**BIOLOGY 150 Midterm Exam Winter 2007**

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. 60 points total.

The last page is scratch paper for organizing your thoughts. Good luck.

1. Experiments with 'risk-sensitive' foraging behavior reveal that animals sometimes gamble.

a) Show that you understand what 'risk-sensitive' means by describing an experiment you could perform to demonstrate whether or not individual animals make 'risk sensitive' foraging decisions. Note: we are interested in risk-sensitivity in general and recall there are two ways to show risk sensitivity (5 points).

b) Two factors — a particular body size and a specific physiological state —are shared in common with all the different animals that have ever been shown to make risk-prone foraging decisions at times. What are these factors and why does this pattern make sense? (2 points)

2. At time zero (t = 0) the population size of Stephen Colbert's Wimpy Eagle is 5. The annual growth rate of the Eagle population is $\lambda = 2$. What is the population size at time t = 3 years? Show the equation that allowed you to calculate your answer and your calculations. (3 points)

3. This question is designed to test your understanding of the process of natural selection as well as one aspect of the field methods required to show natural selection in a wild population (6 points).

i) Outline the three conditions required for natural selection to occur (the three "ifs" we outlined in class). For each condition, also indicate you would require data and comparisons from within a single generation or data from more than one generation to provide evidence for that condition.

| Condition | within or across generations? |
|---|---|
| 1) _____ | _____ |
| 2) _____ | _____ |
| 3) _____ | _____ |

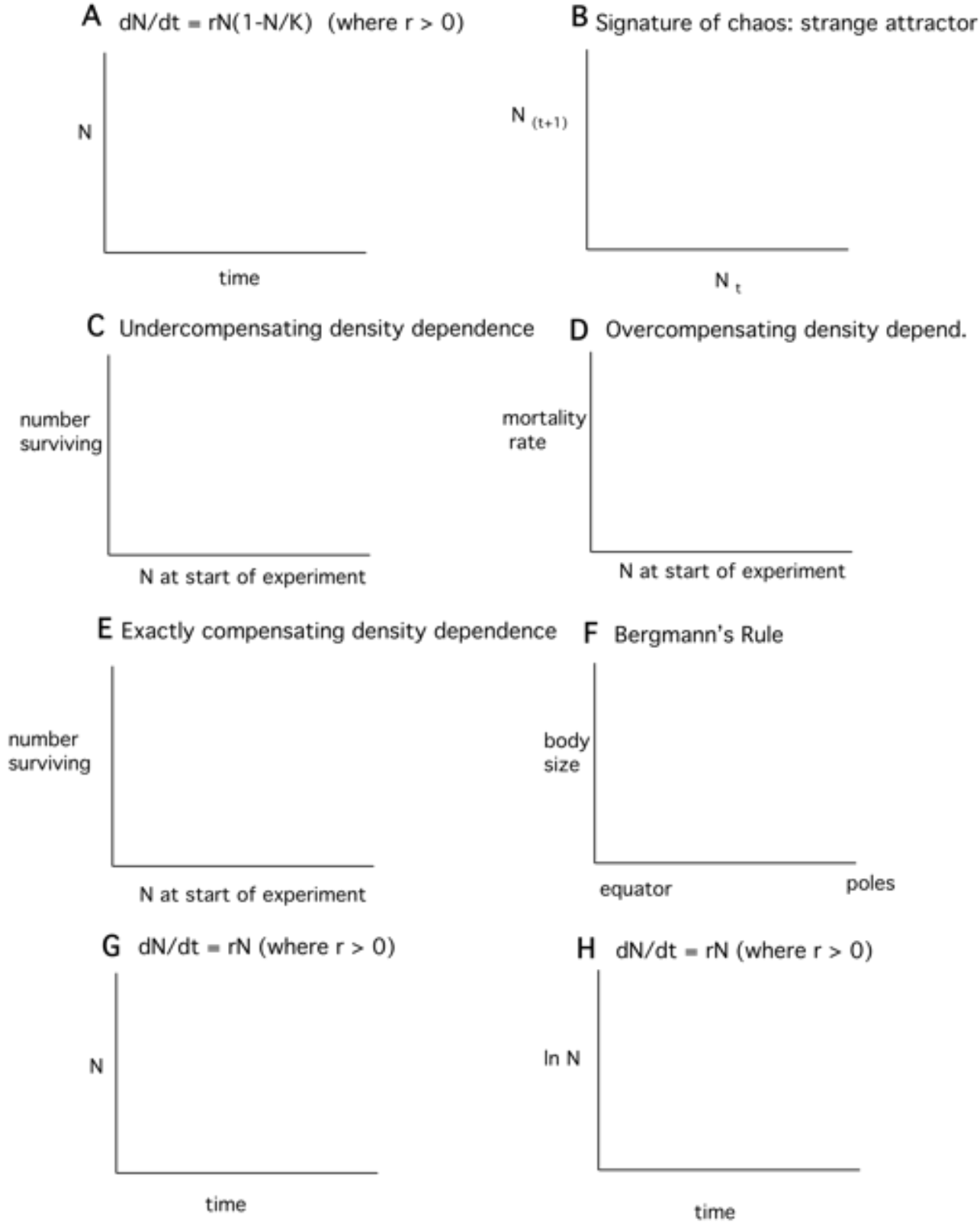
4. The population growth rate per individual, r, is a very useful population parameter that is used in many population models. However, the value of r depends on the time scale used. If r per day is 2, what is r per week? (1 point)

5. You are one of the biologists in charge of conserving the relatively small population of grizzly bears in Yellowstone Park. On your annual bear counts, you notice that the population size fluctuates, and this is also reflected in your estimates of $\lambda$, a measure of per individual population growth rate or decline across years. In good years $\lambda = 4.0$, in bad years $\lambda = 0.2$, 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 $\lambda$ is 2.1 and plugging this value into the deterministic population model 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 $\lambda$ values to obtain the appropriate estimate of some sort of 'average' $\lambda$ 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? Explain. (3 points).

6. Fill in each graph below with the curves or lines predicted by the equation or phrase at the top of the graph beside the large letters. Read the x and y axes carefully: don't jump to conclusions (8 points)



7. Match each term on the left with one term on the right that is the BEST match and write the letter of the term in the space provided (7 points).

1. adaptive radiation _____
2. central place optimal foraging model _____
3. Cocos Island finch _____
4. convergent evolution _____
5. Wallace's line _____
6. increased female body size _____
7. $\lambda < 1$ _____

A. Island Rule
B. ecologically similar taxa that are not related
C. fecundity selection
D. tilt in earth's rotational axis
E. sink population
F. speciation + ecological specialization
G. travel time + in patch time
H. behavioral specialization
I. ecologically (& morphologically) similar but unrelated taxa
J. continental drift

8. According to population models, the density-dependent effects of intraspecific competition can have very different and interesting consequences for the population dynamics of populations with discrete breeding seasons compared to populations with continuous breeding. These consequences are best illustrated by contrasting the population dynamics (changes in N over time) predicted by the continuous logistic ($dN/dt = rN(1-N/K)$) versus the discrete logistic model ($N_{t+1} = N_t + r_d N_t(1-N_t/K)$).

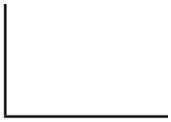
(i) What is the major difference between these models in terms of the population dynamics each model predicts when r is very high? You can describe in words or you draw a couple of graphs (2 points)

(ii) Why specifically do these two models produce such different outcomes? (2 points)

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

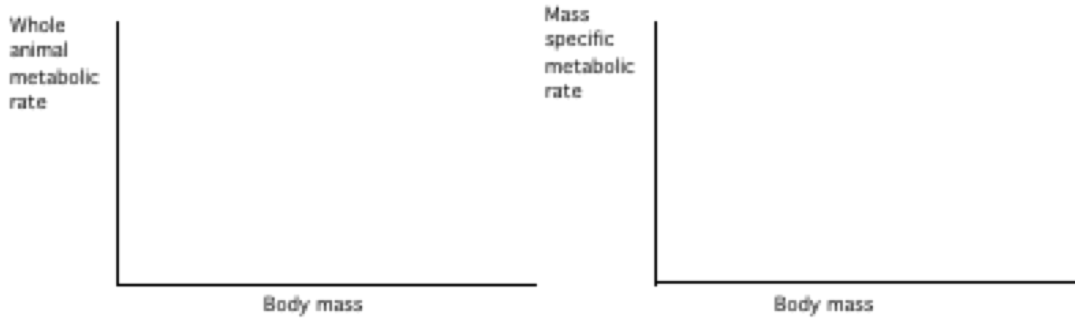
(i) List two mechanisms that can cause density-dependence. (2 points)

(ii) Use the graph below to illustrate how a density-dependent birth rate and/or a density-dependent death rate can "regulate" a population so that it will be stable. Label each axis, all lines and indicate where the population is stable. Also, explain clearly in words why the population will be stable in terms of population growth rate parameter r. NOTE: this is general density-dependence, not the logistic model due to intraspecific competition. (3 points)



10. Allometry is the study of how traits or factors change in relation to body size. The relation between metabolic rate and body mass, in particular, has been the focus of intense interest and a couple of key patterns have been discovered.

(i) Fill in the graphs below with a line or curve to show the relation between <u>whole animal metabolic rate</u> ($VO_2$/unit time) and body mass (left) and <u>mass specific metabolic rate</u> ($VO_2$/gram/unit time) and body mass (right). Graphs are arithmetic, not logarithmic (2 points)




ii) Two new mammals have just been discovered in the wilds of Alaska — an elephant-sized beast and a tiny shrew-sized creature. Based on the implications of the above graphs, 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. (4 points)

11. The "ideal free distribution" is a theory that predicts how foraging animals will distribute themselves among feeding patches of different intrinsic quality (where quality is based on the total amount of food in patch or the rate at which food is produced). The theory is easily tested with a school of fish in an aquarium and two separate food dispensers that differ in the rate at which they dispense food. (3 points)

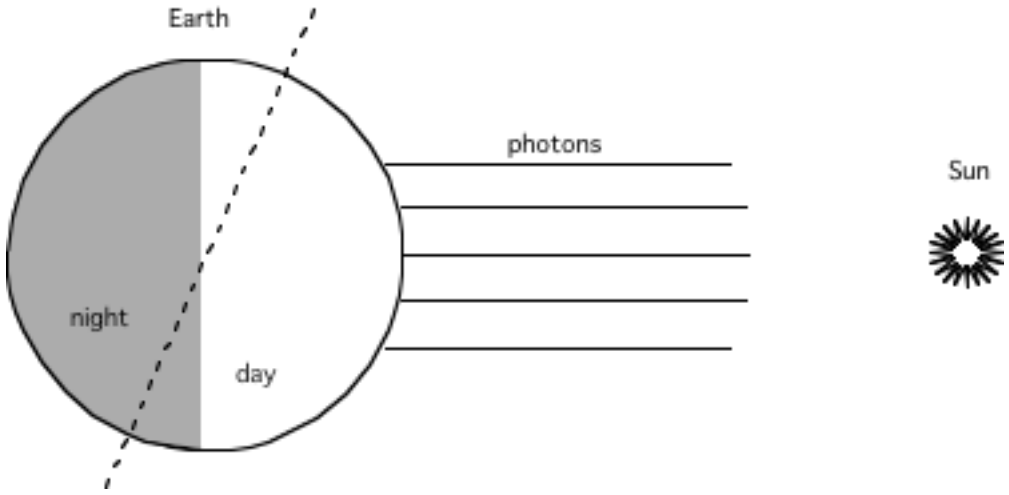
i) A test of the ideal free distribution is conducted in a tank with 20 fish. There are two feeding stations. Station A dispenses 3 fish pellets per minute, while Station B dispenses 1 fish pellet per minute. If these fish show a perfect ideal free distribution:

How many individuals will be at Station A? (1 point) _____

ii) What are the two key features of this system that are critical for producing the ideal free distribution? (2 points)

12. The globe illustrated below shows the earth on June 21, the longest day of the year in the northern hemisphere. The top of the globe is the northern hemisphere and the dashed line shows the earth's rotational axis relative to the sun on this day.

On the globe, draw in and label the <u>equator</u> and the <u>arctic circle</u>. Draw carefully as we want the exact location based on information in the drawing. (2 points)



SCRATCH PAPER FOR ORGANIZING YOUR THOUGHTS OR COOL DOODLES
DO NOT LEAVE IMPORTANT THINGS ON THIS PAGE — WE THROW IT OUT.

*"You know, of course, that these are legumes, not nuts."*