AP Biology - **Population Ecology Practice Problems**   Name: _____

<p style="text-align:center;">**From your AP Biology Exam Formula Sheet:**</p>

Rate and Growth

Rate

$$\frac{dY}{dt}$$

Population Growth

$$\frac{dN}{dt} = B - D$$

Exponential Growth

$$\frac{dN}{dt} = r_{max}N$$

Logistic Growth

$$\frac{dN}{dt} = r_{max}N\left(\frac{K-N}{K}\right)$$

dY = amount of change

dt = change in time

B = birth rate

D = death rate

N = population size

K = carrying capacity

r_{max} = maximum per capita growth rate of population

Simpson's Diversity Index

Diversity Index $= 1 - \Sigma\left(\frac{n}{N}\right)^2$

n = total number of organisms of a particular species

N = total number of organisms of all species

★ Remember though that **b = B/N**, **d = D/N**, and that, **r = b - d** **(which are not on the formula sheet)**

Answer these questions. *Show formulas used and show your calculation work in the space provided.*

1. If 3400 maple trees are counted on a 3km x 4km rectangular patch of land, what is the density of maple trees per square kilometer? Round to the nearest tenth.

2. Suppose the population density of a sample of deer is 50 per square kilometer. Assuming that the population is uniformly distributed what would the population size be if the deer encompassed an area that was 20km x 20km? Round to the nearest whole number.

3. There are 252 deer in a population. There is no net immigration or emigration. If 47 deer die and 32 deer are born in one month, what is the population size at the end of the month? Round to the nearest whole number.

4. In a population of 600 squirrels, the per capita birth rate in a particular period is 0.06 and the per capita death rate is 0.12.

    a. What is the per capita growth rate of the population? Round to the nearest hundredth.

    b. What is the actual number of squirrels that die during this particular period? Round to the nearest whole number.

    c. What is the actual number of squirrels that are born during this period? Round to the nearest whole number.

5. In a population of 600 squirrels, the per capita birth rate in a particular period is 0.06 and the per capita death rate is 0.12.

    a. What is the per capita growth rate of the population? Round to the nearest hundredth.

    b. What is the actual number of squirrels that die during this particular period? Round to the nearest whole number.

    c. What is the actual number of squirrels that are born during this period? Round to the nearest whole number.

6. In a population of 750 fish, 25 die on a particular day while 12 were born.

    a. What is the per capita death rate for the day? Round to the nearest thousandth.

    b. What is the per capita birth rate for the day? Round to the nearest thousandth.

    c. What is the per capita rate of increase for the day? Round to the nearest thousandth.

7. Suppose that of a cohort of 200 rats in a rat colony born in January, 160 are still alive at the start of March and 120 are still alive at the start of May.

    a. What is the survivorship up to the start of March? Round to the nearest hundredth.

    b. What is the mortality rate from the beginning of March to the beginning of May? Round to the nearest hundredth.

    c. If the survivorship during May is 0.3, how many rats died during the month of May? Round to the nearest whole number.

8. There are 190 grey tree frogs in a swamp. The population is under carrying capacity. If r = (-0.093) frogs/year, predict the population size next year. Round to the nearest whole number.

9. A population of 1492 Baltimore orioles was introduced to an area of Nerstrand Woods. Over the next year, the Orioles show a death rate of 0.395 while the population drops to 1134. What's the birth rate for this population? Round to the nearest hundredth.

10. There are 780 turkeys living in Merriam Township, which is 92 acres in size. The birth rate is 0.472 turkeys/year per capita. The death rate is 0.331 turkeys/year per capita.

    a. What is the population density? Round to the nearest tenth.

    b. What is dN/dt? Round to the nearest whole number.

c. Predict N after one year, assuming dN/dt stays constant. Round to the nearest whole number.

11. One dandelion plant can produce many seeds, leading to a high growth rate for dandelion populations. If a population of dandelions is currently 40 individuals and $r_{max} = 0.2$ dandelions/month per capita, how many dandelions would be in this population after 4 months. Round to the nearest whole number.

12. Imagine the dandelion population of 40 (in Question #11) cannot continue to grow exponentially due to lack of space. The carrying capacity for their patch of lawn is 70 dandelions. What is their dN/dt in this logistic growth situation? Round to the nearest tenth.

13. A hypothetical population has a carrying capacity of 1,500 individuals and r is 1.0. Fill out the following table. Round all answers to the nearest whole number and record your answers here (no grids provided).

Population Size	Show Work Here	Population Growth
1600		
1750		
2000		

Think: Why did the number of deaths (D) increasing as the population size grew to 2,000?

14. **Habitat fragmentation** is a process by which a large and contiguous habitat gets divided into smaller, isolated patches of habitats. The initiation of these smaller habitats has a direct impact on all of the species, their community structure, and the overall ecosystem of those fragments. Habitats can be fragmented because of numerous natural reasons. Out of them, volcanic eruptions, fire, and change in climate are the three major natural factors that lead to the onset of habitat fragmentation. Humans are also directly responsible for rapid and fast habitat fragmentation. Some of the ways in which humans trigger fragmentation include urbanization, rural development, claiming new agricultural lands, logging and cutting down forests, construction of roads and railway tracks, building water reservoirs etc.

Habitat fragmentation is not only responsible for change in the characteristics of a fragment but also causes extinction of many species. When a habitat faces fragmentation, it triggers the **edge effec**t in these smaller and isolated fragments. The edges of these fragments become less suitable for some or many of the species and organisms. The edges of a habitat are usually the least populated areas, and when that habitat divides into many fragments, they become challenging and competitive areas for their inhabitants. This phenomenon also affects territorial animals to the point of extinction, as their **territories** **shrink down**. With that, traveling through one fragment to another becomes dangerous as it involves having to cross roads, rail tracks, and even fences. Next, extensive fragmentation of a habitat means that its inhabitants will have **lesser resources**. Apart from that, the inhabitants will also have to deal with challenges like **increased competition** and a comparatively dangerous place to live in. The battle for survival speeds up as new species travel to the fragments. This results in **migration or extinction** of many species, which further affects the entire ecosystem of the fragment. While there are many downsides of habitat fragmentation, it has a few advantages too. First, it has the potential to increase diversity as it shapes speciation and evolution. Geographical and reproductive isolation triggered by fragmentation leads to allopatric speciation. Apart from that, it diversifies landscapes as well. All in all, habitat fragmentation has a few advantages to offer. However, its drawbacks far outweigh its benefits.

Watch https://youtu.be/WbrMFtblAT4. Let's assume this aquatic territory had undergone habitat fragmentation following a major earthquake that collapsed natural land bridges in the area, and was now composed of three isolated communities of aquatic life. As you see in the video, one community of 90 organisms had a Simpson Diversity Index of 0.638 while a second community of 100 organisms had a Simpson Diversity Index of 0.421. Data is now collected on the largest of the three habitat, the sample containing 700 organisms thought to accurately represent this community. The following table lists results of sampling data.

Species	# of individuals in Sample 3
Pacific Sea Star	85
Hermit Crab	305
Asian Green Mussel	180
Bat Star	130
Total Number	700

a. Calculate the Simpson Diversity Index for this third habitat. *Show how you plugged your numbers into the formula.*

b. Comparing the 3 fragmented habitats, which is considered the most fragile and the most stable?

c. **From the video**, why is a community with a high species diversity more resilient and stable?