**mall reserves, the so-called SLOSS debate. List two reasons why it would be better to create a single reserve that is as large as possible, and two reasons why it might be better to create several smaller reserves. (4 points)

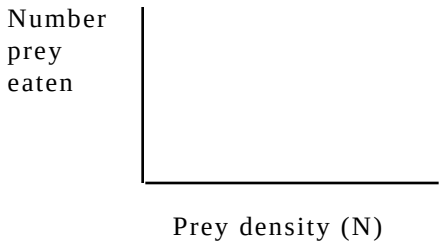
2 reasons why we should make a single large reserve:

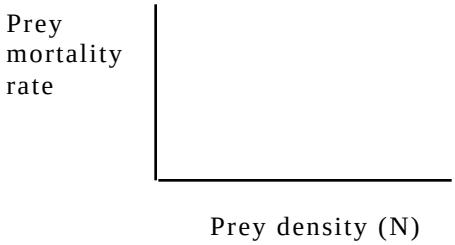
2 reasons why we should make several smaller reserves:

5. Ecologists have long been interested in the conditions under which predators can stabilize their prey populations (i.e. keep the prey populations in check and from increasing). One aspect of predator behavior of particular interest is the 'functional response.

(a) What exactly is a functional response? (2 points)

(b) One type of functional response in particular can potentially impose the type of density-dependent predation on prey that can limit and stabilize prey numbers. On the graphs below, draw this functional response **(only one, no points if you draw all three)** in terms of **number** of prey eaten (left graph) and in terms of the **percapita mortality rate** of prey (or proportion of prey population consumed) (right graph). (2 points)

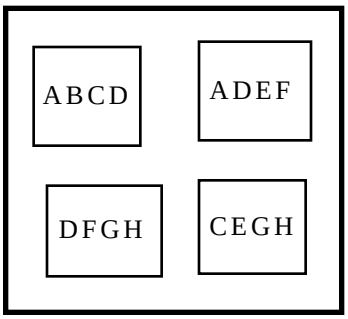




(c) Explain **in words** why this type of functional response is thought to stabilize prey population growth rate (i.e. in words) and indicate on the above right graph the range of prey densities over which density-dependent regulation of prey is possible. (2 points)

(d) Name two specific behavioral mechanism that can give rise to this type of functional response? (2 point)

6. The diagram below shows diversity on various spatial scales: each smaller box is a **different** type of habitat and the letters indicate the different species in each of the four habitats (some species are found in more than one habitat). The larger box is the entire region.



(a) Calculate the average alpha (α) diversity, the beta (β) diversity and the gamma (γ) diversity for this set of observations. (3 points)

alpha = _____

beta = _____

gamma = _____

(b) Which species is the most extreme habitat specialist? (1 point)

7. The box below shows four species of snakes, each identified by its own letter. The snakes vary in their markings, which provide some sort of visual signal, and in their toxicity as well. Snakes with **smiles** are **harmless**, those with **frowns** are **poisonous**. The background pattern inside the box is the background on which predators would look for the snake. **Important details**: These 5 species are the only ones we need to consider and the resemblence of the three similar snakes (A,B,D) is due to convergence, not common ancestry.

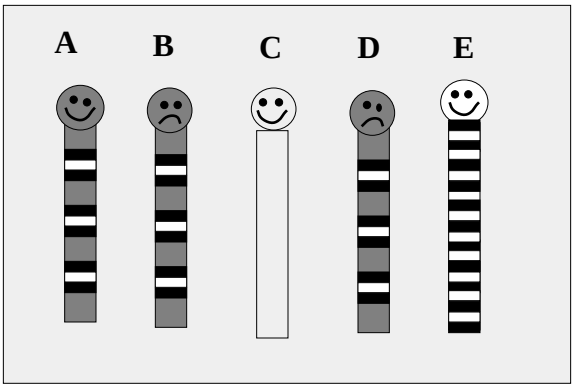
Identify the snake(s) that fit the following descriptions by filling in letters next to the description (5 points):

Mullerian mimic(s) _____

Batesian mimic(s)_____

Aposomatic coloration _____

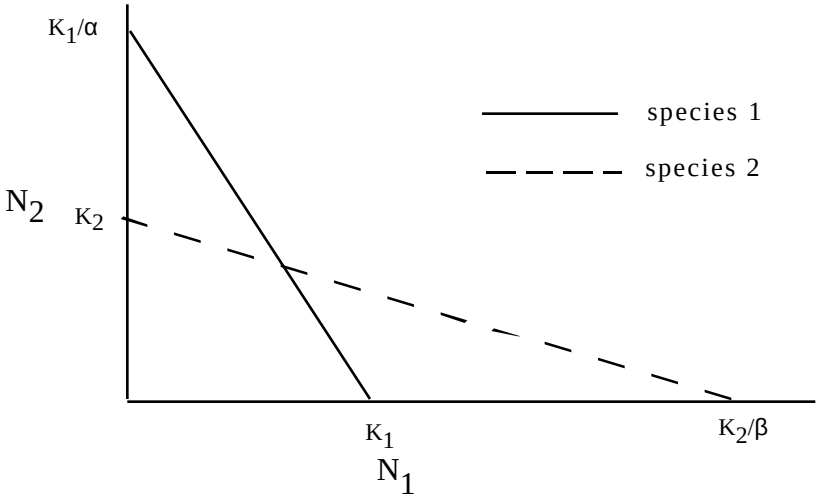
Cryptic_____



8. Using two graphs, illustrate the key difference between the terms ‘open’ (individualistic) or ‘closed’ (superorganism) communities, as applies to the debate over whether or not plant communities are functional units with discrete boundaries. Be sure to label your axes (4 points)

9. The Lotka-Volterra interspecific competition model explores the outcome of competition between two species. This can be done graphically by examining the joint change in populations of two competing species, relative to each of their isoclines.

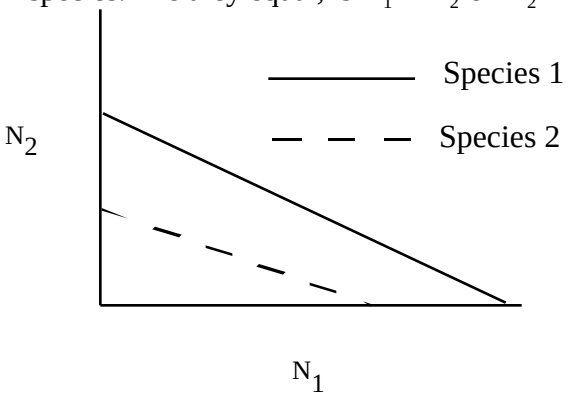
(a) Show with the use of arrows and vectors the joint movement of both populations for each distinct region of the graph below (distinct regions with respect to the isoclines). Show with big dots (one, two or three dots if necessary) what the outcome of competition in this system. (3 points)



(b) What do we call the above outcome? (1 point):_____

(c) Assuming there is no predator involved here (i.e. just competition) what kind of experimental evidence would indicate that the **specific** outcome shown above is occurring in nature? Describe both the experiment(s) and the result(s) from the experiment(s) needed to show the specific case shown above. (4 points)

(d) The graph below shows the isoclines for two competing species whose competition coefficients are equal: i.e., $\alpha = \beta$. Given this, and your understanding of how the Lotka-Volterra competition models are put together, what can you conclude about the relative size of the carry capacity of each species. Are they equal, is $K_1 > K_2$ or $K_2 > K_1$? (2 points)



More Tutorial at www.dumblittledoctor.com

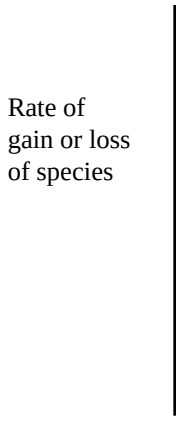
 Name _____

10. The equilibrium theory of island biogeography was developed to explain two interesting relationships:(a) the relation between diversity (number of species) and area and (b) the difference in patterns of diversity between mainland areas and islands (including distance between an island and mainland source):

(a) Draw the two species-area relationships that illustrates the **two patterns described** above and **fully label the Y axis**. (3 points)

Log Area

(b) Fill in the graph below to illustrate the how the Theory of Island Biogeography can explain why bigger islands have more species than smaller islands. **Label the X axis** and **all of your immigration and extinction lines** and be sure to **indicate the equilibrium numbers of species** on each of the two islands (5 points)



(c) If you surveyed two islands of identical size and distance from the mainland, does the theory predict that you will find an identical list of species on two islands will be the same? Why or why not? (2 points)

 Name _____

11. Consider Scum Lake, named because it is scummy, green and full of algae. Scum Lake is well known for being a lousy fishing spot because it only contains small minnow fish. To remedy this, somebody adds bass to the lake, a species popular with fishers. (Bass are top predators that eat the smaller minnows.) The bass do well and now one year later, Scum Lake is no longer scummy and green, but is crystal clear with few algae. Explain , with reference to food webs and trophic levels, why this change has taken place. In particular, why the does the number of trophic levels in a food web affect whether or not the "world is green"? (6 points)

12. Senescence is the pre-programmed deterioration in performance of an organism as it increases in age. On a proximate (immediate) level, senescence is due to genes that have nasty effects on the organism later in life, but not early in life. Life history theory provides an evolutionary explanation for senescence based on natural selection. Outline the basic idea. (6 points)

 Name _____

PART B. Essay question. Answer one of the following three essay questions. ANSWER ONLY 1 QUESTION (20 points)

1. Ecologists developed the concept of 'metapopulations' to examine the population dynamics of species that life in habitats that are patchily distributed.
(a) What is a metapopulation? In words or basic equations, outline the key features of the basic metapopulation model, including its main assumptions and predictions.
(b) What data would one need to collect from a field study to provide convincing evidence for metapopulation dynamics in a species?
(c) What are the important implications of metapopulations for ecologists and conservation biologists?

2. Aspects of the biology of the European cuckoo and the songbirds they parasitize provide convincing evidence that co-evolution has shaped traits and behaviors of the cuckoos and their hosts.

(a) What is co-evolution and what, **in general terms**, is required to provide evidence for it ?

(b) Outline the hypothesized co-evolutionary process that has taken place between cuckoos and their hosts. For each of the two participants – cuckoos and hosts – indicate specifically which trait or behavior has negatively impacted the other participant and how this has caused natural selection for an evolutionary response by the harmed party.

(c) Outline the observational and experimental evidence for each of the proposed steps of the co-evolutionary process.

3. You have conducted a comparison of many species of annual and perennial plants within the plant family Bushacea and found a clear pattern: on average, the annual species have far more babies (seeds) than the perennial species. There are two approaches to explaining this kind of life history variation: r–and–K selection versus optimality (or optimal demography).
(a) With reference to the number of babies produced by annuals and perennials, contrast and compare these two different approaches to understanding variation in life history traits.
(b) What type of experimental evidence or observational evidence would allow you to distinguish between an r–and-K selection explanation and an optimality explanation for the observed difference in seed numbers between annuals and perennials.