

Ecology & Environment

Quick Revision Material

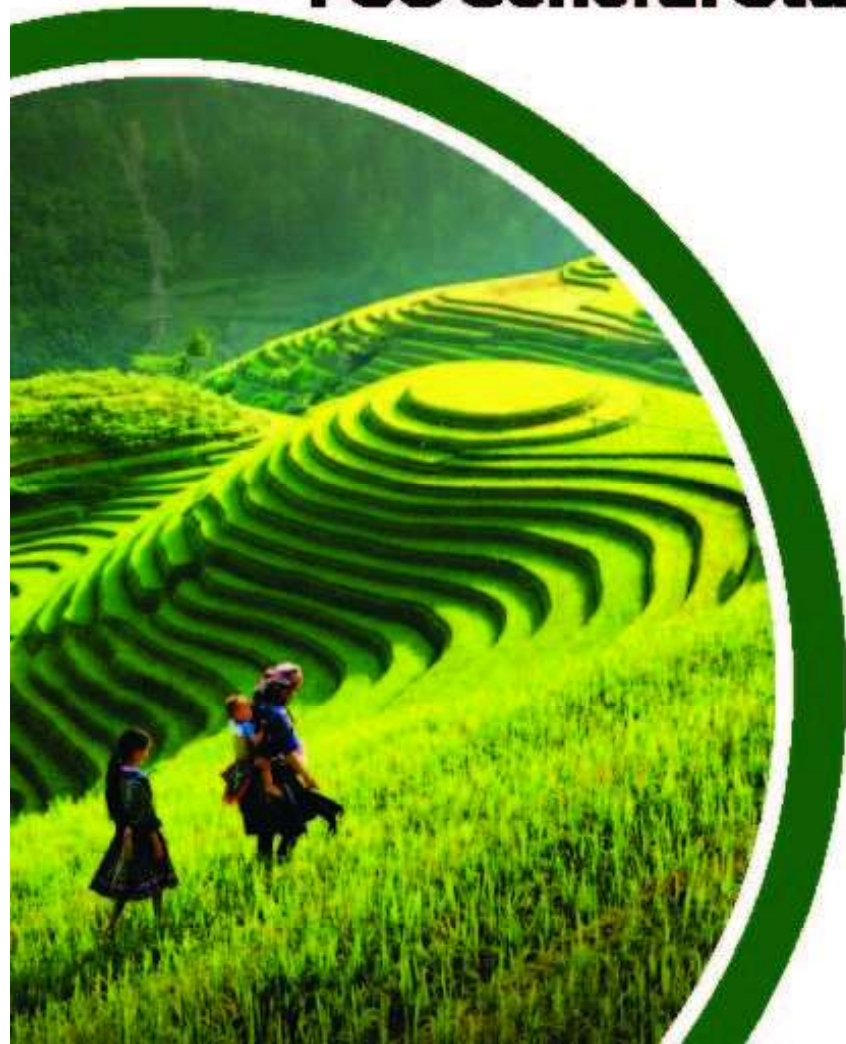
for UPSC & State
PSC General Studies Exams

Covers:

- Environmental Issues & Management
- Convention Policies

8
Chapters

200+
MCQs



Ecology & Environment

Quick Revision Material

**for UPSC & State
PSC General Studies Exams**

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CHAPTER

Ecology and Environment

Introduction

In this chapter we will study about ecology and environment in general; and ecosystem, food chain, food-web, ecological pyramids, succession, nutrition cycling, biomes, population interactions, ecological indicators, importance of ecosystems in particulars.

ECOSYSTEM

- The term 'ecosystem' was proposed by a British ecologist **A.G. Tansley (1935)**. It represents the basic fundamental, functional unit of ecology which comprises of the biotic community together with its abiotic (non-living) environment.
- Ecosystem is the functional unit of nature where living organisms interact with each other and with their environment.
- Ecosystems can be recognized as self regulating and self sustaining units of landscapes that may be **terrestrial** or **aquatic**. Forests, grasslands and deserts are **examples of terrestrial ecosystems**. The **aquatic ecosystems** can be either fresh water (ponds, lakes, streams) or salt water (marine, estuaries) type.
- Ecosystem may be **natural** (forest, sea), if developed under natural conditions or **artificial** (garden, aquarium, agriculture) if created by man.
- Ecosystem is normally an **open system** because there is a continuous and variable entry and loss of energy and materials. Ecosystem is known by different terms *i.e.*, biogeocoenosis or geobiocoenosis or microcosm or ecosom or biosystem, etc. the whole earth can be called biosphere or ecosphere.
- Ecosystem is composed of a variety of abiotic (non-living) and biotic (living organisms) components that function in an interrelated fashion.

Kinds of Ecosystem

Ecosystem can be classified as :

Natural ecosystem: The ecosystem which are completely dependent on solar radiation e.g. forests, oceans, grasslands, lakes, rivers and deserts.

Man-made ecosystem: The ecosystem which are dependent on human intervention e.g. agricultural fields and aquaculture ponds. Such ecosystems are also dependent on fossil fuels, e.g. urban and industrial ecosystem.

Components of Environment

- | Abiotic | Biotic |
|------------------------------|--------------------|
| ▪ Water | ▪ Man |
| ▪ Energy | ▪ Animals |
| ▪ Radiation | ▪ Green Plants |
| ▪ Fire | ▪ Non-Green Plants |
| ▪ Temperature & heat Flow | ▪ Parasites |
| ▪ Gravity | ▪ Symbionts |
| ▪ Atmospheric gases and wind | |
| ▪ Soil | |
| ▪ Geologic substratum | |
| ▪ Topography | |

Structure and Function of Ecosystem

- Ecosystem is self sustained functional units.
- The structure of an ecosystem can be expressed by the following terms –
 - Species compositor:** Plant and animal species found in an ecosystem.
 - Stratification:** Vertical layers of plants.
 - Standing crop:** Amount of biomass.
 - Standing state:** Amount of inorganic substances.

Species composition

- It differs from one ecosystem to another depending upon geography, topography and climate.
- Each ecosystem has a biotic community composed of particular grouping of species.
- Maximum species composition occurs in tropical rainforests and coral reefs. Minimum occurs in deserts and arctic regions.

Stratifications

- Stratification is the occurrence of vertical zonation in the ecosystem & indicates the presence of favorable environmental conditions, for *e.g.*, trees occupy top vertical strata or layer of a forest, shrubs and herbs & grasses occupy the bottom layers.

- Stratification helps in accommodation of large number & types of plants in the same area. It also provide a number of microhabitat & niches for various types of animals.
- It is absent or poor where environmental conditions are unfavorable, *e.g.* desert ecosystems have very few trees & shrubs.

Standing crop

- Standing crop is the amount of living biomass in an ecosystem. It indicates the productivity & luxuriance of growth.
- It is expressed in the form of number or biomass of organisms per unit area.
- A terrestrial ecosystem with high standing crop possesses a forest while the one with low standing crop occurs in grassland followed by arid ecosystem.

Standing state

- The amount of nutrients, *e.g.* nitrogen, phosphorus & calcium present in the soil at any given time is known as **standing state**.
- The proper functioning of an ecosystem takes place through the following processes:
 - Productivity
 - Decomposition
 - Relationship of producers and consumers
 - Flow of energy through different trophic levels, and
 - Cycling of nutrients.

Decomposition

- **Decomposition** is the breakdown of complex organic compounds of dead bodies of plants and animals into simpler inorganic compounds like CO₂, water & various nutrients.
- The organisms carrying out decomposition are called **decomposers**.
- Decomposers include **micro-organisms** (bacteria and fungi), **detritivores** (earthworm) and some **parasites**.

Energy flow

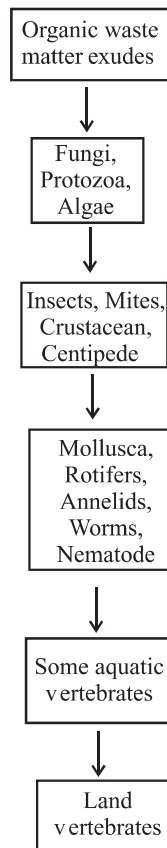
- Energy is the ability to do work. The main source of energy for an ecosystem is the radiant energy or light energy derived from the sun. 50% of the total solar radiation that falls on earth is **photosynthetically active radiation (PAR)**. The amount of solar radiation reaching the surface of the earth is 2 cal/sq.cm/min. It is more or less constant and is called **solar constant or solar flux**. About 95 to 99% of the energy is lost by reflection. The light energy is converted into chemical energy in the form of sugar by photosynthesis.



Food chain

- The ecosystems is characterized by the energy flow and the circulation of material through its members.

Detritus food chains is



The different organisms of an ecosystem are linked together by their nutritional requirements. Individual related in this manner constitute a food chain.

- **Food chain** is an order or sequence of different organisms which are arranged in a way that the food is passed from one type of organism to other organisms such that the organisms of one order or trophic level are the food of the organisms of next order.

Food web

- **Food web** refers to a group of inter-related food chains in a particular community. Under natural conditions, the linear arrangement of food chain hardly occurs & these remain indeed inter-connected with each other through different types of organisms at different trophic level.
- Simple food chains are very rare in nature. This is because each organism may obtain food from more than one trophic level. In other words, one organism forms food for more than one organisms of the higher trophic level.
- Food webs are very important in maintaining equilibrium (homeostasis) of ecosystem.

Example: In a grassland ecosystem

- Grass → Grasshopper → Hawk
- Grass → Grasshopper → Lizard → Hawk

- Grass → Rabbit → Hawk
- Grass → Mouse → Hawk
- Grass → Mouse → Snake → Hawk

TYPES OF ECOSYSTEMS

Ecosystems are of various types including the following:

Terrestrial Ecosystem

Tundra: Tundra is the world coldest and driest biome. This type of biome is totally snow covered vegetation at mountain tops.

- Soils are rich in organic matter due to slow decomposition rate and it is also one among the earth's three major carbon dioxide sink. There are three types of tundra- 1. Arctic Tundra 2. Antarctic Tundra 3. The Alpine Tundra

Grassland Ecosystem

A grassland ecosystem is the collection of plants, animals and micro-organisms that live within an environment where grasses are the primary form of vegetation. Grasslands cover around 40 percent of the earth's surface, and they exist in both temperate and tropical regions, generally within the dry interior areas of land masses. Such grassland experience wide range of temperature from about -20 to 30°C in extrem winter and warm summer. The amount of rainfall in grassland ecosystems is too little to support many large plants, though some trees do occur.

- In tropical grassland ecosystems, the heavy precipitation of the rainy season follows months of dry heat.
- Temperate grasslands alternate periods of abundance with periods of dormancy when the temperatures are too cold for growth.
- Some grassland ecosystems, such as the savanna or the prairie, produce tall grasses.
- Others, such as the windy steppes, grow very short grasses often less than an inch high.

Grassland ecosystems can support high densities of grazing animals. They are home to many familiar and fascinating species that live in herds, including zebras and antelopes, and the predators that prey on them, like lions and cheetahs.

- Temperate grassland: Such types of grassland have cold winters and warm summers. Summer temperature ranges to 38°C in summer and as low as -40°C in winter. Various species of grassland which include purple needle grass, blue grass, and buffalo grass are found here. Located between temperate forest at high latitude and desert at subtropical latitude and known by different names in different parts of the world as:
 - The Prairies of the great plains of North America
 - The Pampas of South America
 - The Veldt of South Africa
 - The Steppes of Central Euraisa
 - The Savanna in Africa

Forest Ecosystems

Forest ecosystem is the scientific study of the interrelated patterns, processes, flora, fauna and ecosystems in forests. The management of forests is known as forestry, silviculture,

and forest management. A forest ecosystem is a natural woodland unit consisting of all plants, animals and micro-organisms (Biotic components) in that area functioning together with all of the non-living physical (abiotic) factors of the environment. Forests accumulate large amounts of standing biomass, and many are capable of accumulating it at high rates, i.e. they are highly productive. Since trees can grow larger than other plant life-forms, there is the potential for a wide variety of forest structures (or physiognomies). The infinite number of possible spatial arrangements of trees of varying size and species makes for a highly intricate and diverse micro-environment in which environmental variables such as solar radiation, temperature, relative humidity, and wind speed can vary considerably over large and small distances.

Aquatic Ecosystem

An aquatic ecosystem is an ecosystem in a body of water. Communities of organisms that are dependent on each other and on their environment live in aquatic ecosystems. The two main types of aquatic ecosystems are marine ecosystems and freshwater ecosystems.

- **Marine Ecosystem:** Marine ecosystems cover approximately 71% of the Earth's surface and contain approximately 97% of the planet's water. They generate 32% of the world's net primary production. They are distinguished from freshwater ecosystems by the presence of dissolved compounds, especially salts, in the water. Approximately 85% of the dissolved materials in seawater are sodium and chlorine. Seawater has an average salinity of 35 parts per thousand (ppt) of water. Actual salinity varies among different marine ecosystems. Marine ecosystems can be divided into many zones depending upon water depth and shoreline features:
 - (1) The oceanic zone is the vast open part of the ocean where animals such as whales, sharks, and tuna live.
 - (2) The benthic zone consists of substrates below water where many invertebrates live. The intertidal zone is the area between high and low tides; in this figure it is termed the littoral zone.
 - (3) Neritic zones can include estuaries, salt marshes, coral reefs, lagoons and mangrove swamps.
 - (4) Abyssal Zone, hydrothermal vents may occur where chemosynthetic sulfur bacteria form the base of the food web.

Classes of organisms found in marine ecosystems include brown algae, dino-flagellates, corals, cephalopods, echinoderms, and sharks.

Sea Life

Sea regions are broadly divided into coral reefs, estuaries and oceans.

- **Oceans:** They are the biggest and the most varied of the ecosystem. Most of the oxygen in the atmosphere is generated by the algae. Here salt water evaporates and turns to rain which in turn falls on land. Large amount of carbon dioxide is absorbed by the algae in the atmosphere. Inter - tidal zone is the zone which connect ocean to the land. Only few species exist in rocky coastal areas as very few tides reach there.

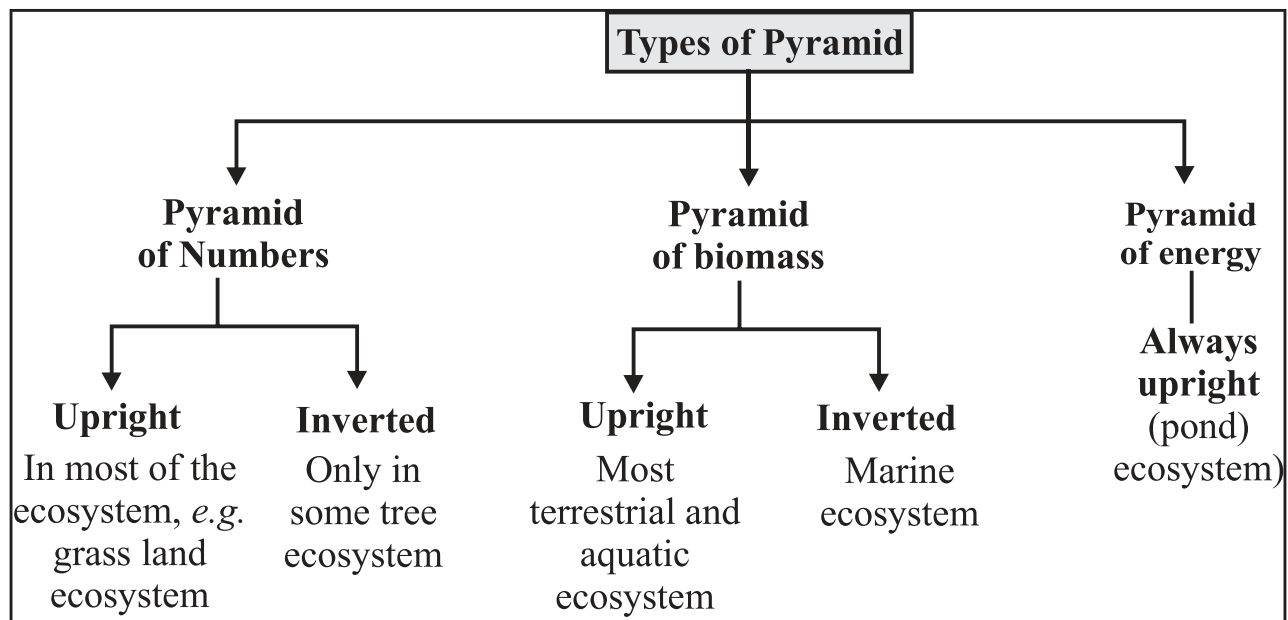
- **Other oceanic zones:** Deep sea which is also called benthic zone is the host to slit, sand and slowly decomposing organisms. Sunlight does not reach these areas so these areas are very cold. There are only few plants here and animals include starfish, anemones, sponges, amongst others, as well as several micro-organisms. Abyssal zone is the deepest part of the ocean. Fishes such as oddities and many species of invertebrates are found here.
- **Coral Reefs:** They are the marine ridges and mounds which are formed due to the decomposition of calcium carbonate of living organisms. Coral consist of animal and algae tissues. It is a living organism. Corals use tentacles to catch microorganisms like animals do and feed by the process of photosynthesis like plants. The coral reef is also host to other species such as starfish, octopi and other mollusks. Coral animals cannot live in water cooler than 65°F (18°C), therefore coral reefs are found mostly in warm, shallow, and tropical seas.
- **Estuaries:** Transition area between river and sea is called estuary. They are highly productive and rich in nutrients. There are many different names of estuaries like bays, sounds, inlets, harbors, and sloughs.
- **Freshwater Ecosystem:** Freshwater ecosystems cover 0.78% of the Earth's surface and inhabit 0.009% of its total water. They generate nearly 3% of its net primary production. Freshwater ecosystems contain 41% of the world's known fish species.

Mangroves

- Mangrove trees are an indigenous species to tropical as-well-as subtropical regions with approximately 70 identified species worldwide. They are a major contributor to the littoral and marine environments & Mangrove trees are halophytes, plants that thrives in salty condition & Mangroves have the ability to grow where no other tree can, thereby making significant contributions that benefit the coastal ecology. Their coverage of shorelines and wetlands provides many diverse species of birds, mammals, crustacea, and fish a unique, irreplaceable habitat Mangroves preserve water quality and reduce pollution by filtering suspended material and assimilating dissolved nutrients.

ECOLOGICAL PYRAMIDS

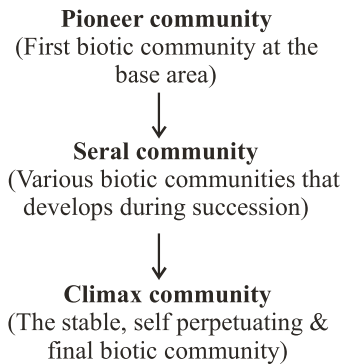
- The number, biomass and energy of organisms gradually decrease from the producer level to the consumer level. The number of individuals present or amount of biomass synthesized or amount of energy stored at successive trophic levels in an ecosystem can be graphically represented in the form of pyramids. These are called **ecological or Eltonian pyramids**. The use of ecological pyramid was first described by Charles Elton in 1927.
- In the ecological pyramid, the producer forms the base and the final consumer occupies the apex.
- Three ecological pyramids which are studied are – **pyramid of number, pyramid of biomass and pyramid of energy**.



ECOLOGICAL SUCCESSION

- Ecological succession is the successive development of different biotic communities at the same site. The communities develop one after another till the development of a community which is near equilibrium with the environmental conditions. This is called **climax community**.
- Climax community is the stable perpetuating and final biotic community that develops at the end of biotic succession. It has maximum diversity & niche specialization.
- The first biotic community which invades a base area is called **pioneer community**. It is characterized by high growth rate and short life span.

- The transitional communities which develop during the ecological succession or in between the pioneer and climax community are called **seral communities**.



- The entire series of communities that is characteristic of given site is called a **sere**.

Types of Succession

- Succession is of **two types**: Primary and Secondary
- Primary succession**: It is the ecological succession occurring in an area where no organisms are found, like bare rocks.
- Secondary succession**: This type of succession takes place in those areas where all the previous biotic communities have been destroyed, *e.g.* - burned forests, flooded fields.

NUTRIENT CYCLING

- These are the cyclic events by which various nutrients which are essential for the living organisms are transferred from one form to other. During these cycles, the nutrients pass from the biotic components to the abiotic components and *vice-versa*; hence these are also called **biogeochemical cycles**.
- Two types** of nutrient cycles are –
 - Gaseous cycles** (nitrogen, oxygen, carbon cycles)
 - Sedimentary cycles** (phosphorus, sulphur cycles)
- In gaseous cycle, the main reservoirs of chemicals are the atmosphere and ocean.
- In sedimentary cycles, the main reservoirs are soils and rocks.

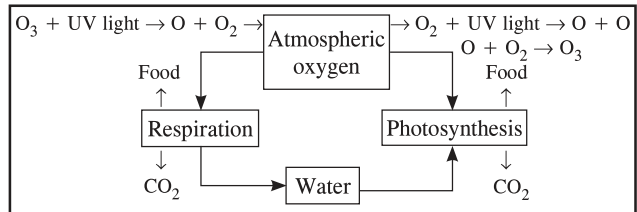
Nitrogen (N₂) Cycle

Nitrogen cycle is a process by which nitrogen is converted between its various chemical forms. 78% of earth atmosphere is nitrogen. Nitrogen cycle is necessary because plants cannot absorb nitrogen directly; they can only absorb in the form of *nitrate*. Nitrogen cycle have 5 important processes, i.e., fixation, ammonification, nitrification, assimilation and denitrification.

Oxygen (O₂) Cycle

- Oxygen is a very important element for the existence of all flora and fauna. Atmosphere contains 21% of oxygen.
- The main source of oxygen is atmosphere. Plants and animals absorb oxygen through respiration either from water or air and leaves through photosynthesis.

- In respiration process some of the oxygen returns to the atmosphere in the form of carbon dioxide and water vapour. During the process of photosynthesis gaseous oxygen is released completing the oxygen cycle.
- The source of ozone is the oxygen in the atmosphere. Ozone layer protects the living being from the UV radiation which reaches the earth.
- By burning fossil fuels man decreases the amount of oxygen in the atmosphere and increases the carbon dioxide content.



Oxygen Cycle

As the oxygen concentration in the atmosphere remains constant at 21%, it is likely that natural degradation of ozone must occur to maintain the ozone : oxygen equilibrium. The oxygen cycle is affected most by human activities such as running of automobiles and consumption of fossil fuels, thus releasing more carbon dioxide in the atmosphere.

Carbon(C) Cycle

- Carbon is present in carbohydrates, proteins and fats.
- Carbon is taken up by green plants as CO₂ for photosynthesis.
- Carbon is present as CO₂ in atmosphere, as graphite and carbonates in rocks and also in fossil fuels (coal, petroleum).
- Ocean are big reservoirs of carbon.
- Carbon is released as CO₂ in atmosphere during –
 - respiration of plants and animals
 - burning of fossil fuels
- Carbon is also released in atmosphere as methane by rice fields and marshes.

Phosphorus(P) Cycle

- Phosphorus is an important element for living beings.
- The cycling of phosphorus between biotic & abiotic components of the environment represent phosphorus cycle.
- Phosphorus is present in
 - biomembranes (as phospholipids).
 - nucleic acids (as phosphoric acid).
 - nucleotides (as AMP, ADP, ATP etc).
 - bones and teeth (as hydroxyapatite).
- Consumers obtain phosphorus directly or indirectly from plants.
- Phosphorus is also present in phosphatic rocks.
- Phosphorus is released during the decomposition of plant and animal remains.
- The released phosphorus may reach the deeper layers of soil and gets deposited as phosphate rocks.
- Phosphorus containing rocks are mined for manufacture of fertilizers, which provide an additional supply of an organic phosphates to the abiotic environment.

BIOMES

Community Ecology or Synecology: Community ecology is a study of pattern and processes involving at least two species on many spatial and temporal scale which include the distribution, structure, abundance, demography, and interactions between coexisting populations.

Biomes: Biome is a part of large ecosystem that have common characteristic due to similar climates and can be found over a range of continent. In other words biomes are largely natural eco-system wherein we study the total assemblage of plant and animal communities. Though a biome includes both plant and animal communities but a biome is usually identified and named on the basis of its dominant vegetation. Most of the ecologists have recognized at least nine different biomes.

Land biome include tropical rain forest coniferous forest, temperate broad leaf deciduous forest, mediterranean forest, tropical deciduous forest, tropical scrub, grassland, tundra and desert.

Biomes of India

There are five biomes in India.

- (i) Tropical Humid Forest
- (ii) Tropical Dry of Deciduous Forest (including monsoon forest)
- (iii) Warm deserts and semi-deserts
- (iv) Coniferous Forest
- (v) Alpine meadows

Ecological Indicators

Ecological indicators are used to communicate information about ecosystems and the impact human activity has on ecosystems to groups such as the public or government policy makers. Ecosystems are complex and ecological indicators can help describe them in simpler terms that can be understood and used by non-scientists to make management decisions.

There are different types of ecological indicators:

- (a) **Keystone Species:** A keystone species is a species that has a disproportionately large effect on its environment relative to its abundance. Such species are described as playing a critical role in maintaining the structure of an ecological community, affecting many other organisms in an ecosystem and helping to determine the types and numbers of various other species in the community.
- (b) **Umbrella Species:** Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat. Species conservation can be subjective because it is hard to determine the status of many species.
- (c) **Flagship Species:** The concept of flagship species has its genesis in the field of conservation biology. The flagship species concept holds that by raising the profile of a particular species, it can successfully leverage more support for biodiversity conservation at large in a particular context. e.g. Bengal tiger, Giant Panda etc.

EXERCISE

1. A sandy and saline area is the natural habitat of an Indian animal species. The animal has no predators in that area but its existence is threatened due to the destruction of its habitat. Which one of the following could be that animal?
 - (a) Indian wild buffalo
 - (b) Indian wild ass
 - (c) Indian wild boar
 - (d) Indian gazelle
2. In addition to global climate change, humans are negatively impacting coral reefs by:
 - (a) destructive harvesting of fish for food or pets.
 - (b) using large amounts of coral rock to pave roads.
 - (c) destroying large regions of coral reefs for commercial aquaculture.
 - (d) introducing alien species that are thought to be more productive.
3. The concept of sustainable development relates to:
 - (a) consumption levels
 - (b) exhaustible resources
 - (c) social equity
 - (d) Intergenerational equity
4. The variability among living organisms from all sources including terrestrial, marine and other ecosystems and the ecological complexes of which they are part which includes diversity within species, between species of ecosystems refers to:
 - (a) geographical diversity
 - (b) zoological diversity
 - (c) ecological diversity
 - (d) biological diversity
5. 'Population dividend' refers to:
 - (a) total number of population
 - (b) youthful age structure of a population
 - (c) relatively high proportion of experienced aged people
 - (d) migration from richer region to poorer region
6. Inclusion strategy does not focus on:
 - (a) reduction of inequality
 - (b) reduction of poverty
 - (c) diversifying livelihood for tribal population
 - (d) getting poorer countries close
7. Which one of the following is the best description of the term 'ecosystem'?
 - (a) A community of organisms interacting with one another.
 - (b) That part of the Earth which is inhabited by living organisms.
 - (c) A community of organisms together with the environment in which they live
 - (d) The flora and fauna of a geographical area
8. Which one of the following is the national aquatic animal of India?
 - (a) Saltwater crocodile
 - (b) Olive ridley turtle
 - (c) Gangetic dolphin
 - (d) Gharial