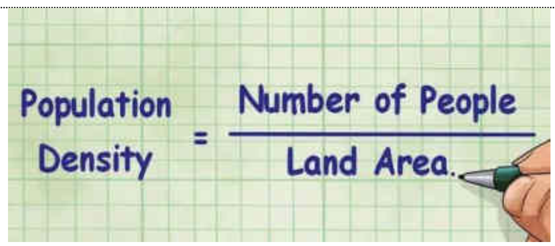
CLASS NOTES

Class: XII	Topic: ECOLOGY (ORGANISM AND POPULATION)
Subject: BIOLOGY	

Population Density

- Number of individuals of a species per unit area.
- Designated as 'N'.
- Calculation of Population density:
  - ✓ For Fish– the number of fish caught per trap.
  - ✓ For Tiger– based on the pug marks and faecal pellets.



Population Growth

- The size of a population which keeps on changing depends on various factors:
  - ✓ Food availability
  - ✓ Predation pressure
  - ✓ Weather condition over a period of time
- Fluctuation in the population density is due to changes in four basic processes
  - ✓ **Natality**: Number of births during a given period in the population that are added to the initial population density.

- ✓ **Mortality**: Number of deaths in the population during a given time period.
- ✓ **Immigration**: Number of individuals of the same species that have come into the habitat from elsewhere during a specific time period.
- ✓ **Emigration**: Number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.

- Representing Population Density

$$N_{t+1} = N_t + [(B+I) - (D+E)]$$

N_t = Population density at time t

N_{t+1} = Population density at time t+1

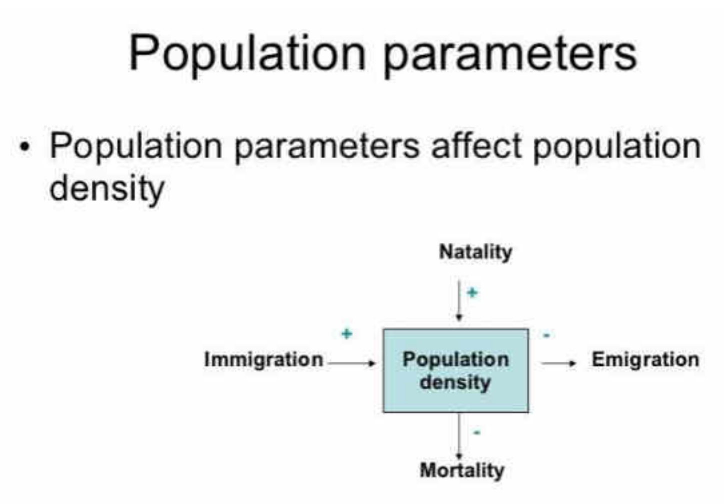
B = Birth rate

I = Immigration

D = Death rate

E = Emmigration

- Population density will increase if the number of births plus the number of immigrants (B + I) is more than the number of deaths plus the number of emigrants (D + E), otherwise, it will decrease.



Population Growth Models

- The growth models can be used to predict the growth of a population with time.
- There are two growth models:
  - ✓ Exponential growth
  - ✓ Logistic Growth

Exponential growth

- Seen in habitat with an unlimited resource (food and space) for the individuals.
- Each species has the ability to realize fully its innate potential to grow in number.
- Equation for exponential growth:

$$dN/dt = (b - d) \times N$$

Let (b–d) = r, then

$$dN/dt = rN$$

N= Population size

b = Birth rate

d = Death rate

r = intrinsic rate of natural increase

- When N in relation to time is plotted in graph, it results in a J-shaped curve.
- It can also be represented as

$$N_t = N_0 e^{rt}$$

N_t = Population density after time t

N_0 = Population density at time zero

r = intrinsic rate of natural increase

e = the base of natural logarithms (2.71828)

Logistic growth

- None of the population have unlimited resources at their disposal to support the exponential growth.
- Populations with limited resources leads to competition among individuals for the resources.
- Eventually, the 'fittest' individual will survive and reproduce.
- **Carrying capacity (K):** It states that a given habitat has enough resources to support a maximum possible number, beyond which no further growth is possible.
- A population growing in a habitat with limited resources exhibit initially a lag phase, followed by phases of acceleration and deceleration finally an asymptote when the population density reaches K.
- A plot of N in relation to time (t) results in a sigmoid curve and is also called as Verhulst-Pearl Logistic Growth.
- The logistic growth can be represented by the following equation:

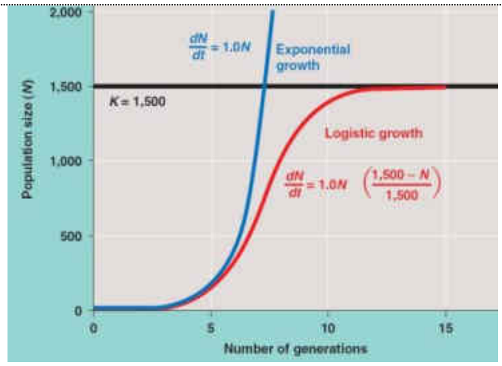
  $$dN/dt = rN\,[(K-N)/K]$$

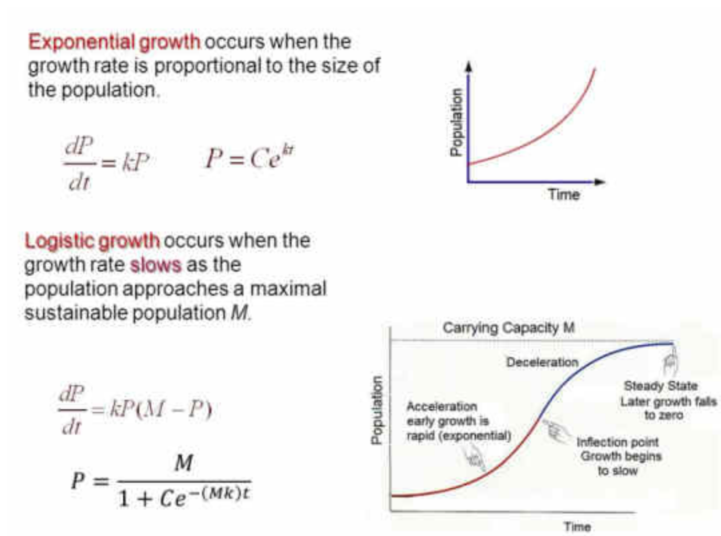
  N = Population density at time t

  r = Intrinsic rate of natural increase

  K = Carrying capacity

- Since resources for growth for most animal populations are finite and become limiting sooner or later, the logistic growth model is considered a more realistic one.





Life History Variation

- Populations have evolved to maximise their reproductive fitness, also called
  Darwinian fitness (high r-value), in the habitat in which they live.
- Some organisms breed only once in their lifetime (Pacific salmon fish, bamboo).
- Some others breed many times during their lifetime (most birds and mammals).
- Some produce a large number of small-sized offspring (Oysters,
  pelagic fishes).

- Some others produce a small number of large-sized offspring (birds, mammals).
- Ecologists suggest that life history traits of organisms have evolved in relation to the constraints imposed by the abiotic and biotic components of the habitat in which they live.

Population Interactions

- In nature, animals, plants, and microbes do not and cannot live in isolation but interact in various ways to form a biological community.
- Interspecific interactions are the interaction of populations of two different species.
- These interactions may be:
  - ✓ Beneficial (represented by + sign)
  - ✓ Detrimental (represented by – sign)
  - ✓ Neutral (represented by 0 sign)

Sl. No.		Interaction	Species A	Species B
Positive Interaction	1	Mutualism	+	+
	2	Commensalism	+	0
	3	Proto-cooperation	+	+
Positive Interaction	4	Ammensalism	0	-
	5	Parasitism	+	-
	6	Predation	+	-
	7	Cannibalism	+	-
	8	Competitions	-	-

Analysis of two-species population interactions

Type of interaction	*Species 1*	*Species 2*	*General nature of interaction*
Neutralism	0	0	Neither population affects the other
Competition, direct interference type	−	−	Direct inhibition of each species by the other
Competition, resource use type	−	−	Indirect inhibition when common resource is in short supply
Amensalism	−	0	Population 1 inhibited, 2 not affected
Commensalism	+	0	Population 1, the *commensal,* benefits, while 2, the *host,* is not affected
Parasitism	+	−	Population 1, the *parasite,* generally smaller than 2, the *host*
Predation (including herbivory)	+	−	Population 1, the *predator,* generally larger than 2, the *prey*
Protocooperation	+	+	Interaction favorable to both but not obligatory
Mutualism	+	+	Interaction favorable to both and obligatory

Note: 0 indicates no significant interaction; + indicates growth, survival, or other population attribute benefited (positive term added to growth equation); − indicates population growth or other attribute inhibited (negative term added to growth equation).

Note: This content has been prepared from home.
(All images- Courtesy Google)