BIO 2129 – Introduction to Ecology

STUDENT #: _____

Do not write your name on this exam, ONLY your student number, above. This is a closed book exam. Questions have different mark values: read them carefully and budget your time accordingly. Remember to observe university regulations on academic honesty.

1. A small desert plant shows the following patterns of mortality with respect to individual age in the absence of any herbivory:

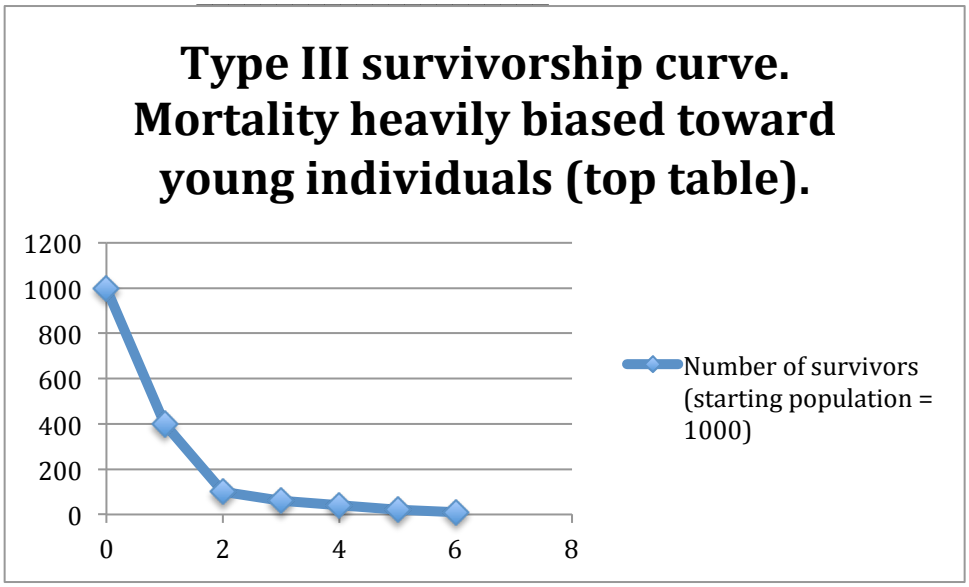
Age (weeks)	Number of survivors (starting population = 1000)
0	1000
1	950
2	900
3	850
4	800
5	500
6	250

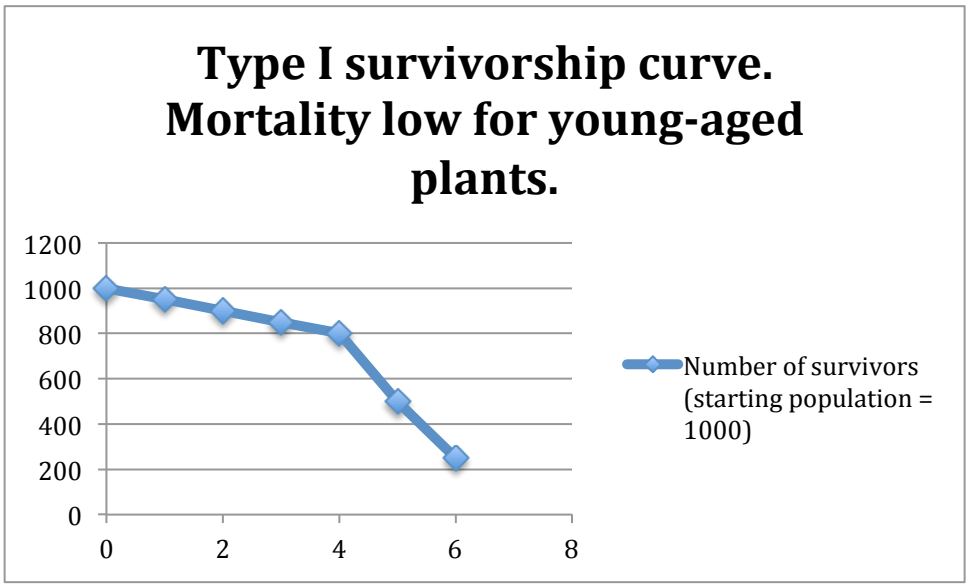
The same plant species shows this mortality pattern in the presence of a herbivorous beetle:

Age (weeks)	Number of survivors (starting population = 1000)
0	1000
1	400
2	100
3	60
4	40
5	20
6	10

Compare and constrast survivorship curves for this plant species in the two datasets. Use graphs. Ensure you explain the differences thoroughly and specifically.

STUDENT #: _____





2 marks for each graph (4 marks total)

*The first trend shows a strong tendency for the young plants to die at an early age, due to herbivory from the beetle. Beetle herbivory effectively targets juvenile plants (**1 mark**). It is possible the beetle really doesn't eat older plants, but the data do not prove or disprove this point.*

*In the absence of beetle herbivory, the plant's mortality relative to age is low for juveniles but begins to get very high as the plants age. They plants die quickly after 5 or 6 weeks. There is no information on the cause of mortality increasing with age, just that it does. This is a type I survivorship curve. (**1 mark for a coherent comment on mortality here).***

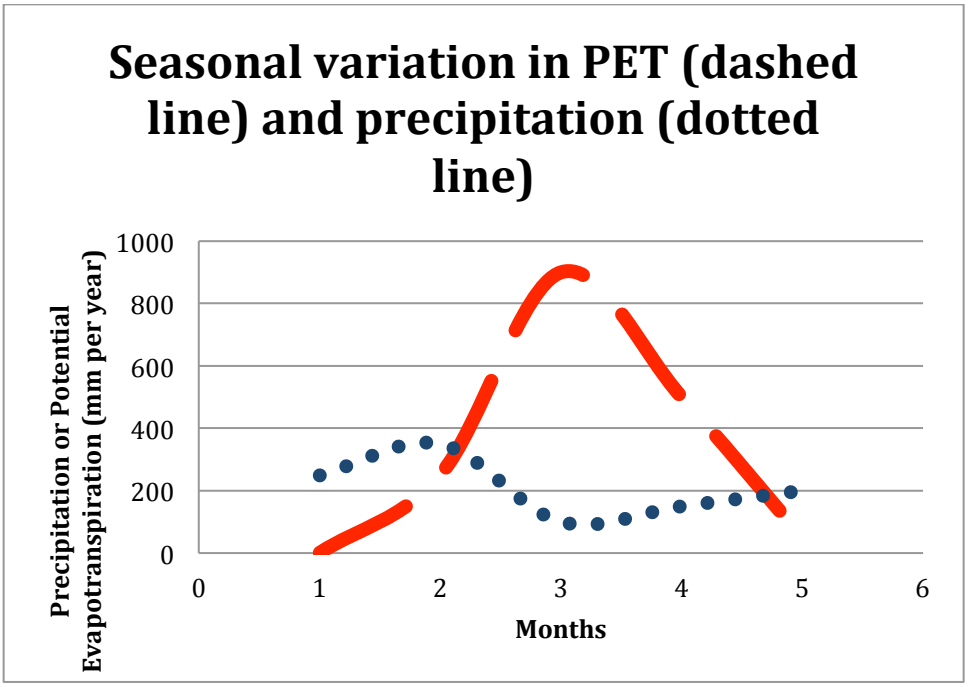
STUDENT #: _____

2. Carefully explain the hypothesis that "mountain passes are higher in the tropics" and how it might help explain global patterns of species diversity. (4 marks)

*In this hypothesis (which is not necessarily correct, although students don't need to point that out), the climatic differences between the base of a mountain range and a high altitude pass through the mountains will be very large in the tropics. For instance, at the base of the Andes in Peru, there is warm, humid tropical forest. In the mountain passes through the Andes, climatic conditions can be very cold, and be outside the range of climatic conditions that species ever experience in the tropical forests below. This creates isolation around mountain ranges in the tropics and the potential for greater diversification. In temperate to cold areas, species living at the base of mountain ranges will experience cold winters, which means that those species would be better able to tolerate cold temperatures compared with their tropical counterparts. Isolation is harder if species can cross barriers more easily and therefore speciation would be liable to be less/slower in colder areas. (**4 marks for any explanation that sounds about this inclusive and detailed or better)***

3. Describe the climate in a locale with the following annual climatic patterns using a climate graph, describe the vegetation that results from this climate pattern, and which part of the world you would be in. (4 marks):

	January	March	June	September	December
PET (mm/yr)	0	250	900	500	50
Precip	250	350	100	150	200



Students may shade in the space where precipitation is ABOVE the PET line. This is a time of the year when water availability is higher than water demand and water is increasingly saturated, so streams may be filling. This locale has a very hot, dry period in the summer, however. The summer is a northern hemisphere summer. It is sufficiently dry that is will be a low biomass environment, definitely not a forest.

STUDENT #: _____

More likely, a sparse prairie, like a short grass prairie. It could even be a desert. A guess for a place like this would be the southwestern USA. (4 marks)

4. A plant species found on an island occupies the following habitats: coastal sage scrub, inland forest, alpine forest. After the introduction of a second plant species, the first species occupies only coastal sage scrub habitat. The introduced species occupies inland forest and alpine forest. Explain these observations in detail. (4 marks)

*This is about competition and the species' fundamental and realized niches. The fundamental niche of the first plant encompasses each habitat. It can tolerate the conditions or use the resources present in those habitats in the absence of a better competitor (1 mark). The second plant is a superior competitor in thorn forest and tallgrass prairie (1 mark). This reduces the first plant's fundamental niche to a smaller, realized niche that only includes short grass prairie (1 mark). The other plant's fundamental niche also includes all habitats (this point is actually ambiguous), but is clearly a superior competitor in thorn forest and tall grass prairie. Its realized niche includes those last two habitats. (1 mark), (**4 marks total**)*

5. Consider a location 200 km north of Ottawa. Describe this location's ecozone, current vegetation, and dominant animal species. If substantial climate warming occurs, the location will begin to resemble the ecozone in which Ottawa is found. What ecozone will the location resemble in the future and how are its vegetation and animal species likely to differ in the future? Provide specific examples. (4 marks)

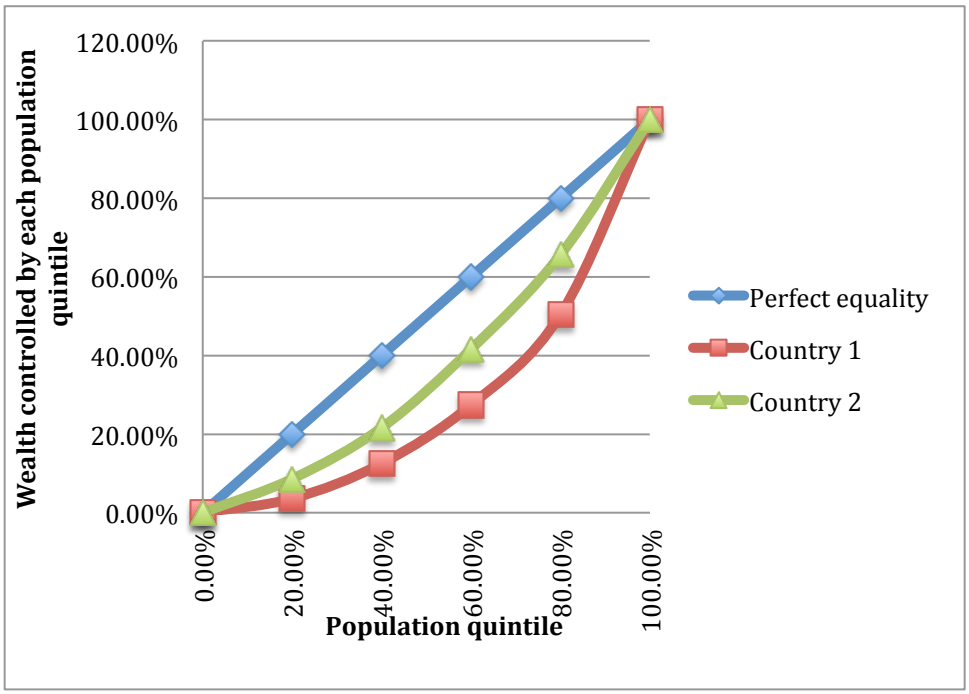
In central Quebec, the ecozone is the Boreal Shield (1 mark). Vegetation characteristics include coniferous forests, with species like black spruce and various pine trees. Substrates are frequently granite and soils are poorly drained and have low pH. Animal species include big herbivores like moose and a variety of carnivorous mammals, like wolves. Lots of migratory birds in summer (1 mark – don't need all this detail in this part of the answer, but students have to "get the idea" that it's boreal). After substantial warming, vegetation may more strongly resemble the Mixed Wood Plains (the ecozone that Ottawa is within, 1 mark). Vegetation of the Mixed Wood Plains includes mixed deciduous forests, like maple and beech trees, but also conifers such as hemlock. Animals include deer, but few large carnivores. Bird species examples like blue jays. (1 mark for getting the vegetation and animal species basically right).

6. Analyze the following data.

Cumulative population % (ranked poorest to wealthiest)	Cumulative % GNP controlled, COUNTRY 1	Cumulative % GNP controlled, COUNTRY 2
20%	3.6	8.5
40%	8.9	13
60%	14.9	20
80%	23	24
100%	49.6	34.5

STUDENT #: _____

Both countries in this dataset have equal per capita GNP. Given this information, describe how human population growth rates will likely differ between them, and explain in detail. Use fully labeled graphs to support your conclusion. (6 marks)



The data in the table show the equality of the distribution of wealth within two different countries, according to quintiles of the country's population (i.e. 20% segments of the population). The greater the deviation from the straight, 1:1 line, the less equal is the distribution of the country's wealth. Country 1 is less equitable than Country 2 ***(some basic description of the patterns, PLUS the graph or graphs = 4 marks)****. Because the distribution of wealth predicts birth rates in these countries, it is likely that human population growth rates will be LOWER in Country 2 and HIGHER in Country 1 (****1 mark****). The reason this occurs is that if most of the wealth of a country is concentrated in the hands of a few, then most of the country's population experiences a lower standard of living than the few wealthy members of the population. Their birth rates are then representative of areas that are poor, as a result. (****1 marks****)*

7. A biologist observes that an invertebrate species' population growth through several weeks. The population reproduces continuously with a growth rate of 4% per week during the period of observation.

a. If the starting population is 500 individuals, what will the population size be after 12 weeks? Show ALL calculations and formulae (4 marks).

$N(t) = N_{(0)} * lambda^t$ → For discrete population growth (this is the wrong equation to use in this question)
$N(t) = N_{(0)} * e^{rt}$ --> For continuous population growth – the right equation. ***(1 mark)***

STUDENT #: _____

The question asks for the population size after 12 weeks, in other words N(12).
So,
$N(12) = \text{Starting population size} \times e^{0.04 * 12}$
$N(12) = 500 \times 2.718^{0.04 * 12}$
*N(12) = 808 (**3 marks**)*
Some people may have calculated this out in long-form. That is, generation-by-generation over 12 generations in total, if they forgot to use the simple equation listed above. This can work but it is probably going to get the wrong answer because they will tend to use DISCRETE growth using that approach, not CONTINUOUS growth.
The results of discrete calculations will look like this:

*N(2) = 500*1.04 = 520*
*N(3) = 520*1.04 = 541, etc….*
*After 12 generations, with this kind of discrete growth, you only get 769 as the population size, which is the problem with using discrete growth in what is clearly labeled as CONTINUOUS population growth. If the students use this approach correctly, then give them **3 out of 4 marks**.*

b. After 12 weeks, the population growth rate per week begins to change, according to these data:

Week	Growth rate per week
13	2.50%
14	1.00%
15	0.5%
16	0%
17	0%
18	-45%
19	0%
20	0%

Describe, using a labeled graph, how growth has changed and fully explain the trend you have illustrated. What factors could have caused this change? (4 marks)

*There is more than one way to present the graph. The graph could show the population size through time from generation 1 in the previous part of the question. It could show a graph of just population growth rate through time from generation 1. It could do either of those graphs but starting from generation 13 (remember, this should have been labeled 15, not 13). The operative point is that the students have to get the big, sharp drop in population size (or massive negative population growth rate drop) at what is labeled as generation 18. **(2 marks)***

*The population appeared to rise toward some kind of characteristic size. This pattern resembles (or is actually) logistic population growth, although it began as exponential. The population growth rate, in other words, slowed as it reached K, carrying capacity. The population remained stable for a couple of generations than experienced a sharp drop of -45%, nearly half, then remained stable again. It is likely that this effect was some substantial environmental change that reduced the population in a density-independent way (i.e. kills the same proportion of the population regardless of the population density). **(2 marks)***