Population growth :………………….…………………………………. Lecture 8

All organisms have **a reproductive potential** , which is almost considerably greater than that actually achieved . As examples , a single female insect or fish may lay hundreds or thousands of eggs at a time , one pair of house mice could produce over 3000 individuals in one year .Many animals do not have this great reproductive potential , but still have a relatively higher reproductive potential than the actual one . For example , some of the largest mammals with long life spans , such as elephants and whales as well as the human female . The human female can give birth to about 1 young every 12 to 15 months , or a total of 20 to 25 in the course of her lifetime . This still means a reproductive potential 8 to 10 times greater than the average family size in most countries . The great reproductive potential of most plants and animals gives them a capacity for rapid population growth in favorable habitats .

Patterns of population growth:

1 . Malthusian growth:

In 1798 , Thomas Malthus , an English economist noted the tendency of human populations to increase faster than their means of subsistence and food supplies . In general , he noted that populations tended to increase geometrically (2….4….8 ….16 ….32 ….) or exponentially (2 …4 ….16 ….256 ….65386 …..) , whereas their means of subsistence and food supplies tended to increase only arithmetically (2 ….4 …. 6 …..8 …..10 …) . **Thus , he thought that human populations constantly tended to exceed their food supplies , and then declined by poverty , starvation , disease , warfare or other catastrophes .** Malthus was primarily concerned with human populations , and he thought that moral limit was the only solution to human population pressures . **The concepts of Malthus produced a storm of protest , of course , from both the church and the scientific institutes , and finally were considered nothing than history .**

The ideas of Malthus illustrated arithmetically , by the equation and the curve below (Fig . 14) . The curve shows an exponential increase in the early stages of population growth , but the upper limits of population growth would be characterized by sudden, often drastic mortality .

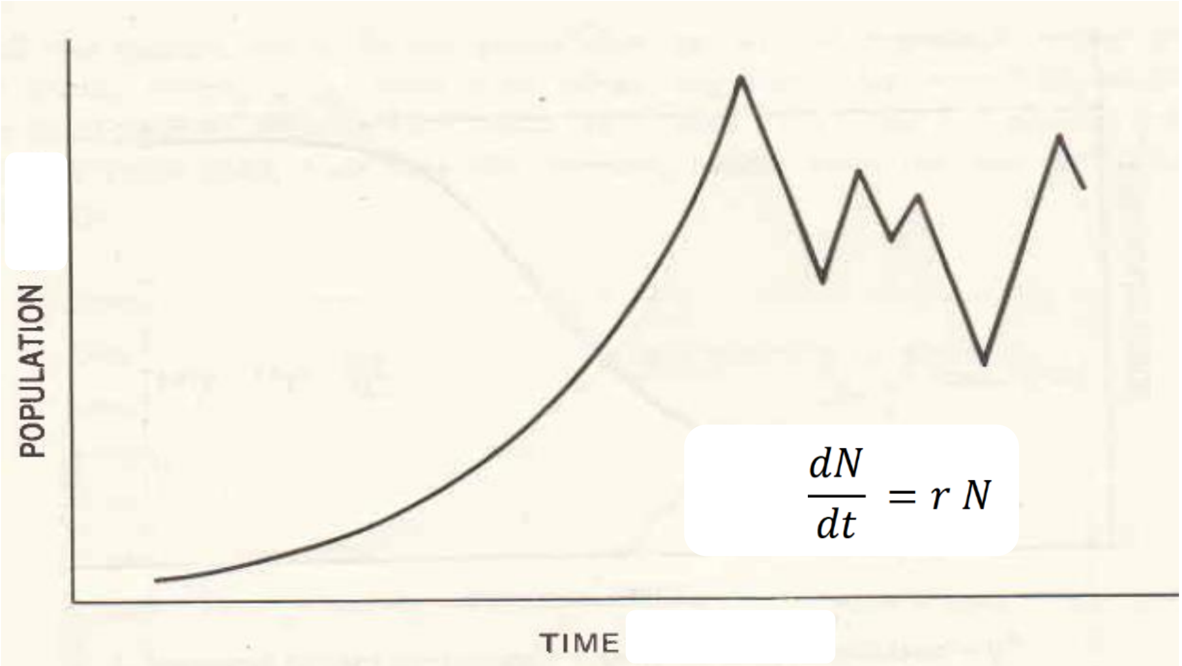

Fig . 14 : Malthusian growth pattern of populations

(N : population size ; t : time ; r : maximum rate of increase)

2 . Logistic growth:

In 1839 , Pierre Verhulst proposed that populations grow in a much more orderly fashion than that proposed Malthus .Thus , he described S – shaped curve for population growth , rather than the J – shaped curve described by Malthus . Verhulst ideas , then became known as the Logistic theory of population growth (Fig . 15) .

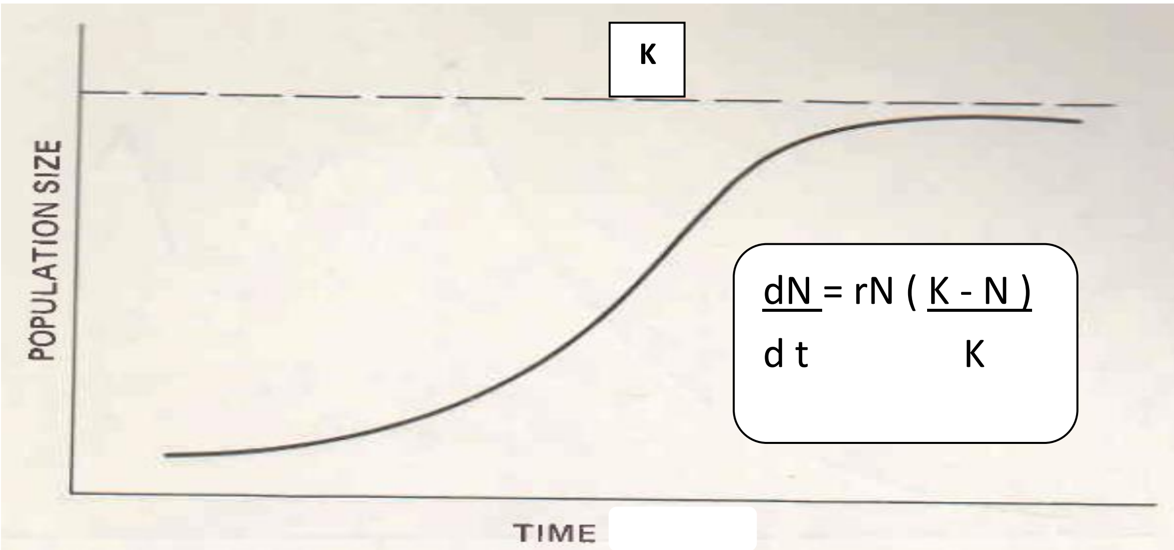

Fig . 15 : Logistic population growth pattern

(N: population size ; t : time ; r : maximum rate of increase ; K : saturation level or carrying capacity ; K – N / K : environmental resistance)

It should be noted that the Logistic curve and the Malthusian curve do not differ in the early stages of population growth , as follow : a slow start followed by exponential growth , but in the upper stages of growth the Malthusian curve is characterized by often catastrophic pattern of limiting growth , whereas the Logistic curve is characterized by smooth , orderly and gradual pattern .

" r " and " K " selection:

In general , populations tend to increase according to Malthusian growth pattern , called r - selected populations , whereas those follow the Logistic population growth pattern , called K – selected populations .

characters of r – selected population :

1 - Fast and opportunistic growth in favorable conditions .

2 - Repeated reproduction in short periods .

3 - Large offspring or large number of eggs .

4 - Fast sexual maturation .

5 - Sudden and high mortality in early stages .

characters of K – selected population :

1 – Gradual and balanced growth .

2 - More constant existence with time .

3 - Less repeated reproduction .

4 - Limited offspring or small number of eggs .

5 - Late sexual maturation .

6 - Parental care .

7 - Low mortality in early stages .

Population fluctuations:

Natural populations often exhibit varying degrees of fluctuations , that is a dynamic rising and falling in response to many factors . The pattern of population fluctuation results may be considered as a continuous series of growth and decline sequences . Thus , the study of population fluctuations becomes closely related with the study of population growth .

It is apparent that most populations have a reproductive potential which substantially exceeds the carrying capacity of their environments . This reproductive potential may often produce excessive numbers of individuals which are then decline by a variety of mortality factors . In general , two types of factors have been considered as the basic causes of population fluctuations :

1 - Extrinsic factors ; that is , those outside of the population itself ,such as climate and weather , cosmic events , competition , predation , shelter and food supply .

2 - Intrinsic factors ; that is those within the population , such as disease , parasitism , behavioral as well as social and physiological responses as population increases and the individuals become crowded .

Thus , it seems illogical to look for any one consistent cause of population fluctuation , since a great variety of factors are interacting collectively and they vary individually in their intensity and significance in different times , places and species .

Population fluctuations are of two general types :

1- Seasonal fluctuations (i.e. , obviously related to seasonal changes of weather) .

2- Nonseasonal or annual fluctuations (i.e. , obviously not related to season) , which are classified into two types : a ; Random or irregular fluctuation and b ; Cyclic or regular fluctuations .

1 - Seasonal fluctuations :

In temperate regions , the population growth of most terrestrial animal populations , typically occurs in the spring and summer seasons , so that these seasons are characterized by population growth . Most arthropods and vertebrates in these regions begin producing young in the spring and summer seasons , and they stop the production of young in late autumn and winter . In aquatic ecosystems of these regions , many populations also show marked seasonal fluctuations , usually with spring and autumn increases . For example , both phytoplankton and zooplankton of these regions show characteristic seasonal changes with peaks in spring and autumn, which often correlated with temperature changes or with recirculation of basic plant nutrients (Fig . 16) .

In the tropical regions of the world , where there are no sharply defined seasons on a temperature basis , seasonal fluctuations still occur in most plant and animal populations , since they often correlated with the cycle of dry and wet seasons .

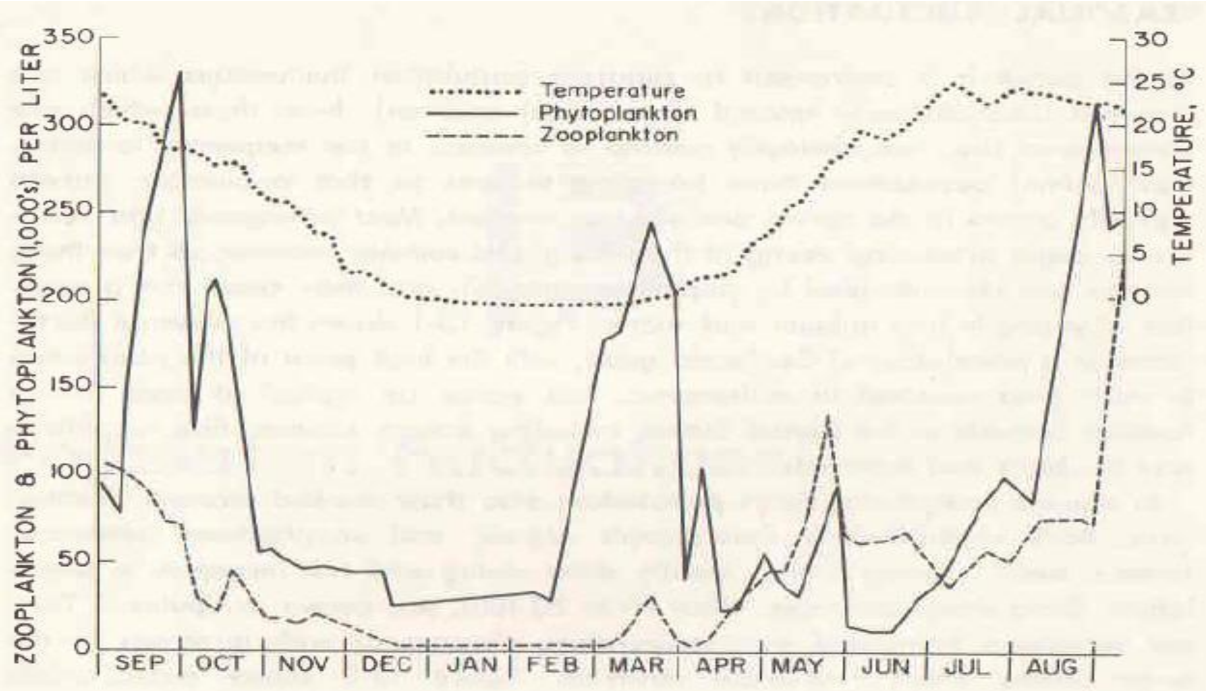

Fig . 16 : Typical seasonal fluctuations of both phytoplankton and zooplankton in temperate regions .

2 - Nonseasonal fluctuations (annual fluctuations) :

a - Random fluctuations (irregular fluctuation) :

These fluctuations are not often recorded in a systematic and continuous fashion . For example the annual fluctuations of cod fish in temperate seas (Fig . 17) .

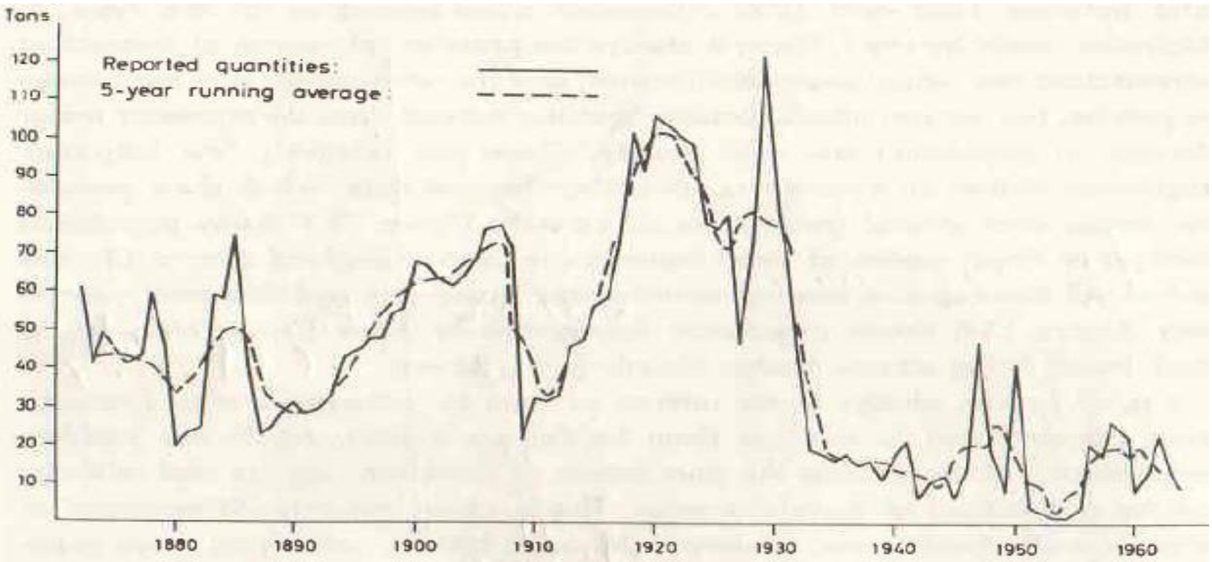

Fig . 17 : Annual fluctuations of cod fish in temperate seas .

b - Cyclic fluctuations (regular fluctuations) :

These are fluctuations in which the population reaches peak numbers at fairly regular intervals . In general , two types of cyclic fluctuations are noted in animal populations :

1 - A cyclical periodicity of 9 - 10 years ; such as those of snowshoe hare and its predator lynx in temperate regions.

2 - A cyclical periodicity of 3 - 4 years , such as those of some foxes in temperate region.

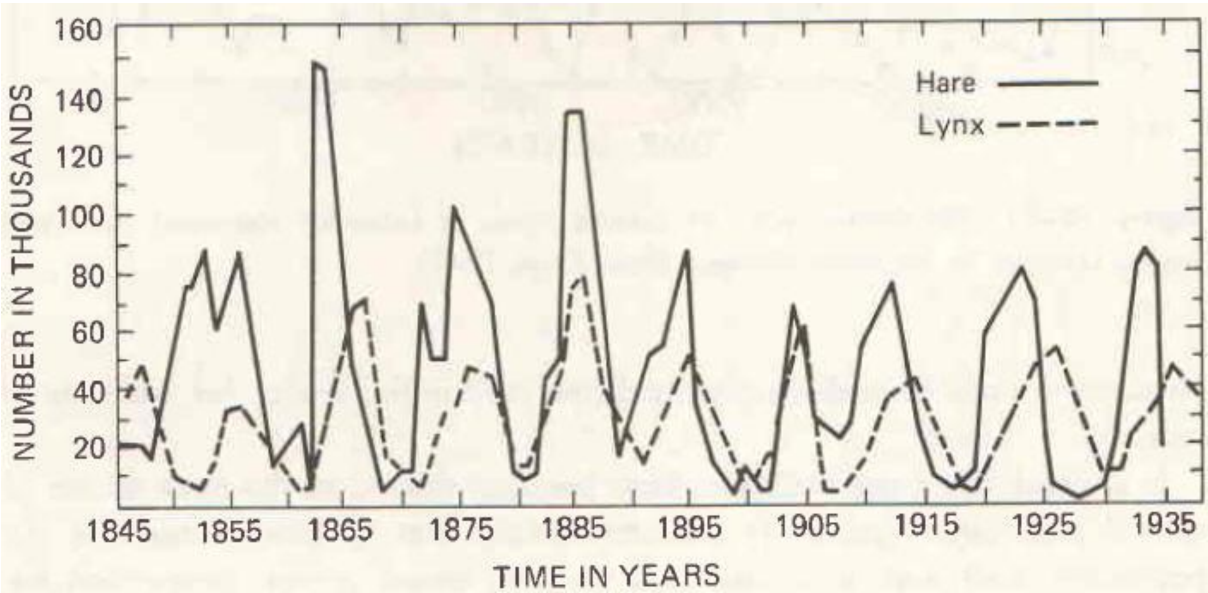

Fig . 18 : Annual fluctuations of snowshoe hares and its predator lynx in temperate region .