

**SUBJECT:** Biology

**CLASS:** SS1

**TOPIC:** POPULATION STUDIES BY SAMPLING

**Specific Objectives:** By the end of the lesson, students should be able to:

1. Define population
2. List the characteristics of a population
3. Explain the methods used in sampling in population studies
4. Enumerate the instruments used in investigating animal life
5. State various factors that affect population
6. List ecological factors that are peculiar to aquatic, terrestrial and those factors that are common to all habitats.

Population is the total number of organisms of the same species living in a particular habitat at a given time. In population studies of a habitat, the following are investigated;

1. Types (species) of organisms that are present
2. Dominant species (Dominance): these are the most commonly or frequently occurring organisms in that community or habitat, for example in Savanna biome, grasses are the most dominant plant while tall trees are dominant in rain forest biome.
3. The characteristic feature of each population.

### **Characteristics of a population**

Characteristics of a population include: population size, frequency, density, percentage cover and distribution (growth rate and dispersal)

#### **Population size**

The size of a population affects the survival of a given species in that habitat. A small population may be wiped out easily by events such as fire outbreak or diseases while a large population stands a better chance of surviving dangers and unfavourable conditions.

#### **Frequency**

This simply means how often the species occurs at different sites in its habitat.

#### **Density**

Population density is the average number of individuals of a species per unit area of the habitat.

Density = population size/area of habitat.

#### **Percentage cover**

Percentage cover is the area of ground covered or occupied by a given species in that habitat

### **Distribution**

This refers to the way in which individuals of a particular population are spread or arranged in a given habitat. The species may be clumped, evenly distributed or randomly spaced.

### **Conducting population studies**

Population of a place is always changing be it that of plants and animals. It is therefore very difficult to count the number or estimate the population of organisms in a given habitat by counting them one by one. In order to eliminate this difficulty, a method known as **SAMPLING** is used. In random sampling, several small areas of the habitat are selected and necessary investigations are conducted on such areas. Here **quadrat** is used.

Quadrat is a rectangular or square frame made from thick wire. The quadrat is thrown at random several times into a measured plot of land and at each landing, the area covered by it is noted. The plants and animals enclosed at each throw is noted and their numbers recorded, the average number of times each species appeared is calculated and the most frequent or dominant species is then determined.

To determine the density of a particular species in a habitat, the following steps are taken:

- a. Frequency of an organism: this is the total number of times an organism occurs in all the quadrat's throws (say for instance 100 times)
- b. Number of tosses/throws, say 20 times  
Therefore, average number of organisms per quadrat toss  
= frequency/number of tosses  
i.e  $100/20 = 5$   
If the area of habitat is  $1.00\text{m}^2$   
Population density = average frequency/area of habitat  
=  $5/1 = 5\text{perm}^2$

### **Major steps taken in studying plants and animals in a given community**

1. Select a particular area in a community and demarcate it
2. Select equipment/tools/apparatus to be used
3. Measure ecological factors in that habitat
4. Count/collect the specimens of each species present
5. Note the distribution of specimen
6. Identify the specimens
7. Preserve the specimens if necessary

Apart from **quadrat sampling**, other methods that can be used to estimate a population include: **transect method and Capture-recapture method.**

## Transect method

In this method, a measuring tape which has been marked at convenient intervals is stretched across the area. The plants encountered at the interval marks are recorded. This is repeated a few times. A fairly accurate estimate of the number and types of plants in the area can be made using this method.

## Capture-recapture method

This method is used to estimate animal populations. Animals of the same species in an area are caught, counted (A1), marked and released. The next day the same number of animals are caught (A2) and recorded. At the same time the number of marked animals (A3) from the previous day, that were found in this sample are also counted and recorded. The population of animals present in the area is found by the formula:

$$\text{Population} = A1 \times A2/A3$$

Assuming 200 *Tilapia* fish (A1) are captured in a pond

The next day 200 *Tilapia* fish (A2) were also caught. This 200 fishes included 40 that were marked on the first day, i.e A3=40

The total number of *Tilapia* fish population is  $200 \times 200 / 40 = 1000$

## Some instruments used in investigating animal life

1. **Butterfly/sweep net:** This is made of mosquito net and used to skim the surface of the water for collecting surface specimens. Flying insects such as butterfly can also be captured with this net.
2. **Traps:** Commercial traps are used in capturing many animals including small mammals and nocturnal animals. Attractive baits are included when setting such traps.
3. **Tullgren funnel:** This is fitted with wire gauze for collecting soil organisms from soil samples. The soil sample is placed on the gauze and heated by lighted bulb. As the animals move away from the heat, they drop into the container of alcohol below the funnel and are collected.
4. **Plankton net:** This is made of fine cloth/net with fine mesh for collecting tiny organisms/planktons from aquatic habitats e.g pool, pond, lakes, streams, seas etc. The net is slowly trailed in water. Plankton accumulates at its tip as the water is filtered.
5. **Fish trap:** Has two large opening which tappers towards the center. Fishes that get in, swim towards the center and are trapped.
6. **Pooter:** Is used to collect small insects, spider and other invertebrates from leaf litter, tree trunks and crevices of rocks and wall surfaces. This can be used by pointing the collecting tube towards tree trunks/rock. Then suck through the mouth piece.

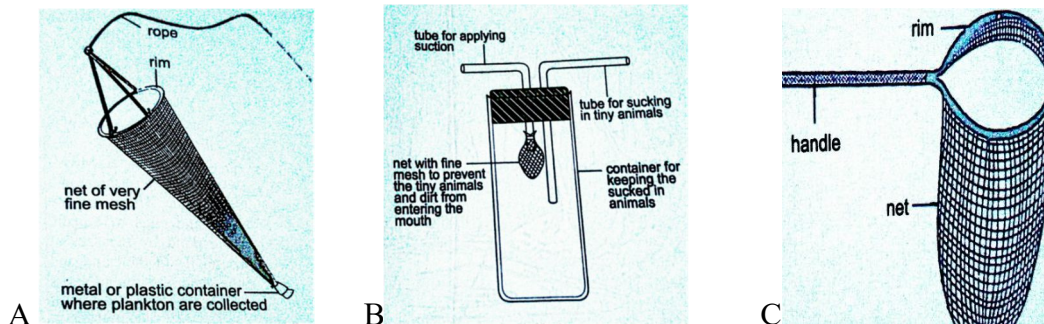


Figure 1: Some instruments used in investigating animal life.  
A: plankton net. B: Pooter. C: Butterfly net

## FACTORS THAT AFFECT POPULATION

Population of organisms in any community is dynamic i.e it is ever changing. Certain factors may lead to its decrease or increase.

### Factors that may lead to increase in population

1. **Natality:** New organisms may be produced by reproductive activities (birth). Organisms with high fecundity (ability to lay more eggs) tend to increase more.
2. **Dispersal/immigration:** Organisms move into a new habitat, thereby increasing the population of animals in the new place.
3. **Abundance of food:** Animals also migrate to where plenty of food is available.

### Factors that lead to decrease in population

1. **Mortality/death rate:** Increase in death rate decreases the population. This may be as a result of diseases/pathogens, competition, accidents etc
2. **Emigration:** When several individuals leave a community, due to unfavourable condition, the population of such community will decrease

## Importance of Competition, Pathogens and Water in Population Growth

### A. Competition

- Limited space, food/other nutrients lead to competition
- Organisms in a population that are unable to compete successfully for food and other nutrients die (i.e survival of the fittest)
- Leading to reduction in the size of population/structural changes in the population/migration/dispersal

### B. Pathogens:

- These are harmful disease causing organisms
- Which kill other organisms in a population
- An attack by pathogens lead to a reduction in the size of population, development of resistant ones/individuals/strains
- Disease-free population multiplies/grows rapidly

### C. Water:

- Water is needed by all organisms in a population for metabolism, for growth in the population.
- Lack of water leads to death of organisms in a population or emigration, thereby leading to a reduction in the size of the population
- Excess water can also be dangerous to the organisms/cause floating/drowning/water logging; leading to reduction in the population size.

## **ECOLOGICAL FACTORS**

Ecological factors are those factors in the environment which can influence living organisms or cause changes in any habitat whether aquatic or terrestrial

1. Factors peculiar to aquatic habitat include: salinity, density, turbidity, currents, tidal movements and waves, dissolved gasses and nature of substratum.
2. Factors that are found only in terrestrial habitat are: relative humidity, topography and edaphic (soil) factors.
3. Factors common to all habitats include: light, temperature, rainfall, oxygen-hydrogen ion concentration (pH), wind and pressure.
  - a. Light:
    - Green plants need sunlight to carry out photosynthesis and most animals need sunlight to carryout vital activities for their well-being.
    - Photosynthetic activity, evaporation of water from exposed surfaces and transpiration rates are directly proportional to light intensity.
    - In aquatic habitat, light penetration is restricted by depth and turbidity. The amount of light reaching the depth of aquatic habitat will determine the distribution and abundance of organisms in such habitat.
  - b. Temperature:
    - This is the measurement of the degree of hotness or coldness of the body or habitat.
    - Temperature is influenced by sunlight and the condition of the body of organisms. As a result, higher temperatures are recorded in the dry season while low temperatures are recorded in the rainy season.
    - In all aquatic habitat, temperature decreases with depth eg in tropical marine waters, the temperature at the surface is 30°C while at the depth of 150m is 4°C.
    - Most organisms are killed by high temperatures, at low temperatures they become inactive, and at optimum temperatures which suit metabolic activities the grow and reproduce rapidly
    - Temperature variations have effect on distribution of organisms, for example in the tropic where temperatures are favourable for life, there is a luxuriant tropical rain forest including large and varied animal life, animals that cannot

survive high temperature of the day, hide and come out at night when temperature is low.

c. Rainfall

- This is the main source of water in all habitats. Water soaks the soil whenever there is rainfall and the excess in form of run-off water flows into pools, ponds, rivers, lakes, seas and oceans.
- Rainfall determines the pattern and distribution of vegetation. For areas where there is long and heavy rainfall, the vegetation produced is an **evergreen** forest. With rainfall, seeds germinate and grow abundantly to form a vegetation which in turn forms protective habitats for animals and food for them.

d. Oxygen

- Most organisms are aerobic and they require oxygen for respiration for the release of energy for vital activities. Few anaerobic ones are not disadvantaged by oxygen deficiency where they are found.
- Living things on land have no problem getting oxygen for respiration because it is well distributed on land.
- The amount of oxygen that is dissolved in water is low compared to that present in the air. Therefore low oxygen content in water restricts the distribution of aerobic organisms in aquatic habitat.

e. Wind

- Wind is air in motion. The direction and velocity of wind is very important to living things in terrestrial and aquatic habitats.
- High wind speed (velocity), sets up waves and current, including evaporation in aquatic habitats. It increases also the rate of transpiration, pollination and dispersal of fruits in plants.
- Strong wind causes rill erosion and weathering of parent rocks leading to formation of soil.
- It knocks down some plants and shelter of animals including those of human beings.
- Strong wind also dissolves more oxygen in aquatic habitat; thereby liberating more oxygen for respiration of plants and animals.

f. Hydrogen-ion concentration (pH)

- This is the measure of acidity and alkalinity of the water in aquatic habitats or soil in terrestrial habitats. Acidic soil supports very little vegetation while alkaline medium supports more vegetation.

- Animals are equally pH sensitive. They prefer neutral to alkaline medium and avoid acid medium.
- g. Pressure
- This affects the distribution of plants and animals in terrestrial and aquatic habitats.
  - Pressure is very low at the top of very high mountains and high at the floor of very deep aquatic habitats. Very few organisms adapt at these extremes of pressure and they are highly adapted to such condition. For instance, organisms found at depths of about 400m are adapted to such conditions of high pressures and cannot survive near surface water where pressure is much lower.

### **Evaluation**

1. Define the term population
2. Mention 3 characteristics of a population
3. List 3 methods used for sampling in population studies
4. Mention 4 instruments that can be used in investigating animal life
5. State 2 factors that are common to all habitats
6. List 4 factors that affect a population

### **Assignment**

1. Describe how you can estimate the population of a named fish species in a named fresh water habitat
2. Outline any 2 equipment that can be used to estimate the population mentioned above