BEFORE YOU START: WRITE YOUR NAME ON EACH PAGE!!!!

Read the questions carefully before answering to ensure that you fully understand what we are looking for. Answer the questions in sufficient detail to let us know that you understand the critical issues in full detail, but do not use the shotgun approach of throwing everything under the sun into your answer in the hope that something will hit the target. Good luck and wow us with your ecological knowledge!

PART A. Shorter answers, graphs or calculations.

1. Biogeography is the study the geographic distributions of organisms. You win a fantastic trip to the southern continents and on your trip you notice a plant with a similar and distinctive morphology occurring in Australia, South Africa and South America. Without a field guide, you know nothing about the taxonomic status of the plant on the various continents (same species? closely related species? unrelated taxa?). Name three explanations that could account for the curious geographic distribution of these plants (a one or two word explanation is sufficient for each). **Briefly**, what critical information is needed to distinguish among these hypotheses and how would it support each specific hypothesis? (6 points).

2. Exponential population growth can be described by a simple model where time is a continuous variable: $N_t = N_o e^{r\,t}$. This equation can be easily altered to calculate the time that it takes for the population to double in size. Show, by manipulating this equation and substituting d (doubling time) for t, how one converts the above equation to obtain a measure of d. Show all of the steps, and don't just give the final answer. Recall that natural logarithm (ln) of $e^x = x$ (3 points).

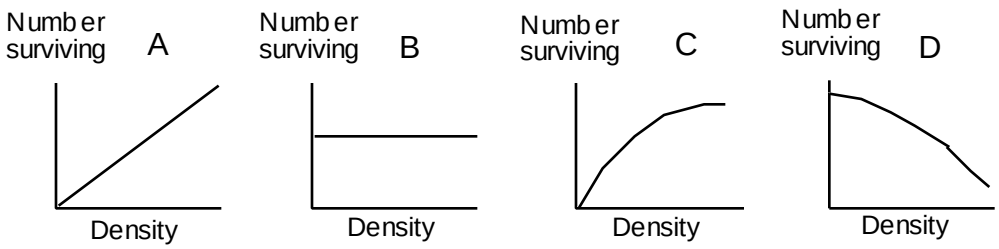
3. You are one of the biologist in charge of conserving the relatively small population of grizzly bears in Yellowstone Park. On your annual bear counts, you notice that the population fluctuates, as reflected in your estimates of λ which tells you about population change across years. In good years λ = 2.0, in bad years λ = 0.4, and good and bad years occur with equal frequency. Your colleague insists that the bear population is in fine shape because the arithmetic mean of λ is 1.2 and plugging this value into the deterministic population shows that the population will grow over the long-term. Being a well-trained ecologist, you correct them and insist that a stochastic population model is needed here.

a). What is the fundamental difference between stochastic population model and deterministic population models? (2 points).

b). Even without running any model you can do a quick calculation with the above λ values to obtain the appropriate estimate of an 'average' λ value that accurately predicts long-term prospects for the bear population. Show this calculation. Is the population growing, stable or declining over the long-term? Why? (3 points).

4. Ecologists recognize a variety of types of density-dependence. Four of the following five types are represented below. Match the graphs to their correct name type, and indicate which type in the list is not illustrated by a graph. Carefully check the y axis and consider rates versus numbers (5 points).

a. _____ Allee effect
b. _____ Undercompensating density-dependence
c. _____ Overcompensating density-dependence
d. _____ Exactly compensating
e. _____ Density independence

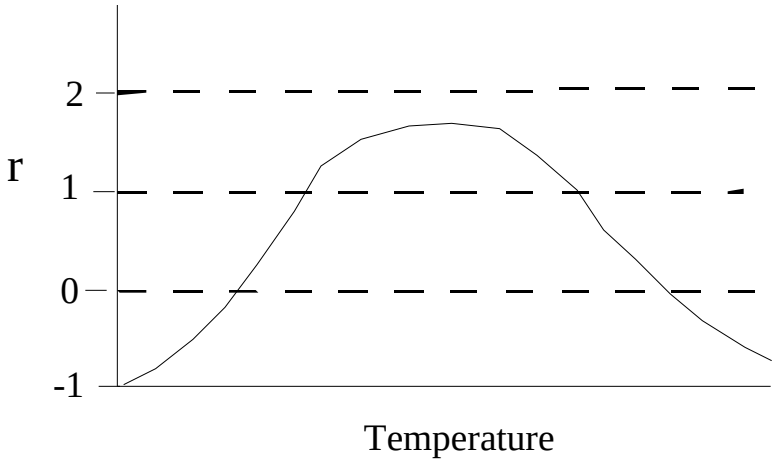


5. Patterns of sexual size dimorphism are interesting because they not only illustrate that body size is an adaptation, but that the sexes differ in the selection pressures (natural/sexual) that select for body size. Provide (i) one example of dimorphism where males are bigger than females and (ii) one example where females are bigger than males. In each case, name a selection pressure that typically differs between sexes and could account for the increased size of the bigger sex (4 points).

6. Why do snakes and other reptiles have forked tongues? What specific function does a forked tongue enhance and why? What ecological problem does it help them solve (i.e. how are forked tongues likely to enhance fitness? What comparative data (among species) support this idea? (4 points).

7. No organism can tolerate all conditions and live everywhere -- hence, organisms have limited distributions that often correlate with abiotic factors. Physiological ecologists use 'performance' or 'tolerance' curves to illustrate this point. Population ecologists approach this problem from a different perspective and point out that species will not occur where populations cannot replace themselves. The following graph links these two concepts and shows the 'performance' of the Shrinking Violet over different temperatures, where performance is measured in terms of percapita population growth rate (r). Indicate (with **shading** or **two vertical lines**) the range of temperatures **on the X axis** over which this species will occur and maintain viable populations (3 points).

Performance
(measured in terms of population growth r)



8. The following time budget data and energetic costs or benefits of activities is gathered for two types of strategies in a population of Anna's hummingbirds: (1) ***Territorial individuals*** and (2) ***Non-territorial individuals.***

ACTIVITY	Costs of activity (Kcal/hour)	Time spent by territorial individuals in each activity	Time spent by non-territorial individuals in each activity
Foraging	2 Kcal/h	4 hours	8 hours
Sitting	1 Kcal/h	5 hours	2 hours
Fighting	3 Kcal/h	1 hours	0 hours

BENEFITS: The rate of food intake while foraging is:

6 Kcal/ hour for a **territorial** individual
4 Kcal/hour for a **non-territorial** individual

a) Based on the time budget data and the costs or benefits of each activity per hour of activity, determine whether the territorial or non-territorial strategy yields the highest **NET energy intake** (costs minus benefits) for a ten hour day. Show all of your calculations (4 points).

b) Optimal foraging models are useful tools for determining what fitness currencies are important to organisms. With this in mind, what can we conclude about what currency territorial birds **are not using**. Name one other currency that could be optimized by the defence of a territory, according to **these data**, and explain why (2 points)?

9. If a physiological ecologist wanted to study the physiology of an organsism that is temperature generalist, as opposed to a specialist, which biome should they head to, the tundra or tropical rainforest? Why? Justify your answer in terms of climatic variation. What simple astronomical fact about planet earth explains this variation? (4 points)

PART B. Answer 3 of the following 4 essay questions. 20 points each.

*** ONLY ANSWER 3 QUESTIONS!!!*****

1. Habitat selection is one explanation for why individuals of a species are found in some areas (i.e. some habitats) but not others (i.e. other habitats). Outline an experimental design and experimental result that could confirm that habitat selection does affect the distribution of a species. The question "why do animals show habitat preference" can be examined on both a proximate (learned or innate?) and an ultimate (evolutionary fitness) level. Outline an experiment that one could perform to address the proximate question, and another that one could perform to examine the ultimate question. In each case, point out how you would interpret the results of the experiment.

2. The metabolic rates of organisms scales with body mass in a way that has profound consequences for the pace that large and small animals live their lives. This scaling also has a huge impact on the ecological lifestyle that is feasible. Show why this is so by contrasting the allometry of **whole organism metabolic rate** and **mass specific metabolic rate**. Be specific about allometric slopes (b). Then, given that energy reserves (fat stored) scale to body size with an allometric slope of 1 (i.e. scales M^1), show how endurance time (time an organism can live of stored reserves) scales with body mass and why. Show how these relationships account for the drastic differences in the lifestyles of whales versus shrews.

3. Many observations of plant distributions, both present and past, suggest that temperature plays an important role in plant distributions. What type of evidence suggests that plants distributions are currently affected by temperature? What evidence suggests that historic plant distributions were affected by climate and changed over time, and what are the present day implications? Finally, studies of the factors that affect the distribution of the treeline up mountains show how several factors can interact with temperature to affect the distribution of plants. How so?

4. Optimality is a useful way of studying adaptation, and it has been widely used to study foraging behavior. Some critics have viciously attacked the approach by suggesting that it is stupid to expect animals to be perfectly optimal at what they do. Rebut this attack with a discussion of optimal foraging, outlining the general approach and goals. Provide support for your discussion with examples, and these examples can either be case histories that we discussed in class or, if you prefer, potential experiments that you propose on your own.