CHAPTER

8 Ecology and Environment Awareness

- The idea about ecology was first started by **Reiter**.
- The term ecology was given and defined by **Haeckel** as **Ecology** is the study of the interactions between the organism and their environment.
- **Population :** The collection of individuals of a given species is called population.
- **Community :** The interacting groups of populations of various species constitute a community.
- **Ecosystem :** A biological community and the physical environment associated with its constitute ecosystem.
- **Biome :** A major ecological community or complex of communities that extends over a large geographical area.
- **Species** is a group of organisms that resembles each other more than they resemble to any other organism, and that can breed among themselves and produces fertile offspring.
- **Habitat :** It is a specific place or locality where an organism lives.
- **Ecotone :** It is the marginal vegetation present in between two well established habitat.
- **Environment :** It is the sum total of physical and biotic conditions influencing the behaviour of the organism.
- **Atmosphere :** The multilayered gaseous envelope. It is divided into 5 distinct layers troposphere, stratosphere, mesosphere, ionosphere & exosphere.

Water Resource : It is the major component of the **hydrosphere** and covers about $3/4^{th}$ of the earth's surface.

- Out of this 97% is sea water which cannot be used directly. Only 3% is fresh water.
- Out of 3% about 77% is stored in ice caps, about 22.5% is ground water. Only about 0.5% is present in river & lakes which is available for direct use.
- Aquatic animals which can tolerate only a narrow range of salinity are called **stenohaline**.
- Aquatic organisms having wide range of salt tolerance are called **euryhaline**.

Soil : Soil is a mixture of inorganic mineral particles derived from weathering of rock and organic matter consisting of humus.

- **On the basis of the size of particles, soil is of following types :**
  (i) Clay - upto .062 mm (ii) Silt - .002 to .02 mm
  (iii) Fine sand - .02 to .2 mm (iv) Coarse sand - .2 to 2 mm
  (v) Fine gravel - 2 to 5 mm (vi) Coarse gravel - 5 and more
- **Population :** It is the total number of individual of a particular species inhabiting a particular area at a particular time.
- **Demography :** Study of population.

Population Characteristics

(1) Population density : It is number of individuals per unit area of environment.

(2) Natality : This is addition of individuals in a population due to birth.

(3) Mortality : It is the rate of death of individuals in a given population.

(4) Population Dispersion

(i) **Emigration** - One way outward movement.
(ii) **Immigration** - One way inward movement.
(iii) **Migration** : It is a cyclical movement with respect to and weather that during life history of an animal at definite intervals, and always includes a return trip from where it began.

(5) Age Structure : The proportion of individuals of various age group in a population forms the age structure.
Pre reproductive > Reproductive > Post reproductive $\rightarrow$ Expanding population
Pre reproductive = Reproductive > Post reproductive $\rightarrow$ Stable population
Pre reproductive < Reproductive < Post reproductive $\rightarrow$ Decline population.

(6) Biotic Potential : The inherent maximum capacity of an organism to reproduce or increase in number is termed as biotic potential. Nature keeps a check on it.

- **Carrying Capacity :** The maximum population size that can be supported by the environment is called carrying capacity.
- **Population growth :** Current population – Initial population + Birth + Immigration – Death – Emigration.

There are two main type of population growth forms

(1) J - Shaped : The population values when plotted against time gives a J - shaped growth curve, and at the peak of the population, growth ceases abruptly due to environmental resistance.

(2) Sigmoid or S-Shaped form : It shows an initial gradual increase in the population size and then it accelerates and finally slows to a nearly constant level.

Biological Interactions

Amensalism : It is a relationship in which one species is harmed whereas the other is unaffected.

Competition : It is best defined as a process in which the fitness of one species is significantly lower in the presence of another species.

Parasitism : Parasitism is a relationship between two species in which one benefits on the host (harm) of the other. It is always an one side relationship for the parasite which is always benefitted from the host.

Commensalism : The interaction in which one species benefits and the other is neither harmed nor benefited is known as **commensalism**.

Mutualism : Mutualism interaction is a positive reciprocal relationship between two different species. *Anabaena* (a nitrogen fixing blue green alga) is associated with water fern *Azolla*.

Predation : Predation is an interaction between members in which one population adversely affects the other by direct attack (capture, kill and eat) but is nevertheless dependent on other. The former is called **predators** & the latter is called **prey**

Structure of Ecosystem

A. Abiotic Components
- (a) Climatic conditions - Soil, temp, light, water.
- (b) Inorganic substances - Nitrogen, sulphur, phosphorus
- (c) Organic substances - Carbohydrate, protein, lipid.

B. Biotic Components
- (a) **Producers :** The organism which produce their own food. Herbs, shrubs, tree, Phytoplanktons, etc.
- (b) **Consumers :** They are the phagocytic heterotrophs which depend for their nutrition on the organic manufactured by producers, the green plants. They are of following 3 types :
- (i) Herbivores (Primary Consumers) - These animals feed directly on living plants or plant remains.
- (ii) Carnivore order - 1 (Secondary Consumers) - These carnivores feed on herbivores, *e.g.* frog, fish.
- (iii) Carnivore order - 2 (Tertiary Consumers) - These are carnivores feeding on other carnivores. (Eagle feeding on snake)
- (c) **Decomposers :** They bring about the decomposition of dead organic matter of producers as well as consumers. They help in returning the mineral elements to the abiotic phase and help in continuing biogeochemical cycle, *e.g.* - bacteria, fungi.

Productivity : The rate of production *i.e.* the amount of organic matter accumulated in any unit time. It is of following types :

(A) Primary Productivity : The rate at which radiant energy is stored by producers.
- (i) Gross Primary Productivity - It refers to the total rate of photosynthesis including the organic matter used up in respiration.
- (ii) Net Primary Productivity - It is the rate of storage of organic matter in plant tissue in excess of the respiratory utilization.

(B) Secondary Productivity : It is the rate of energy storage at consumer's level - herbivores, carnivores & decomposers.

(C) Net Productivity : It is the rate of storage of organic matter not used by heterotrophs or consumers, *i.e.* equivalent to net primary production minus consumption by the heterotrophs during unit period (year).

Energy Flow

Food Chains : The pattern of eating & being eaten forms a linear chain called food chain, which can always be traced back to the producers. Each step of food chain is known as trophic level. (Plants - 1^{st} trophic level)

Producers → Herbivores → Small fish → Large fish

Plants → Grasshopper → Lizard → Hawk

Ecological Pyramids : Concept of ecological pyramid was given by **Elton**.

- There occurs a regular pattern of change in the properties (like number, energy and biomass) of the organisms across different trophic level. It is the graphical representation of food chain.

Types of Ecological Pyramid

1. Pyramid of Number - upright or inverted
2. Pyramid of Biomass - upright or inverted
3. Pyramid of energy - Always upright

Lindeman's ten percent law : The food chain efficiency is only 10% *i.e.* the organism at a particular trophic level consumes 90% of the total energy which it receives from the preceeding trophic level and passes only the 10% remaining energy to the next level.

Ecological Succession

- It includes a series of changes that a biotic community undergoes in maturation towards a stable or climax condition.

Types of Succession

(1) Primary succession : If an area is colonized by organisms for the first time, the succession is called primary succession. Eg. - Newly exposed rock ; modified desert.

(2) Secondary succession : If succession starts on the area previously colonized, but has been cleared off by some environmental force (fire, flood, lightening), it is called secondary succession. Eg. - forest devastated by fire.

(3) Hydrarch : Succession which begins in water bodies like ponds.

(4) Xerarch : Successions initiated on bare rocks, sand dunes, rocky slopes etc. where there is extreme scarcity of water, are termed as xerarch.

Biodiversity

The sum total of all the species including plants, animals and micro-organisms on the earth.

The 3 richest region of biodiversity in India are :

(a) Western Ghats (b) North East (c) Kashmir.

Levels of Biodiversity

(1) Genetic Diversity : It refers to variations of genes within species.

(2) Species Diversity : It refers to variety of species per unit area.

(3) Community and ecosystem diversity : It has three perspectives
- (a) **Alpha diversity :** Diversity of organisms sharing the same community (intra community diversity).
- (b) **Beta diversity :** Diversity among the members of different communities. (inter community diversity).

(c) **Gamma diversity :** Diversity over the total landscape or geographical area.

- Biodiversity increases, as we move from high to low lattitude as (*i.e.*, from poles to equator).

Causes of Loss of Biodiversity

(i) **Natural extinction:** Some species disappear and are replaced by other species when environmental conditions change.

(ii) **Mass extinction:** Disappearance of large number of species because of some catastrophe.

(iii) **Anthropogenic extinction :** Disappearance or extinction of species due to human activity.

Conservation of Biodiversity

- There are 2 basic methods of biodiversity conservation:

(i) *In situ* (on site)

(ii) *Ex situ* (off site)

***In situ* conservation**

- Example of protected areas are National Park, wild life sancturies and biosphere reserve.

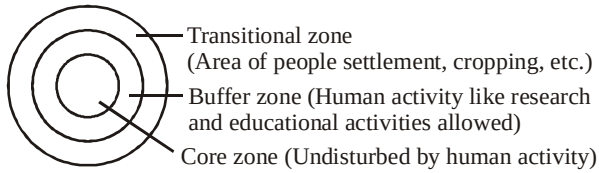
***Ex situ* conservation**

- *Ex situ* conservation includes botanical gardens, zoos, pollen seed, seedling, tissue culture and DNA banks.
- **Cryopreservation** is an *in vitro* conservation technique by which vegetatively propagated crops like potato are preserved in liquid nitrogen at a temperature of –196°C.
- **IUCN** and **WWF** are leading International Organisations concerned with biodiversity conservation.

Sanctuaries and National Parks : A sanctuary or a National park may be defined as an area declared by state, for the purpose of protecting, propagating or developing wild life therein, or it's natural environment for their scientific, educational & recreational value.

Biosphere Reserves : Launched in 1975 as a part of UNESCO's "Man & Biosphere" programme. They are special category of protected area wherein people are an integral component of the system.

- **It consists of 3 zones**



Pollution :

It is an undersirable change in physical, chemical or biological characteristics of environment which adversely affects the biological species including Man.

Waste products are of 2 categories

(1) **Biodegradable waste :** These are such waste substances which are acted upon by microorganisms and broken into simpler components. E.g. - Most of the organic waste.

(2) **Non - biodegradable waste :** These are such waste substances which are not acted upon by micro-organisms and remain in the same form for a long period of time. E.g. - Polythene, glass, DDT, etc.

Air Pollution

Imporrtant Air Pollutants and their Impact

(1) **SO_2, H_2S :** Lichens are most sensitive to SO_2. Eye irritation, destroys bronchial cilia. Causes acid rain thus decreasing the pH of soil.

(2) **Carbon Monoxide :** Reduces O_2 carrying capacity of blood by forming carboxy haemoglobin.

(3) **Nitrogen oxides :** Collapse of leaves. Nitrogen oxides reacts with hydrocarbons like methane, ethane, toluene, etc. to form peroxyacetyl nitrate or PAN ($C_2H_3O_5N$).

Photochemical smog : The mixture of PAN with ozone and various organic radicals.

(4) **Ozone :** $NO_2 \rightarrow NO + O$, $O_2 + O \rightarrow O_3$.

- Causes premature senescence in plants.
- Damage pulmonary organ in animals.

(5) **Cadmium**

- Causes cancer of liver and lungs.
- itai - itai (ouch ouch) disease (painful joints)

Water Pollution

- The term water pollution refers to any type of aquatic contamination between the following 2 extremes -
- A highly enriched, over productive biotic community, such as river or lake with nutrients from sewage or fertilizer (**cultural eutrophication**) or,
- A body of water poisoned by toxic chemicals which eliminate living organisms or even exclude all forms of life.

Causes of Water Pollution

(1) **Sewage**

(2) **Industrial waste**

(3) **Agrochemicals**

- **Methaemoglobinuria** or **Blue baby syndrome :** The surface run off water from agricultural fields contain high percentage of nitrates. When it enters the body of foetus, it reacts with the haemoglobin and forms methaemoglobin which has a highly reduced oxygen carrying capacity.
- Excess of fluoride - causes skeletal fluorosis (teeth and skeletal deformity)
- Arsenic - Black foot disease
- Mercury - Minimata disease (numbness of limbs, lips and tongue)

(4) **Thermal pollution or Calefaction :**

- The source is the heat from thermal & nuclear power plants.
- Gives thermal shocks which affect the aquatic life.

Biological Magnification (Amplification) : It is the increase in the effect of any non degradable chemical as it passes on in the food chain. E.g. - Polychlorinated biophenyl, DDT.

Biological (Biochemical) Oxygen Demand (BOD) : It is the measure of oxygen required by aerobic decomposers for biochemical degradation of organic materials (biodegradable) in water. This demand of oxygen is directly proportional to increasing input of organic wastes in water.

Noise Pollution

- Noise is an undesired sound. Sound pollution starts from 80 decibel.
- A constant exposure to noise level of 80 db causes : Mental irritation, Hypertension, Temporary deafness.

Organic farming

- Integrated approach, a cyclical, zero waste procedure, where waste products from one process are cycled in as nutrients for other processes. This allows maximum utilization of resource and increases efficiency of production.

Radioactive wastes

- This waste is generated as a result of generation of electricity from nuclear energy in nuclear reactors. Radiation emitted out by waste is lethal at high doses and cause mutation and genetic disorder at high doses which can be transmitted generation after generation.

Greenhouse Effect and Global Warming

- Greenhouse gases such as CO_2, CH_4, N_2O and CFC's present in atmosphere radiate part of radiowave radiations emitted by earth back to the earth. This downflux is called **greenhouse flux** which keeps the earth warm and phenomenon is called greenhouse effect.

Effect of Greenhouse Effect

- Temperature of earth has increased by 0.6°C in last 3 decades. This increase in temperature is leading to deleterious change in environment and resulting in climatic changes (**El Nino Effect**), leading to increased melting of polar ice caps as well as of other places like Himalayas snow caps.
- **CO_2 fertilization effect** – Increase in the growth rate of plants in response to elevated concentrations of CO_2 is known as carbondioxide fertilisation effect. **Kyotoprotocol** (1997) was signed to reduce the emission of green house gases. Under the protocol, industrialized countries as a whole will cut their overall CO_2 emission by at least 5.2% below 1990 level.

Global Warming

- The mean annual global temperature is 14°C. Any significant rise in this temperature is regarded as global warming. Major green house gases are CO_2, Methane, Chlorofluorocarbons (refrigerators, sprays), Nitrous oxide (NO_2).

Ozone Depletion

- Dobson unit is the unit for measurement of O_3 level in stratosphere.
  - 1 DV = 0.1 mm of compressed O_3 at NTP.
  - Normal O_3 level should be greater than 400 DV.

Major O_3 depleting substances

- Chlorofluorocarbon (C_1 component destroys O_3), Chloroform, CCl_4, Methane, N_2O (Nitrous oxide).
  - O_3 layer protects life from harmful U.V. radiations.
  - 3 forms of U.V. radiations :

  (a) U.V. C - 100 nm to 280 nm
    - Completely absorbed by O_3.

  (b) U.V. B - 280 nm to 315 nm
    - O_3 layer transforms it into infrared.
    - Thinning of O_3 layer leads to more penetration of U.V. B.

    Harmful impact of U.V. B :

    * Cataract * Skin Cancer (Melanoma)

  (c) U.V. A - 315 nm to 400 nm.
    - Reaches the surface of earth
    - harmless.
- **Montreal protocol** (1987) → Stop use of ozone depleting substances.
- **London protocol** (1990)
- **Chernobyl tragedy** - Radioactive pollution - Russia.

EXERCISE

1. The term 'Ecology' was coined by
   (a) Haeckel (b) Odum
   (c) Warming (d) Dudgeon
2. The age of pyramid with broad base indicates
   (a) high percentage of young individuals
   (b) low percentage of young individuals
   (c) high percentage of old individuals
   (d) low percentage of old individuals
3. Desert regions are characterized by ___ centimeters of rainfall per year.
   (a) less than 5 (b) less than 15
   (c) less than 25 (d) over 50
4. Resemblance of one organism to another for protection and hiding is
   (a) Mimicry (b) Predation
   (c) Adaptation (d) Camouflage
5. Which is not a part of atmosphere ?
   (a) Light (b) Temperature
   (c) Edaphic factor (d) Precipitation
6. Human population growth _____.
   (a) has an S-shaped curve
   (b) is currently in a logistic phase
   (c) is currently exponential
   (d) has reached carrying capacity
7. The term 'precipitation' includes
   (a) Rain
   (b) Hails
   (c) Snow
   (d) All forms of water that fall to the ground
8. Interactions in which the consumer lives within the host and does slow damage to the host are referred to as
   (a) commensalism (b) parasitism
   (c) mutualism (d) competition
9. An assocation between two individuals or population where both the benefitted and where neither can survive without the other is
   (a) Commensalism (b) Amensalism
   (c) Proto-cooperation (d) Mutualism
10. Which most often limits the primary productivity of the ecosystem ?
    (a) Solar radiation/light (b) Oxygen
    (c) Consumers (d) Nitrogen
11. Which of the following is the most stable ecosystem?
    (a) Mountain (b) Desert
    (c) Forest (d) Ocean
12. Energy flow in an ecosystem is
    (a) unidirectional (b) bidirectional
    (c) multidirectional (d) All of these
13. Which one is nature's cleaner ?
    (a) Consumers
    (b) Producers
    (c) Decomposers and scavengers
    (d) Symbionts
14. Who is referred to as the farmer's friend ?
    (a) Ant (b) Sparrow
    (c) Earthworm (d) Rabbit
15. How much portion of the PAR is captured by the plants?
    (a) 5 – 10% (b) 7 – 10%
    (c) 8 – 10% (d) 2 – 10%
16. The animals which occupy the same trophic level are
    (a) Lion & Bees
    (b) Deer & Bees
    (c) Snakes & Earthworm
    (d) Crow & Cow
17. In simple ecosystem with grass, deer and tiger in food chain, how much amount of food available to the tiger if the grass production is one tonne ?
    (a) 100 kg (b) 10 kg
    (c) 1 kg (d) 100 gm
18. In a food chain herbivores/deer are
    (a) Primary producers (b) Primary consumers
    (c) Secondary consumers (d) Decomposers
19. 10% law of flow of energy in ecosystem was proposed by
    (a) Lindeman (b) Carl Mobius
    (c) Tansley (d) Darwin
20. More than 70% of world's freshwater is contained in
    (a) polar ice
    (b) glaciers and mountains
    (c) antarctica
    (d) greenland
21. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time?
    (a) Sparrow (b) Lion
    (c) Goat (d) Frog
22. Which one of the following is not a gaseous biogeochemical cycle in ecosystem ?
    (a) Sulphur cycle (b) Phosphorus cycle
    (c) Nitrogen cycle (d) Carbon cycle
23. Which of the following animal has become almost extinct in India ?
    (a) Wolf (b) Rhinoceros
    (c) Hippopotamus (d) Cheetah
24. Diversity of habitat over the total landscape is called
    (a) β diversity (b) γ diveristy (gamma)
    (c) landscape diversity (d) ecosystem diversity
25. Habitat loss and fragmentation, over exploitation, alien species invasion and co-extinction are causes for
    (a) Population explosion (b) Migration
    (c) Biodiversity loss (d) Pollution
26. Which Biosphere reserve known as "Valley of Flower" ?
    (a) Nilgiri (b) Sunderbans
    (c) Uttarakhand (d) Nokrek
27. Plant genes of endangered species are stored in
    (a) gene library (b) gene bank
    (c) herbarium (d) None of these
28. Which National park is the new home of the Indian one-horned rhinoceros ?
    (a) Dudhwa (b) Jim Corbett
    (c) Kanha (d) Bandhavgarh
29. '*Project Tiger*' in India was started in
    (a) 1970 (b) 1972
    (c) 1981 (d) 1985

30. Which one of the following is an example of *Ex-situ* conservation?
(a) Wildlife sanctuary (b) Seed bank
(c) Sacred groves (d) National park

31. Which one of the following areas in India, is a hot spot of0 biodiversity ?
(a) Eastern Ghats (b) Gangetic Plain
(c) Sunderbans (d) Western Ghats

32. Noise pollution is created if noise is in excess to –
(a) 70-75 dB (b) 50-60 dB
(c) 80-99 dB (d) 40-65 dB

33. Which of the following is most harmful pollutant ?
(a) NO_2 (b) CO_2
(c) SO_2 (d) CO

34. Volcano is _____ source of pollution.
(a) artificial (b) natural
(c) Both (a) and (b) (d) man-made

35. Ozone layer is formed in which zone of atmosphere
(a) Mesosphere (b) Stratosphere
(c) Troposphere (d) Ionosphere

36. Today the concentration of green house gases is very high because of
(a) use of refrigerator
(b) increased combustion of oils and coal
(b) deforestation
(d) All of the above

37. Green house gases include
(a) CO_2, CFC, CH_4 and NO_2
(b) CO_2, O_2, N_2, NO_2 and NH_3
(c) CH_4, N_2, CO_2 and NH_3
(d) CFC, CO_2, NH_3 and N_2

38. Acid rain is caused due to increase in concentration of (in atmosphere)
(a) SO_2 and NO_2 (b) CO and CO_2
(c) CO and SO_3 (d) O_3 and dust

39. Deforestation causes
(a) soil erosion
(b) loss of biodiversity
(c) disturbance in hydrological cycle
(d) All of the above

40. Which constituent of the atmosphere is likely to change if the forest cover is removed ?
(a) O_2 level is increased
(b) CO_2 level is increased
(c) O_2 level is significantly increases
(d) CO_2 level is significantly decreased

ANSWER KEY							
1	(a)	**11**	(d)	**21**	(a)	**31**	(d)
2	(a)	**12**	(a)	**22**	(b)	**32**	(c)
3	(c)	**13**	(c)	**23**	(d)	**33**	(c)
4	(a)	**14**	(c)	**24**	(b)	**34**	(b)
5	(c)	**15**	(d)	**25**	(c)	**35**	(b)
6	(c)	**16**	(d)	**26**	(a)	**36**	(d)
7	(d)	**17**	(b)	**27**	(b)	**37**	(a)
8	(b)	**18**	(b)	**28**	(a)	**38**	(a)
9	(d)	**19**	(a)	**29**	(b)	**39**	(d)
10	(a)	**20**	(a)	**30**	(b)	**40**	(b)

HINTS AND SOLUTIONS

3. (c) Deserts have less than 25 centimeters of rainfall per year.

5. (c) Because edaphic factors affects through soil and rest are the climatic factors.

6. (c) The exponential growth model virtually describes the population explosion of humans.

8. (b) This is the classic definition of a parasitic interaction.

11. (d) 2/3 parts of each is ocean here, various types of food chains form food webs. This ecosystem is most stable due to buffering action of water.

19. (a) Lindeman proposed the 10% law of flow of energy in ecosystem. According to this law only 10% energy passed from one trophic level to other in a food chain.

20. (a) Three fourth surface of earth is covered by oceans which contain 97.5% of total water. It is marine water with about 3.5% salt content only 2.5% is fresh water which occurs on land. Most of this water (1.97%) occurs as frozen ice caps and glaciers, 0.5% fresh water occurs as ground water. Rivers and lakes contain 0.02%, soil 0.01% while atmosphere possesses 0.001% of water as vapours.

21. (a) It feeds upon grains hence called primary consumer and can also feed on insects hence called secondary consumer at the same time in the same ecosystem.

22. (b) Phosphorus is mostly used as phosphate. Its reservoir pool is phosphate rocks while cycling pool is soil for terrestrial ecosystems and water for aquatic ecosystems.

27. (b) Plant genes of endangered species are stored in gene bank which is a collection of cloned DNA fragments representing the entire material of an organism.

30. (b) Ex-situ conservation is the conservation of selected organism in places outside their natural homes. They include off site collection and gene banks.
In situ conservation, on the other hand, is the conservation of endangered species in their natural habitat. Biosphere reserves, National parks, Wildlife sanctuaries and sacred groves all are examples of *In situ* conservation.

31. (d) Hotspots are the geographical area where biodiversity is maximum. Two hot spots in India are Western Ghats and North eastern himlayan region.

38. (a) The main precursors of acid rain are SO_2 and NO_2 in atmosphere which form H_2SO_4 (Sulphuric acid) and HNO_3 (nitric acid) with H_2O and these come down with rain. Such rains are called acid rains.