Before you start please write your name on the top each page!

Read each question carefully before answering to ensure that you fully understand what the question is looking for. Answer the questions in sufficient detail to let us know that you fully understand the critical issues. Do not use the shotgun approach of throwing everything under the sun into your answer in the hope that something will hit the target because we may deduct points for statements that are counter to the correct answer.
The last page is scratch paper for organizing your thoughts.
70 Points total. Good luck.

1. You observe three different species of an organism that **look similar** in morphology (maybe they are closely related, and maybe they are not), but each species is restricted to a different southern continent (a different species in Australia, South Africa, and South America, respectively). Describe three mechanisms (hypotheses) that could account for this observed distribution. (Describe the process, don't just provide a name for each hypothesis). What information would be needed for you to distinguish between the three hypotheses? (6 points)

2. 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 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 type of selection pressure that typically differs between sexes and could account for the increased size of the bigger sex (4 points).

3. Physiological processes scale in interesting ways with body size, and these patterns of scaling have huge implications for many ecological aspects.

i) What is the difference between whole organism metabolic rate and mass specific metabolic rate? How do each of these two measures scale with body mass (i.e. what are the values of the allometric slope ‘b’, for each)? (4 points).

ii) Two new mammals have just been discovered, a new elephant-sized beast, and a tiny shrew-sized creature. Based on what you know about the physiological consequences of body size, speculate about (i) the expected diet differences between these two species (what they eat) and (ii) the risk that a three day cold period without food poses to each. Justify your speculation (4 points)

4. You believe that a nasty non-native snake that was introduced into the arboretum is causing natural selection for increased body size in Arboretum Mouse. Outline a field study you could do to document such natural selection, being careful to identify all components of natural selection and to state how you would measure/show them with your field study (8 points).

5. Experiments with ‘risk-sensitive’ foraging show that animals sometimes gamble.

(i) Show that you understand what ‘risk-sensitive’ means by describing an experiment you could perform to demonstrate whether or not the Lesser Squinting Squeaker is a ‘risk sensitive’ forager. (6 points)

(ii) In several real studies of shrews, bees and small birds, whether or not the animals showed risk-sensitivity depended on their physiological state. Discuss this pattern and state why it makes sense (2 points).

6. As a conservation biologist, you study an endangered annual plant, the Santa Cruz Sparkle. The plant occurs in two habitats and you seek to preserve the habitat with the highest long-term population growth rate. Habitat A is stable and the plant has a consistent population growth rate parameter: λ always is 1. Habitat B is unstable, and λ for that population varies – in any given year, λ has an equal probability of being 2 or 0.4. Which habitat should be preserved? Explain the full logic of your answer (4 points).

7. Ecologists recognize that not all occupied habitats can produce self-sustaining populations, and distinguish between source and sink habitats (3 points).

In a source habitat, λ ___________.

In a sink habitat, λ _____________.

Immigration will be higher into the ________________ habitat.

8. Graphical models of optimal foraging provide a nice way to examine the foraging decisions of an animal that is repeatedly making trips between foraging patches and a central place, as exemplified by a bird that forages for food to feed the chicks in its nest. Below is the skeleton of this graphical model which you need to complete.

- Label all axis including the two separate parts of the x axis (2 points)
- Draw the foraging intake curve for rate of prey gathered while foraging in the patch (1 point)
- Indicate how we solve for the optimal number of prey items that maximizes the **rate** of prey items returned to the nest (1 point)
- Also indicate the optimal number of prey items the forager should collect (it may not be an even number, don't worry about the tick marks) (1 point)

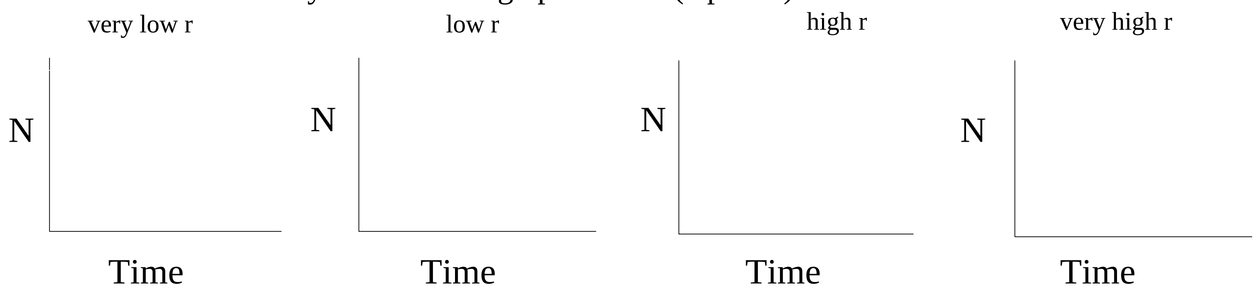
(ii) If you were to test this model in the field and found that birds do not forage as predicted, how specifically might you explain this? (1 point)

9. Density-dependence is of special interest to ecologists because it can potentially explain what limits population growth in some species.

(i) Using a graph illustrate how a density-dependent birth rate (b) and/or a density-dependent death rate (d) can "regulate" a population so that it will be stable at K, its carrying capacity. Label the axes, all lines, and explain clearly in words why the population will be stable at K (i.e. why r = 0). (5 points)

(ii) Describe a mechanism that can give rise to density-dependence (1 point)

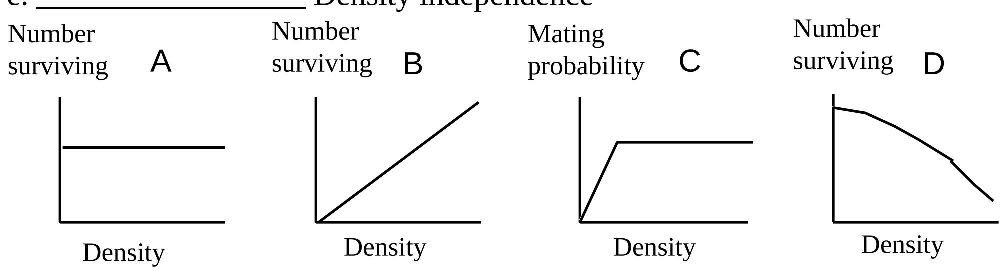
10. Two types of models can be used to model the logistic model of growth. One of these, the discrete model of logistic population growth, produces different and increasingly complex population dynamics as the value of r_D, the per individual population growth rate, increases (r_D is just another way to represent λ). Four distinct types of dynamics are produced as we increase the value of r. Draw these dynamics in the graphs below (4 points).



11. If r = 1 per day, r per week is ____________ (2 points).

12. 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 (write 'no graph'). (5 points).

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



13. The Ideal Free Distribution predicts how animals should distribute themselves among habitats to maximize their fitness, given what other individuals in the population are doing. This idea can be illustrated graphically. Complete the graph below to illustrate the Ideal Free Distribution (i.e. at equilibrium). State in words the two most important predictions of the theory, and illustrate these predictions on the graph (6 points).