**7. Population Growth Models**

 Growth rate: of a population as the amount by which a population size changes in a given time. Population grows, shrinks, or remain the same size depends on four processes: birth, death, emigration and immigration. Immigration is the movement of individuals into a population, and emigration is the movement of individuals out of the population. Two of these processes – birth and immigration – add individuals to a population, while the other two processes – death and emigration – subtract individuals from the population.

Birth rate – death rate = growth rate

* **Population growth and the growth curves**

 The population is not static . Over each and every moment in the world, the population size differs. The growth is one of the dynamic features of the population size increase. When the number of the individuals of the species plotted on the y- axis and time on the x- axis a curve is obtained that indicates the trend in the growth of the population size in the given area. Therefore the obtained curve of the population through the time is known as the population curve.

**There are two types of the curve**

**1 .Exponential Growth (J-shaped growth curve)**

 If growth is J-shaped, the population grows exponentially, and after reaching the peak value, the population may suddenly fall apart. This population increase continues until a large amount of food is available in the habitat.

After some time, due to increase in population size, food supply in the habitat becomes limited which ultimately results in decrease in population size. For example, many insect populations show explosive increase in numbers during the rainy season, followed by their disappearance at the end of the season.

The equation for population growth can be Written

∆N ∕∆t = r max N

Where:

∆N = the change in number of individuals

∆t = the change in time

r = is the net reproductive rat = The difference between birth rate (b) and death rate (d).

b = the average of birth rate (includes immigrations)

d = the average of death rate (includes emigrations)

N = the initial population size

When condition are optimal , r is at its highest value (r max ), called the specific rate of increase

 Real population do not grow exponentially for long because of environmental limitations

This Environmental limitations include :

1. Food 2.Water 3. Space 4. Diseases 5. Oxygen 6. Diseases

**2.Logistic Growth (S- shaped growth curve).**

 In the S- shaped curve the initial growth is slow and is known as lag and then occurs the positive acceleration phase. This is followed by the rapid growth continuous up to certain point after which there is the steady decrease in the growth taken as negative form. The level beyond which no major increase can occur is referred to as saturation level or carrying capacity (K). In the last phase the new organisms are almost equal to the number of dying individuals and thus there is no more increase in population size.

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Sigmoid growth curve is formed of five phases.

a) Lag phase

b) Positive acceleration phase

c) Logarithmic or exponential phase

d) Negative acceleration phase

e) Stationary phase.

1. Lag phase - Period where individuals adapt to the new environment.
2. Positive acceleration phase - Period of slow increase in the population
3. Logarithmic or exponential phase - Period of rapid rise in population due to availability of food and requirements in plenty and no competition.
4. Negative acceleration phase - Period in which these is a slow rise in population as the environmental resistance increases.
5. Stationary phase - Finally, growth rate becomes stable because mortality and natality rates become equal.

**Carrying Capacity K** , is the maximum number of individuals that the environment can support. The logistic growth equation is :

 ∆N ∕∆t = r max N(K- N ∕ K)

Where:

r max = Maximum rate of increase under ideal conditions.

When N nears K ,the right side of the equation nears zero.

N ∕ K = Environmental resistance



**Reproductive Strategies**

According to growth models there are two kinds of reproductive strategies

**1- r-strategist**

 These species tend to be opportunistic and they reproduce rapidly under the favorable condition, even in the disturbed environment but the competition among the opportunists makes more or less unfavourable condition. To survive opportunists must continually invade new areas to compensate for being displaced by the more competitive species. E.g algae, bacteria, rodents, annual plants and most of the insects

Species that follow this pattern usually.

 1. Short life

 2. Rapid growth

 3. Early maturity

 4. Many , small offspring

 5. Little parental care and protection

 6. Adapted to unstable environment

 7. Low trophic level

**2- *K- strategist***

 They are called *k- selected* ( for carrying capacity ), because they are adapted to thrive when the population is near its carrying capacity . Examples are:

Most large mammals such as elephant, human etc.

Birds, prey animal etc.

Species that follow this pattern usually.

1. Long life
2. Slower growth
3. Later maturity
4. few , large offspring
5. High parental care and protection
6. Adapted to stable environment
7. High trophic level
8.

Any factor weather limiting or favorable ملائم (negative or positive) to population is:

1. **density- independent**: if the effect or action is independent of the size of the population. **(Density- Independent factors: factors that strongly affect the growth of the group regardless of the density of life. A tornado may perish or cold snap 95% of the group life**)
2. **density- dependent:** A limiting factor that depends on population size is called a density-dependent limiting factor.

 Density-dependent factors operate only when the population density reaches a certain level. These factors operate most strongly when a population is large and dense.

They do not affect small, scattered populations as greatly

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**Climatic factors often act in a density— independent manner, whereas biotic factors (completion , parasites , pathogens and so forth ) often act in a density —dependent manner.**

**SPECIES INTERACTIONS**

**1. How are ecological interactions classified?**

 Ecological interactions are classified as intraspecific or interspecific interactions and as harmonious or inharmonious interactions.

**2. What are intraspecific and interspecific ecological interactions?**

* Intraspecific ecological interactions are those between individuals of the same species.
* Interspecific ecological interactions are ecological interactions between individuals of different species.

**3. What is an inharmonious ecological interaction?**

An inharmonious, or negative, ecological interaction is when at least one of the participating organisms is harmed..

**4. What is harmonious ecological interaction?**

An harmonious, or positive, ecological interaction is when none of the participating organisms is harmed

**Negative inharmonious interactions may be considered as follows** :

**1- PREDATION ( \_ )**

 Predation is a powerful force in a community. in predation, one individual, the predator, captures, kills, and consumes another individual. Predation is also an effective regulator of population size.

**Predators, Prey, and Natural Selection**

**2- Parasitism(-)**

**Parasitism** is a species interaction that resembles predation in that one individual is harmed while the other individual benefits. In par­asitism, one individual, known as the **parasite,** feeds on another individual, known as the **host.** But while most forms of predation immediately remove an individual of the prey species from the population, parasitism usually does not result in the immediate death of the host. Often, the parasite feeds on the host for a long time instead of killing it.

Parasites can be grouped into two general categories, based on how they interact with their host. **Ectoparasites** are external parasites; they live on their host but do not enter the host's body. Examples of ectoparasites are ticks, fleas, mosquitoes. **Endoparasites**  are internal parasites, and they live inside the host's body. such as malaria parasites, and tapeworms.

**3- COMPETITION (** - )

 Competition is the ecological interaction in which individuals explore the same ecological niche or their ecological niches partially coincide and, therefore, competition for the same environmental resources takes place.

Competition is harmful for all participating organisms and is therefore classified as an inharmonious (negative) ecological interaction. Some species of plants release toxins into the soil that prevent individuals of other species from growing nearby, restricting the living space of the other Species.

Examples of interspecific competition are: the competition between snakes and eagles for rodents. Some species of plants release toxins into the soil that prevent individuals of other species from growing nearby, restricting the living space of the other Species. More often. One organism will be able

**4-Ammensalism**

Ammensalism is the ecological interaction in which an individual harms another without obtaining benefit. Ammensalism is an inharmonious (negative) ecological interaction since one participant is harmed.

(Sometimes it is wrongly said that ammensalism is a form of ecological interaction in which an organism releases substances that harm another species in the environment; this situation is indeed an example of ammensalim but the concept is not restricted to it.)

One of the best examples of ammensalism is between humans and other species under threat of extinction due to human actions such as habitat devastation by fires, ecological accidents, leisure hunting, etc. Another example is the red tide, a proliferation of algae that can lead to death by intoxication of fish and other animals.

**Positive interactions may be considered as follows** :

 **(Mutualism , Commensalism and Protocooperation )**

**1-Mutualism**

 Mutualism is the ecological interaction in which both participants benefit and which is obligatory for their survival. Mutualism is a harmonious (positive) ecological interaction. The bacteria and the human. A certain kind of bacteria lives in the intestines of humans and many other animals. The human cannot digest all of the food that it eats. examples of mutualistic relationships The bacteria eat the food that the human cannot digest and partially digest it, allowing the human to finish the job. The bacteria benefit by getting food, and the human benefits by being able to digest the food it eats.

2- **Commensalism**

 Commensalism is the ecological interaction in which one individual benefits while the other is neither benefits nor is harmed. Commensalism is a harmonious (positive) ecological interaction, since none of the participants is harmed. An

is the ecological interaction in which one individual benefits while the other is neither benefits nor is harmed. Commensalism is a harmonious (positive) ecological interaction, since none of the participants is harmed. An

 is the ecological interaction in which one individual benefits while the other is neither benefits nor is harmed. Commensalism is a harmonious (positive) ecological interaction, since none of the participants is harmed. An example of commensalism is the numerous bacteria that live on the skin and in the digestive tract of humans without being pathogenic or beneficial. They are innocuous bacteria living in commensalism with humans

**3-protocooperation**

 Protocooperation is the ecological interaction in which both participants benefit but which is not obligatory for their survival. Protocooperation is a harmonious (positive) interspecific ecological interaction. Examples of protocooperation are: the removal of ectoparasites from the back of bovines by some birds that eat the parasites; and the hermit crab, which live inside shells on top of which sea anemones live (these offer protection to the crab and gain mobility to obtain food).