Abiotic and Biotic Limiting Factors

Pre-Activity Reading and Check for Understanding

A population is a group of organisms of the same species that live in a certain area. Ecologists regularly monitor the number of organisms in many populations, but why do they do this? Why do we care if the number of organisms in an area is growing or shrinking? Well, populations that are growing and shrinking can be indicators of potential problems occurring in the organisms' environment, and gives ecologists a "heads up" if something is going wrong. But it is not enough to simply know if the number of organisms in an area is going up or going down; ecologists need to know *why* the number of organisms is fluctuating. So, one of the main questions ecologists ask themselves is this: Why is a population's size is going up or going down?

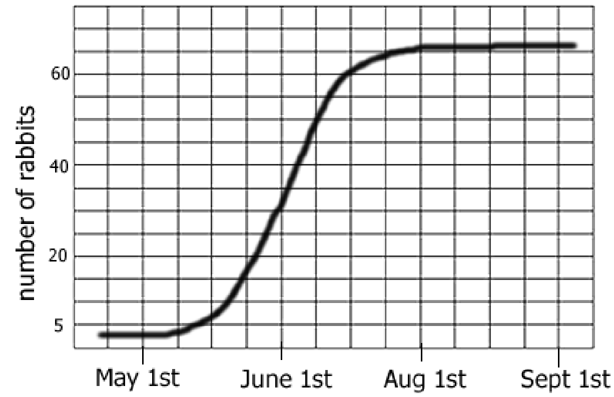
There are many factors that can cause a population's size to change. But first, you must understand the basic reasons behind why a population grows or shrinks. Any population, whether it be humans, chipmunks, the mold growing on bread, or the bacteria living in your intestines, will grow if more organisms are being created, or born, than are dying. If a population has more organisms dying than are being born, then the population will shrink. The number of births in a population is called the ***birth rate*** (also referred to as *natality*). The number of organisms that are dying in a population is called the ***death rate*** (also referred to as *mortality*). Thus, if the birth rate is greater than the death rate, a population will grow. If the death rate is greater than the birth rate, then the population will decrease in size.

While populations would probably like to continue to grow in size, a population of organisms cannot grow forever—its growth will be limited, or stopped, at some point, and the death rate will be greater than the birth rate. A population's growth is limited by two general factors: ***density-independent factors*** and ***density-dependent factors***. Why are these factors named in such a complicated way? Well, actually, these names aren't as complicated as they seem; in fact, they can even help you remember what each of the terms means.

To understand why scientists named these factors in the way they did, you must first understand the concept of ***population density***. A population's density is NOT whether or not the population will float or sink (they would probably sink. . .resulting in a lot of tragic, needless organism deaths). Population density refers to how many organisms there are in one particular spot. If a population's density is very high, that means there are a lot of organisms crowded into a certain area. If a population's density is low, that means there are very few organisms in an area.

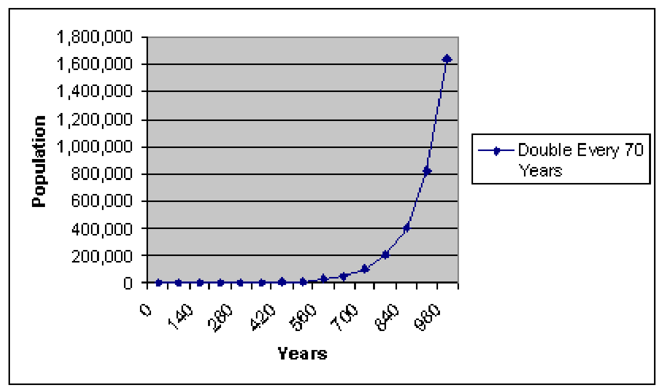
Now that you know about population density, we can talk about the difference between the two types of limiting factors. If a factor that stops a population's growth is influenced by the population's density, then it is called a density-dependent limiting factor. If the population's density does not influence whether or not the factor stops the population's growth, then it is called a density-independent limiting factor.
Density-independent limiting factors that can stop a population from growing can be such things as natural disasters, temperature, sunlight, and the activities of humans in the environment. *Natural disasters* such as tornadoes, floods, and fires will stop a population from growing no matter how many organisms are living in a certain area. The same goes for the *temperature* of an area and the amount of *sunlight* an area receives—if the temperature increases due to global warming, or if the ash kicked up into the atmosphere from an asteroid smashing into the earth blocks out a lot of sunlight for a few decades, these will both cause a decrease in a population's numbers, no matter how large or small the population was to begin with. *Human activities* that alter the environment will also decrease the amount of organisms in a population, no matter the size of the population.

Density-dependent limiting factors come into play when a population reaches a certain number of organisms. Thus the number of organisms in the population matters when talking about density-dependent limiting factors. For example, when a population reaches a certain size, there won't be enough *resources* (food, shelter, water) for all of the organisms. This could cause the population to stop growing when it reaches the maximum number of organisms that can be supported, or "carried," by the environment. This number is known as the population's ***carrying capacity***. Each population of organisms has a different carrying capacity, depending on the area in which it lives and the amount of resources available in that area. Below is a graph of a rabbit population that has reached its carrying capacity:



This type of population growth is called ***logistic population growth***; it represents what actually occurs as a population's numbers get too large for the environment to support it. While the number of rabbits in the population increased rapidly at first, its growth began to slow down towards the end of August. Once the population numbers leveled off, roughly equal numbers of rabbits were dying as being born.

Before a population reaches its carry capacity, it experiences a period of rapid growth. This period of growth is called ***exponential population growth***, because, mathematically, the population is adding organisms at an exponential rate. During this time period, there are plenty of resources available for all organisms, so more organisms are being born than are dying. The graph for exponential population growth looks sort of like the graph for logistic population growth, only without the flat "leveling off" line at the end of it:



The amount of resources is not the only limiting factor that depends on a population's density. *Diseases and parasites* can limit a population's growth once the population reaches a certain number of organisms. The more organisms there are, the faster a disease can spread or a parasite can be transferred to another organism because there are more available hosts that are near each other. *Competition* for resources—either between the same species or two different species—will also decrease a population's size. Resources are limited in any habitat, and, when populations reach a certain size, there will not be enough to go around. When two organisms in the same habitat are trying to use the same resource, they are competing for that resource. Whichever organism has the better adaptations to obtain that resource will be able to reproduce more often, and their population will grow. The organism that is not successful at competing for the resource will not reproduce as often, and their population will decrease.

Predation is another density-dependent limiting factor seen in populations. When lots of prey is available, predators will eat the prey, have energy to reproduce, and their numbers will increase. The population of their prey will begin to decrease as more and more of them are eaten. However, the predator population will eventually reach carrying capacity—there will not be enough prey for all of the predators in the population, since the predators themselves are competing for their "prey" resource. As the number of prey decreases, so will the number of predators, because there isn't enough food to go around. As the number of predators decreases, that means the prey have time to reproduce and increase their population.

One last density-dependent limiting factor that stops a population from growing is *emigration*. Emigration occurs when, as a population approaches carrying capacity, individual organisms from the population leave and go to a new area where they can find enough resources for survival and reproduction. This, obviously, will cause a decrease in the amount of organisms in a population. You may have heard of a word that has the exact opposite meaning and effect on population size—*immigration*.

Read each situation in the chart below. Then, state if it is a density-independent limiting factor or a density-dependent limiting factor. Then, state the specific limiting factor that is occurring. The first one is done for you as an example.

Situation	Density-independent, or density-dependent?	Limiting Factor:
Mrs. Engelbrecht has 32 students assigned to her Biology class, but she only has room for 28. Because the room is so crowded, the extra 4 students leave the room to go to Guidance and have their schedules changed.	density-dependent	emigration
Northern pike (it's a fish) feed on another fish, the yellow perch. An increase in the yellow perch population causes an increase in the northern pike population.		
The BP oil spill in the Gulf of Mexico has harmed many aquatic organisms that live in the Gulf region.		
A new strain of influenza (the flu) breaks out in New York City.		
A population of rabbits and a population of deer are both feeding off the same plants in the same habitat.		
Hurricane Katrina forced thousands of people to leave New Orleans.		
65 million years ago, a large asteroid collided with the Earth. As a result, large amounts of ash were ejected into Earth's atmosphere.		
Due to humans putting increasing amounts of greenhouse gases into the atmosphere and cutting down trees that would normally take up some of those gases, the Earth slowly gets warmer and changes climates around the globe.		