Population Ecology

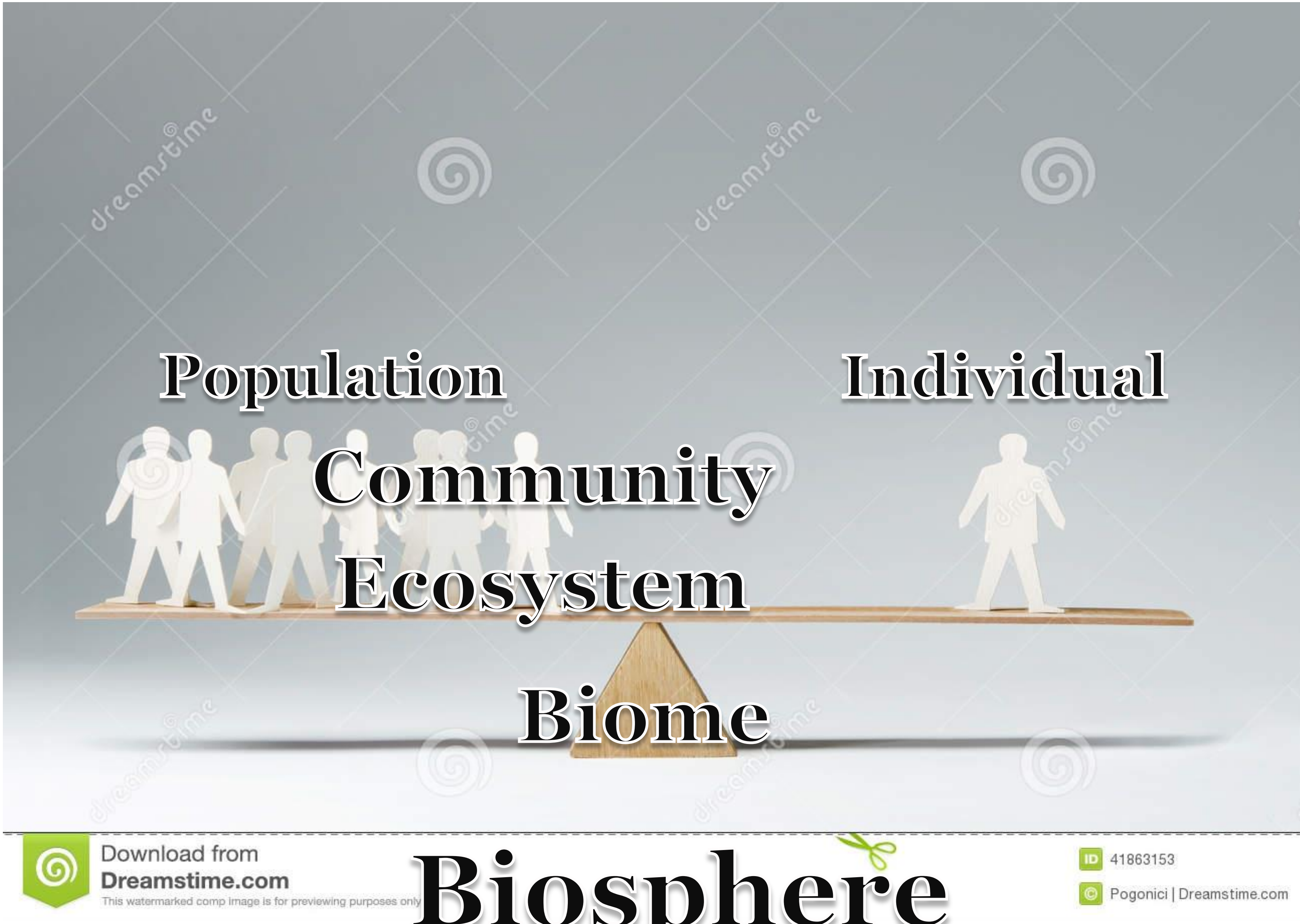
ANISH BHATTACHARYA
ASSISTANT PROFESSOR
DURGAPUR GOVERNMENT COLLEGE

Are you alone or do you feel lonely?

Does it feel OKAY to be alone ?

NO !! **.....atleast Biologically !!!**


???
alamy
Image ID: KAKEX5
www.alamy.com



Population

Individual

Community

Ecosystem

Biome

Biosphere


Biosphere
Biome
Ecosystem
Community
Population
Individual

Features of Population

Density – **the number of individuals per unit area**

Abundance – **A percentage of the total number of species present in community**

Frequency – **Frequency is the number of times a plant species occurs in a given number of quadrats**

$$\text{Relative Dominance (RDo)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Relative Density (RD)} = \frac{\text{Number of individuals of the species}}{\text{Number of occurrence of all the species}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of a species}}{\text{Frequency of all species}} \times 100$$

$$\%\text{Frequency} = \frac{\text{Number of quadrats in which thespecies occurred}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Number of quadrats in which species occurred}}{\text{Total number of quadrats occupied by all species}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals of species}}{\text{Total number of quadrats used in sampling}}$$

$$\text{Relative Density} = \frac{\text{Total number of individuals of species}}{\text{Sum of all individuals of all species}}$$

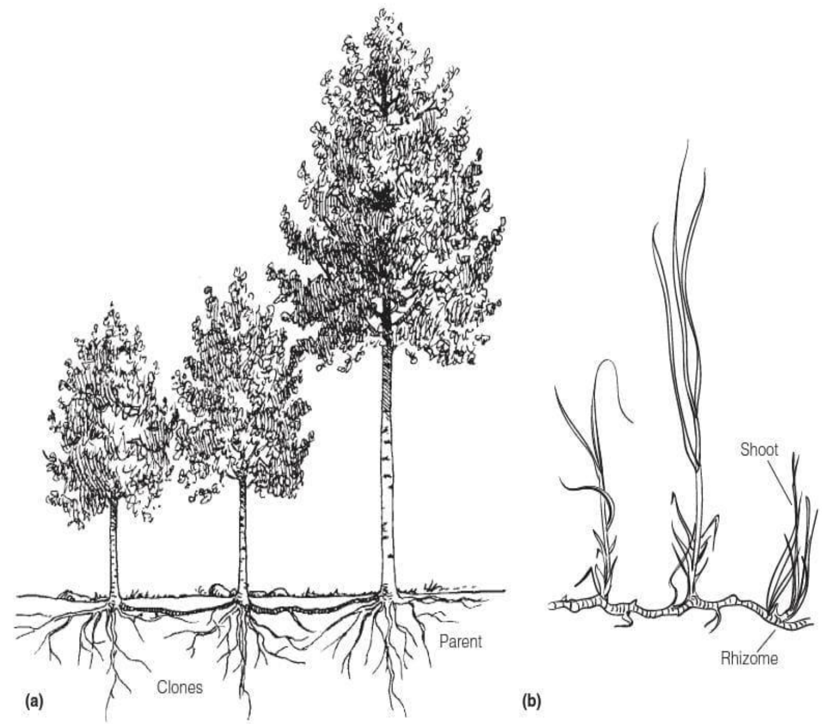
$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Number of quadrats in which they occurred}}$$

Important value = Relative frequency (RF) + Relative Density (RD)

Features of Population

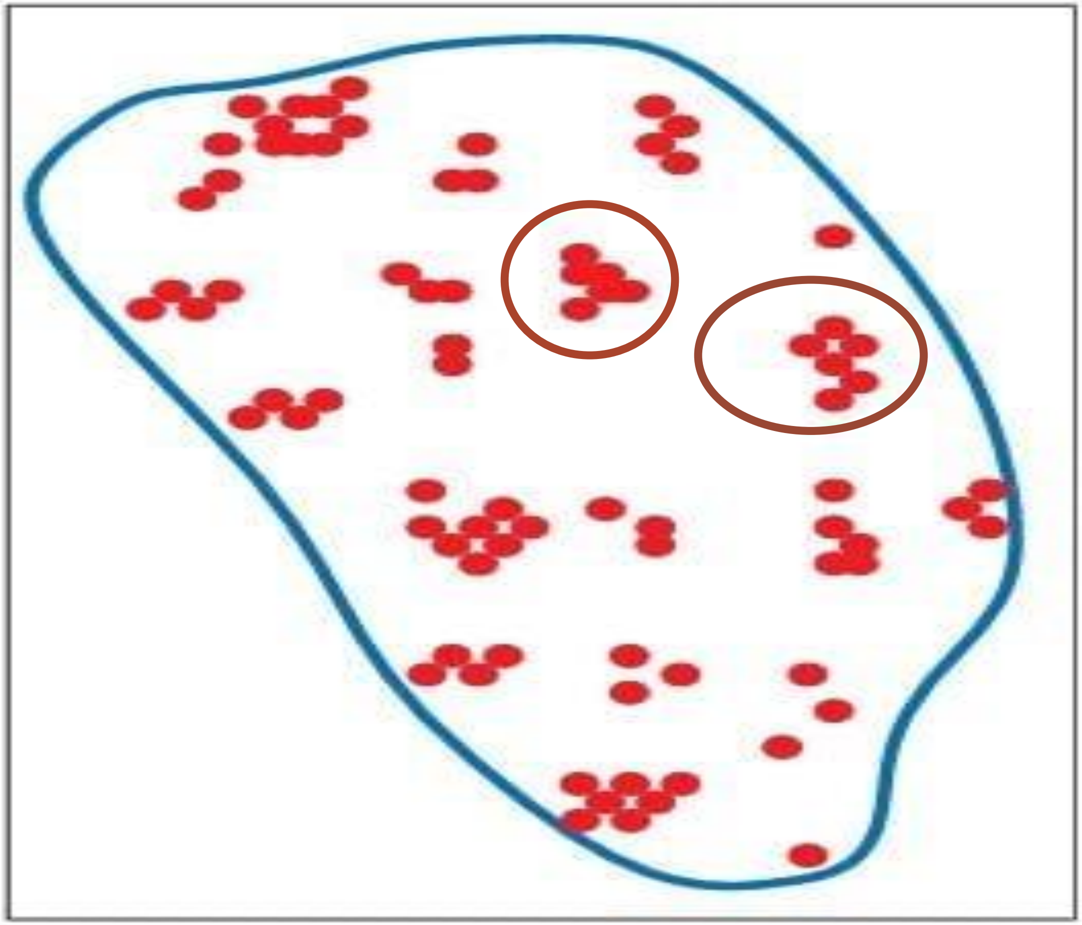
- Population Density and Size
- Dispersion
- Age Structure
- Natality (Birth rate)
- Mortality (Death rate)
- Life tables

Population Density & Size



Unitary **Modular**

Size ? = Distribution

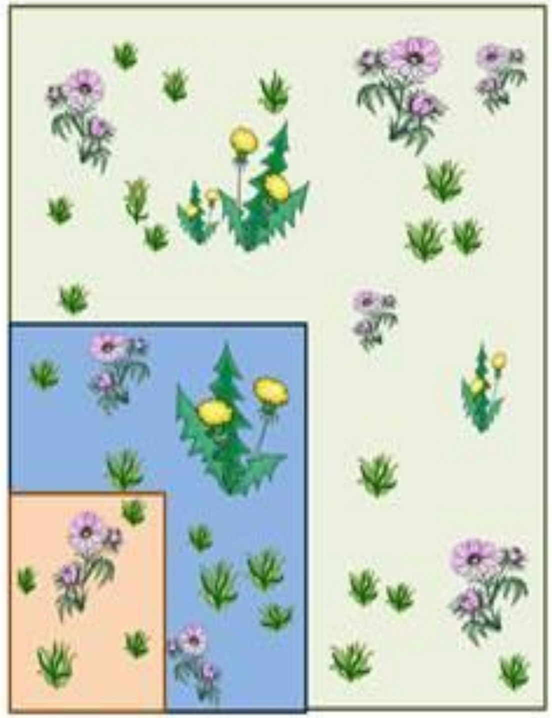


How to measure ??

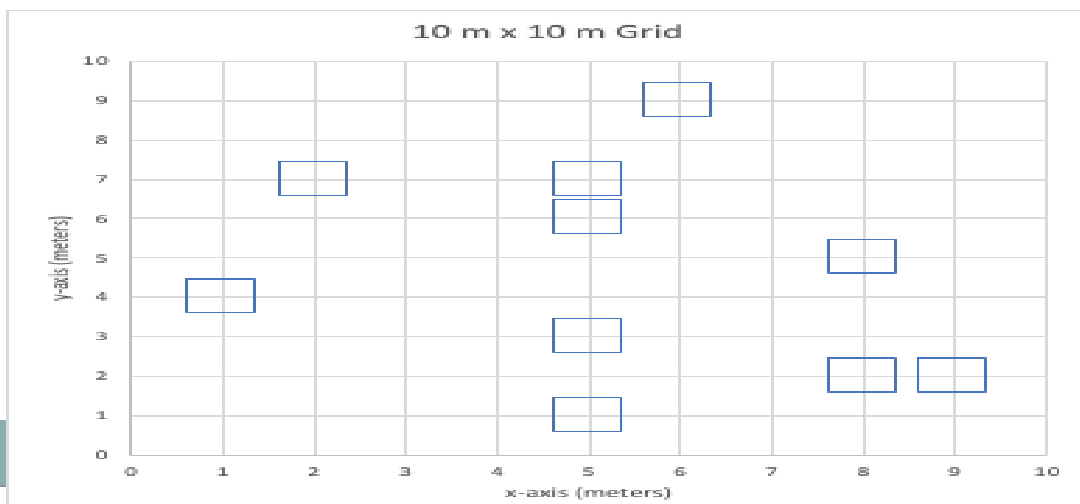
Crude or Ecological Density ??

Quadrat Method
Or
Mark Recapture Method
Or
Biomass Method

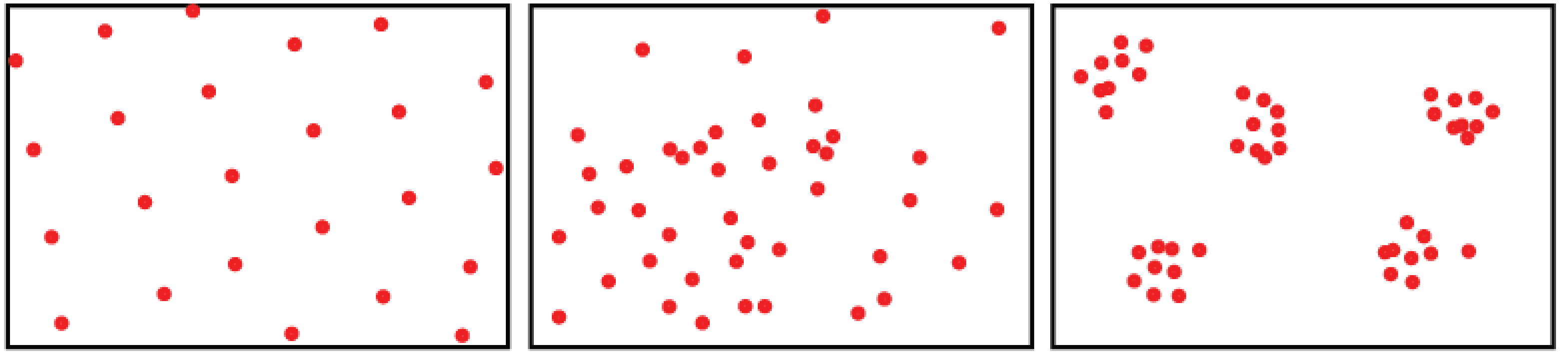
Quadrat Method



Plant Species	Small quadrat	Medium quadrat	Large quadrat
Yellow dandelion	0	1	4
Pink flower	1	3	8
Grass	4	10	25



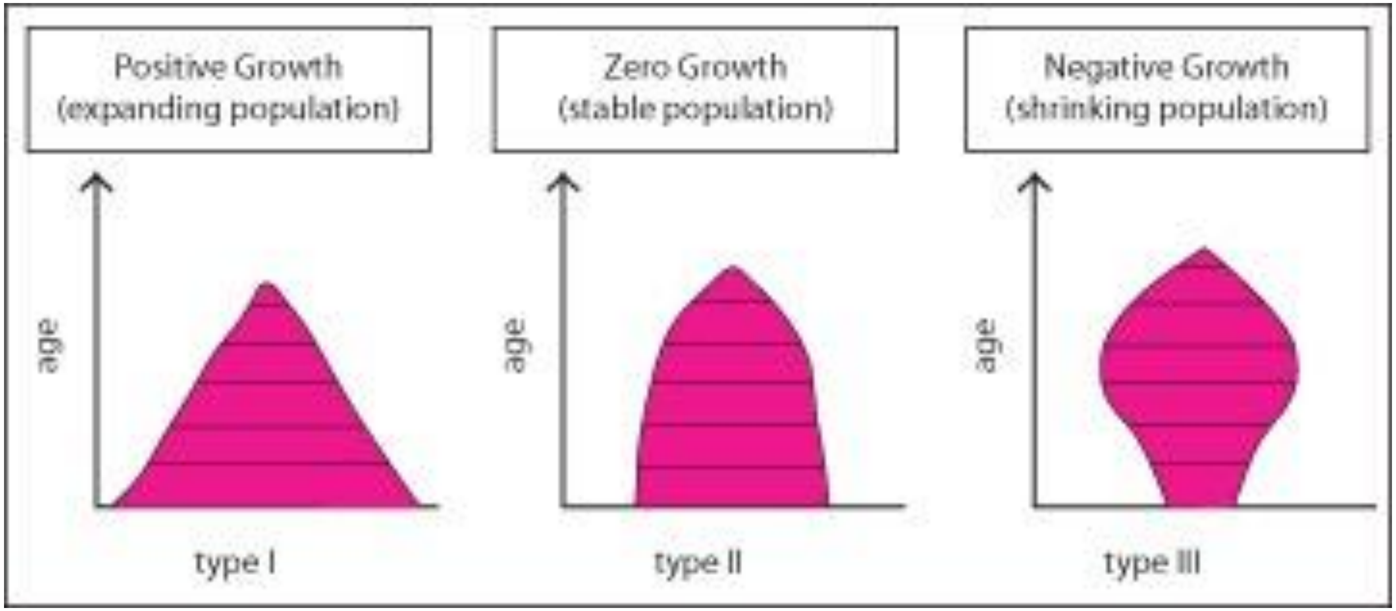
Dispersion



Uniform dispersion | Random dispersion | Clumped dispersion

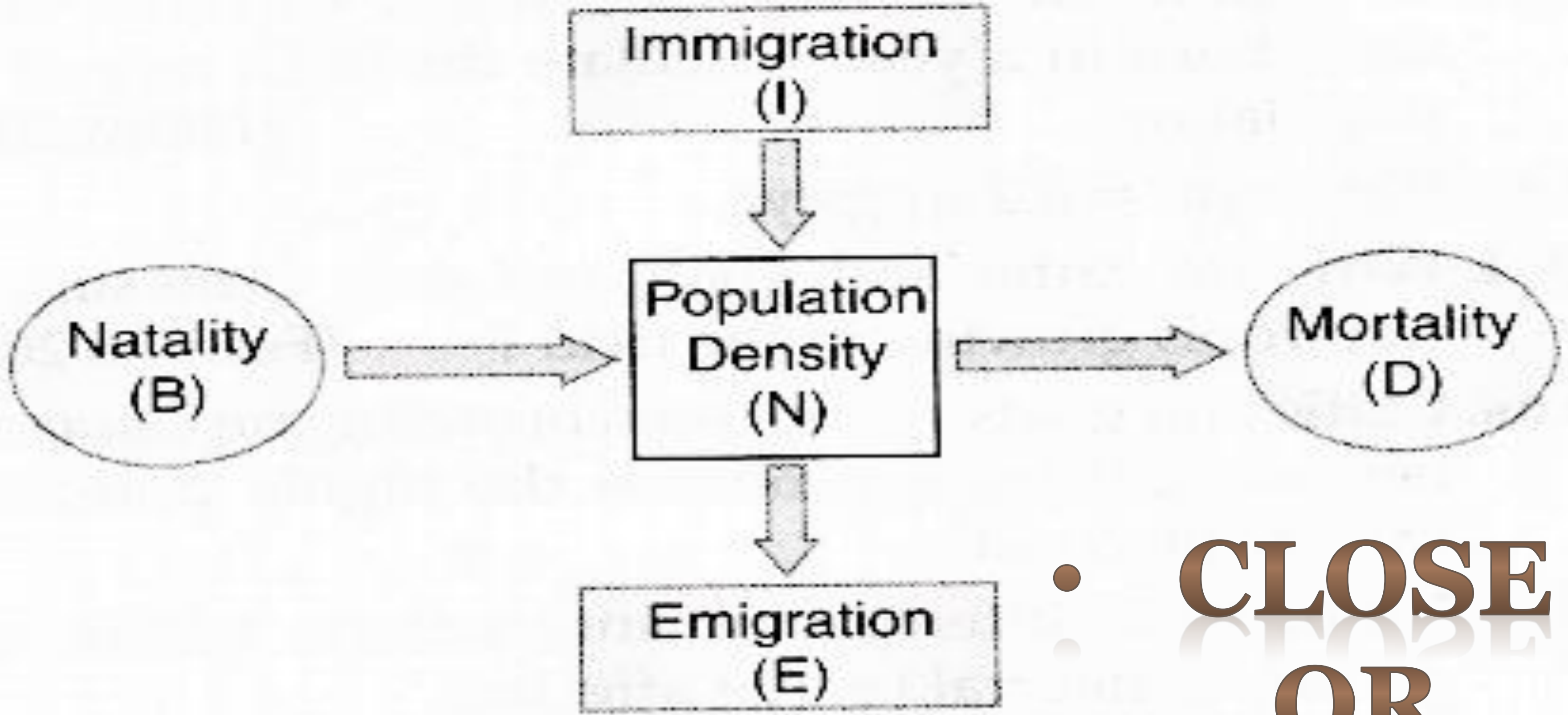
?

Age structure



- PRE-REPRODUCTIVE
- REPRODUCTIVE
- POST REPRODUCTIVE

Natality , Motality and Growth



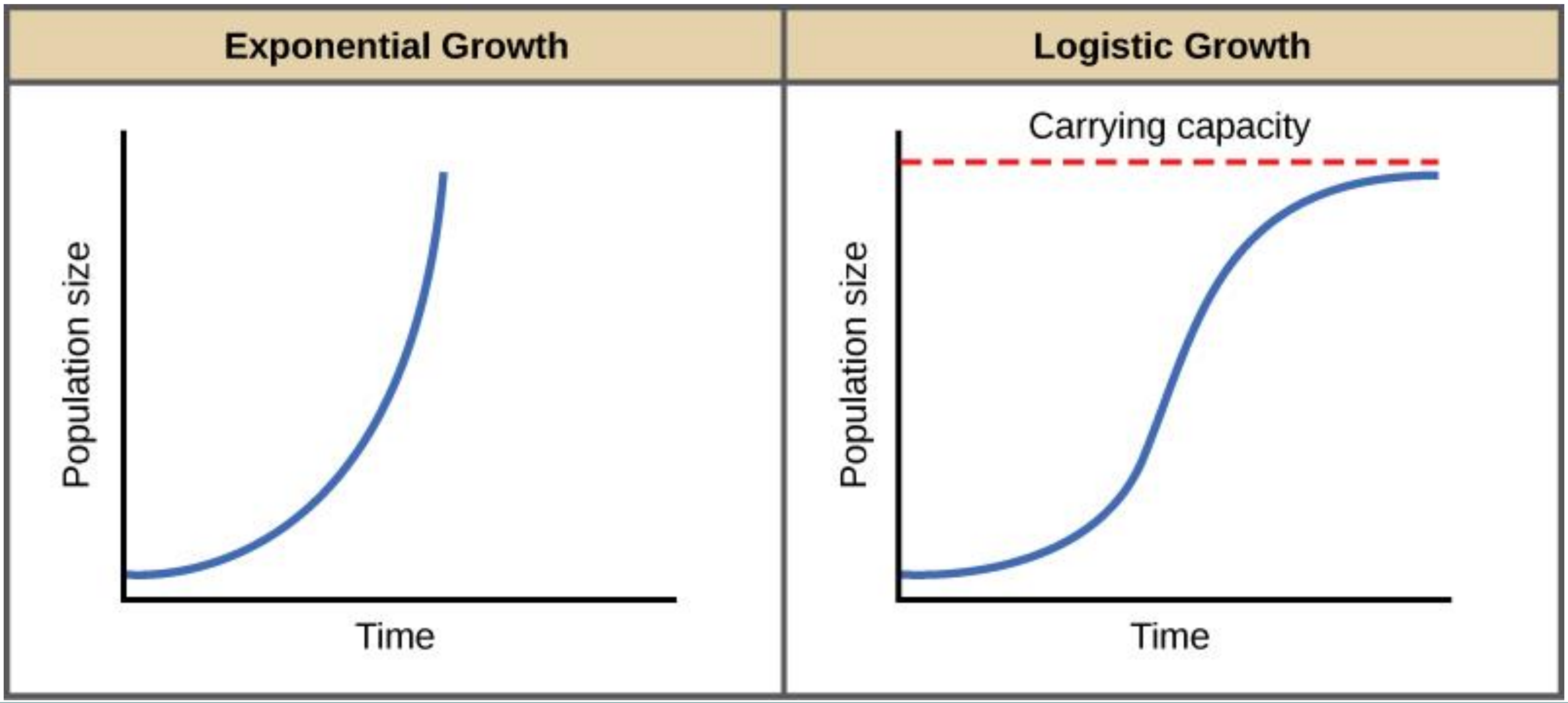
- CLOSE
  OR
- OPEN
  SYSTEM?

Exponential Growth

$$\frac{dN}{dt} = rN$$

Logistic Growth

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



Exponential Growth

$$\frac{dN}{dt} = rN$$

defined period of synchronized birth or death), we can define the proportion of hydra producing a new individual per unit of time as b, and the proportion of hydra dying per unit of time can be d. If we start with $N(t)$ hydra at time t, then to calculate the total number of hydra reproducing over a given time period, Δt (the symbol Δ refers to a "change" in the associated variable; in this case, a change in time or time interval), we simply need to multiply the proportion reproducing per unit time by the total number of hydra and the length of the time period: $bN(t)\Delta t$. Because each reproducing hydra will add only one individual to the total population (see Figure 9.1), the number of births is $B(t) = bN(t)\Delta t$. Note that B and N are functions of time (because they change as time goes along), but the per capita birthrate b is a constant. For this reason, we write $B(t)$ and $N(t)$, but simply b. The number of deaths, $D(t)$, is calculated in a similar manner, so that $D(t) = dN(t)\Delta t$.

The population size at the next time period $(t + \Delta t)$ normal would then be

$$N(t + \Delta t) = N(t) + B(t) - D(t)$$

or

$$N(t + \Delta t) = N(t) + bN(t)\Delta t - dN(t)\Delta t$$

The resulting pattern of population size as a function of time is shown in Figure 9.2.

We can define the change in population over the time interval (Δt) by rearranging the equation just presented. First, we move $N(t)$ to the left-hand side of the equation, and then divide both sides by Δt:

$$\frac{N(t + \Delta t) - N(t)}{\Delta t} = bN(t) - dN(t)$$
$$= (b - d)\,N(t)$$

If we substitute ΔN for $[N(t + \Delta t) - N(t)]$, we can rewrite the equation as

$$\frac{\Delta N}{\Delta t} = (b - d)N(t)$$

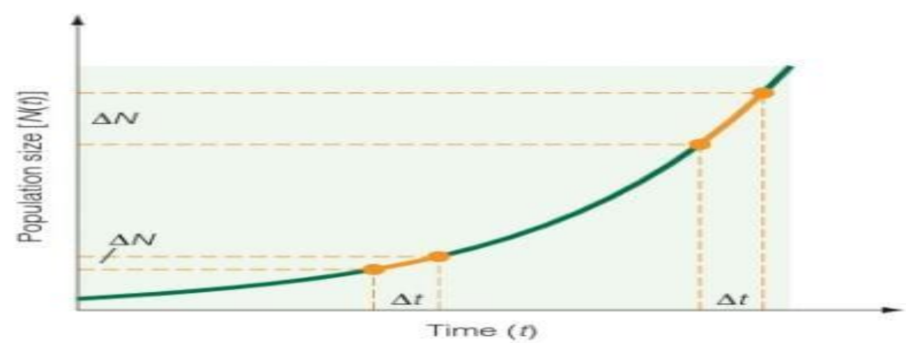


Figure 9.2 Change in the size of a hypothetical population of hydra through time (green line). The change in population size, ΔN, for a given time interval, Δt, differs as a function of time (t), as indicated by the slope of the line segments shown in orange.

Logistic Growth

We can derive the logistic population growth by beginning with the equation that allows the rates of birth (b) and death (d) to vary as a function of population size, as outlined in Section 11.1:

$$\frac{dN}{dt} = (b - d)N$$

Because $b = b_0 - aN$ and $d = d_0 + cN$, we rewrite the equation as follows:

$$\frac{dN}{dt} = [(b_0 - aN) - (d_0 + cN)]N$$

After rearranging the terms (see p. 203), we have

$$\frac{dN}{dt} = [(b_0 - d_0) - (a + c)N]N$$

Next, we multiply by $(b_0 - d_0)/(b_0 - d_0)$. This term is equal to 1.0, so it only simplifies the equation further:

$$\frac{dN}{dt} = \frac{(b_0 - d_0)}{(b_0 - d_0)}[(b_0 - d_0) - (a + c)N]N$$

$$\frac{dN}{dt} = [(b_0 - d_0)]\left[\frac{(b_0 - d_0)}{(b_0 - d_0)} - \frac{(a + c)}{(b_0 - d_0)}N\right]N$$

Because we have defined $r = (b_0 - d_0)$ in Section 11.1, we have:

$$\frac{dN}{dt} = rN\left[1 - \frac{(a + c)}{(b_0 - d_0)}N\right]$$

Note that $(a + b)/(b_0 - d_0) = 1/K$, as shown on page 205.

Making the appropriate substitution, we have:

$$\frac{dN}{dt} = rN\left[1 - N\left(\frac{1}{K}\right)\right]$$

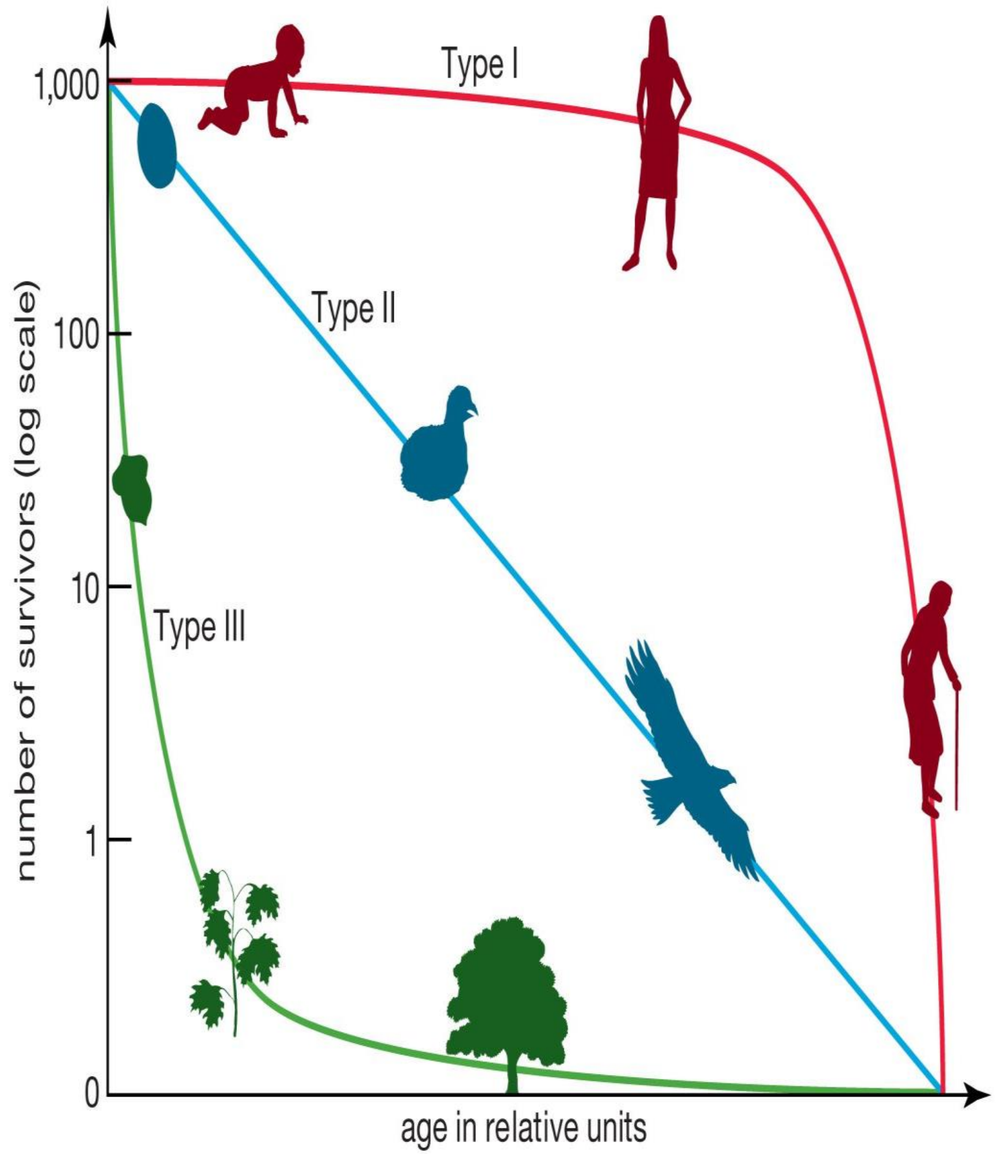
$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

This is the equation for the logistic model of population growth.

1. The equation is sometimes presented in an alternative but equivalent form: $dN/dt = rN[(K-N)/K]$. Show algebraically how this equation is equivalent to the one presented above.

Table 10.1 Characteristics of *r*- and *K*-selected species.

Life history feature	*r*-selected species	*K*-selected species
Intrinsic Rate of Increase, r_{max}	High	Low
Development	Rapid	Slow
Reproductive rate	High	Low
Reproductive age	Early	Late
Body size	Small	Large
Length of life	Short	Long
Competitive ability	Weak	Strong
Survivorship	High mortality of young (Type III)	Low mortality of young (Type I)
Population size	Variable	Fairly constant
Dispersal ability	Good	Poor
Habitat type	Disturbed	Not disturbed
Example	Weedy plants, small fish, insects, bacteria	Canopy trees, large mammals, some parrots, large turtles



Lets hunt for IDEAS In the Field !!