ECOSYSTEMS AND ECOLOGICAL SUCCESSION

No organism can exist by itself without the environment. The living organisms (biotic) and their non living (abiotic) environment are inseparable inter-related and interact upon each other. Any unit, in which there is interaction between organisms and their physicochemical environment and when there is an exchange of material between the two, is called ecosystem. The term *'Ecology'* has been derived from the Greek word Oikos, meaning house and Logos, means to study. The interaction results in continuous production, consumption and exchange of materials between the living and nonliving component of the environment following cyclic process.

1.1 TYPES OF ECOSYSTEM:

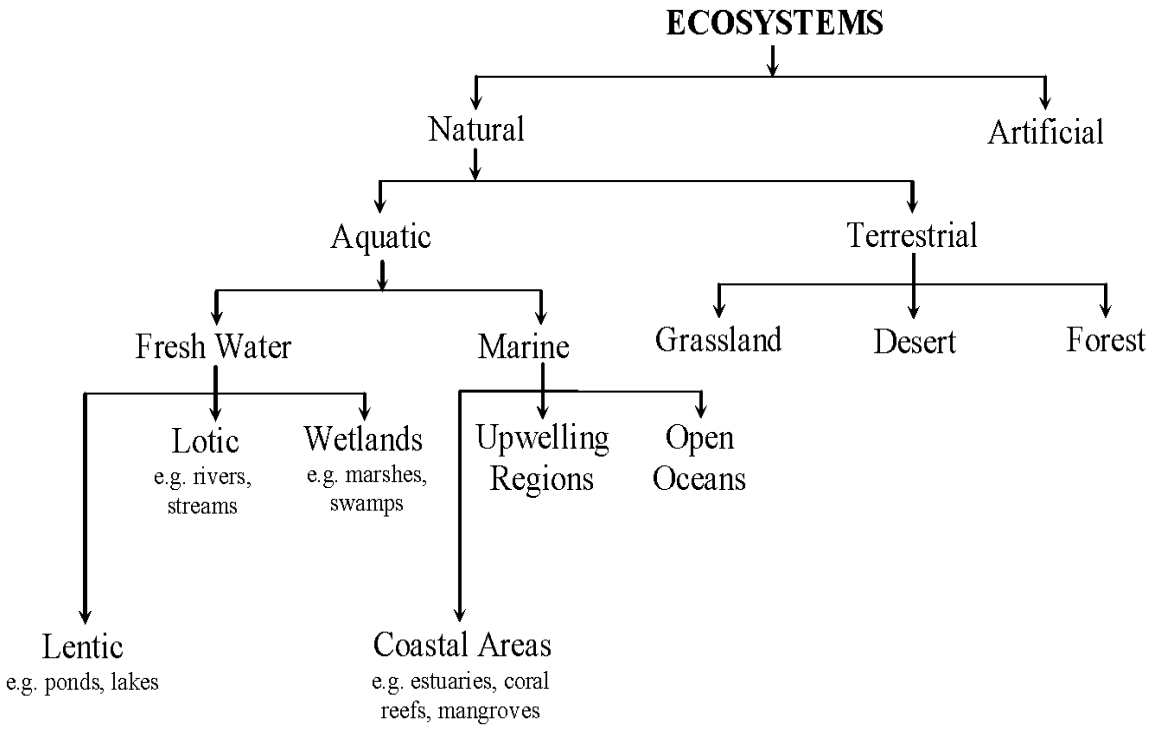
According to habitat types and formation, ecosystem are of following types:

1. Natural : Form by nature
2. Manmade: Form by Man

Natural ecosystem are of two types:

A: Terrestrial ecosystem: The ecosystem are operating in land.

B: Aquatic ecosystem: ecosystem operating in water.



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1.2 STRUCTURE OF ECOSYSTEM:

Ecosystem consist of two major components:

(A) **Abiotic components** (weather, earth, sun, water, soil, climate, atmosphere etc.)

(B) **Biotic components** (producer, consumer, decomposer)

(A) Abiotic structure (The non living environment)

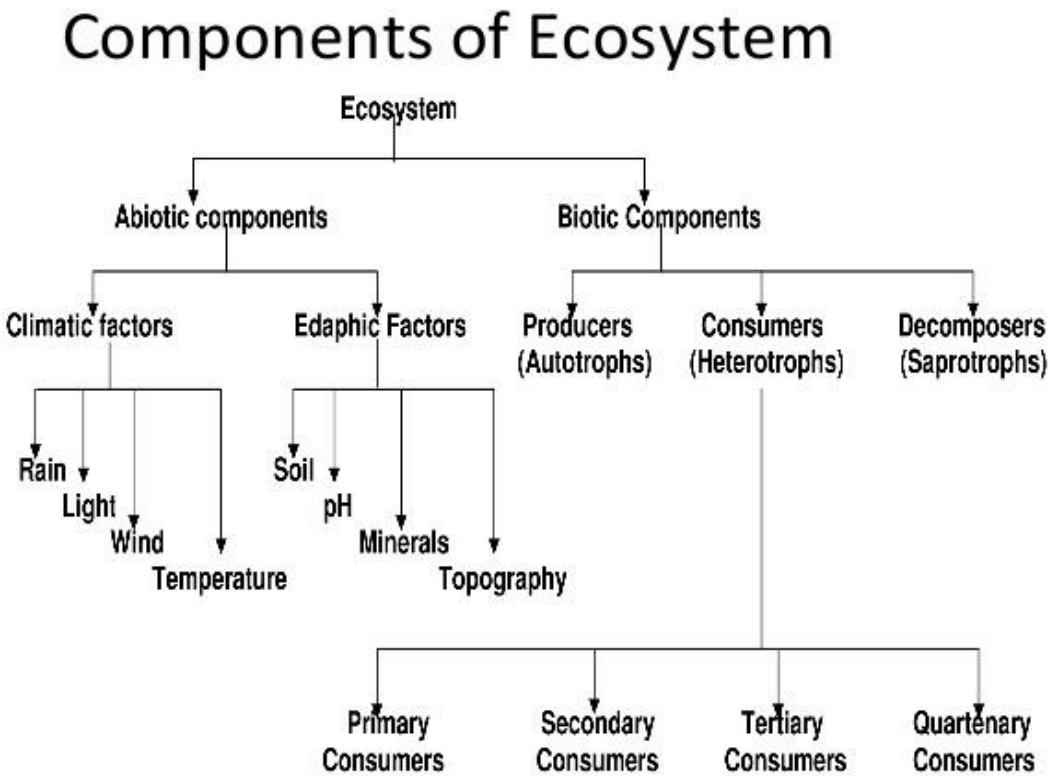
Components those are nonliving are called as abiotic components. The physical environment with its several interacting variables constitutes the abiotic components of an ecosystem. They have a strong influence on the structure, distribution, behavior and interrelationship of organisms. The non living substances enter into the body of living organisms, take a part of metabolic activities and then return to the environment. The abiotic factors include:

(i) The solid mineral matter of the earth i.e. lithosphere

(ii) The water in the ocean, river, lake, ponds etc. i.e. hydrosphere

(iii) The gaseous mixture in the air i.e. the atmosphere

(iv) The radiant solar energy i.e. radiant energy of sun



(B) Biotic structure (The living environment)

In an ecosystem, living organisms (plants and animals) are generally considered as the biotic components. The group of living organisms which can prepare their own food materials are called as autotrophic (auto means self, troph means nourishing) organisms. Examples of this category are all the green trees, grasses, crops, phytoplankton etc. In the other hand group of living organisms which can't prepare their own food materials and depends upon other living organism directly or indirectly are called as heterotrophic (hetero means other, troph means feeder) organisms. Examples of this category are all animals including human being. On the basis of their role and behavior in the ecosystem the biotic components are classified into three major groups like;

(i) Producers (ii) Consumers (iii) Decomposers.

(i) Producers

Producers are the autotrophic members of the ecosystem which are mainly green plants and are capable of synthesizing food from non-living simple inorganic substances. They include plants, algae and diatoms. They convert solar energy into chemical energy with the help of inorganic substances such as water and carbon dioxide and organic substances such as enzymes.

The kinetic energy of light is absorber by chlorophyll (the green pigment) in the cells of the plant. This removes the hydrogen atoms from water (H_2O) molecule. The hydrogen atoms combine with carbon atoms available from carbon dioxide (CO_2) to form a glucose molecule. As a result, the oxygen atoms that remain combine with each other to form oxygen gas which is released in to the air. This physiological process taking place in plant is called photosynthesis. The overall process of photosynthesis is described in the equation below;

$$6\,CO_2 + 12\,H_2O \xrightarrow[\text{Solar energy}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6\,H_2O + 6\,O_2$$

The rate of photosynthesis is proportional to the intensity of light. Utmost, 2 calories of sugar are formed for each 100 calories of light energy falling on the plant. Thus green plants are considered as machines in performing the conversion of light energy to chemical energy which is the source of energy for other living organisms of ecosystem.

(ii) Consumers

Consumers are heterotrophic members of the ecosystem, which feed upon other living organisms. The animals lack chlorophyll and are unable to synthesize their own food. Therefore, they depend upon the producer for their food. On the basis of their food habits, consumers are of two types, i.e. herbivores (plant eaters) and carnivorous (flesh eaters). Insects, zooplankton, deer, cow goat, elephant etc. are the example of herbivores and tiger, lion etc. are the examples of carnivorous. Further, on the basis of their food habits carnivores are either order I (C 1), order II (C 2) and so on.

Classes of Consumers

Primary consumers (also called as secondary producer)- herbivorous (plant eaters) e.g. rabbit, dear, goat, cattle, grasshopper etc.

Secondary consumers (also called as tertiary producer) -primary carnivorous (flash eaters) e. g. cat, dog, fox, snake etc.

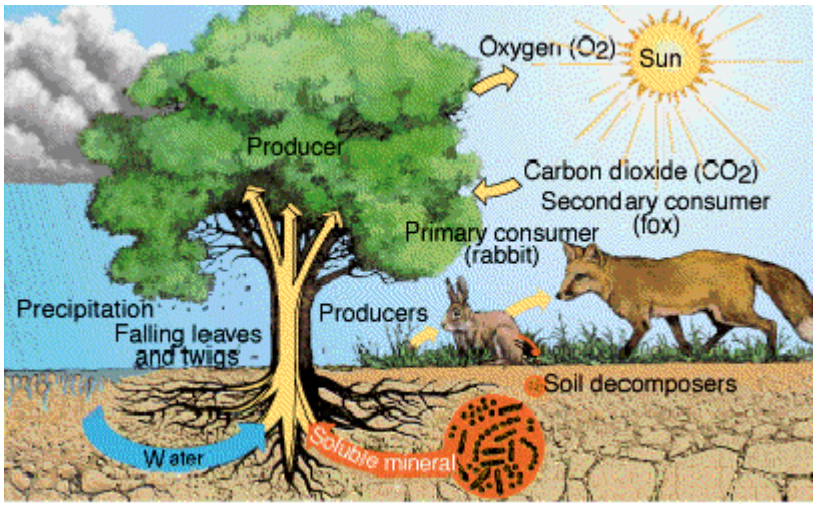
Tertiary consumers – (also called secondary carnivorous)- top carnivorous (meat eaters) e.g. wolves.

Quaternary consumer – Omnivores (eat both plants/animals) e.g. man

About 60-90% of the food eaten by consumers is oxidized for energy and the remaining 10-40% is converted to the body tissue of the consumer. This is the fraction that enables the body to grow, maintain and repair by itself.

(iii)Decomposers

Decomposers are also heterotrophic organisms which depend upon dead organic matter for their food. Mostly bacteria, actinomycetes and fungi are microorganisms coming under this group. They imbibe dead organic matter and break down the complex organic matter like cellulose, hemicelluloses, chitin etc. which are present in the plant and animal body and converts it into simpler substances which can be used by the green plants.



Role of organisms

1.3 FUNCTION OF ECOSYSTEM:

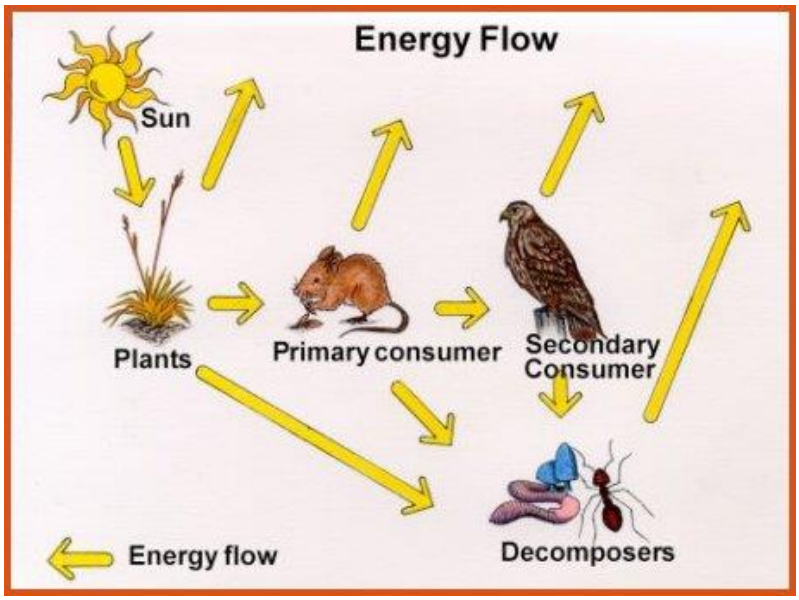
Some of the important functions of any ecosystem are;

- Energy flow
- Food chain
- Food web
- Nutrient cycles
- Ecological pyramid

Energy Flow In Ecosystem:

- ❖ All organisms must obtain a supply of energy and nutrients from their environment in order to survive.
- ❖ The transformations of energy in an ecosystem begin first with the input of energy from the sun.
- ❖ Because, it is the first step in the production of energy for living things, it is called “Primary production”.
- ❖ Photosynthesis -- Chemical reaction where green plants use water & carbon dioxide to store the sun’s energy in glucose.
- ❖ ENERGY is stored in glucose.
- ❖ Glucose is stored as starch in plants
- ❖ The majority of autotrophs are photoautotrophs that harness the energy of the sun and pass some of this energy onto consumers through feeding pathways.
- ❖ The energy contained within producers and consumers is ultimately passed to the decomposers that are responsible for the constant recycling of nutrients.
- ❖ Thus, there is a one-way flow of energy through the biotic community and a cycling of nutrients between the biotic and abiotic components of the ecosystem

- Energy flow cannot occur in reverse direction.
- Starts from autotrophs (the producer level, i.e., first trophic level) to Heterotrophs including plant eaters or Herbivores (second trophic level) and so on.
- The amount of energy decreases with successive trophic levels.
- Only About 1% of energy from the sun is used by green plants & rest remains unutilized.
- Similarly, there is loss of energy in each trophic level.
- The transfer of food energy between the organisms in an ecosystem can be tracked by constructing food chains, food webs, pyramids of numbers, biomass and energy and energy flow diagrams.



Energy Flow

Food Chain:

All living things need food to get energy to grow, move and reproduce. But what do these living things feed on? Small insects feed on green plants and bigger animals feed on smaller ones and so on. This feeding relationship in an ecosystem is called as a food chain. Food chain is usually in a sequence, with an arrow used to show the flow of energy.

- A food chain may be defined as, “the transfer of energy and nutrients through a series of organisms with repeated process of eating and being eaten”.
- In an ecosystem, all the organisms are linked together with one another by food relationship.
- Each organism living or dead is potential food for some other organism.

There are three types of food chain exists in a mature ecosystem;

- Grazing food chain

- Detritus food chain
- Parasitic food chain
- **Grazing food** chain starts from green plants followed by grazing herbivorous and finally become a prey to carnivorous. Here the food chains are directly depending on an influx of solar radiation. This depends on the capture of solar energy by the autotrophic organisms and conversion of this to chemical energy and the movement of this energy in form of food to herbivorous and then to carnivorous of different orders. Ecosystems like grassland, pond or lake are herbivorous based and herbivorous are considered as important consumers. In Grazing food chain, the primary producers are the living green plants which are grazed on by grazing animals. It is found in aquatic and grassland ecosystem.
- Food chain in aquatic ecosystem:- Phytoplankton →Zooplankton→ Small Fish→ Big Fish
- Food chain in grassland ecosystem:- Grass → Rabbit → Fox → Wolf →Tiger

  or

  Grass→ Grasshopper→ Frog→ Snake → Hawk

❖

- **Detritus food chain** starts from dead organic matter into microorganisms and then to the organisms feeding on detritus and their predators. Here the food chain does not depend on the capture of solar energy but it depends on the influx of dead organic matter. In case of forest ecosystem, big plants are mainly the primary producers and the dominant primary consumers are insects. The dominant detritus feeding animals in such ecosystem are microarthropods, oligochaetes and microorganisms such as bacteria, fungi, actinomycetes, protozoa etc. The dead complex organic matter is broken down into simple nutrients by microorganisms like fungi and bacteria. This type of food chain is found in forest ecosystem.
  - Example of detritus food chain:- Dead organic matter→ Detritus → Predators

- In **Parasitic food chain** either the producer or the consumer is parasitized and therefore the food passes to the smaller organism. Parasites live on or inside the body of the host and

derive benefit from the host. The parasite gets nutritional benefit and the host is harmed. The energy transfer through this kind of food chain is not significant.

- Examples of parasitic food chain:-
- Producer→ Herbivores (Host)→ Parasite (tick / aphid)→ Birds →Carnivore
  - or
- Trees→ Fruit eating birds→ Lice and bugs→ Bacteria and fungi
  - or
- Radiant energy of the sun -> Green Plants -> Sheep -> Liver fluke
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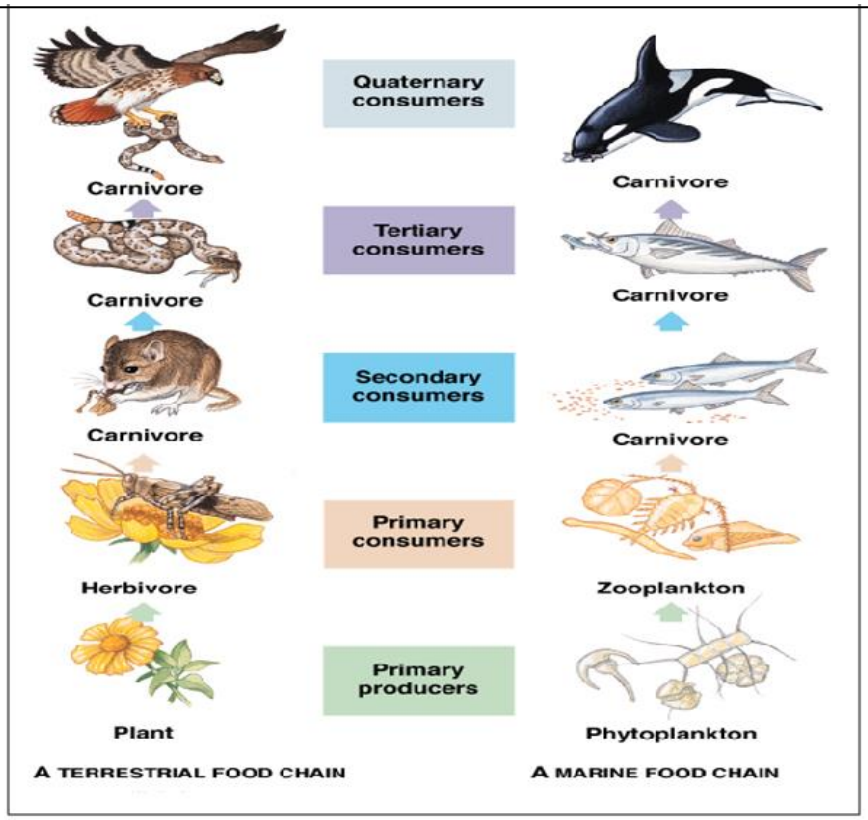
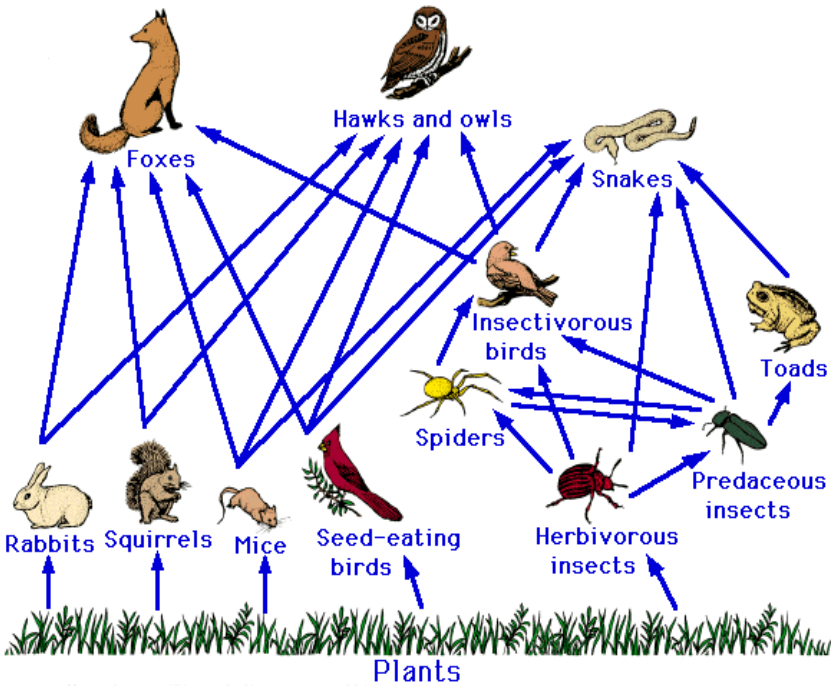


Food Chain

Food Web:

- Under natural conditions, the linear arrangement of food chains hardly occurs & these remains connected interconnected with each other through different types of organisms.
- Interlocking pattern of several interlinked food chains is termed as food web.



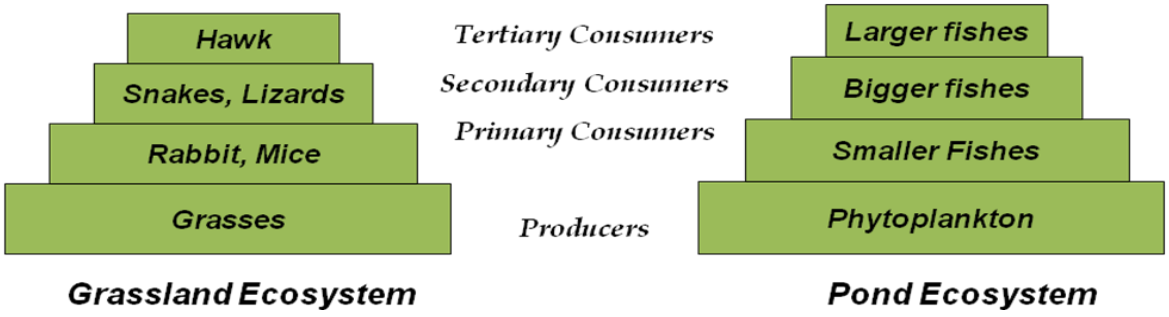
Food web in grassland ecosystem

Ecological Pyramids:

- An"Ecological pyramid" is a graphical representation that shows the relative amounts of energy or matter contained within each tropic level in a food chain or food web.
- An ecological pyramid shows the relationship between consumers and producers at different tropic levels in an ecosystem
- There are three ecological pyramids recognized by ecologists:

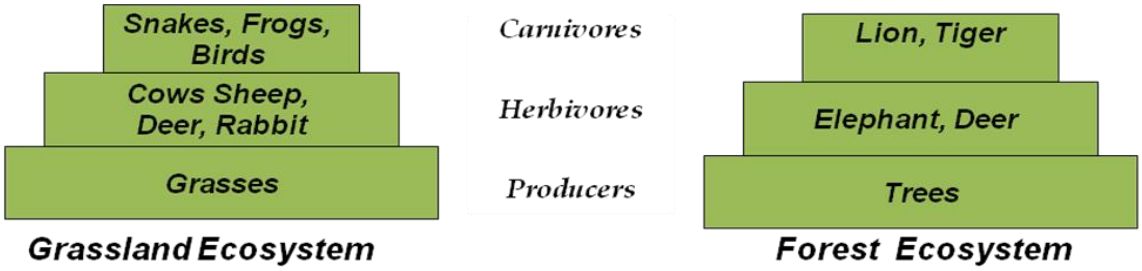
1. Pyramid of Numbers:

- ✓ Shows the relative number of individual organisms at each tropic level.



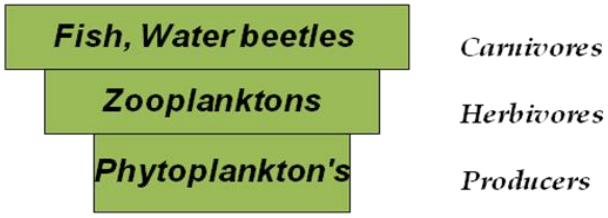
2.Pyramid of Biomass

- A pyramid of biomass represents the total dry mass (in grams per square meter of area) of all the organisms in each tropic level at a particular time.



Grassland Ecosystem

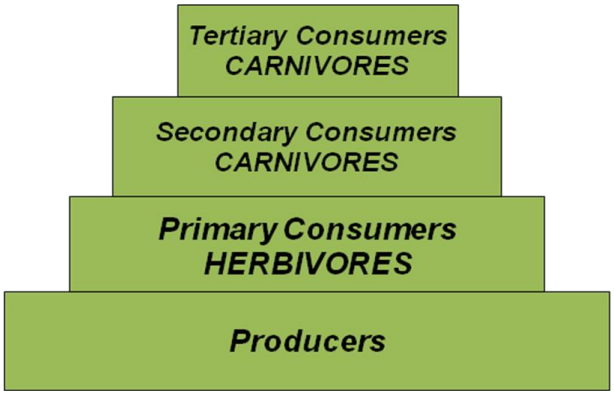
Forest Ecosystem



Pond Ecosystem

3. Pyramid of Energy

- A pyramid of biomass represents the rate of energy flow and/or productivity at successive tropic levels. The pyramids of energy are always upright.



Nutrient Cycles:

- Nutrient cycles involve storage and transfer of nutrients through different components of the ecosystem, so that the nutrients are repeadly used.
- The cyclic movements of chemical elements of the biosphere between the organisms and environment are referred as **"Biogeochemical Cycles"**

Gaseous cycle: Those elements in which the reservoir is the air or the oceans (via evaporation). Gaseous cycles include those of Carbon, Nitrogen, Oxygen, Carbon, and Water.

Sedimentary cycle: Those elements which are received from the Earth's crust. Sedimentary cycles include those of iron, calcium, phosphorus, and other more earth bound elements.

1. Nitrogen Cycle

- Nitrogen is crucial for all organisms
  - Nucleic acids
  - Proteins
  - Chlorophyll
- Nitrogen- 78% in Atmosphere
- N_2 is very stable and must be broken apart by organisms, combined with other atoms into a usable form.
- Nitrogen cycle completes in 5 steps:

i) Nitrogen Fixation

Conversion of $N_2 \rightarrow NH_3$

- Combustion, volcanic action, Lightning, Industrial processes (making fertilizer). Bacteria (Azotobactor, Clostridium, Nostoc etc.)

ii) Nitrification

Conversion of $NH_3 \rightarrow NO_3$

Soil bacteria convert in a two step process.

iii) Assimilation

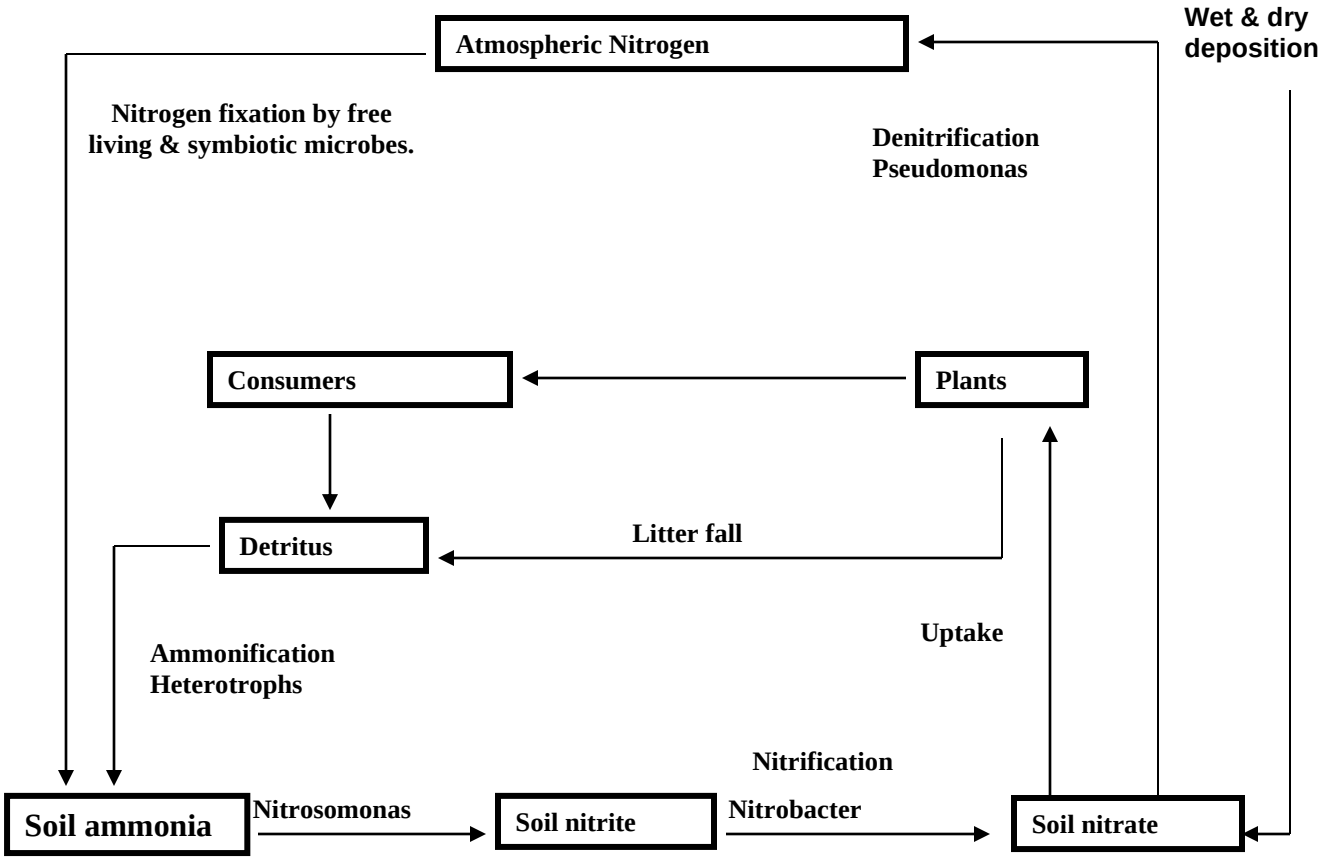
Roots absorb NH_3, NH_4, or NO_3 and incorporate them into nucleic acids and protein.

iv) Ammonification

Amino acids and nucleotides are broken down into waste products NH_3 or NH_4

v) Denitrification

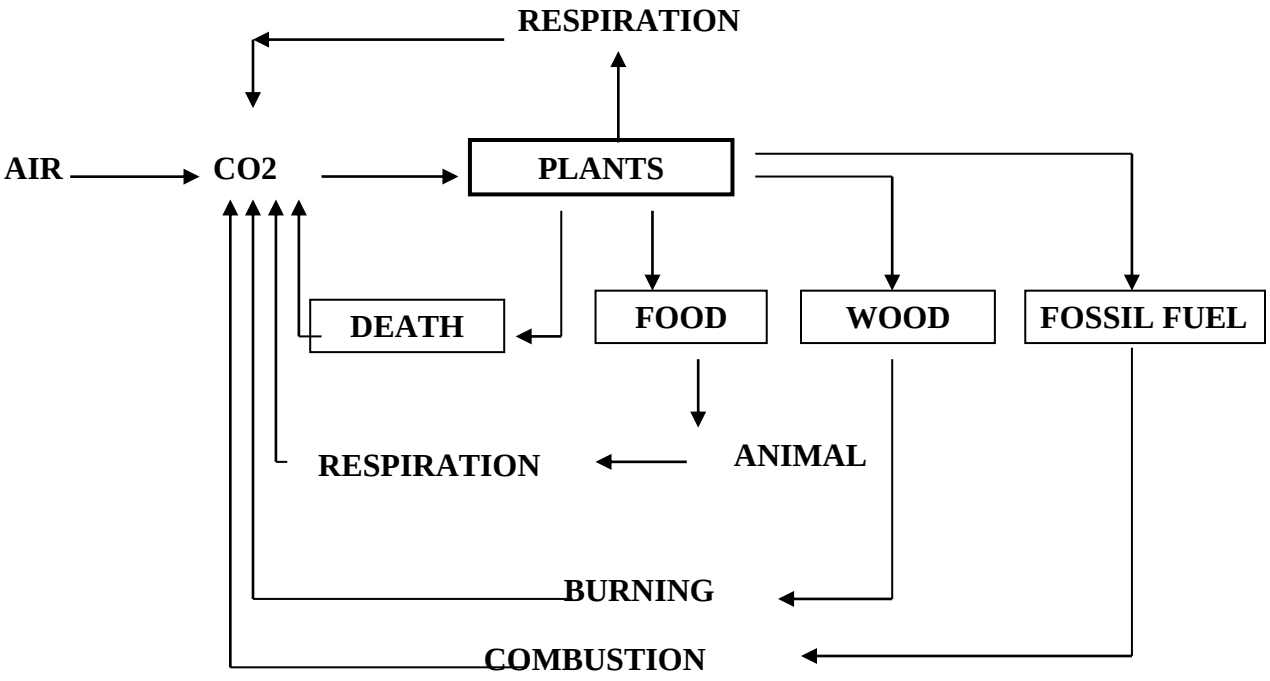
The reduction of NO_3 to N_2 .Denitrifying bacteria return some of the nitrogen to the atmosphere.



1.Nitrogen Cycle

2. Carbon Cycle

- Carbon enters plants, etc., as CO_2
  - Bacteria process carbon in a fashion that allows it to be recycled.
  - Obtain energy from the molecules, and convert carbohydrates to carbon dioxide as a result of respiration.
- Photosynthesis removes carbon from the abiotic environment (fixes carbon into organic molecules)
- Carbon moves through food chain through consumption of one organisms by another
- Cellular respiration, combustion, and erosion of limestone return carbon to the atmosphere, water and abiotic environment.

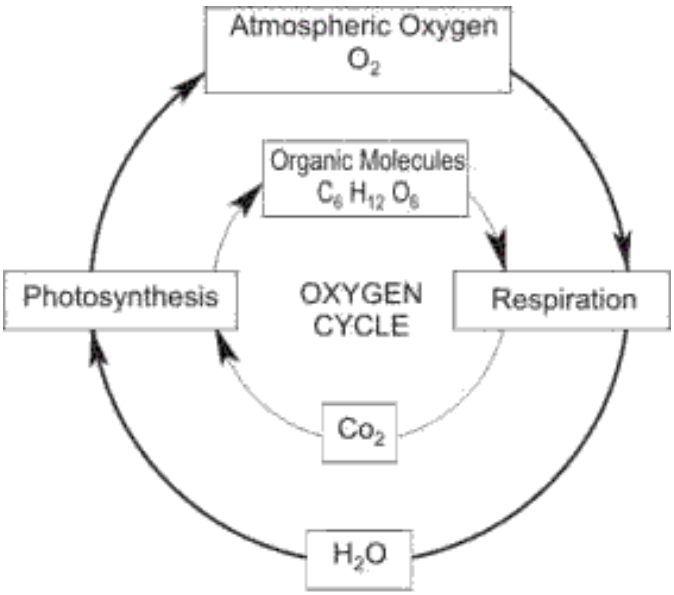


2. Carbon Cycle

The source of atmospheric carbon dioxide is variable but only plants can utilize atmospheric carbon directly

3.Oxygen Cycle

Oxygen is an important element of life on earth. It is the most common element of human body which makes up about 65% of the mass of the human body, most of which is in the form of water (H_2O). Oxygen also makes up about 30% of the Earth and 20% of the atmosphere. Oxygen is present at about 20.94% by volume in the atmosphere and in dissolved state in water. It also present in combined state with CO_2, CO_3^{2-}, HCO_3^-. The oxygen cycle describes the movement of oxygen within its three main reservoirs i. e. the atmosphere (air), the total content of biological matter within the biosphere (the living part of the earth), and the lithosphere (earth's crust). Plants, animals and human beings use oxygen from the surrounding for aerobic respiration and release oxygen in the form of CO_2 and water. Green plant use CO_2 during photosynthesis and release oxygen to atmosphere. The following table offer estimates of oxygen cycle reservoir capacities and fluxes.



Oxygen cycle

1.4 ECOLOGICAL SUCCESSION

- Ecological succession is defined as, "A change in the community in which new populations of organisms gradually replace existing ones".
- There are two types of ecological succession:

1) Primary Succession

- Occurs where there is no soil, e.g. after a volcanic eruption or a glacial retreat.
- "Pioneer organisms"
- Simple plants first – no or shallow roots.
- Gradual influx of more complicated and larger plants as the habitat changes
- Unfavorable for life at first.
- Ends with a "climax community" – ecosystem stays constant, provided there are no changes in abiotic influences.

2) Secondary Succession

- Community development in the areas that were previously occupied by other community.
- Occurs after a disturbance. E.g., loss of trees after disease, Fire or wind, deforestation etc.
- Conditions are favorable for as soil and nutrients are already present.
- More rapid than primary succession.
-

Primary Succession Vs Secondary Succession

Primary	Secondary
➢ No soil. ➢ Pioneer species. ➢ Weathering & decomposition ➢ Humus and sand increase over time. ➢ End = Climax community.	➢ Soil already exists. ➢ Seeds have suitable soil conditions. ➢ Occurs much faster. ➢ Climax community.

XEROSERE (Primary Succession)

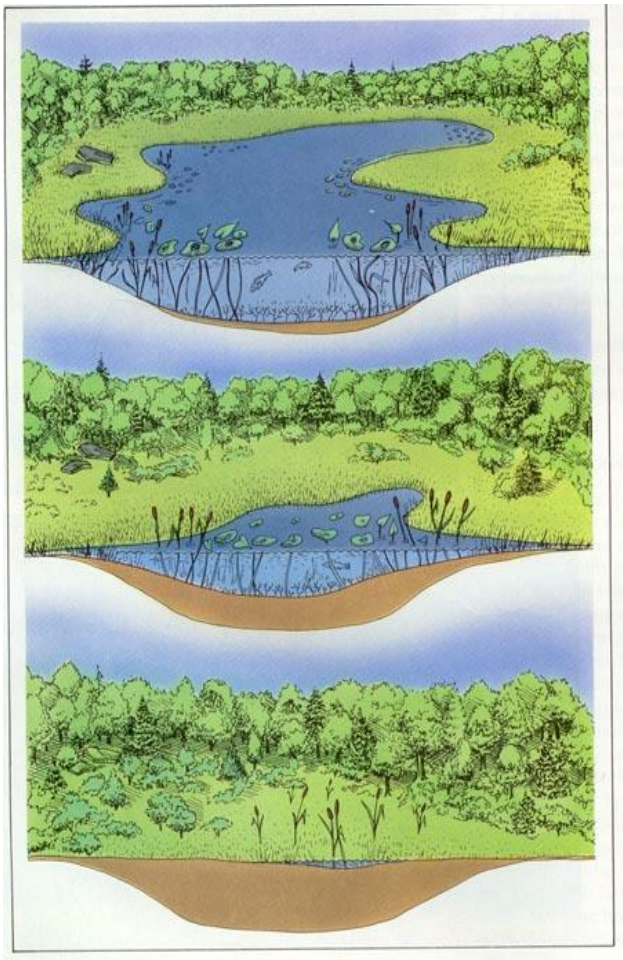
Xerosere is a plant succession which is limited by water availability. It includes the different stages in a xerarch succession. Xerarch succession of ecological communities originated in extremely dry situation such as sand deserts, sand dunes, salt deserts, rock deserts etc. A xerosere may include lithoseres (on rock) and psammoseres (on sand).

STAGES OF XEROSERE

- Bare rocks
- Crustose lichen stage
- Foliose and fruticose lichen stage
- Moss stage
- Herb stage
- Shrub stage
- Tree stage
- Climax stage

2) HYDROSERE (Secondary Succession)

- A Hydrosere is a plant succession which occurs in an area of fresh water, be it an oxbow lake, kettle lake etc. In time, an area of open freshwater will naturally dry out, ultimately becoming woodland. During this change, a range of different land types such as swamp and marsh will succeed each other.
- The succession from open water to climax woodland takes centuries or millennia. Some intermediate stages will last a shorter time than others. For example, swamp may change to marsh within a decade or less. How long it takes will depend largely on the amount of siltation occurring in the area of open water.



STAGES OF HYDROSERE

1. Phytoplankton stage
2. Submerged stage
3. Floating stage
4. Reed swamp stage
5. Sedge-meadow stage
6. Woodland stage
7. Climax stage

Summary of ecological succession

1. Ecological succession is the orderly and progressive replacement of one community by another until a relative stable community occupies the area.

2. It is of two types i.e. primary succession and secondary succession.
3. Species composition, change in species diversity, progressive increase in biomass, shift in community metabolism are some of the trends of ecological succession.
4. Pioneers are the beginners/starters of any ecological succession.
5. The process of succession starts from a pioneer and through some seral stages it ends in a climax stage which is a forest community.
6. Ability to survive on low nutrient, slow growth rate, small in size, dynamic in interacting with other species are some of the important characteristic feature of a pioneer.
7. When the succession stats from an aquatic environment it is called hydrosere and when it starts from a rock in desert condition it is known as xerosere.

FOREST ECOSYSTEM (TERRESTRIAL ECOSYSTEM)

1 Introduction

- A forest is an area with a high density of trees.
- World's total land area is 13,076 million hectares - (Source: FAO; 1989)
- Of which total forests account for about 31% of the world's land area.
- In India, the forest cover is roughly 19% of the total land area.
- The forest ecosystems are of great concern from the environmental point of view.
- It provides numerous environmental services like;
    - Nutrient cycling,
    - Maintaining biodiversity
    - Providing wildlife habitat
    - Affecting rainfall patterns
    - Regulating stream flow
    - Storing water
    - Reducing flooding
    - Preventing soil erosion
    - Reclaiming degraded land & many more….
- Apart from environmental values, forest ecosystems have some traditional values as well.
- Examples are:
    - Fire Wood & Timber.
    - Fruits.

- Gums.
- Herbs & drugs.

1.1 Structure and Function of Forest Ecosystem

I. Biotic components

- The various biotic components, representatives from the three functional groups, of a forest ecosystem are:

1) Producer Organisms

- In a forest, the producers are mainly trees.
- Trees are of different kinds depending upon the type of forest developed in that climate.
- Apart from trees, climbers, epiphytes, shrubs and ground vegetation.
- Dominant species of trees in major types of forest ecosystems are:
  - Tectona grandis, Acer, Betula, Picea, Pine, Cedrus.

2) Consumers

- In a forest, consumers are of three main types;

a) Primary Consumers

- These are Herbivores which feed directly on producers.

  Eg:

  - Ants, Beetles, Bugs, spiders etc. feeding on tree leaves.
  - Larger animals such as Elephants, Deer, giraffe etc. grazing on shoots and/or fruits of trees.

b) Secondary Consumers

- These are carnivores and feed on primary consumers.

  Eg: Birds, Lizards, Frogs, Snakes and Foxes.

c) Tertiary Consumers

- These are secondary carnivores and feed on secondary consumers
  - These include top carnivores like Lion, Tiger.

3) Decomposers

- These include wide variety of saprotrophic micro- organism like;
  - Bacteria (Bacillus Sp., Clostridium sp., pseudomonas.
  - Fungi (Aspergillus sp., Ganoderma sp., Fusarium.
  - Actinomycetes (Streptomyces).
- They attract the dead or decayed bodies of organisms & thus decomposition takes place.
- Therefore, nutrients are released for reuse.

II. Abiotic components

- These include basic inorganic & organic compounds present in the soil & atmosphere.
- In addition dead organic debris is also found littered in forests.

Producers: Different tree species

Consumers in a Forest Ecosystem

Decomposers in a Forest ecosystem

Fig- Forest Ecosystem

GRASSLAND ECOSYSTEM (TERRESTRIAL ECOSYSTEM)

1. Introduction

- Grasslands (also called Greenswards) are areas where the vegetation is dominated by grasses and other herbaceous (non-woody) plants.
- Grasslands occupy about 24% of the earth's surface.
- Grasslands occur in regions too dry for forests and too moist for deserts
- The annual rainfall ranges between 25- 75 cm, Usually seasonal
- The principal grasslands include:
  - Prairies (Canada, USA),Pampas (South America),Steppes (Europe & Asia) Veldts (Africa)
- The highest abundance & greatest diversity of large mammals are found in these ecosystems.
- The dominant animal species include
  - Wild horses, asses & antelope of Eurasia,
  - Herds of Bison of America; and

- The antelope & other large herbivores of Africa.

1.1. Structure and functions of Grassland Ecosystems

I. Biotic components

1) Producer Organisms

- In grassland, producers are mainly grasses; though, a few herbs & shrubs also contribute to primary production of biomass.
- Some of the most common species of grasses are:
  - Brachiaria sp., Cynodon sp., Desmodium sp., Digitaria sp.

2) Consumers

- In a grassland, consumers are of three main types;

a) Primary Consumers

- The primary consumers are herbivores feeding directly on grasses. These are grazing animals such as
  - Cows, Buffaloes, Sheep, Goats, Deer, Rabbits etc.
  - Besides them, numerous species of insects, termites, etc are also present.

b) Secondary Consumers

- These are carnivores that feed on primary consumers (Herbivores)
- These include;-Frogs, Snakes, Lizards, Birds, Foxes, Jackals etc.

c) Tertiary Consumers

- These include hawks etc. which feed on secondary consumers.

3) Decomposers

- These include wide variety of saprotrophic micro- organism like: Bacteria; Fungi; Actinomycetes
- They attract the dead or decayed bodies of organisms & thus decomposition takes place.
- Therefore, nutrients are released for reuse by producers.

II. Abiotic components

- These include basic inorganic & organic compounds present in the soil & aerial environment.
- The essential elements like C, H, N, O, P, S etc. are supplied by water, nitrogen, nitrates, sulphates, phosphates present in soil & atmosphere.

Producers: Different grass species

Consumers of Grassland ecosystem

Decomposers in a Grassland ecosystem

Fig. Grassland Ecosystem

DESERT ECOSYSTEM

1. Introduction

- A desert is a landscape or region that receives almost no precipitation.
- Deserts are defined as areas with an average annual precipitation of less than 250 millimeters per year.
- It occupies about 17% of the earth's surface.
- Deserts are characterized by hot days & cold nights.
- The deserts of the world are mainly located in the

  South- western United States, Mexico, North

  America, Asia (Thar, Gobi, Tibet) & west Asia.
- Deserts are characterized by scanty flora & fauna.
- Soils of deserts often have abundant nutrients but little or no organic matter.

1.1. Sturucture and Functions of Desert Ecosystms

I. Biotic components

1) Producer Organisms

- In a desert, producers are mainly shrubs/bushes; some grasses & a few trees.
- Dominant plant species include: Succulents (water - retaining plants adapted to arid climate or soil conditions) & hardy grasses.
- Besides some lower plants such as lichens & xerophytic mosses are also present.

2) Consumer Organisms

These include animals such as insects, reptiles which are capable of living in xeric conditions

- Besides some nocturnal rodents, birds & some mammalians like camel etc are also found.

3) Decomposers

Due to poor vegetation with very low amount of dead organic matter, decomposers are poor in desert ecosystem.

- The common decomposers are some bacteria & fungi, most of which are thermophillic.

II. Abiotic components

Due to high temperature & very low rainfall, the organic substances are poorly present in the soil.

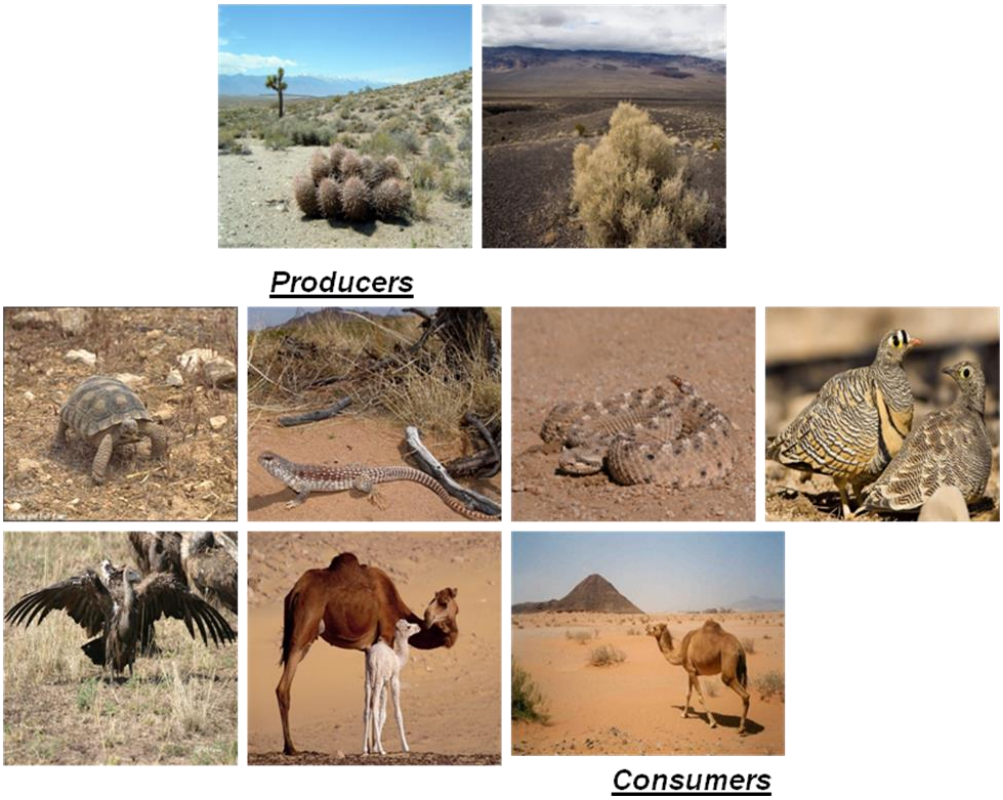


Fig. Desert Ecosystem

AQUATIC ECOSYSTEMS

1. Introduction

- Aquatic ecosystems deal with biotic community present in water bodies.
- In terrestrial ecosystem, carbon dioxide & oxygen are present in gaseous form whereas in aquatic ecosystem, these are available in dissolved state.
- Depending upon the quality and nature of water, the aquatic ecosystem are categorized into:

- Freshwater Ecosystem and
- Marine Ecosystem.

2. Freshwater Ecosystems

- Freshwater ecosystems cover 0.8% of the Earth's surface and contain 0.009% of its total water.
- Freshwater ecosystems contain 41% of the world's known fish species.
- Aquatic ecosystems perform many important environmental functions. For example:
  - They recycle nutrients, purify water, attenuate floods, recharge ground water and provide habitats for wildlife.
  - Aquatic ecosystems are also used for human recreation, and are very important to the tourism industry, especially in coastal region.
- There are three basic types of freshwater ecosystems:
  - Lentic: slow-moving water, including Pools, Ponds, and Lakes.
  - Lotic: rapidly-moving water, for example Streams and Rivers.
  - Wetlands: areas where the soil is saturated with water or inundated for at least part of the time

3. Lakes & pond Ecosystem

- A pond is a place where living organisms not only live but interact with biotic & abiotic components.
- Ponds are often exposed to tremendous anthropogenic pressure which significantly affects the system.
- Lakes are usually big standing freshwater bodies.
- They have a shallow water zone called Littoral zone; an open water zone where effective penetration of solar light takes place, called limnetic zone and a deep water zone where light penetration is negligible, called Profoundal zone.

I. Biotic components

1) Producer Organisms

- It includes submerged, free floating and amphibious macrophytes (like; Hydrilla, Utricularia, Wolfia, Azolla, Typha etc.) and minute floating and suspended lower phytoplanktons (like; Ulothrix, Spirogyra, Oedogonium etc.)

2) Consumer Organisms

a) Primary consumers:These are zooplanktons (ciliates, flagellates, other protozoan, small crustaceans) and benthos.

b) Secondary consumers: These are carnivores like insects and fishes feeding on herbivores

c) Tertiary consumers: These are the large fishes feeding on small fishes.

3) Decomposers Micro – organisms like bacteria, fungi and actinomyctes.

II. Abiotic component

- These are the inorganic as well as organic substances present in the bottom soil or dissolved in water. In addition, to the minerals, some dead organic matter is also present.

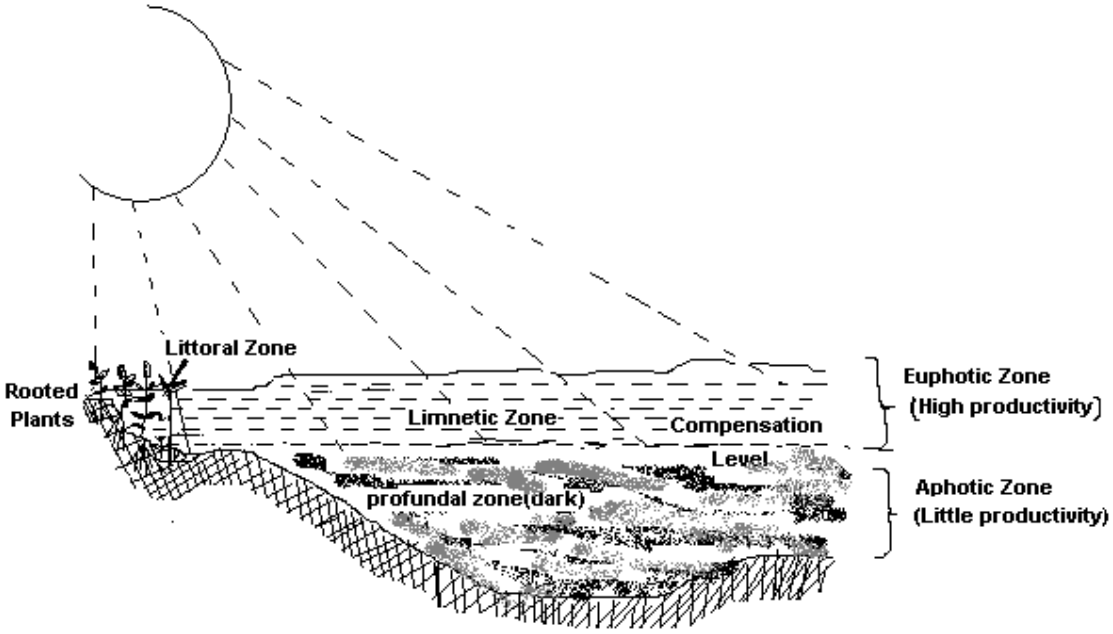


Fig.2.6.4 Zonation in a lake ecosystem

Marine or Ocean Ecosystem

- Marine ecosystems are among the Earth's aquatic ecosystems. They include: Oceans, Estuaries and Lagoons, Mangroves and Coral reefs, the Deep sea and the Sea floor.
- These are the gigantic reservoirs of water covering approximately 71% of the Earth's surface (an area of some 361 million square kilometers).
- These ecosystems are different from freshwater ecosystem mainly because of its salty water.
- The salt concentration in an open sea is usually 3.5% (35 parts per thousand (ppt)). Dominant ions are sodium & chloride.
- Average temperature of Marine ecosystem is 2-3 degree centigrade, devoid of light.

I. Biotic components

1) Producers It includes phytoplanktons (diatoms, dinoflagillates), large seaweeds (mainly algae like chlorophyceae, phaeophyceae & rhodophyceae; angiosperms like Ruppia, Zostera, posidonia), and mangrove vegetation (like Rhizophora, Carapa etc.)

2) Consumers

a) Primary consumers: These are herbivores and feed directly on producers (Crustaceans, Mollusks, fish etc.)

b) Secondary consumers: These are carnivorous fishes (Herring, Sahd and Mackerel)

c) Tertiary consumers: These are top carnivorous fishes (Cod, Haddock, etc.)

3) Decomposers These are micro – organisms like bacteria, fungi

II. Abiotic components

- High Na, Ca, Mg and K salt concentration, variable dissolved oxygen content, light & temperature make a unique physiochemical conditions in marine water.

Fig. Ocean Ecosystem