Ecology **2-22-10**
Biol 228 **Prof. Kerkhoff**
Review Materials for Exam I

The exam will include mostly short-response questions, though there may be some matching or even multiple choice. Most of the questions will ask you to synthesize ideas or display facility with reasoning, rather than just spitting back jargon. You may be asked to interpret graphs, develop hypotheses, and design experiments to test them.

All necessary equations will be provided. You may be asked to make simple calculations, and you may use a calculator.

<u>Book resources:</u> The chapter review questions in the book (for Chapters 1 – 4.1, 5 – 6, and 9 – 11) are an excellent source of review information.

Below, I've included some further review questions (in no particular order), to highlight other important information. Several are questions from past exams. They should give you an idea of what to expect

1. With global warming and the continued increase in CO2 concentration of the atmosphere, we can expect interactions to occur between the effects of temperature, CO2, and water availability on plant growth. Discuss the *trade-offs* that might influence how plants will respond to all three factors at once.

2. At the global scale, climate is a powerful predictor of biome type. Reproduce (in general) Whittaker's temperature and precipitation scheme for predicting biome type presented in lecture. Explain what environmental measurements you would need to predict the biome type for northwestern Ohio. Be able to relate the location of a biome in the diagram to maps of the biome, based on what you know about global patterns of climate.

3. What is the origin of the intertropical convergence zone. Why does it "wander"? Explain how Hadley cells form. Discuss their role in creating dominant wind directions. Explain how the Hadley cells are responsible for tropical rain forests at the equator and deserts at 30 degrees latitude.

4. Consider beech trees (*Fagus grandifolia*) and the blue jays (*Cyanocitta cristata*) which eat beech nuts, hiding them in the soil in small *caches* for later consumption. How might blue jays be an important determinant of beech responses to climate

change, even though jays are very generalist feeders, eating many things besides beech nuts? Under climate change, how would shorter, less severe winters affect rates of caching by blue jays? If higher rates of caching result in more widespread caches, how will changes in blue jay behavior influence beech responses to climate change? Explain.

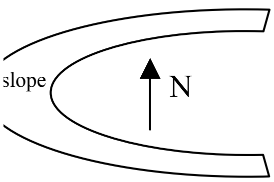
5. Create a Walter climate diagram for the data below (starred months have mean minimum temps below 0 deg. C). Be able to do this without the book in front of you. No fancy colors necessary.

Month	Mean Temp (deg. C)	Mean Precipitation (mm)
January*	-1.0	18.9
February*	1.6	17.5
March*	3.9	19.1
April	8.2	21.1
May	13.1	24.0
June	18.9	21.0
July	20.9	67.2
August	19.8	65.1
September	16.7	41.2
October	11.2	30.9
November*	4.2	16.3
December*	-0.6	24.5

From the climate diagram, tell which months will have a moisture surplus and which a deficit. What type of biome would you expect to find at this location?

Also be able to match climate diagrams to biomes (and their maps) in general.

6. Central New Mexico is the meeting place of two closely related grass species, *Bouteloua eriopoda* ("black grama") and *Bouteloua gracilis* ("blue grama"). Both are perennials that utilize the C4 photosynthetic pathway and grow in discrete clumps. Black grama is characteristic of the arid desert grasslands of southern New Mexico and the Mexican state of Chihuahua, while blue grama is more common in the somewhat moister short-grass prairies of southern Kansas and Colorado. How would you expect the two species to be distributed within a small basin that curves around from a north-facing to a south-facing slope (see below)? Consider the primary factor(s) that determine the distribution, as well as how other factors might complicate your predictions.



7. Focusing just on blue grama described above, predict how patterns of allocation to above- and below-ground biomass would change from the interior of it's geographic range (in the relatively cool, fertile, and moist prairies of Colorado) to the southernmost limit (in the warmer, more arid high plains of southern New Mexico). Describe an experiment that would determine the relative importance of genetic and environmental influences on these changes.

8. Consider eusocial leafcutter ants of the genus *Atta*, which use leaf cuttings to "farm" edible fungus in their underground colonies. Imagine an *Atta* species in the seasonally dry forests of Costa Rica that has a single queen and five distinctive *castes*: reproductive males, and female soldiers (which protect the colony), leaf-gatherers, larval nurses (which tend the eggs and larvae) and fungal gardeners. In terms of foraging, it is more appropriate to consider the whole colony as a forager rather than a single ant. Why? The leaf-gatherers and soldiers are busily stripping the leaves from a tall tree. Would you expect the ants to strip every single leaf from the tree? What are the factors that determine when the ants will give up and move on to another tree, as well as which tree to choose next? Describe this foraging process in terms of cost-benefit tradeoffs, considering leaf quality, search time, and travel (handling) time. Remember, the leaves have to make it back to the colony to be used to grow fungus.

9. Compare the light saturation curve for photosynthesis to the functional response of animal herbivores and predators. How are the plants and the animals different? How are they the same? Do all functional response curves eventually saturate, and why is this important?

10. Below is a life table and fecundity schedule for a biennial plant species, which grows through a first year without reproducing (mostly), then reproduces in its second year before dying. Remember that:

$R_0 = \sum l_x m_x \quad T = \sum x l_x m_x \quad$ and $\quad r = \dfrac{\ln R_0}{T}$

age (x, yr)	survivorship (l_x)	fecundity (m_x)		$l_x m_x$	$x l_x m_x$
0	1	0		0	0
1	0.3	1		0.3	0.3
2	0.001	800		0.8	1.6
			SUM:	1.1	1.9

Is this population growing, stable, or shrinking? How do you know? Why is the generation time less than 2 yr, even though this is a *biennial* plant? Theoretically, it is advantageous for biennial plants to delay reproduction until the second year because they end up larger and can bear more fruit in the second year. Under what survivorship conditions might a mutant annual variety (which reproduces in the first year and dies) have a greater advantage? Recall that fecundity is an average that includes both reproducing and non-reproducing individuals.

11. Think about white-tailed deer (*Odocoileus,* ~200 kg) and a species of deer mouse (*Peromyscus,* ~20 g) that share a very similar geographic range in North America. Compare the likely carrying capacities and intrinsic rates of increase of these two coexisting species. Would you expect one or the other to show higher variability in local population density across the range? Would you expect one or the other to exhibit more extreme population fluctuations? Support your answers.

12. What sort of population growth model (discrete or continuous, limited or unlimited) would you use in the following situations? Justify your answer.
    a. Annual herbaceous plants colonizing a hillside recently cleared by an Avalanche.
    b. Trees growing to fill a tree-fall gap in an aseasonal tropical forest, which will take many decades to 'fill-in.'
    c. An insect that dies just after egg-laying, living on a small, isolated mangrove island in the Florida Keys.
    d. An unusual species of primate that discovers animal domestication, agriculture, and fossil-fueled technology.

13. In the last case above, characterize how the three factors mentioned may have changed the life table, fecundity schedule, and carrying capacity of this unusual primate.

14. You are working near Iquitos, Peru in a lowland rainforest that has large patches of white sand soil spread throughout the area. This soil has a unique chemistry, different from the soil of the neighboring clay-rich areas of the forest, and results in a different composition of plants. In particular, you notice one understory herb that is common throughout many of the white sand patches. However, you also notice that some smaller patches of white sand do not have this herb, though they do have other forest species usually found on the white sand.

a) Briefly describe three factors that you hypothesize may explain the patchy distribution of the herb;
b) Describe an experiment to test **one** of these hypotheses. What results would you expect to show support for your hypothesis? What results would not support your hypothesis?