Changes in Populations

Lesson 14
Text Book Reference: 2.9, page 74-76

Biologists often examine ecosystems by breaking it down into populations and communities. Human population remained constant until the agricultural revolution, when it began to grow, and exploded by the mid 1600's, tripled in the 1900's. At the start of the third millennium, the human population was 6.5 billion, (world population is increasing at a rate of 2.5 people per second).

Definitions

Population: consists of all the individuals of the same species that live in a given area.

Community: all the living things in an area (many populations).

Species: consists of organisms so similar that they can mate and produce fertile offspring.

Population Density: the number of individuals per unit of space.

Population Distribution: shows variations in population density within a particular habitat.

Carrying Capacity: the maximum number of individuals of a species that can be supported by an ecosystem.

Growth Rate: of a population tells how much its size has changed in one year.

Doubling Time: the time needed for the population to double in size.

Population Growth Rates

Changes in population size occur because individuals are added or removed from a community. Although many environmental factors such as: food supply, space availability, disease, climate, predators and natural disasters affect population growth, only **four** processes can change the size of a population:

- births
- deaths
- immigration and
- emigration

Definitions

Natality: the number of offsprings of a species born in one year.

Mortality: the number of individuals of a species that die in one year.

Immigration: the number of individuals of a species moving into an existing population.

Emigration: the number of individuals of a species moving out of an existing population.

1. If natality, (the number of offsprings of a species born in one year) increases, while other factors remain constant, then the population will increase.

2. If immigration, (the number of individuals of a species moving into an existing population), increases , then the population will also increase.

3. If mortality, (the number of individuals of a species that die in one year), increases then the population will decrease.

4. If emigration, (the number of individuals of a species moving out of an existing population) increases, then the population will also decrease.

In natural ecosystems of populations, all four factors, (i.e. births, deaths, immigration and emigration), interact, however, births, (i.e natality), and deaths, (i.e mortality), having the greatest impact.

Growth Rate:

$$\text{Growth Rate} = \frac{(\text{Births} + \text{immigration}) - (\text{Deaths} + \text{emigration})}{\text{Initial population number}} \times 100$$

Extremely fast growth rate is called a **population explosion**, this can occur when a new species is introduced into an ecosystem in which there are few, if any, predators, a plentiful food source, and an abundant space.

In mature ecosystems, (i.e. ecosystems where either resources are constant or available in predictable patterns), populations remain stable over the long term, i.e. **zero population growth**; increases in births are balanced by increases in deaths or increases in emigration. Ecosystems with stable population growth are referred as **Dynamic Equilibrium** or a **Steady State**, i.e. gaining or losing individuals at the same rate.

If deaths and emigration exceeds births and immigration, the population will decline and a **negative growth rate** will result.

Conversely, a **positive growth rate** results when births and immigration exceed death and emigration.

Example:
An animal population of 50 has no immigration or emigration, 3 births and 4 deaths in one year, what is the percentage growth rate of this population.

$$\%\ \text{Growth Rate} = \frac{3 - 4}{50} \times 100 = -2\ \%$$

i.e. a 2 % reduction in population

Populations are classified as :

1. **Open Populations**: these are where all four factors, (births, deaths, immigration and emigration), are acting upon the population of each organism in the ecosystem, example: seals, crows

2. **Closed Populations**: these are where births and deaths affect the population size, there is no immigration or emigration, example: herds of arctic animals such as elk.

Population Histograms

Population histograms are useful when studying populations of organisms.

Double histograms provide information about populations of organisms in terms of its age structure and the proportions of males and females at a specific instant in time.

The shape of the pyramid indicates changes in population:

1. A pyramid with a wide base in the histogram indicates:
   - rapidly growing population
   - the number of births is high
   - the number of individuals capable of reproduction, (those in the center of the pyramid) is high.

2. An equally placed histogram indicates:
   - a stable population
   - smaller number of births, and mortality rate of infants is high
   - population is growing very slowly.

This population is referred to as **Zero Population Growth**.

3. In a histogram where the base of the pyramid is narrower than the middle section, this indicates:
   - fewer births
   - population will decline.

Scientists also show population growth on a line graph, this produces a pattern referred to as a **Population Growth Curve**.

1. Most population growth curves are **sigmoidal,** (i.e. an S-shape), **beginning** with a very **slow rate of growth** with a small population living in favourable conditions.

As the number of available mates increases, the growth curve gradually becomes vertical and the growth rate speeds up, and eventually reaches a steady state, finally the growth rate declines to zero and population size stabilizes.

2. A population with a **linear growth rate** is a **straight line** angling **upward to the right** (Figure 4, page 76),on a graph.

Organisms that take longer to develop sexually and have long gestation periods and single offsprings exhibit linear growth rate, example: large mammals, elephants, whales, bears, and birds such as eagles and the whooping cranes.

3. A **curve that increases in steepness** as it rises demonstrates an **exponential growth rate**.

Animals that mature quickly with short gestation periods and multiple offsprings show exponential growth rate, example: mice rabbits, domestic cats, fish and insects.

Human population demonstrated a linear growth until about 1600 and has since shown exponential growth rate, taking less time each time it doubles.

Homework

1. Read pages 74 - 76

2. Answer Understanding Concepts, Page 76, # 1 - 7

3. Work sheet: (i) Monitoring Changes in Population
   (ii) Population Growth Curves
   (iii) Bacteria Population Curves
   (iv) Population Graphs