UNIT I: Environmental Studies: Ecosystems, Bio-diversity and its Conservation

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2019

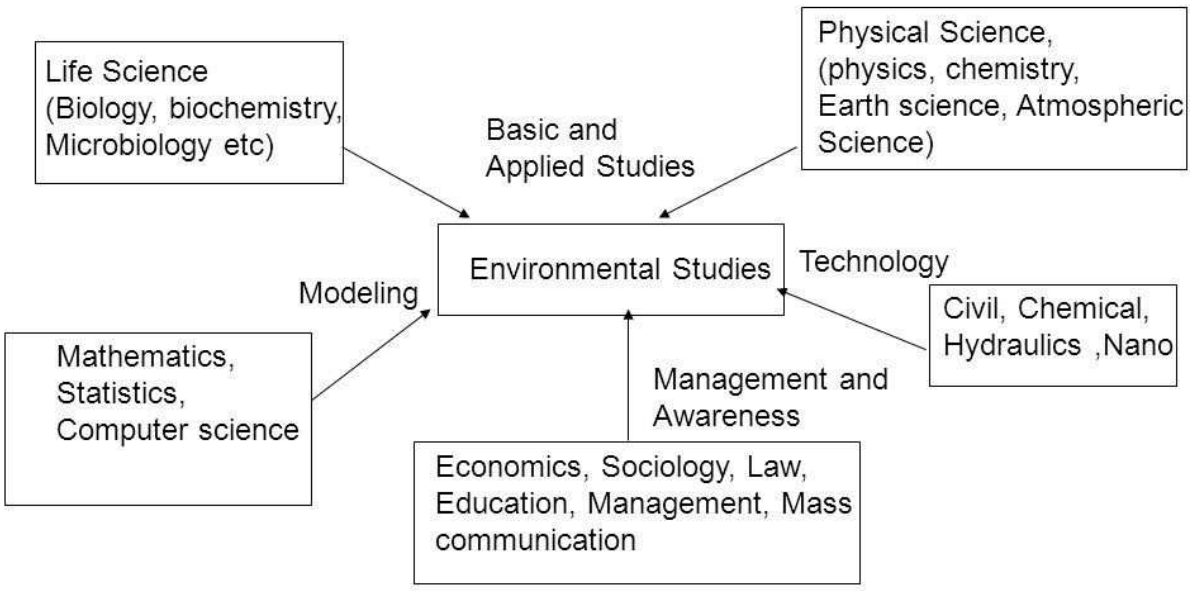
Notes compiled by the Teachers

The multi-disciplinary nature of environmental studies

Definition:

The science of Environment studies is a multidisciplinary science because it depends on various disciplines like ***chemistry, physics, medical science,*** etc. It is the science of physical phenomena in the environment. It is inherently a multidisciplinary field that draws upon not only its core scientific areas, but also applies knowledge from other non-scientific studies such as ***economic, law and social sciences***

The multidisciplinary nature of environmental science is illustrated in following diagram



Objectives of Environmental Education

According to UNESCO (1971): The following are the objectives of environmental education:

1. Awareness:

To help the social groups and individuals to acquire knowledge of pollution and environmental degradation.

2. Knowledge

To help social groups and individuals to acquire knowledge of the environment beyond the immediate environment including distant environment.

3. Attitudes

To help social groups and individuals to acquire a set of values for environmental protection.

4. Skills

To help social groups and individuals to develop skills required for making discriminations in form, shape, sound, touch, habits and habitats. Further, to develop ability to draw unbiased inferences and conclusions.

5. Participation

To provide social groups and individuals with an opportunity to be actively involved at all levels in environmental decision making.

The scope of ecological study includes

1. It deals with the study of flow of energy and materials in the environment.
2. It deals with the study of nature and its function.
3. It deals with the exchange of various materials between the biotic and abiotic components of environment. e.g., Biogeochemical cycles.

Importance of Environmental studies

1. To clarify modern environmental concept like how to conserve biodiversity.
2. To know the more sustainable way of living.
3. To use natural resources more efficiently.
4. To know the behavior of organism under natural conditions.
5. To know the interrelationship between organisms in populations and communities.

6. To aware and educate people regarding environmental issues and problems at local, national and international levels.

Need of Public Awareness about Environment

In today's world because of industrialization and increasing population, the natural resources has been rapidly utilized and our environment is being increasingly degraded by human activities, so we need to protect the environment.

It is not only the duty of government but also the people to take active role for protecting the environment, so protecting our environment is economically more viable than cleaning it up once, it is damaged.

The role of mass media such as newspapers, radio, television, etc is also very important to make people aware regarding environment. There are various institutions, which are playing positive role towards environment to make people aware regarding environment like BSI (Botanical Survey of India, 1890), ZSI (Zoological Survey of India, 1916), WII (Wild Life Institute of India, 1982) etc

REFERENCES

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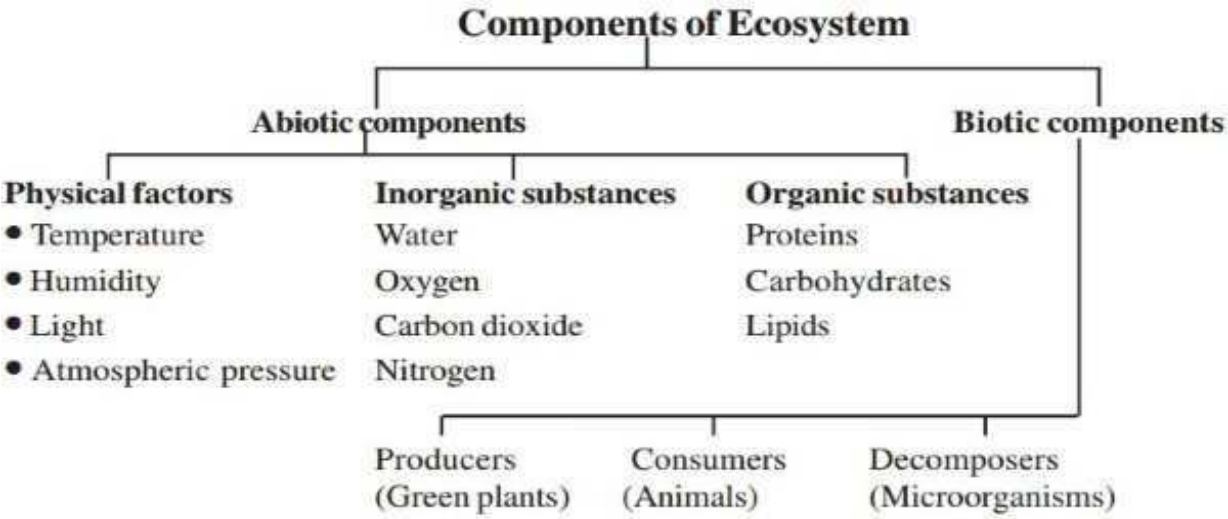
Ecosystem

Ecosystem is defined as the complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space.

"Ecosystem is a complex in which habitat, plants and animals are considered as one interesting unit, the materials and energy of one passing in and out of the others" – Woodbury.



Structure of Ecosystem

Ecosystem is the basic functional unit of organisms and their environment interacting with each other and with their own components.

1. Abiotic components 2. Biotic components

1. Abiotic Components

Abiotic component of ecosystem includes basic inorganic elements and compounds, such as soil, water, oxygen, calcium carbonates, phosphates and a variety of organic compounds. It also includes such physical factors and ingredients as moisture, wind currents and solar radiation. Radiant energy of sun is the only significant energy source for any ecosystem. The amount of non-living components, such as carbon, phosphorus, nitrogen, etc. that are present at any given time is known as standing state or standing quantity.

2. Biotic Components

The biotic components include all living organisms present in the environmental system.

On nutrition based

(i) Autotrophic components, and
(ii) Heterotrophic components

The **autotrophic components** include all green plants which fix the radiant energy of sun and manufacture food from inorganic substances. The heterotrophic components include non-green plants and all animals which take food from autotrophs.

So biotic components of an ecosystem can be described under the following three heads:

1. Producers (Autotrophic components),
2. Consumers, and
3. Decomposers or reducers and transformers

The amount of biomass at any time in an ecosystem is known as ***standing crop*** which is usually expressed as fresh weight, dry weight or as free energy in terms of calories/meter.

Producers (Autotrophic elements)

The producers are the autotrophic elements—chiefly green plants. They use radiant energy of sun in photosynthetic process whereby carbon dioxide is assimilated and the light energy is converted into chemical energy. The chemical energy is actually locked up in the energy rich carbon compounds. Oxygen is evolved as by-product in the photosynthesis.

This is used in respiration by all living things. Algae and other hydrophytes of a pond, grasses of the field, trees of the forests are examples of producers. Chemosynthetic bacteria and carotenoid bearing purple bacteria that also assimilate CO_2 with the energy of sunlight but only in the presence of organic compounds also belong to this category.

Consumers

Those living members of ecosystem which consume the food synthesized by producers are called consumers. Under this category are included all kinds of animals that are found in an ecosystem.

There are different classes or categories of consumers, such as:

(a) Consumers of the first order or primary consumers,
(b) Consumers of the second order or secondary consumers,
(c) Consumers of the third order or tertiary consumers, and
(d) Parasites, scavengers and saprobes.

(a) Primary consumers:

These are purely herbivorous animals that are dependent for their food on producers or green plants. Insects, rodents, rabbit, deer, cow, buffalo, goat are some of the common herbivores in the terrestrial ecosystem, and small crustaceans, molluscs, etc. in the aquatic habitat. Elton (1939) named herbivores of ecosystem as "*key industry animals*". The herbivores serve as the chief food source for carnivores.

(b) Secondary consumers:

These are carnivores and omnivores. Carnivores are flesh eating animals and the omnivores are the animals that are adapted to consume herbivores as well as plants as their food. Examples of secondary consumers are sparrow, crow, fox, wolves, dogs, cats, snakes, etc.

(c) Tertiary consumers:

These are the top carnivores which prey upon other carnivores, omnivores and herbivores. Lions, tigers, hawk, vulture, etc. are considered as tertiary or top consumers.

(d) Besides different classes of consumers, the parasites, scavengers and saprobes are also included in the consumers. The parasitic plants and animals utilize the living tissues of different plants and animals. The scavengers and saprobes utilize dead remains of animals and plants as their food.

Decomposers

Decomposers and transformers are the living components of the ecosystem and they are fungi and bacteria. Decomposers attack the dead remains of producers and consumers and degrade the complex organic substances into simpler compounds. The simple organic matters are then attacked by another kind of bacteria, the transformers which change these organic compounds into the inorganic forms that are suitable for reuse by producers or green plants. The decomposers and transformers play very important role in maintaining the dynamic nature of ecosystems.

Function of Ecosystem

An ecosystem is a discrete structural, functional and life sustaining environmental system. The environmental system consists of biotic and abiotic components in a habitat. Biotic component of the ecosystem includes the living organisms; plants, animals and microbes whereas the abiotic component includes inorganic matter and energy.

Abiotic components provide the matrix for the synthesis and perpetuation of organic components (protoplasm). The synthesis and perpetuation processes involve energy exchange and this energy comes from the sun in the form of light or solar energy.

Thus, in any ecosystem we have the following functional components:
(i) Inorganic constituents (air, water and mineral salts)
(ii) Organisms (plants, animals and microbes), and
(iii) Energy input which enters from outside (the sun).

Thus the Principal steps in the operation of ecosystem are as follows:
(1) Reception of radiant energy of sun,
(2) Manufacture of organic materials from inorganic ones by producers,
(3) Consumption of producers by consumers and further elaboration of consumed materials; and.
(4) After the death of producers and consumers, complex organic compounds are degraded and finally converted by decomposers and converters into such forms as are suitable for reutilization by producers.

The principal steps in the operation of ecosystem not only involve the production, growth and death of living components but also influence the abiotic aspects of habitat. It is now clear that there is transfer of both energy and nutrients from producers to consumers and finally to decomposers and transformers levels. In this transfer there is a progressive decrease of energy but nutrient component is not diminished and it shows cycling from abiotic to biotic and vice versa.

The flow of energy is unidirectional. The two ecological processes—energy flow and mineral cycling which involve interaction between biotic and abiotic components lie at the heart of ecosystem dynamics. The principal steps and components of ecosystem are illustrated in Fig

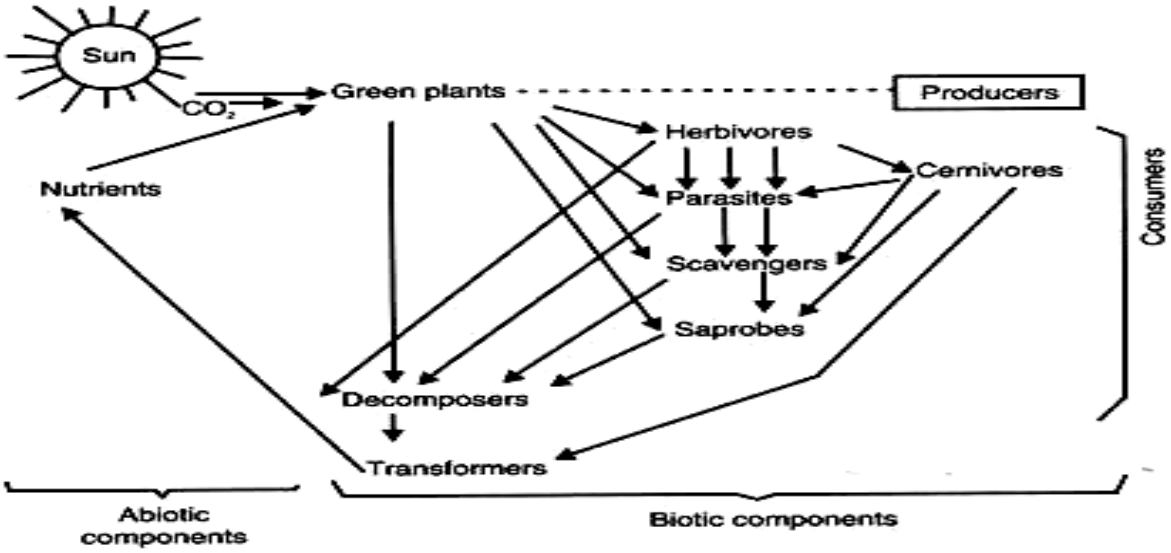
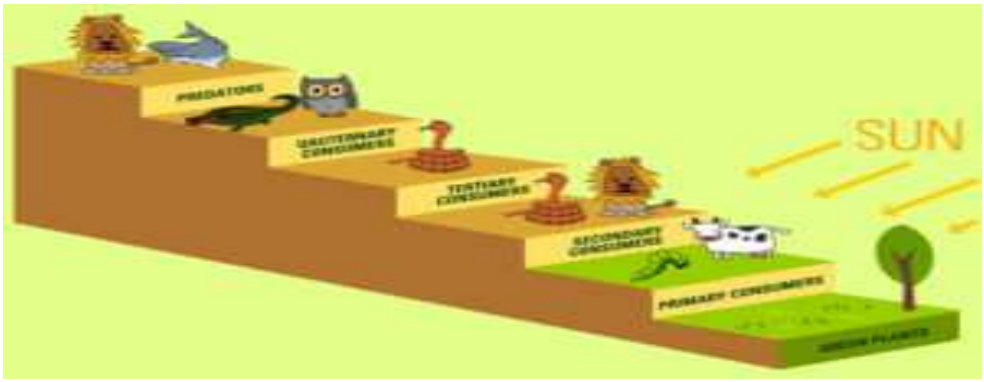


Fig. 3.1. Different components of ecosystem.

Food Chain

A food chain shows a single pathway from the producers to the consumers and how the energy flows in this pathway. In the animal kingdom, food travels around different levels. To understand a food chain better, let us take a look at the terrestrial ecosystem.



Example of food chain

Grass (Producer) ——Goat (Primary Consumer) —— Man (Secondary consumer)
When dead organic matter becomes the starting of a food chain, then it is called the *detritus food chain* (DFC). The decomposers, which are the fungi and bacteria, feed on the organic matter to meet the energy requirements. The digestive enzymes secreted by the decomposers help in the breakdown of the organic matter into inorganic materials.

Types of food chain

There are basically two different types of food chains in the ecosystem, namely –

- **Grazing food chain (GFC)** – This is the normal food chain that we observe in which plants are the producers and the energy flows from the producers to the herbivores (primary consumers), then to carnivores(secondary consumers) and so on.
- **Saprophytic or Detritus food chain (DFC)** – In this type of food chain, the dead organic matter occupies the lowermost level of the food chain, followed by the decomposers and so on.
- **Parasitic food chains (PFC) –** In this type of food chain, large organisms either the producer or the consumer is exploited and therefore the food passes to the smaller organism.

In nature, we mostly observe food web as there are many organisms which are omnivores. As a result, they occupy multiple trophic levels.

Food Web

Many interconnected food chains make up a food web. When you look at the larger picture, a food web shows a realistic representation of the energy flow through different organisms in an ecosystem

Sometimes, a single organism gets eaten by many predators or it eats many other organisms. This is when a food chain doesn't represent the energy flow in a proper manner because there are many trophic levels that interconnect. This is where a food web comes into place. It shows the interactions between different organisms in an ecosystem.

The following diagram shows the energy flow between various organisms through a food web.

Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html

Energy Flow in an Ecosystem (With Diagram)

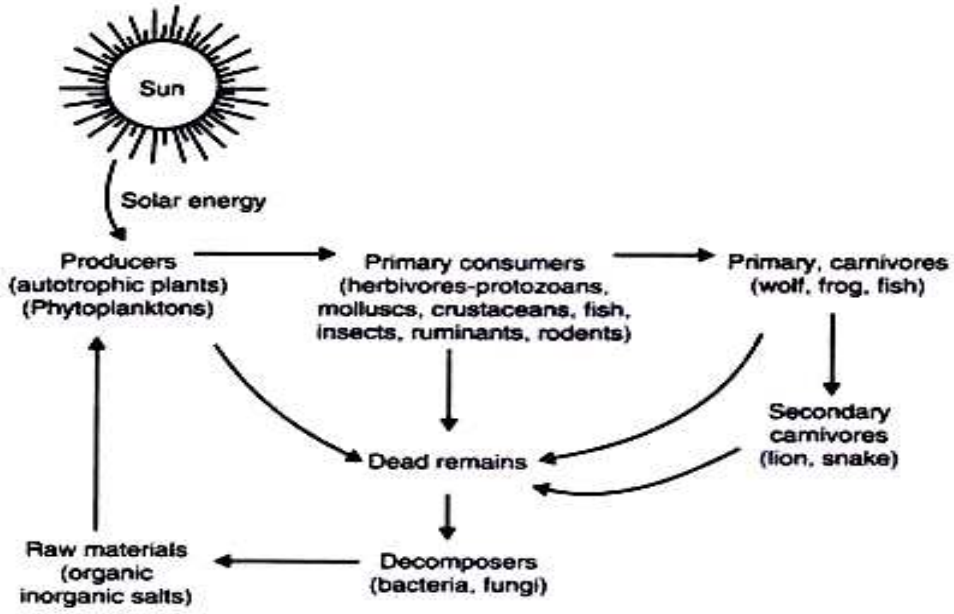


Fig. 3.7. Flow of energy at different levels of ecosystem.

Trophic levels

- The feeding levels from producers to consumers is called trophic level. The energy flows only one way through various trophic levels.
- First trophic level- Producers – Autotrophs
- Second trophic level – Primary consumers – Herbivores
- Third trophic level – Secondary consumers – Carnivores
- Fourth trophic level – Tertiary consumers – Top level carnivorous

1. Producers

- They are autotrophs and represent 1st trophic level which can synthesize the food using light energy.
- They produces food for all other organisms of ecosystem.
- They are largely green plants and photosynthetic prokaryotes which converts inorganic substrate into organic food by the process of photosynthesis.
- The rate at which the radiation energy is stored by the process of photosynthesis in the green plant is called gross primary productivity (GPP).

2. Consumers

- They are heterotrophs which obtain energy from producers directly or indirectly. They can be further divided as

i. Primary consumers

- They are animals which feeds directly on plants.
- They are 1st level consumers and therefore they are known as primary consumers.
- Primary consumers make the II trophic level in food chain.
- Examples: herbivores animals such as deer, goat, cow etc.

ii. Secondary consumers

- These are animals that feed on other animals.
- They are omnivores and carnivores. E.g. Bear, wolf, jackal, and snake etc.

iii. Tertiary consumers

- These animals get their food from all consumers.
- They are top carnivores. Eg lion, tiger, and eagle etc.

3. Decomposers

- They feed on dead and decayed plants or animals.
- They make up the final trophic level in food chain.
- They decompose the dead and decay matter and helps in recycling the nutrients.
- They are classified into two class:
  - Micro-decomposers: Bacteria, Fungi, Protozoa
  - Macro-decomposers: Earth worm, Nematodes, Mollusca's
  -

Energy flow in an ecosystem

- The process of transfer of energy to various trophic level of food chain is known as flow of energy.
- Energy flow in ecosystem from energy source to autotrophs to heterotrophs.
- For most ecosystems the energy source is the sun and the autotrophs are the green plants and BGAs. The solar energy that is captured in as ecosystem is based on the amount of photosynthesis that occurs there.
- The energy flow is best described by net primary productivity(NPP) = Gross primary productivity (GPP)- Respiration (Rp)
  - NPP = GPP-Rp

- Secondary productivity is the amount of bio-mass produced by consumers. It is dependent on the amount of energy made available by primary producers and so on.
- The entire process of energy floe is summarized in following points;
  - The flow of energy in an ecosystem is always linear and unidirectional.
  - At each energy step in food chain, the energy received by the organisms is used for its own metabolism and maintenance. The left over energy is passed to next higher trophic level. Thus the energy flow decreases with successive trophic level.
  - Flow of energy follows the ecological rule of 10%.

Ecological Pyramid

It is a graphic representation of the relationship between organisms at various trophic levels in a food chain. The basis of an ecological pyramid is the *biomass, energy, and number.* Just as the name suggests ecological pyramids are in the shape of a pyramid. The concept was first introduced by Charles Elton, the pioneer British Ecologist The bottom of an ecological pyramid is the broadest and is occupied the producers, which form the first trophic level. Producers are at the lowest level. Just as in a food chain, the producers are consumed by the primary consumers, in an ecological pyramid; the next level is occupied by the primary consumers. A pyramid-shaped diagram representing quantitatively the numbers of organisms, energy relationships, and biomass of an ecosystem; numbers are high for the lowest trophic levels (plants) and. low for the highest trophic level. Since some energy is lost as heat, in each transformation. This relationship is sometimes called ecological pyramid

Types of Ecological Pyramids

Depending on the factors that we use to represent an ecological pyramid, there are three types. They are:

1. Pyramid of numbers–

It depicts the number of individual organisms at different trophic levels of food chain. This pyramid was advanced by Charles Elton (1927), who pointed out the great difference in the number of the organisms involved in each step of the food chain. As we go up the levels of the pyramid, the number of organisms decreases. The producers form the largest number and hence are at the bottom of the pyramid.

The pyramid of number ignores the biomass of organisms and it also does not indicate the energy transferred or the use of energy by the groups involved. The *lake ecosystem* provides a typical example for pyramid of number.

2. Pyramid of biomass –

This pyramid represents the amount of biomass of the organisms present at each trophic level. Biomass is nothing but the weight of the organisms.

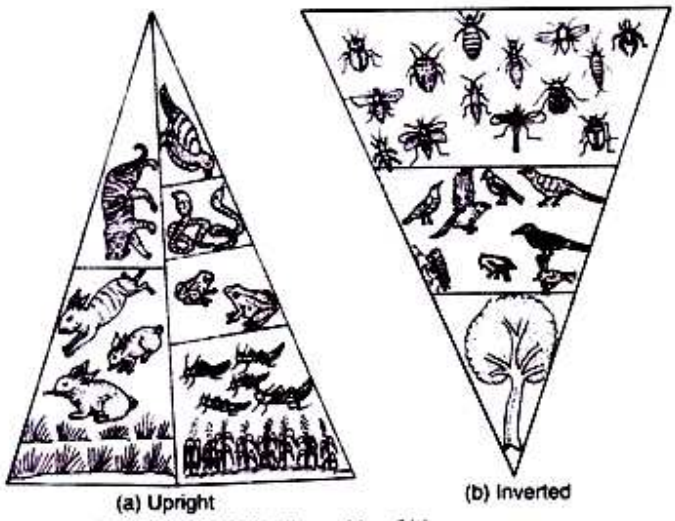


Fig. 3.14. (*a* & *b*). Pyramids of biomass
(*a*) A grassland ecosystems showing upright-triangular
(*b*) Inverted pyramid of biomass of an aquatic ecosystem.

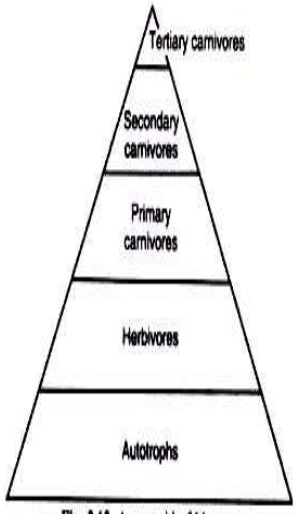
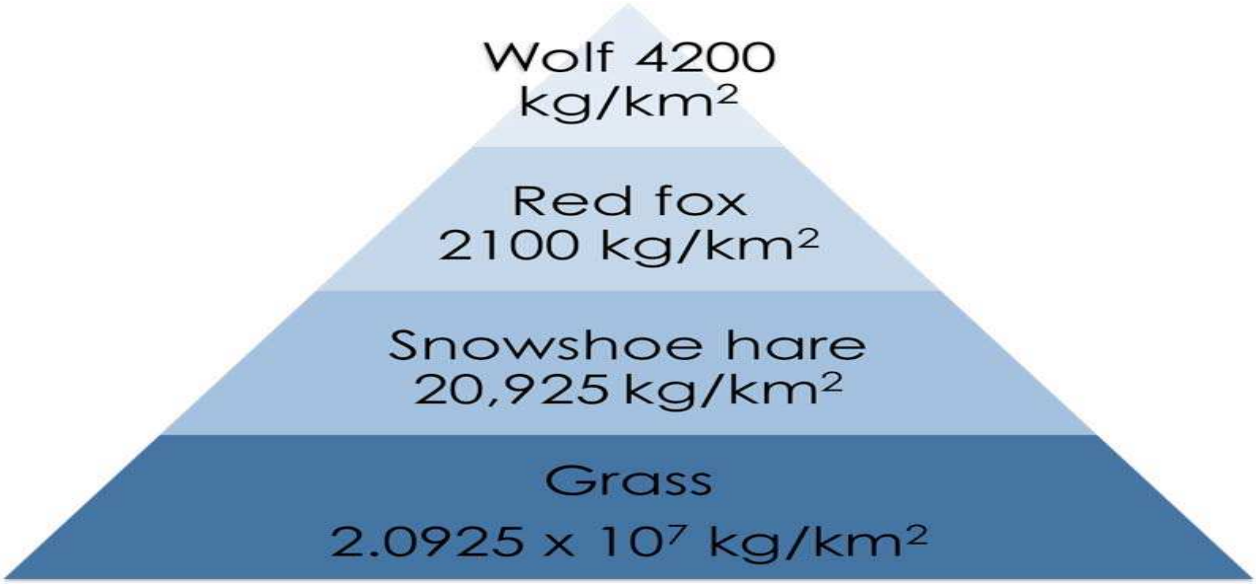


Fig. 3.13. A pyramid of biomass

In general, all ecological pyramids are upright, except in certain cases. For example, in a detritus food chain, the pyramid of numbers is not upright because many organisms feed on one dead plant or animal.

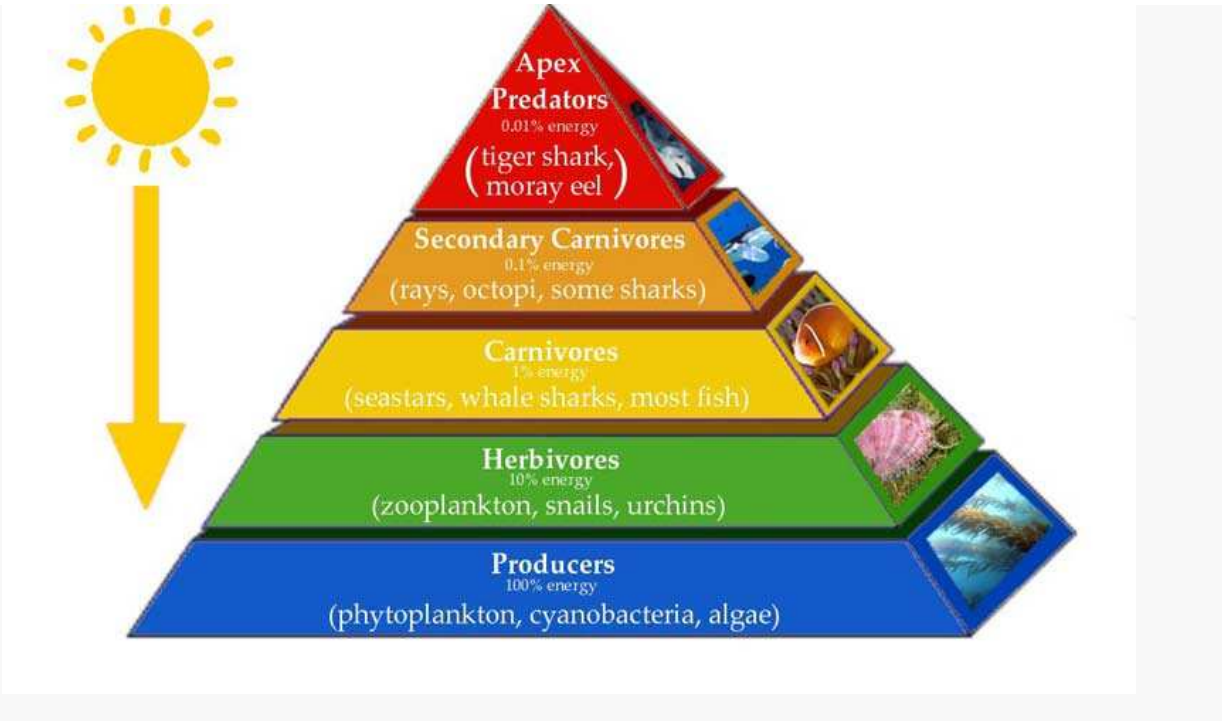
The pyramid of biomass in an ocean is also inverted. But a point of note is that the pyramid of energy is always upright as the flow of energy is unidirectional. The biomass of the members of the food chain present at any one time forms the pyramid of the biomass. Pyramid of biomass indicates decrease of biomass in each tropical level from base to apex.



For example, the total biomass of the producers ingested by herbivores is more than the total biomass of the herbivores in an ecosystem. Likewise, the total biomass of the primary carnivores (or secondary consumer) will be less man the herbivores and so on.

3. Pyramid of energy–

This is an upright pyramid that represents the flow of energy from the producers to the final consumers.
When production is considered in terms of energy, the pyramid indicates not only the amount of energy flow at each level, but more important, the actual role the various organisms play in the transfer of energy. An energy pyramid illustrates how much energy is needed as it flows upwards to support the next trophic level.



The pyramid is constructed according to the rate at which food material (in the form of energy) passes through the food chain. Some organisms may have a small biomass, but the total energy they assimilate and pass on, may be considerably greater than that of organisms with a much larger biomass. Energy pyramids are always slopping because less energy is transferred from each level than was paid into it. In cases such as in open water communities the producers have less bulk than consumers but the energy they store and pass on must be greater than that of the next level.

Ecological Succession

A characteristic feature of biological communities is that their structure and composition changes according to certain changes in environmental conditions. Some of these changes occur in a

more predictable and orderly fashion. The phenomenon through which these changes occur in ecological communities is Ecological succession.

This is an important aspect of the study of ecology and forms the core of ecological science. This ecological succession can be triggered by some form of disturbance or even due to the formation of new habitats in the ecosystem.

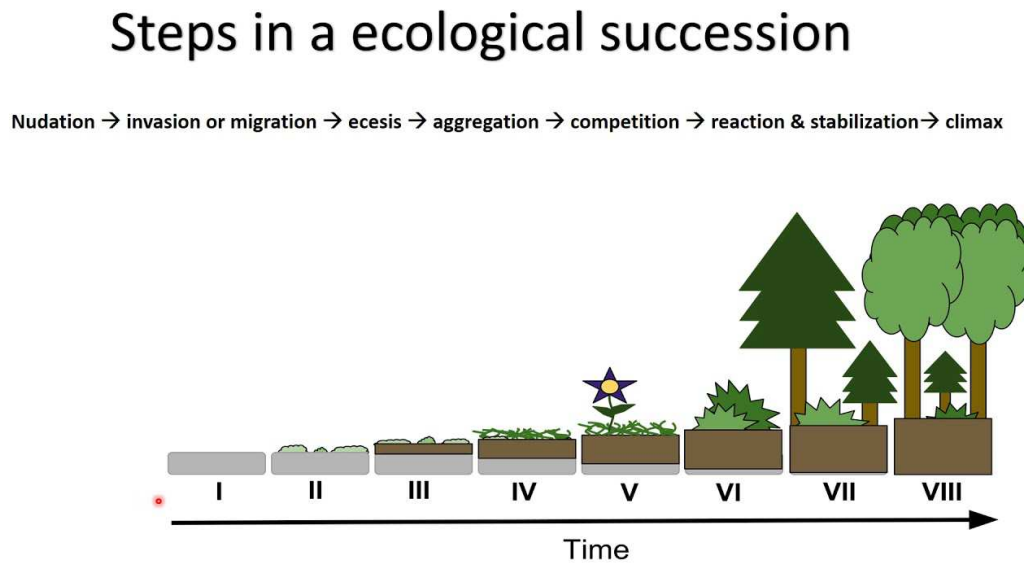
When the changes create a community that is almost in equilibrium with the environment, it is what we call a climax community. In a given ecological area, the communities change successively. This sequence of communities is a sere. The transitional communities are called seral communities. As the seral communities progress, there is an increase in diversity of organisms, increased number, and an increased biomass.
The starting point of ecological succession can be traced back to millions and millions of year back, where living organisms never existed. Slowly, as environmental changes happened, over time, new organisms developed, and the diversity of the planet started showing changes**.**

Types of Ecological Succession

Ecological succession is mainly of two types-

Primary succession: The primary succession is a slow process that initiates in areas where there are no living organisms.

Secondary succession: Secondary succession begins in areas that were once inhabited but destroyed due to environmental disturbances. This is generally faster, as most of the other factors are already present.



Steps involved in ecological succession

1. **Nudation:** Succession begins with the development of a bare site, called Nudation (disturbance).
2. **Migration (Dispersal):** It refers to arrival of propagules.
3. **Ecesis (Establishment):** It involves establishment and initial growth of vegetation.
4. **Aggregation:** Increase in numbers of individuals in community
5. **Invasion:** That Migration which ends in establishment
6. **Competition:** As vegetation becomes well established, grow, and spread, various species begin to compete for space, light and nutrients.
7. **Reaction:** During this phase autogenic changes such as the buildup of humus affect the habitat, and one plant community replaces another.
8. **Stabilization:** A supposedly stable climax community forms.

Types of Ecosystems

Forest Ecosystem

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.

Types:

(a) Temperate Forest Ecosystem

The temperate forest ecosystem is very important on Earth. Temperate forests are in regions where the climate changes a lot from summer to winter. Tropical rain forests are in regions where the climate stays constant all year long. Temperate forests are almost always made of two types of trees, deciduous and evergreen. Deciduous trees are trees that lose their leaves in the winter.

Evergreens are trees that keep them all year long, like pine trees. Forests can either be one or the other, or a combination of both. A fourth kind of forest is a temperate rain forest. These are found in California, Oregon and Washington in the United States.

These forests are made of redwoods and sequoias, the tallest trees in the world. The amount of rainfall in an area determines if a forest is present. If there is enough rain to support trees, then a forest will usually develop. Otherwise, the region will become grasslands.

(b) The Tropical Rain Forest Ecosystem

Tropical rain forests are one of the most important areas on Earth. These special ecosystems are homes to thousands of species animals and plants. Contrary to popular belief, rain forests are not only densely packed plants, but are also full of tall trees that form a ceiling from the Sun above. This ceiling keeps smaller plants from growing. Areas where sunlight can reach the surface are full of interesting plants. The famous Amazon jungle is located in Brazil, in South America. This particular forest is called the Neotropics. Other large blocks are located in Central and West Africa.

(i) Insects of the Tropical Rain Forest

The most feared and well known spider in the world resides in the jungle. Tarantulas are one of the creepiest animals you will ever see. Most species of tarantula have poisonous fangs for killing prey and for protection.

Although some are life-threatening to humans, others are harmless. Army ants are just one species of ant in the rain forest. They are called army ants because they march in a long, thick line through the jungle. They only stop when the young larvae reach pupil stage. Once the queen lays its eggs, the ants start marching again.

Beautiful butterflies fill the forest, but at one time these insects weren't so pretty. Butterflies start out as caterpillars, which tend to be a tad on the ugly side. They go through metamorphosis, which is the process of changing into a butterfly. Centipedes aren't so lucky. They don't turn into butterflies, but instead roam the forest looking for food. Some centipedes use poison to kill their prey.

(ii) Tropical Rain Forest Birds

The birds of the rain forest are the most beautiful in the world. A wide range of colors can be seen darting through the trees as the forest tops come to life. Many species of tropical birds are kept as pets because of their looks.

Hundreds of species of parrot live in the rain forest. The scarlet macaw is just one of these. It is also one of the longest, stretching to a length of 3 feet from its head to the tip of its tail. When these macaws eat a poisonous fruit, they eat a special type of clay that neutralizes the poison.

Toucans are also very interesting birds. They have large beaks that they use to reach fruit they can't get to. Scientists estimate there are 33 species of toucan in the rain forest. Not every tropical bird was blessed with looks. The hoatzin looks more like a peacock without the pretty tail.

(iii) Tropical Rain Forest Mammals

Birds aren't the only creatures that fly through the rain forests. Several species of flying mammals live in the jungle. From the harmless fruit bat to the unique flying squirrel, the tropical rain forests are full of surprises.

The Indian flying fox is one of the largest bats in the world. Its wings can spread out to 5 feet in width. Unlike bats in other parts of the world, these bats do not live in caves. They prefer to .hang in trees during the day. Hundreds or even thousands of bats can be spotted in a single tree.

Vampire bats live in the Amazon jungle in South America. The famous stories of blood-sucking bats probably originated here. These bats do in fact drink the blood of their victims. They usually attack farm animals, but have also enjoyed the blood of humans. But vampire bats only drink a very small amount of fluid.

(iv) Tropical Rain Forest Reptiles

The tropical rain forests of the world are full of reptiles. Reptiles are cold blooded, which means their body temperature depends on their environment. So, it is important for them to stay in warm climates. Snakes are reptiles, and the rain forests are home to many. The mamba family is the most poisonous of all. They kill their prey by injecting poison with their sharp fangs.

Anacondas make up another snake family. They are some of the longest creatures in the world, as they can reach 30 feet in length. Anacondas prefer to wrap themselves around their prey and squeeze, rather than inject poison. Anacondas swallow their prey whole and sleep while the food is digesting. Chameleons are interesting lizards that can change color.
This enables them to blend in with their surroundings. Not only is this a great disguise from predators, it is also an easy way to sneak up on their prey. Chameleons only eat insects. Geckos are very neat creatures. The flying gecko can glide from tree to tree to escape from predators. Their grip is so strong, that if you tried to pull one off a window, the glass would break before the gecko would let go.

(v) Tropical Rain Forest Primates

Monkeys and their cousins are all primates. Humans are also primates. There are many species of monkeys in the tropical rain forests of the world. Monkeys can be divided into two groups: new world monkeys and old world monkeys. New world monkeys live only in South and Central America. Spider monkeys live in the rain forests in the Andes Mountains.
They look very strange with their long noses. Spider monkeys eat mostly fruit and nuts, so they are called frugivores. They are joined by the howler monkeys. These primates are so named because they have a special sac that makes their sounds louder.

Old world monkeys live only in Africa and Asia. The colobus monkey is one such kind. These monkeys are called foliovores because they eat leaves. They live in small groups of 15, but other primates live in larger groups of up to 200. There are too many species. Chimpanzees, orangutans and gorillas are all called pongids. These primates are more famous than the others. Gorillas are too big to climb trees, so they are found on the forest floor.

(c) Boreal or Taiga Forests

The boreal forest ecosystem is the contiguous green belt of conifer and deciduous trees that encircles a large portion of the Northern Hemisphere. In North America, the boreal forest stretches across most of northern Canada and into Alaska. It has long been identified as one of the world's great forest ecosystems.

This forest ecosystem covers roughly 35% of Canada's land mass and is the single largest land based ecosystem in North America. It also contains a significant proportion of Canada's biodiversity and has long been recognized as an important global carbon sink.
Although the boreal is relatively unknown, it is important as the "great lung" of North America, "breathing in" carbon dioxide and "exhaling" oxygen into the atmosphere. In short, the boreal forest manages to do what the rain forest of the Amazon does but with only the fraction of the flora and fauna.
This forest ecosystem houses the largest and smallest mammal species (wood bison & pygmy shrews) of the North American continent. The Boreal forest has many things: great lakes and northern rivers; vast bogs, fens and other organic wetlands. The rich wildlife diversity of the Boreal is a joy to behold: woodland caribou and lynx; whooping cranes and wood bison; northern owls; woodpeckers with three rather than four toes; colorful wood warblers.

Structure of Forest Ecosystems

Different organisms exist within the forest layers. These organisms interact with each other and their surroundings. Each organism has a role or niche in sustaining the ecosystem.
Some provide food for other organisms; others provide shelter or control populations through predation

Producers

All living organisms intake energy in order to survive. In a forest ecosystem, trees and other plants get their energy from sunlight. Plants produce their own food, in the form of carbohydrates. Plants are, therefore, called the primary producers, since they produce the basic foodstuffs for other organisms within food chains and food webs. Photosynthesis is the chemical reaction that allows plants to produce their own food.

Consumers

Animals cannot produce their own food. They must consume food sources for die energy they need to survive. All animals, including mammals, insects, and birds, are called consumers. Consumers rely on plants and other animals as a food source. Details of these animals in a forest ecosystem have been given earlier.
Primary consumers only eat plants and are referred to as herbivores. Secondary consumers are referred to as carnivores and feed on herbivores. Tertiary consumers are carnivores that feed on other carnivores. Omnivores eat both plant and animal matter.

Decomposers

Leaves, needles, and old branches fall to the forest floor as trees grow. Eventually all plants and animals die. So what happens to all of this plant and animal material? Does it sit on the forest floor forever? Thankfully No. These materials are decomposed by worms, microbes, fungi, ants, and other bugs.
Decomposers break these items down into their smallest primary elements to be used again. Decomposers are important in that they sustain the nutrient cycle of ecosystems.

Humans are part of Forest Ecosystem

Humans are consumers. We get food and materials from forests. Because of this, we are a part of the forest ecosystem. Human consumption alters forest ecosystems. Human intervention may be necessary to sustain forest communities under the increased pressure of human use

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.

Communities of plants and animals living in water are known as aquatic ecosystems. They are divided into two main groups.

Components of Ecosystem

There are two main components of an ecosystem which are in constant communication with each other. They are the biotic components and the abiotic components.

Biotic Components

The living components of an ecosystem are called the biotic components. Some of these factors include plants, animals, as well as fungi and bacteria. These biotic components can be further classified, based on the energy requirement source. Producers, consumers, and decomposers are the three broad categories of biotic components.

- ***Producers*** are the plants in the ecosystem, which can generate their own energy requirement through photosynthesis, in the presence of sunlight and chlorophyll. All other living beings are dependent on plants for their energy requirement of food as well as oxygen.

- ***Consumers*** include the herbivores, carnivores, and omnivores. The herbivores are the living organisms that feed on plants. Carnivores eat other living organisms. Omnivores are animals that can eat both plant and animal tissue.

- ***Decomposers*** are the fungi and bacteria, which are the saprophytes. They feed on the decaying organic matter and convert this matter into nitrogen and carbon dioxide. The saprophytes play a vital role in recycling the nutrients so that the producers i.e. plants can use them once again.

Abiotic Components

Abiotic components are the physical and/or the chemical factors that act on the living organisms at any part of their life. These are also called as the ecological factors. The physical and chemical factors are characteristic of the environment. Light, air, soil, and nutrients etc. form the abiotic components of an ecosystem.

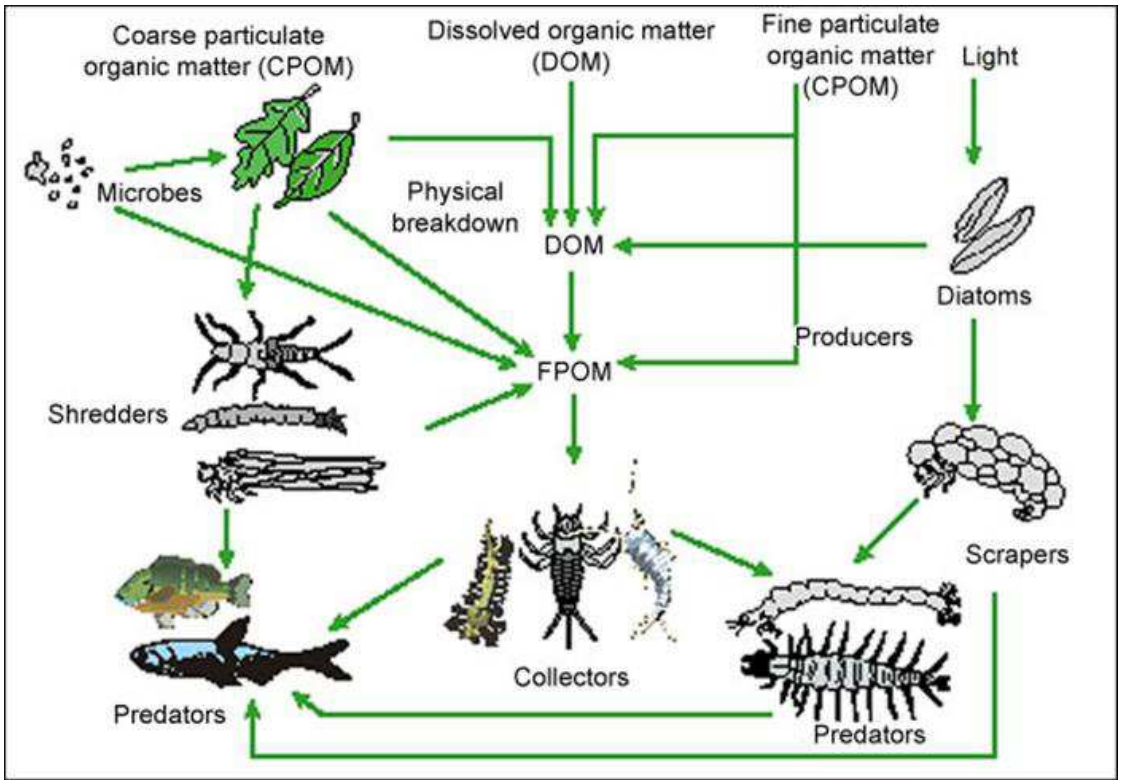
The abiotic factors vary from ecosystem to ecosystem. In an aquatic ecosystem, the abiotic factors may include water pH, sunlight, turbidity, water depth, salinity, available nutrients and dissolved oxygen. Similarly, abiotic factors in terrestrial ecosystems can include soil, soil types, temperature, rain, altitude, wind, nutrients, sunlight etc.

Here, the sun is the energy source. Producers/plants use this energy to synthesize food in the presence of carbon dioxide and chlorophyll. The energy from the sun, through several chemical reactions, turns into chemical energy.

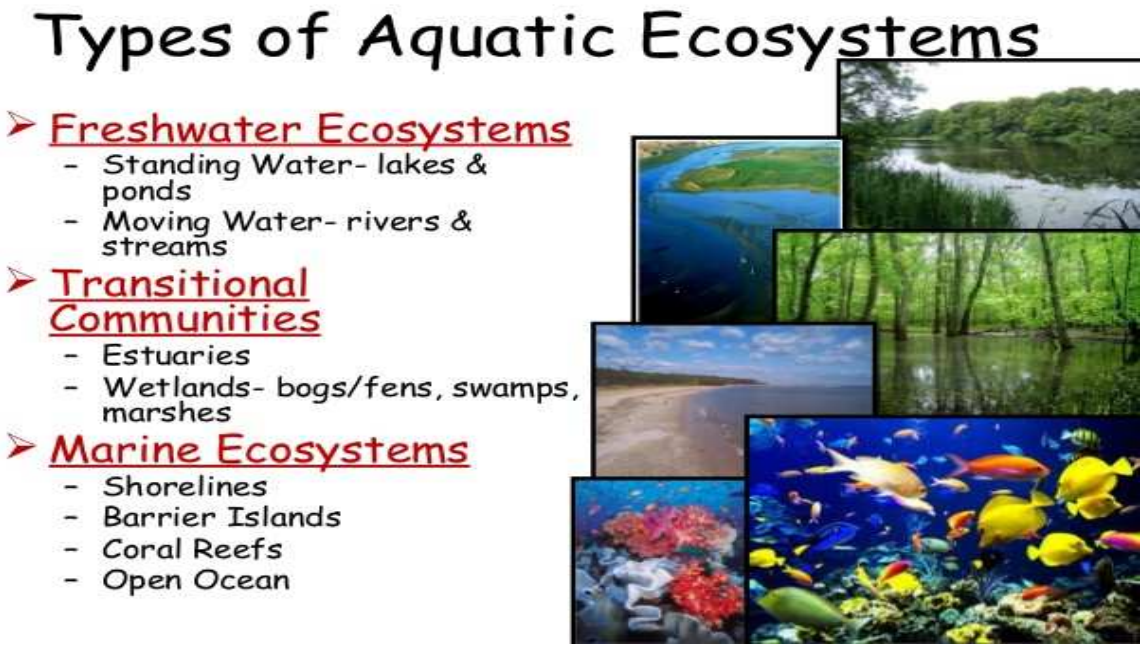
The herbivores are dependent on plants for the energy requirements. The carnivores, in turn, feed on the herbivores and other carnivores. At any level, microbes then decompose any dead and decaying organic matter. These decomposers, after various chemical reactions, release molecules back to the environment in the form of chemicals. The chemicals are again used by the producers, and the cycle starts again.

In conclusion, ecosystems have a complex set of interactions that happen between the biotic and abiotic components. The components of an ecosystem are linked to each other through the *energy flows and nutrient cycles*. Even though ecosystems do not have clear boundaries, these interactions

get affected, even if one factor is changed or removed. This ultimately has the capacity to affect the entire ecosystem.



Types of Aquatic Ecosystem



Freshwater ecosystems are found in water containing low concentrations of salts, from ponds to estuaries.

Marine ecosystems are found in the saltwater of seas and oceans. Most of us are not far away from an aquatic ecosystem of some kind, whether it be in the ocean or a local pond.

The nature of an aquatic ecosystem is shaped, as on land, by the availability of food, oxygen, and the prevailing temperature. Added to this is salinity, which is the salt concentration of the water. Aquatic ecosystems in shallow waters, where there is plenty of sunlight, generally tend to be the most productive. Water pollution, generally coming from human activities, comprises the greatest pressure on aquatic ecosystems. For instance, fish can be killed by *acid rain* in lakes or lack of oxygen where excess nutrients have been dumped in an estuary.

Around half of the 25,000 known species of fish live in the marine environment, mainly in shallower, warmer

EUPHOTIC ZONE: The uppermost layer of a body of water in which the level of sunlight is sufficient for photosynthesis to occur.

EUTROPHICATION: The process whereby a body of water becomes rich in dissolved nutrients through natural or man-made processes. This often results in a deficiency of dissolved oxygen, producing an environment that favors plant over animal life.

FRESHWATER: Water containing less than one gram per liter of dissolved solids.

LITTORAL: The region of a lake near the shore.

LOTIC: Flowing water, as in rivers and streams.

Impacts and Issues

Many human activities threaten the health of aquatic ecosystems. For instance, acid rain created from sulfur and nitrogen oxide emissions have turned many lakes and streams acidic, so they no longer support various fish species. Meanwhile, the building of dams to create hydroelectric power plant can block the routes of migratory fish like salmon.

In the marine environment, the coral reefs are among the world's most threatened ecosystems. They are affected by a range of factors, including destructive fishing practices, pollution, sewage, and global warming. Estuaries and shore areas are also at risk from pollution, which can cause eutrophication by raising nutrient levels in the water. Eutrophication encourages the growth of plant decomposers, which consume available oxygen in the water, affecting fish, and other marine organisms.

Desert Ecosystem

Desert are areas of land that are arid, or dry, and get less than 10 inches of rain per year. Deserts can be hot or cold. Plants and animals in the *desert ecosystem* have adaptations that allow them to survive the lack of rainfall and extreme temperatures.

Types and Characteristic Features

One can find at least one desert on every continent except Europe and Antarctica. Each desert is different in some way, but they all have one thing in common. In order for an area of land to be considered a desert, it must receive less than 10 inches of water a year.

There are plenty of differences between the deserts of the world. Some deserts are made of very fine, red sand, others consist of sand mixed with pebbles and rocks. The desert sand started out as rock, but years of weathering by wind and water has created dunes in the deserts. These sands are mostly minerals, and sometimes oil can be found hidden deep within the rocks.

Structure and Function

The different components of a desert ecosystem are:

(A) Abiotic Component

The abiotic component includes the nutrients present in the soil and the aerial environment. The characteristic feature of the abiotic component is lack of organic matter in the soil and scarcity of water.

(B) Biotic Component

The various biotic components representing three functional groups are:

(a) Producers

The producers are mainly shrubs or bushes, some grasses and a few trees. Surprisingly, there are many species of plants that survive in the desert. Most of them are succulents, which mean they store water. Others have seeds that lay dormant until a rain awakens them. Regardless, these plants find a way to get water and protect themselves from the heat.

The most famous desert plant is the cactus. There are many species of cacti. The saguaro cactus is the tall, pole shaped cactus. The saguaro can grow up to 40 feet tall. It can hold several tons of water inside its soft tissue. Like all cacti, the saguaro has a thick, waxy layer that protects it from the Sun.

Other succulents include the desert rose and the living rock. This strange plant looks like a spiny rock. It’s disguise protects it from predators. There are many other kinds of desert plants. Some of them have thorns others have beautiful flowers and deadly poisons. Even in the worst conditions, these plants continue to thrive.

(b) Consumers

These include animals such as insects and reptiles. Besides them, some rodents, birds and some mammalian vertebrates are also found.

Desert Reptiles
Reptiles are some of the most interesting creatures of the desert. Reptiles can withstand the extreme temperatures because they can control their body temperatures very easily. You can put most of the desert reptiles into one of two categories: snakes and lizards. Many species of rattlesnakes can be found in the desert. Rattlesnakes have a noisy rattle they use to warn enemies to stay away. If the predator isn't careful, the rattlesnake will strike, injecting venom with its sharp fangs. Other desert snakes include the cobra, king snake and the hognose.

Lizards make up the second category of desert reptiles. They are probably the most bizarre looking animals in the desert. While some change colors and have sharp scales for defense, others change their appearance to look more threatening. There are only two venomous lizards in the world, and one of them is the gila monster. It has a very painful bite.

Camels – The Cars of the Desert
Camels could be included in the mammal section. Camels are the cars of the desert. Without them, people would have great difficulty crossing the hot terrain. There are two types of camels: Bactrian and dromedary.

(c) Decomposers
Due to poor vegetation the amount of dead organic matter is very less. As a result the decomposers are very few. The common decomposers are some bacteria and fungi, most of which are thermophile.

Grassland Ecosystem

Grassland ecosystem is a type of terrestrial **ecosystem** with an open land of grasses. The grassland ecosystem occupies about 25% of the total land area throughout the world. Abiotic components of grassland ecosystem are light, temperature, wind, humidity, atmospheric pressure and some chemicals.

Structure and functions of Grassland Ecosystems
I. Biotic components

1) Producer

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.

In addition to the biotic components, abiotic factors influence the environment in the grasslands.

- Temperature. Grasslands occur in both high-temperature areas near the Equator and mid-to-low-temperature areas nearing subarctic regions. ...
- Precipitation
- Humidity
- Topography

Types of grassland

A **grassland** consists of large rolling fields of grasses, flowers and herbs. Grasslands ecosystems emerge due to low levels of sporadic precipitation that is only substantial enough to support smaller plants. ... There are two main *types of grasslands* -- tropical and temperate -- with several subcategories within each type

Tropical and subtropical

These grasslands are classified with tropical and subtropical savannas and shrublands as the tropical and subtropical grasslands, savannas, and scrublands biome. Notable tropical and subtropical grasslands include the Llanos grasslands of South America.

Temperate

Temperate grasslands are characterized as having grasses as the dominant **vegetation**. Trees and large shrubs are absent. Temperatures vary more from summer to winter, and the amount of rainfall is less in temperate grasslands than in savannas.

Mid-latitude grasslands, including the prairie and Pacific grasslands of North America, the Pampas of Argentina, Brazil and Uruguay, calcareous downland, and the steppes of Europe.

They are classified with temperate savannas and shrublands as the temperate grasslands, savannas, and shrublands biome. Temperate grasslands are the home to many large herbivores, such as bison, gazelles, zebras, rhinoceroses, and wild horses. Carnivore

2 CASE STUDY (to be done by the students)

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BIODIVERSITY AND ITS CONSERVATION

'**Biological diversity**' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

Types of Biodiversity

1. Species diversity

It is defined as the number and abundance of different species that occupy a location. To accurately determine species diversity, both the **species richness**, which is the number of different species, and the **relative abundance**, which is the number of individuals within each species, must be considered. An example of species diversity would be the number and abundance of different types of mammals in a forest.

2. Genetic diversity

It is the amount of variation in genetic material within a species or within a population. There is a high level of diversity among species, but there is an even higher level of diversity among the genetic material of the individuals of a specific species. An example of genetic diversity is the variation in the genes that encode for hair color in humans

3. Ecological diversity

Ecological diversity includes the variation in both terrestrial and aquatic ecosystems. Ecological diversity can also take into account the variation in the complexity of a biological community, including the number of different niches, the number of trophic levels and other ecological processes. An example of ecological diversity on a global scale would be the variation in ecosystems, such as deserts, forests, grasslands, wetlands and oceans. Ecological diversity is the largest scale of biodiversity, and within each ecosystem, there is a great deal of both species and genetic diversity.

Biodiversity and Ecosystem Stability

Ecosystem stability is the ability of an ecosystem to maintain a steady state, even after a stress or disturbance has occurred. In order for an ecosystem to be considered stable, it needs to have mechanisms in place that help it return to its original state after a disturbance occurs.

It has been shown that biodiversity of an area has a large impact on the ecosystem stability of that area. Areas with high levels of species and genetic diversity are likely to have a more complex ecosystem, with a variety of food webs and biotic interactions. This increase in complexity makes it more likely that the ecosystem will return to a stable state after a disturbance, because the ecosystem has more ways to respond to a disturbance and fix problems.

Bio-geographical Classification of India

India is a mega diverse country. With only 2.4 per cent of the total land area of the world, the known biological diversity of India contributes 8 percent to known global biological diversity. In terms of Biogeography, India has been divided into 10 biogeographic zones as shown in the below table: India has been divided into ten recognizable biogeographic zones as follows

Trans-Himalayan Region

The Himalayan ranges immediately north of the Great Himalayan range are called the Trans-Himalayas. The Trans-Himalayan region with its sparse vegetation has the richest wild sheep and goat community in the world. The snow leopard is found here, as is the migratory black-necked crane.

Himalayas

The Himalayas consist of the youngest and loftiest mountain chains in the world. The Himalayas have attained a unique personality owing to their high altitude, steep gradient and rich temperate flora.The forests are very dense with extensive growth of grass and evergreen tall trees. Oak, chestnut, conifer, ash, pine, deodar are abundant in Himalayas. There is no vegetation above the snowline. Several interesting animals live in the Himalayan ranges. Chief species include wild sheep, mountain goats, ibex, shrew, and tapir. Panda and snow leopard are also found here.

Semi-Arid Areas

Adjoining the desert are the semi-arid areas, a transitional zone between the desert and the denser forests of the Western Ghats. The natural vegetation is thorn forest. This region is characterized by discontinuous vegetation cover with open areas of bare soil and soil-water deficit throughout the year. Thorny shrubs, grasses and some bamboos are present in some regions. A few species of xerophytic herbs and some ephemeral herbs are found in this semi-arid tract. Birds, jackals, leopards, eagles, snakes, fox, buffaloes are found in this region.

Western Ghats

The Western Ghats extend from the southern tip of the peninsula (8°N) northwards about 1600 km to the mouth of the river Tapti (21°N).The mountains rise to average altitudes between 900 and 1500 m above sea level, intercepting monsoon winds from the southwest and creating a rain shadow in the region to their East. The varied climate and diverse topography create a wide array of habitats that support unique sets of plant and animal species. Apart from biological diversity, the region boasts of high levels of cultural diversity, as many indigenous people inhabit its forests. The Western Ghats are amongst the 25 biodiversity hot-spots recognized globally. These hills are known for their high levels of endemism expressed at both

higher and lower taxonomic levels. Most of the Western Ghat endemic plants are associated with evergreen forests. The region also shares several plant species with Sri Lanka. Rice cultivation in the fertile valley proceeded gardens of early commercial crops like areca nut and pepper. The original vegetation of the ill-drained valley bottoms with sluggish streams in elevations below 100m would be often a special formation, the Myristica swamp.Expansion of traditional agriculture and the spread of particularly rubber, tea, coffee and forest tree plantations would have wiped out large pockets of primary forests in valleys. The Western Ghats are well known for harboring 14 endemic species of caecilians (i.e., legless amphibians) out of 15 recorded from the region so far.

North-West Desert Regions

This region consists of parts of Rajasthan, Kutch, Delhi and parts of Gujarat. The climate is characterised by very hot and dry summer and cold winter. Rainfall is less than 70 cm. The plants are mostly xerophytic. Babul, Kikar, wild palm grows in areas of moderate rainfall. Indian Bustard, a highly endangered bird is found here. Camels, wild asses, foxes, and snakes are found in hot and arid parts of the desert.

Deccan Plateau

Beyond the Ghats is Deccan Plateau, a semi-arid region lying in the rain shadow of the Western Ghats. This is the largest unit of the Peninsular Plateau of India. The highlands of the plateau are covered with different types of forests, which provide a large variety of forest products.the Deccan plateau includes the region lying south of the Satpura range.it extends up to the southern tip of peninsular India.Anai mudi is the highest peak of this region.The Deccan plateau is surrounded by the western and the eastern ghats.These ghats meet each other at the Nilgiri hills. The western ghats includes the Sahyadri, Nilgiris, Anamalai, and cardamom hills.many rivers such as Mahanadi, Godavari, krishna, and kaveri originates from western ghats and flow toward the east.The eastern ghats are broken into small hill rangesby river coming from the western ghats.Most of these rivers fall into the bay of bengal.The Godavari is the longest river in the Deccan plateau .the Narmada and the Tapi flow westwards and fall into the Arabian sea.

Gangetic Plain

In the North is the Gangetic plain extending up to the Himalayan foothills. This is the largest unit of the Great Plain of India. Ganga is the main river after whose name this plain is named. The aggradational Great Plains cover about 72.4mha area with the Ganga and the Brahmaputra forming the main drainage axes in the major portion.The thickness in the alluvial sediments varies considerably with its maximum in the Ganga plains. The physiogeographic scenery varies greatly from arid and semi-arid landscapes of the Rajasthan Plains to the humid and per-humid landscapes of the Delta and Assam valley in the east.Topographic uniformity, except in the arid Western Rajasthan is a common feature throughout these plains. The plain supports some of the highest population densities depending upon purely agro-based economy in some of these areas. The trees belonging to these forests are teak, sal, shisham, mahua, khair etc.

North-East India

North-east India is one of the richest flora regions in the country. It has several species of orchids, bamboos, ferns and other plants. Here the wild relatives of cultivated plants such as banana, mango, citrus and pepper can be grown

Islands

The two groups of islands, i.e., the Arabian Sea islands and Bay Islands differ significantly in origin and physical characteristics. The Arabian Sea Islands (Laccadive, Minicoy, etc.) are the foundered remnants of the old land mass and subsequent coral formations. On the other hand, the Bay Islands lay only about 220 km.Away from the nearest point on the main land mass and extend about 590 km. With a maximum width of 58 km the island forests of Lakshadweep in the Arabian Sea have some of the best-preserved evergreen forests of India. Some of the islands are fringed with coral reefs. Many of them are covered with thick forests and some are highly dissected.

Coasts

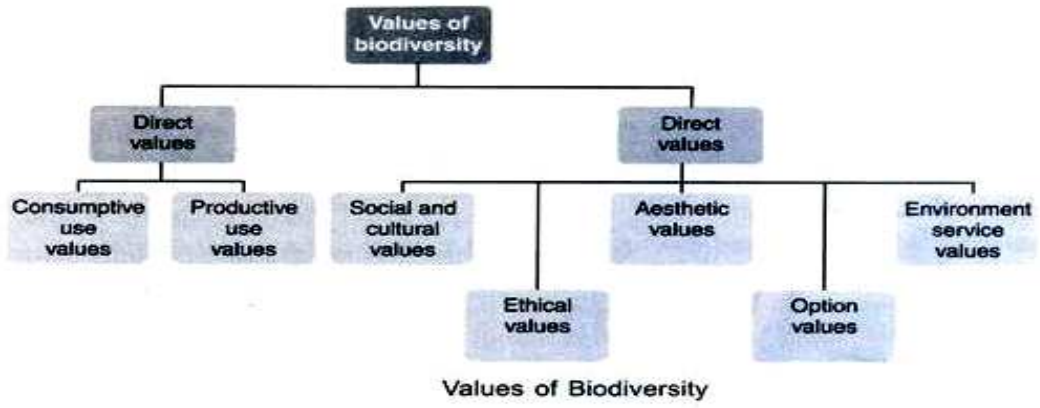
The Indian coasts vary in their characteristics and structures. The west coast is narrow except around the Gulf of Cambay and the Gulf of Kutch. In the extreme south, however, it is somewhat wider along the south Sahyadri.The backwaters are the characteristic features of this coast. The east coast plains, in contrast are broader due to depositional activities of the east-flowing rivers owing to the change in their base levels. Extensive deltas of the , Godavari, Krishna and Kaveri are the characteristic features of this coast. Mangrove vegetation is characteristic of estuarine tracts along the coast for instance, at Ratnagiri in Maharashtra. Larger parts of the coastal plains are covered by fertile soils on which different crops are grown. Rice is the main crop of these areas. Coconut trees grow all along the coast. Coconut and rubber are the main vegetation of coastal area. Main states of coastal areas are- Gujarat, Maharashtra, Goa, Karnataka, Kerala, West Bengal, Odisha, Andra pradesh, Tamil nadu and Puducherry.

Value of Biodiversity

Biodiversity has a fundamental **value** to humans because we are so dependent on it for our cultural, economic, and environmental well-being.

Biodiversity forms the backbone of viable ecosystems on which we depend on for basic necessities, security, and health.

Biodiversity provides a range of goods, from agricultural crops to medicines and fibres, to which a direct **value** and cost can be assigned. This direct economic **value** of the natural environment can be divided into those associated with consumption and production i.e. **consumptive use** and **productive use values**.



Values of Biodiversity

1. Environmental Value

The environmental value of biodiversity can be found by examining each ecosystem process and identifying the ecosystem services that result. For instance, in wetlands the vegetation captures water- carried sediment and the soil organisms break down a range of nutrients and pollutants washed into the area. These processes provide the ecosystem service of purifying water. Wetlands also act as spawning and nursery grounds for some fish and provide a refuge for animals in times of drought. Some ecosystem services are easy to overlook until the underlying process is impaired. For instance, dry-land salinity has emerged as a problem following sustained clearance of deep rooted perennial plants over wide areas. Water tables have raised carrying dissolved salts which then concentrate in the soil. Forests regulate the amount of carbon dioxide in the air by releasing oxygen as a by-product during photosynthesis, and control rainfall and soil erosion.

2. Social Value

The social value of biodiversity includes aesthetic, recreational, cultural and spiritual values. To this can be added health benefits resulting from recreational and other activities. While traditional societies which had a small population and required less resources had preserved their biodiversity as a life supporting resource, modern man has rapidly depleted it even to the extent of leading to the irrecoverable loss due to extinction of several species.

Thus apart from the local use or sale of products of biodiversity there is the social aspect in which more and more resources are used by affluent societies. The biodiversity has to a great extent been preserved by traditional societies that valued it as a resource and appreciated that its depletion would be a great loss to their society.

There can be marked differences in landscape and biodiversity preferences according to age, socioeconomic factors and cultural influences. The lifestyle of the ancient people was closely interwoven with their surroundings.

The life of the indigenous people in many parts of the world still revolves around the forests and environment, even in these modern times, many of them still live in the forests and meet their daily requirements from their surroundings.
The biodiversity in different parts of the world has been largely preserved by the traditional societies. Since the indigenous people always protect the forests for their own benefit. In ancient times, especially in India, the environment in totally i.e., flora, fauna, etc., were held in high esteem.Trees like Peepal, Banyan and Tulsi are still worshipped. Ladies offering water to Tulsi daily is considered good and there are festivals when ladies tie sacred threads around Peepal and Banyan trees and pray for the welfare of their families.

3.Ecosystem Services

These services also support human needs and activities such as intensely managed production ecosystems.

Ecosystem service includes

The provision of native species and genes used in industry research and development, for instance, in traditional breeding and biotechnology applications in agriculture, forestry, horticulture, chemicals production and bioremediation;

- Pollination of agricultural crops, forest trees and native flowering plants by native insects, birds and other creatures.
- Pest control in agricultural land by beneficial native predators.
- Flood mitigation by vegetation slowing run off and trapping sediment.
- Breakdown of pollutants by micro-organisms in soil and aquatic ecosystems and sequestration of heavy metals in marine and fresh water sediments;
- Greenhouse gas reduction by, for instance, sequestering atmospheric carbon in wood and marine calcium carbonate deposits.
- Maintenance of habitats for native plants and animals; and
- Maintenance of habitats that are attractive to humans for recreation, tourism and cultural activities and that has spiritual importance.

4. Economic Value

The economic potential of biodiversity is immense in terms of food, fodder, medicinal, ethical and social values.
The salient features regarding the economical potential of biodiversity are given below:

1. The major fuel sources of the world including wood and fossil fuels have their origin due to biodiversity.
2. It is the source of food for all animals and humans.
3. Many important chemicals have their origin from the diverse flora and fauna, used in various industries.
4. Diverse group of animals are used for medical research during the testing of new drugs.

5. Consumptive use value

This is related to natural products that are used directly for food, fodder, timber, fuel wood etc. Humans use at least 40,000 species of plants and animals on a daily basis. Many people around the world still depend on wild species for most of their needs like food, shelter and clothing. The tribal people are completely dependent on the forests for their daily needs

6. Productive Use Value

This is assigned to products that are commercially harvested and marketed. Almost all the present date agricultural crops have originated from wild varieties. The biotechnologists continuously use the wild species of plants for developing new, better yielding and disease resistant varieties. Biodiversity represents the original stock from which new varieties are being developed.

7. Ethical and Moral Value

It is based on the principle of 'live and let others live'. Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life. All forms of life have the right to exist on earth. Man is only a small part of the Earth's great family of species.

Don't plants and animals have an equal right to live and exist on our planet which is like an inhabited spaceship? Morality and ethics teach us to preserve all forms of life and not to harm any organism unnecessarily.

Some people take pleasure in the hunting of animals. People also sometimes degrade and pollute the environment by their unethical actions. Through proper education and awareness, the people's conscience against such practices must be raised.

8. Aesthetic Value

The beauty of our planet is because of biodiversity, which otherwise would have resembled other barren planets dotted around the universe. Biological diversity adds to the quality of life and provides some of the most beautiful aspects of our existence. Biodiversity is responsible for the beauty of a landscape.

People go far off places to enjoy the natural surroundings and wildlife. This type of tourism is referred to as eco-tourism, which has now become a major source of income in many countries. In many societies, the diversity of flora and fauna has become a part of the traditions and culture of the region and has added to the aesthetic values of the place.

Biodiversity Hotspots in India

1. The Western GhatS

These hills are present along the western edge of peninsular India. Since they are situated near the ocean, they are likely to receive a good amount of rainfall. Most of the deciduous, as well as rainforests, are present in this region. Around 77% of the amphibians and 62% of the reptiles found here cannot be spotted elsewhere in the world. Sri Lanka in South India is a country which is rich in species too. It is connected to India through a land bridge which has a width of nearly 140 km.

There are more than 6000 vascular plants here which belong to more than 2500 genus. 3000 plants out of these are endemic. Most of the spices found in the world such as black pepper and cardamom all are believed to have originated in the Western Ghats. Most of the species are however present in the Agasthyamalai Hills situated in extreme South. The region is also home to around 450 species of birds, 140 mammals, 260 reptiles and 175 amphibians. Such diversity is quite beautiful as well as rare but now lies on the verge of extinction. The vegetation in this region was originally spread over 190,000 square kilometres but has reduced to 43,000 square kilometres today. Only 1.5% of the original forest is still prevalent in Sri Lanka.

2. The Eastern Himalayas

This region comprises of Bhutan, Northeast India, and Southern, Central and Eastern Nepal. These Himalayan Mountains are the highest in the world and abode to some of the highest peaks of the world including Mount Everest and K2. Some of the major rivers in the world originate from the Himalayas. The Himalayas comprise of more than 100 mountains beyond 7200 meters. There are almost 163 endangered species in this region including one-horned rhinoceros, wild Asian water buffalo and as many as 45 mammals, 50 birds, 12 amphibians, 17 reptiles, 3 invertebrate and 36 plant species. One such endangered species found here is the relict dragonfly whose only other species is found in Japan. Himalayan Newt is also present in this region. Coming to the fauna, there are 10,000 species of plants in the Himalayas a third of which are endemic and cannot be located anywhere else in the world. Some of the threatened ones include Cheer pheasant, Western Tragopan, Himalayan quail, Himalayan vulture, White-bellied heron and the like. Mammals too can be spotted here with over 300 species such as Asiatic wild dogs, sloth bears, snow leopard, black bear, blue sheep and wild water buffalo. Namadapha flying squirrel is, however, a mammal which is almost on the verge of extinction and therefore needs immediate attention.

Threats to biodiversity

1. Climate Change

Changes in climate throughout our planet's history have, of course, altered life on Earth in the long run — ecosystems have come and gone and species routinely go extinct.
But rapid, manmade climate change speeds up the process, without affording ecosystems and species the time to adapt. For example, rising ocean temperatures and diminishing Arctic sea ice affects marine biodiversity and can shift vegetation zones, having global implications.

Overall, climate is a major factor in the distribution of species across the globe; climate change forces them to adjust. But many are not able to cope, causing them to die out.

Solutions: Individuals can take various steps to fight climate change, such as *reducing their carbon footprints*, *promoting education* and contacting elected officials. International governments and cities can lead the charge, however, and the 2015 United Nations Climate Change Conference in Paris will hopefully be a turning point.

2. Deforestation and habitat loss

Deforestation is a direct cause of extinction and loss of biodiversity. An estimated 18 million acres of forest are lost each year, due in part to logging and other human practices, destroying the ecosystems on which many species depend.
Tropical rainforests in particular, such as the Amazon, hold a high percentage of the world's known species, yet the regions themselves are in decline due to humans.

Solutions: companies and corporations can adopt best practices and refuse to use timber and paper suppliers that contribute to deforestation. In the same vein, conscious consumers can refuse to patronize companies that do, and put pressure on retailers that employ unsustainable manufacturing methods. Individuals can also participate in land preservation through charities and private corporations. Ultimately, however, international governments need to enact stronger, scientific forest protection laws.

3. Overexploitation

Overhunting, overfishing and over-harvesting contribute greatly to the loss of biodiversity, killing off numerous species over the past several hundred years. Poaching and other forms of hunting for profit increase the risk of extinction; the extinction of an apex predator — or, a predator at the top of a food chain — can result in catastrophic sequences for ecosystems.

Solutions: Conservation and continued awareness surrounding overexploitation, especially poaching and overfishing, are key. Governments need to actively enforce rules against such practices, and individuals can be more conscious of what they eat and purchase. Other solutions, such as removing Subsidies granted to large-scale fisheries can help, too.

4. Invasive species

The introduction of non-native species into an ecosystem can threaten endemic wildlife (either as predators or competing for resources), affect human health and upset economies.

Solutions: According to the National Wildlife Federation, solutions include creating systems to prevent introduction of invasive species in the first place, effectively monitoring for new infestations and swiftly eradication newly detected invaders.

5. Pollution

From the burning of fossil fuels (releasing dangerous chemicals into the atmosphere and, in some cases, depleting ozone levels) to dumping 19 billion pounds of plastic into the ocean every year, pollution completely disrupts the Earth's ecosystems. While it may not necessarily cause extinction, pollutants do have the potential to influents species' habits.

For example, acid rain, which is typically caused by the burning of fossil fuels, can acidify smaller bodies of water and soil, negatively affecting the species that live there by changing breeding and feeding habits.

Man wildlife conflicts

Man wildlife conflict is the negative impact of man's activities on the habitat and resources of the wild animals due to growing human populations overlap with wildlife territory.

Causes of man-animal conflict

- Habitat fragmentation and shrinking of habitats
- Increased disturbance due to collection of fuel wood, fodder, NTFPs, water etc. from the forests has also increased the incidences of man-animal conflict
- People have to go deeper and deeper, year by year for fetching firewood
- Decreased prey base

Impact of man wildlife conflict

- Injury or loss of human lives or animals
- Crop damage , livestock depredation
- Damage to human property and destruction of habitat

Solution

- Capacity building of forest guards
- Increased vigilance and protection of identified locations using hi-tech surveillance tools like sensors for knowing Animal movements – Eg. Buxa forest

- Construction ossf highways/railways bypassing wildlife rich areas like Trans-Canada Highway bypassed Banff National park
- Expansion of protected reserves : in-situ and ex-situ habitat conservation measures will help in securing animals their survival and reduced conflict with humans
- Safe animal zones creation: re-locating of animal habitats away from residential and commercial centers will serve to minimize animal-man conflict for illegal and self-interested motives
- Community based rehabilitation measures: making community responsible for resolution of animal-man conflict will aid in decentralized approach of governance for wildlife preservation. For ex it is done Keibul Lamjao National Park, Kaziranga national park, Sundarbans etc;
- Partnering with WWF which provide tailor made solutions to man wildlife conflict with community and species in consideration
- Adequate compensation after rehabilitation – Baiga tribe in Kanha tiger reserve were relocated without proper compensation

Conservation of Biodiversity

Conservation is the protection, preservation, management, or restoration of wildlife and natural resources such as forests and water. Through the conservation of biodiversity and the survival of many species and habitats which are threatened due to human activities can be ensured. There is an urgent need, not only to manage and conserve the biotic wealth, but also restore the degraded ecosystems.

Types of Conservation

Conservation can broadly be divided into two types:

1. In-situ conservation 2. Ex-situ conservation

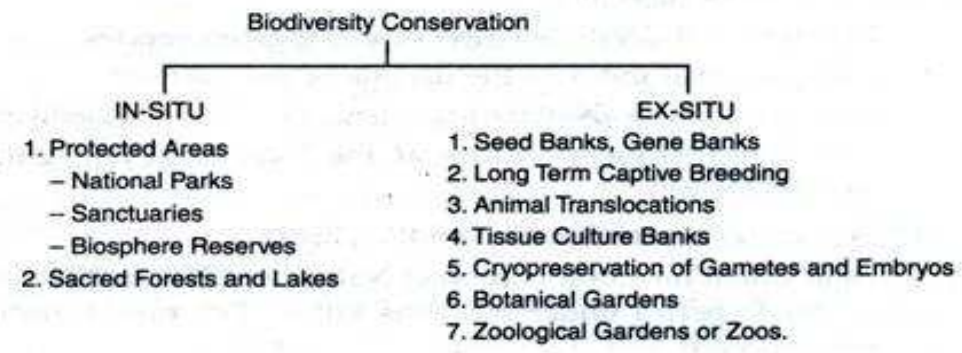


Table. List of some major National Parks of India

S.No.	Name	State	Established	Area (in km^2)
1.	Corbett National Park	Uttarakhand	1921	1318.5
2.	Dudhwa National Park	Uttar Pradesh	1977	490.29
3.	Gir National Park	Gujarat	1965	258.71
4.	Kanha National Park	Madhya Pradesh	1955	940
5.	Kanger Ghati National Park (Kanger Valley)	Chhattisgarh	1982	200
6.	Kaziranga National Park	Assam	1974	471.71
7.	Nanda Devi National Park	Uttarakhand	1982	630.33

8.	Sariska National Park	Rajasthan	1955	866
9.	Silent Valley National Park	Kerala	1980	237
10.	Sundarbans National Park	West Bengal	1984	1330.12

In-situ Conservation

In-situ conservation is on site conservation of genetic resources in natural populations of plant or animal species, such as forest genetic resources in natural populations of tree species. It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or cleaning up the habitat itself, or by defending the species from predators. In-situ conservation is being done by declaring area as protected area.

In India following types of natural habitats are being maintained:

1. National Park 2. Wildlife Sanctuary 3. Biosphere Reserves
India has over **600 protected area** which includes over **90 national parks**, over **500 animals sanctuaries** and **15 biosphere Reserves**

1.National Park

A national park is an area which is an area which is strictly reserved for the betterment of the wildlife and where activities like forestry, grazing on cultivation are not permitted. In these parks, even private ownership rights are not allowed.

Their boundaries are well marked. They are usually small reserves spreading in an area of 100 Sq. Km. to 500 sq. Km. In national parks, the emphasis is on the preservation of a single plant or animal species.

2. Wildlife Sanctuaries

A Sanctuary is a protected area which is reserved for the conservation of only animals and human activities like harvesting of timber, collecting minor forest products and private

ownership rights are allowed as long as they do not interfere with well-being of animals. Boundaries of sanctuaries are not well defined and controlled biotic interference is permitted, e.g., tourist activity.

Table. List of some major Wildlife Sanctuaries of India

S.No.	Name	State	Established	Area (in km^2)
1.	Ghana Bird Sanctuary	Rajasthan	1982	28.73
2.	Hazaribag Wildlife Sanctuary	Jharkhand	1954	183.89
3.	Mudumalai Wildlife Sanctuary	Tamil Nadu	1940	321.55
4.	Jaldapara Wildlife Sanctuary	West Bengal	2012	216
5.	Mount Abu Wildlife Sanctuary	Rajasthan	1960	288.84

6.	Anamalai Wildlife Sanctuary (Indira Gandhi Wildlife Sanctuary and National Park)	Tamil Nadu	1989	117.10

3. Biosphere Reserves

It is a special category of protected area where human population also forms a part of the system.They are large protected area of usually more than 5000 sq. Km.A biosphere reserves has 3 parts- core,buffer and transition zone.

1. Core zone is the inner zone; this is undisturbed and legally protected area.
2. Buffer zone lies between the core and transition zone.Some research and educational activities are permitted here.
3. Transition zone is the outermost part of biosphere reserves.Here cropping, forestry,recreation, fishery and other activities are allowed.

Table. List of some major Biosphere Resesrves of India

S.No.	Name	State	Established	Area (in km
1.	Nanda Devi	Uttarakhand	1982	5,860.69
2.	Manas	Assam	1990	2837
3.	Gulf of Mannar	Tamil Nadu	1980	10,500

4.	Great Nicobar	Andaman and Nicobar Islands	1989	885
5.	Panchmarhi	Madhya Pradesh	1999	4,926.28

The main functions of biodiversity reserves are:

1. Conservation: To ensure the conservation of ecosystem, species and genetic resources.

2. Development: To promote economic development, while maintaining cultural, social and ecological identity.

Advantages of in-situ conservation

1. The flora and fauna live in natural habitats without human interference.
2. The life cycles of the organisms and their evolution progresses in a natural way.
3. In-situ conservation provides the required green cover and its associated benefits to our environment.
4. It is less expensive and easy to manage.
5. The interests of the indigenous people are also protected.

Ex-Situ Conservation

Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated or species, and draws on a diverse body of techniques and facilities. Such strategies include establishment of botanical gardens, zoos, conservation strands and gene, pollen seed, seedling, tissue culture and DNA banks.

1) *Seed gene bank:*

These are cold storages where seeds are kept under controlled temperature and humidity for storage and this is easiest way to store the germ plasma of plants at low temperature. Seeds preserved under controlled conditions (minus temperature) remain viable for long durations of time.

2) *Gene bank:*

Genetic variability also is preserved by gene bank under normal growing conditions. These are cold storages where germ plam are kept under controlled temperature and humidity for storage; this is an important way of preserving the genetic resources.

3) *Cryopreservation:*

This is the newest application of technology for preservation of biotic parts. This type of conservation is done at very low temperature (196°C) in liquid nitrogen. The metabolic activities of the organisms are suspended under low temperature, which are later used for research purposes.

4) *Tissue culture bank:*

Cryopreservation of disease free meristems is very helpful. Long term culture of excised roots and shoots are maintained. Meristem culture is very popular in plant propagation as it's a virus and disease free method of multiplication.

5) *Long term captive breeding:*

The method involves capture, maintenance and captive breeding on long term basis of individuals of the endangered species which have lost their habitat permanently or certain highly unfavorable conditions are present in their habitat.

6) *Botanical gardens:*

A botanical garden is a place where flowers, fruits and vegetables are grown. The botanical gardens provide beauty and calm environment. Most of them have started keeping exotic plants for educational and research purposes.

7) *Animal Translocation:*

Release of animals in a new locality which come from anywhere

Endangered and Threatened Species of India

India is home to different types of animals, birds and fishes which includes some important farm animals like goats, poultry, cows, buffaloes, pigs etc. The country is also a habitat for wild animals like *Bengal tigrs, deer, wolves, pythons, Indian lions, bears, snakes, monkeys, Asian elephants and Antelope species.*

India is one of the mega diverse countries, including India, are the habitats of around 60-70 % of the world's biodiversity. The Western Ghats, The Eastern Himalayas and Indo-Burma are the three biodiversity hotspots out of total 34 in the whole world. India has 6.5% of the world's total wildlife species according to report which was published by the United Nations Office on Drugs and crime (UNODC) that includes 7.6% of all mammals and 12.6% of all bird species.

Endemism

Endemism is an ecological word meaning that a plant or animal lives only in a particular location, such as a specific island, habitat type, nation or other defined zone. **Endemic** types are most likely to develop on islands because they are isolated. For example, many species of lemur are endemic to the island of Madagascar.

Threats to highly endemistic regions

Some of the principal threats to these special ecosystems are:

- Large scale logging operations
- Slash-and-burn techniques (which are sometimes a part of shifting cultivation)
- Destruction of habitat or vegetation leads to endangering of the endemic species

Rare Species

A **rare species** is a group of organisms that are very uncommon, scarce, or infrequently encountered. This designation may be applied to either a plant or animal taxon, and is distinct from the term *endangered* or *threatened.*

"Rare" is also a designation that the IUCN—The World Conservation Union gives to certain species "with small world populations that are not at present 'endangered' or 'vulnerable' but are at risk. These species are usually localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range." Some American states have also employed this category in protective legislation.

According a report issued by the International Union for Conservation of Nature(IUCN) Red List in 2014, ***15 species of birds, 12 species of mammals, and 18 species of reptiles and amphibian have joined the critically endangered list.***

Few examples are as follows:

1. Greater One-Horned Rhinoceros
2. Nilgiri Tahr
3. Bengal Tigers
4. Asiatic Lion
5. Black Buck
6. Lion Tailed Macaque
7. Snow Leopard

Endangered species

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