

Principles of Ecology (PoE). Final exam. Fall 2010. Name: _____

The test has 215 points + 12 extra credit points. These points are arbitrary. The contribution of your performance on this exam to your final grade is calculated with the following relationship: (your pts earned on this exam / 215) * your weighting factor (below)

Weighting factor for final exam (points): _____ (range = 100 – 250; default = 150)

$N_t = N_0 \lambda^t$	$dH/dt = rN - cNP$	$dN_1/dt = r_1 N_1 (K_1 - N_1 - \alpha_{12} N_2) / K_1$
$N_t = N_0 e^{rt}$	$dP/dt = acNP - dP$	$dN_2/dt = r_2 N_2 (K_2 - N_2 - \alpha_{21} N_1) / K_2$
$H' = -\sum [p_i * \ln(p_i)]$	$dN/dt = rN(1-N/K)$	$d\mu/dt = \Lambda_o V * E + e^c * \Omega \lambda \Omega * G^y$
$dS/dt = -B SI - dS$	$dI/dt = B SI - dI - \alpha I - \nu I$	$dR/dt = \nu I - dR$
$\frac{N_{\text{captured and marked initially}}}{N_{\text{total}}} = \frac{N_{\text{marked at recapture}}}{N_{\text{total recaptured}}}$		$N_{t+1} = N_t + r_o N_t (1 - N_t / K)$
$N_e = 1 / [(1 / \{4N_m\}) + (1 / \{4N_f\})]$	or	$N_t = K / (1 + [(K - N_o) / N_o] * e^{-rt})$
		$N_e = 4N_m N_f / (N_m + N_f)$

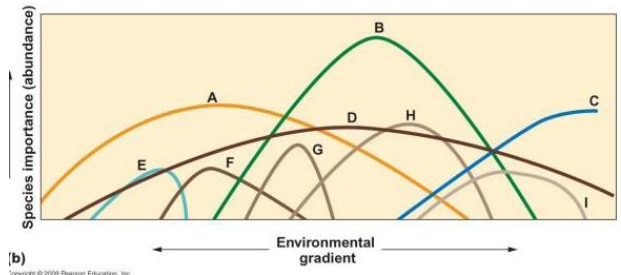
- A. What are the four, easily observed characteristics of natural selection? Answers must be **precise**. (-2 pts for first wrong, -1 thereafter. 5 pts total) (**from Syllabus**)
- a. _____
 - b. _____
 - c. _____
 - d. _____

Pick the best answer possible and place that answer on the scan-tron. 5 pts each, 145 pts total.

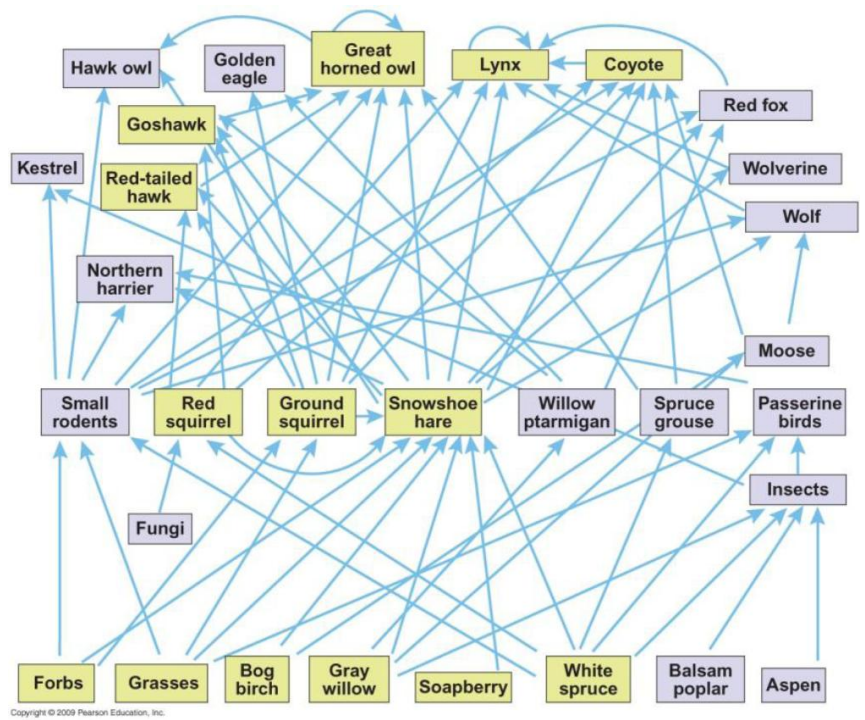
1. _____ is "the change in gene frequencies within a species over time." (See syllabus, PoE = # 1)
 - a. Gene flow
 - b. Natural selection
 - c. Evolution
 - d. Hardy-Weinberg law
 - e. Mutation
2. As a plant community develops there is an inverse relationship between the mean size of individuals and density. Which of the following is the name of this process? (See syllabus, PoE = # 23)
 - a. Interactive species composition.
 - b. Facilitation model.
 - c. Inhibition model.
 - d. -3/2 Law
 - e. species-area relationship.
3. Liebig's Law of the minimum suggests that the growth rate of populations is limited by which of the following? (See syllabus, PoE = # 8)
 - a. Respiration.
 - b. The scarcest resource
 - c. Net primary productivity.
 - d. Source-sink dynamics.
 - e. All of the above work in concert to define this law.

4. A keystone species is one that, in all circumstances, (See syllabus, PoE = # 24)
- is found at the top of the food chain.
 - is found at the bottom of the food chain
 - is a dominant species within the guild of predatory species.
 - when removed causes another species to decline and eventually go extinct deterministically.
 - has a disproportionate effect on a community, based on its relative biomass.
5. I would like to determine the diversity of what are called "mesopredators" in Geneseo. Mesopredators are medium sized animals. I recorded the following numbers of animals from my work within the township of Geneseo.:
red foxes = 23, coyotes = 8, wolverines = 0, otters = 2. The best estimates for H' and J' are represented by which of the following pairs of numbers?
- | | H' | J' | |
|----|-------|-------|----------------------------|
| a. | 0.76 | 0.70 | |
| b. | 0.33 | 0.30 | |
| c. | 0.40 | 0.36 | |
| d. | 3.65 | 3.33 | |
| e. | _____ | _____ | Your best answers instead. |
6. A pack of wolves has reportedly been living in the Adirondacks (OK, I'm making this up). The researcher, who has kept this quite, reports that the population in 2007 was 5 animals and is now, three years later (2010), numbering 22. Your best estimate of the per capita yearly growth rate parameter "r" is which of the following?
- 4.40
 - 1.48
 - 0.88
 - 1.64
 - 0.49
7. Which of the following food web types represents the effect of species interactions on population growth?
- Energy web
 - Connectedness web
 - Functional web
 - Inference web
 - All of the above represent this.
8. Robert MacArthur made many important contributions to the principles of ecology (e.g., see the theory of island biogeography question below). One of these was that he showed that birds can partition insect food resources spatially in trees that appear relatively homogenous. From this work he and Henry Horn, who we've also talked about several times, showed that the relationship between bird species diversity (H') and foliage height diversity exhibited which of the following relationships?
- positive
 - negative
 - constant
 - zero relationship (zero slope)
 - infinite (vertical relationship)

9. The diagram to the right depicts different species abundances along an environmental gradient. The patterns shown are consistent with which of the following community concepts?
- Clements' "organismic" concept.
 - Gleason's "individualistic" concept.
 - Egler's "stochastic energy" concept
 - All of the above.
 - None of the above.



10. In the food web diagram to the right (just who eats who) how many "top predators" are there?
- 2
 - 4
 - 5
 - 6
 - 12



11. According to Hairston, Smith, and Slobodkin (1960) which of the following represents the regulating factors, in the order: plants, herbivores, and predators?
- competition, predation competition.
 - predation, competition, predation.
 - competition, predation, diseases.
 - All are regulated by diseases
 - Their work showed that all species are regulated by abiotic factors.

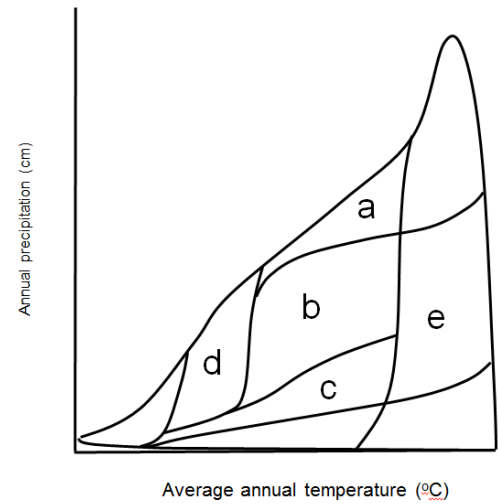
12. The emission of which of the following is most responsible for the acidification of lakes in the northeastern USA and the destruction of the ecosystem downwind from the Sudbury Canada plant discussed in class?
- O₂.
 - CO₂.
 - NO₂.
 - SO₂.
 - All of the above.

13. Which of the following is not a "structural layer" in a forest found in NY:
- Herbaceous/fern layer
 - Understory layer
 - lower canopy layer
 - upper canopy layer
 - emergent layer.

14. We spent some time talking about savanna ecosystems and the migrations of animals. There's actually a succession of animals as they migrate through this ecosystem. In general, the first animals to migrate into these tall grass plains is the
- giraffe.
 - elephant.
 - wildebeest.
 - dikdik.
 - zebra.

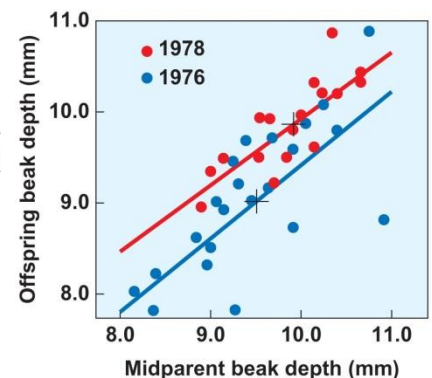


15. Based on the diagram to the right which biome do you live in?
Choose the appropriate letter.
- a.
 - b.
 - c.
 - d.
 - e.
16. Most of the area of the Genesee River watershed (where you are now) is
- a. moving water
 - b. standing water (lakes)
 - c. wetlands
 - d. agriculture
 - e. forest



17. The ecosystem where freshwater meets salt water is referred to as
- a. a swamp
 - b. a bog
 - c. an estuary
 - d. the brackish zone
 - e. all of the above are fine for this.
18. Which of the following is the **best answer** to why organic matter builds up at high latitude bog communities?
- a. Soils and water are cold.
 - b. pH is low.
 - c. productivity rates exceed decomposition rates.
 - d. all of the above.
 - e. none of the above.
19. In terms of species richness you live on a planet dominated by
- a. plants
 - b. mammals
 - c. insects
 - d. crustaceans
 - e. fungi
20. In general, species richness _____ with latitude and _____ with elevation.
- a. increases, increases.
 - b. increases, decreases.
 - c. decreases, increases.
 - d. decreases, decreases.
 - e. does something, does something too.
21. If we have a population with 12 individuals, 3 of which are female, the “effective population size” would be calculated to be
- a. 9
 - b. 10
 - c. 11
 - d. 12
 - e. none of the above

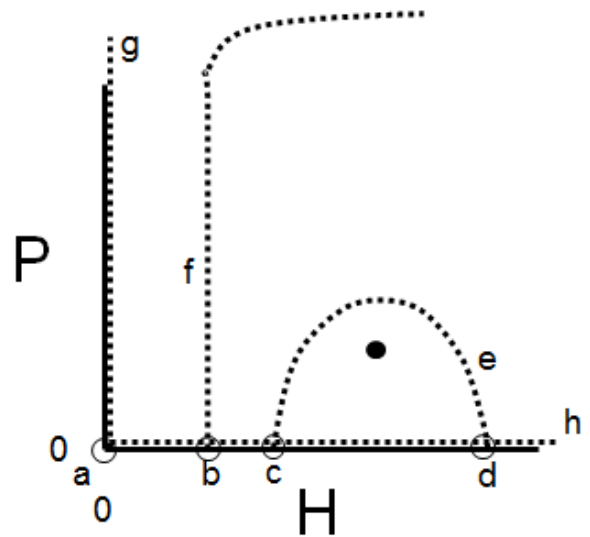
22. Based on the figure to the right which of the statements "a" through "c" is **not** supported by these data?
- a. Beak depth is a heritable trait.
 - b. Beak depth is a trait that exhibits variability.
 - c. These data suggest evolution took place.
 - d. All of the above are supported by the data.
 - e. None of the statements is supported.



24. Which of the following community types is the most efficient in terms of having the highest gross primary productivity per unit biomass (GPP/biomass)?
- tropical rain forest.
 - coral reef
 - open ocean
 - eastern deciduous forest
 - desert
25. The order of community types that experience the **least to the most herbivory** in terms of NPP removed would be
- aquatic algae, aquatic macrophytes, terrestrial plants
 - aquatic macrophytes, aquatic algae, terrestrial plants
 - terrestrial plants, aquatic algae, aquatic macrophytes
 - terrestrial plants, aquatic macrophytes, aquatic algae
 - none of the above.

26. In the graph to the right the black dot represents the starting population of predators (P) and prey (H). Which of the below represents the equilibrium to which these populations will move?

- point a.
- point b.
- point c.
- point d.



27. Which of the time intervals below is the closest to the actual doubling time of a population that increases from 33 to 39 individuals in one year?

- 5.0 years.
- 4.1 years.
- 3.3 years.
- 4.9 years.
- 0.59 years.

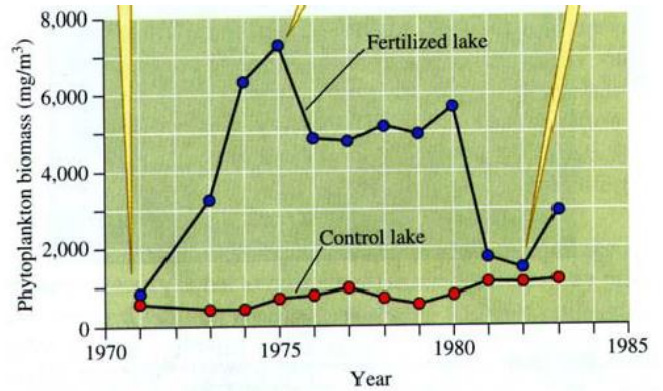
28. To the right are data on four tree species and their initial population sizes of the 100 trees in a forest. The number of red maple trees (species 3) that are expected to be in our forest in the next time step is which of the following?

- 33.25
- 27
- 38.25
- 25
- 51.7

Species	N
Species [1] = Gray Birch	25
Species [2] = Black Gum	25
Species [3] = Red Maple	25
Species [4] = Beech	25

	[1]	[2]	[3]	[4]
[1]	0.05	0.36	0.50	0.09
[2]	0.01	0.57	0.25	0.17
[3]	0.00	0.14	0.55	0.31
[4]	0.00	0.01	0.03	0.96

29. The graph to the right shows the results from an experiment. The main result, along with the main concern, is best represented by which of the following?
- Plants respond with positive growth to fertilizer, despite eutrophication from human activities.
 - Phytoplankton grew more in the fertilized lake but we can't say "lakes increase productivity in response to fertilization."
 - Phytoplankton productivity remained low in control lakes because of poor waste management practices
 - All of the above are true.
 - None of the above.



Short Answer Questions. Answer SIX of ELEVEN. Circle CLEARLY the numbers of those you want me to evaluate. 5 pts each. 30 pts total.

- A population of fruit flies in Australia that express the recessive trait "curly wing" have a genotype frequency that seems to differ from the expected. The genotype frequencies are shown below

$A_1A_1 = 30$, $A_1A_2 = 40$, $A_2A_2 = 50$. When I ran the chi-square test on these data, using $p = 0.16$, I get a p-value of 0.003. This is curious.

 - Explain why these fruit flies are or are not in Hardy-Weinberg equilibrium. (3 pts)
 - Calculate the frequency of the A_1 allele. $p =$ _____ (2 pts)
- Provide a diagram that accurately represents two species that have overlapping fundamental niches but non-overlapping realized niches over two resources gradients. Note that you want to show this for both resources simultaneously (in 2-dimensions).

3. Provide the main result and the main scientific concern you have with the data presented in the graph and discussed at length in lecture.

a.

b.

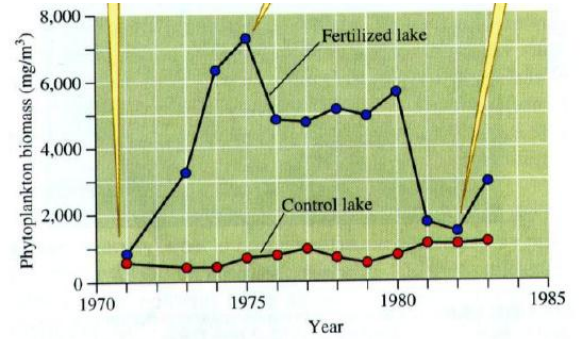
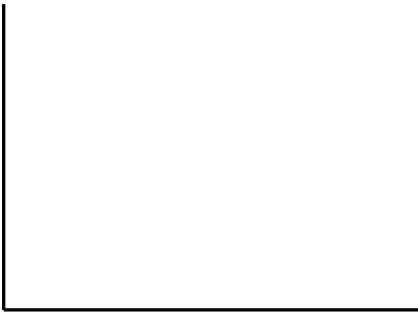


FIGURE 15.8 A whole lake experiment shows the effect of nutrient additions on average phytoplankton biomass (data from Findlay and Kasian 1987).

4. Provide a carefully drawn graph showing how CO₂ has changed over the last 5 years (1 pt). Provide the relationship over continuous time, show any cycles, and provide an explanation for the timing of any cycles (2 pts). Label your axes (1 pt) with units on the y-axis (1 pt)



5. Provide a "climate diagram" (a specific kind of graph) that is consistent with weather in Geneseo, NY.

6. We hear so much about sustainability these days. We learned about the definition used by SUNY Geneseo. Please provide the complete definition for "sustainability."

7. Provide five clear, **independent**, substantial, and economically valuable services provided by **natural, unmanaged ecosystems** that improve the lives of humans. Please be **specific** with your examples. Use biotic examples. An answer such as "nature gives us amphipods" tells the reader nothing of what you mean.

a.

b.

c.

d.

e.

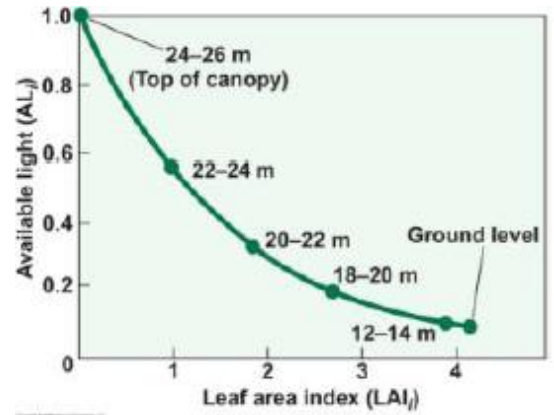
8. Draw a histogram of a trait discussed in the Arboretum that, before disruptive selection, is normally distributed on the left and then what it looks like after disruptive selection has led to evolution on the right. Be sure to label your axes correctly (y-axis = 1 pt, each x-axis = 1 pt, relationships = 1 pt each).



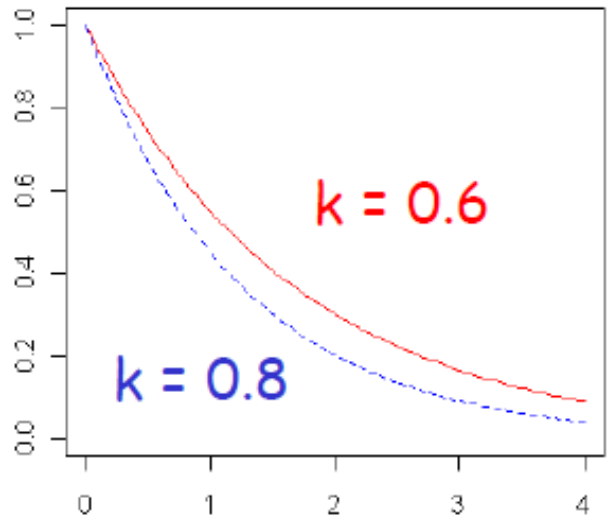
9. We used Beer's law to understand light attenuation through forest canopies. Your textbook showed the negative exponential relationship of available light versus leaf area index (LAI) (above right). When we fit the data (lower right) we got an exponent of $k=0.6$. The equation was

$$y = e^{-(k \cdot LAI)}$$

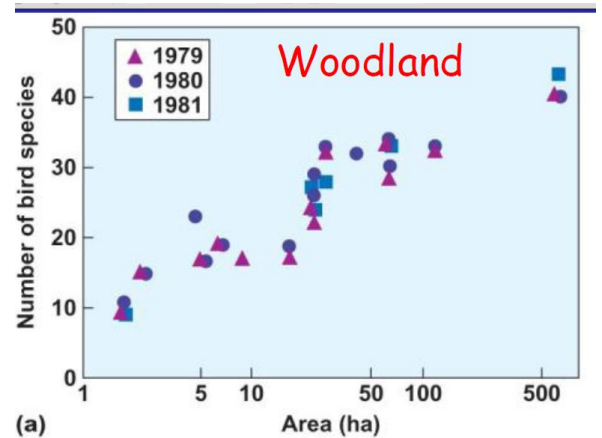
- a. What is LAI? (2 pts)



- b. In the diagram to the right describe how a forest with a higher value of k (e.g., $k = 0.8$) would be different from the one studied with $k = 0.6$? (3 pts)



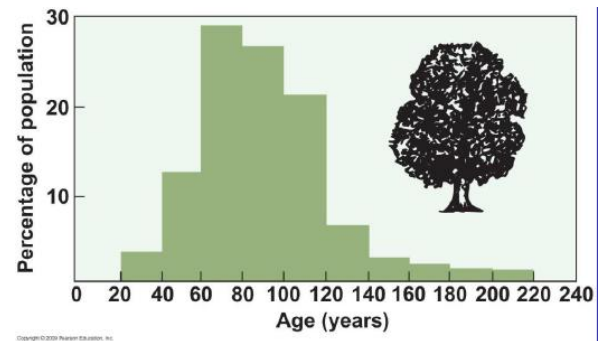
10. Your book suggested that the data to the right supported the idea that species richness plateaus at about 24 hectares (ha). Assess this finding based on the data and discuss this in terms of at least one of your principles of ecology (PoE).



11. A long-standing debate in conservation biology concerns the design of reserves, if we were able to set land aside for the long-term preservation of species. The problem might be thought of as what we should do if we have a million dollars to spend buying land. Based on the design principles we discussed in class, along with other principles of ecology, defend your choice of buying for protection a single, large preserve or several small preserves with the total acreage for both choices being equal. Include one diagram from our suite of good vs. better designs discussed in lecture.

MANDATORY QUESTION (5 pts)

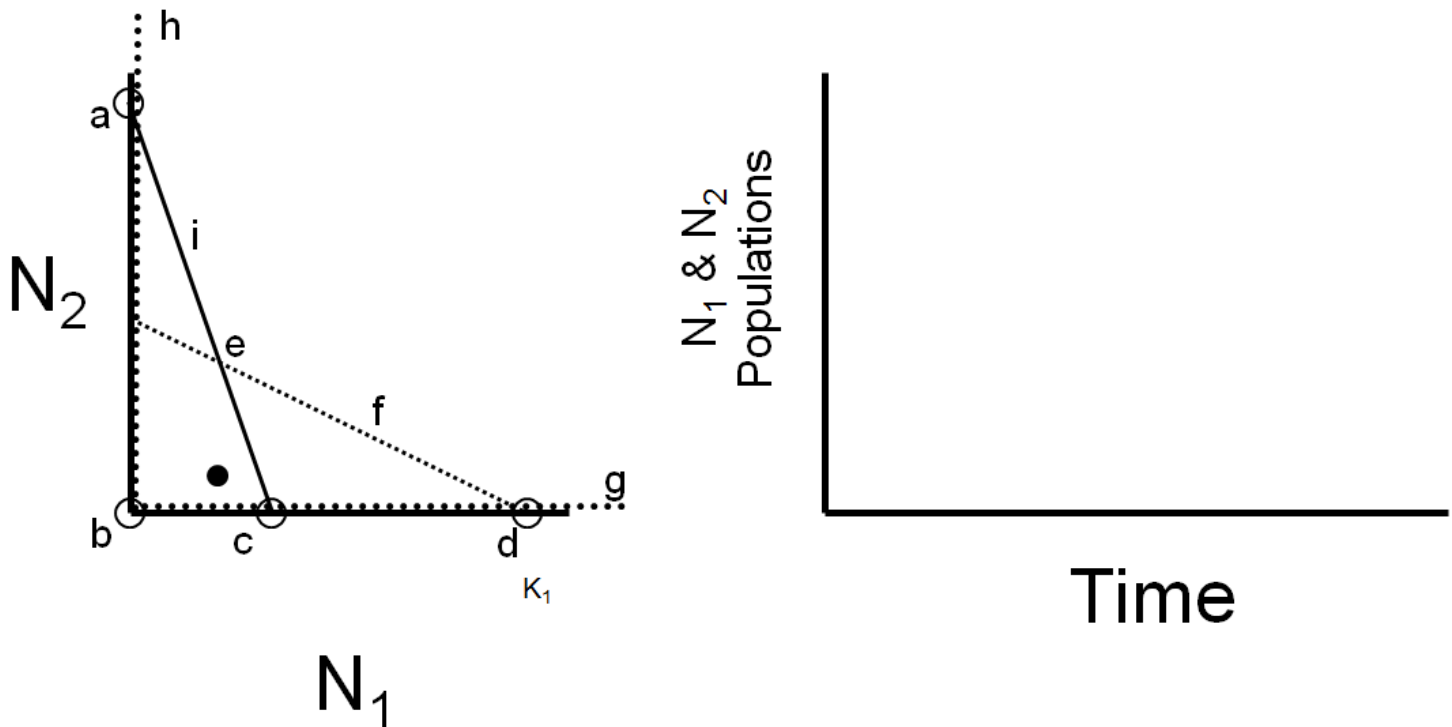
1. The data to the right represent the "age structure" for a population of sugar maple trees in an area where the sugar maple industry is an important part of the local economy. Discuss each of the following relative to the long-term stability of the maple sugar (maple syrup) industry:
- a. Why these data are a serious concern for the industry. (2 pts)



- b. Why these data are not necessarily a concern for the industry: (3 pts)

Longer questions. 15 pts each, 30 pts total.

1. Species Interaction Model.



i. Analyze the following points from the graph on the left. (1 pt each)

- a. point a: _____
- b. point b: _____
- c. point c: _____
- d. point d: _____
- e. point e: _____

ii. What do the following lines represent (provide an equation or written description)? (1 pt each)

- f. line f: _____
- g. line g: _____
- h. line h: _____
- i. line i: _____

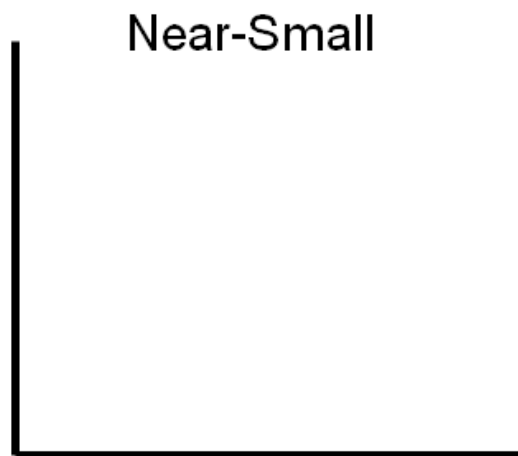
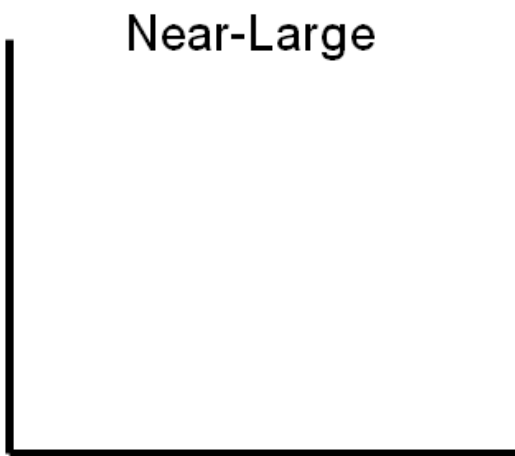
iii. Provide the **entire trajectory** of the big, solid point in the left graph to its equilibrium, assuming it adheres to the model. (3 pts)

iv. Draw the numbers of N_1 and N_2 on the right graph to their equilibria, assuming they start at the big, solid point in the left diagram. Assume the scales for N_1 and N_2 are the same. (3 pts)

2. Provide the theory graph of the Theory of Island Biogeography for each of the four islands below. Make the **scales** for the axes **the same** across all four graphs. **Analyze all four graphs** (3 pts). Use - - - - - for the colonization curves/lines and a solid line for the extinction curves/lines. Proper relative relationships are worth 6 pts. (15 pts total)

What exactly is graphed on the y-axes? _____ (3 pts)

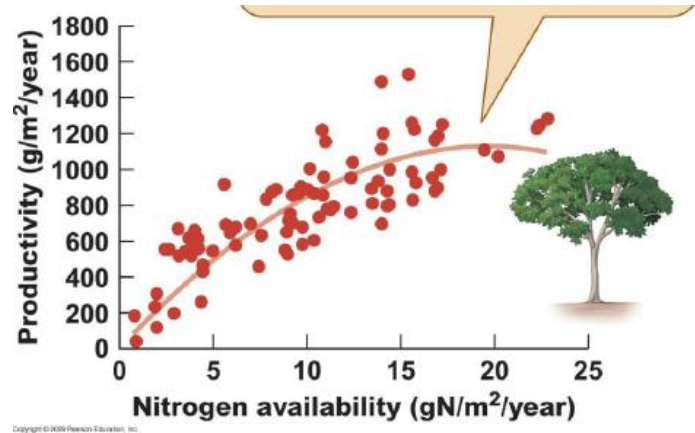
What exactly is graphed on the x-axes? _____ (3 pts)



Extra Credit. (12 pts possible)

1. Provide up to 3 specific, data-driven, independent lines of evidence that global climate change is happening. You can't use anything I've provided in this exam (e.g., # 4 below). (1 pt each)
 - a.
 - b.
 - c.

2. We talked about the data to the right and I noticed that the curve fit to these data does not reach the reported "plateau." Provide the equation that would yield a functionally more appropriate fit for these data than the quadratic equation used. (2 pts)



3. In "what's new?" we talked about the research involving the map to the right. What in the world was "new" regarding the colonies? (1 pts)

4. The evolution of the structure of polar bear skulls was discussed in reference to global warming. These sound unrelated. What was the connection to global warming? (2 pts)



5. I discussed a debate I had with a meteorologist (weather man) in front of a bunch of Rochester high school students. I told them a lot about the data supporting global warming. I gave the students one hand out prior to their meeting with the weather man. What specific thing did they receive from me that I feel solidified an irreconcilable victory on my part? (2 pts)

6. What was the maximum kcalories a blue whale can ingest of krill in a single gulp? (2 pts)