Ecosystems

Components of Ecosystem

In order to understand the ecosystem, a group of students were asked to study a small field carefully.

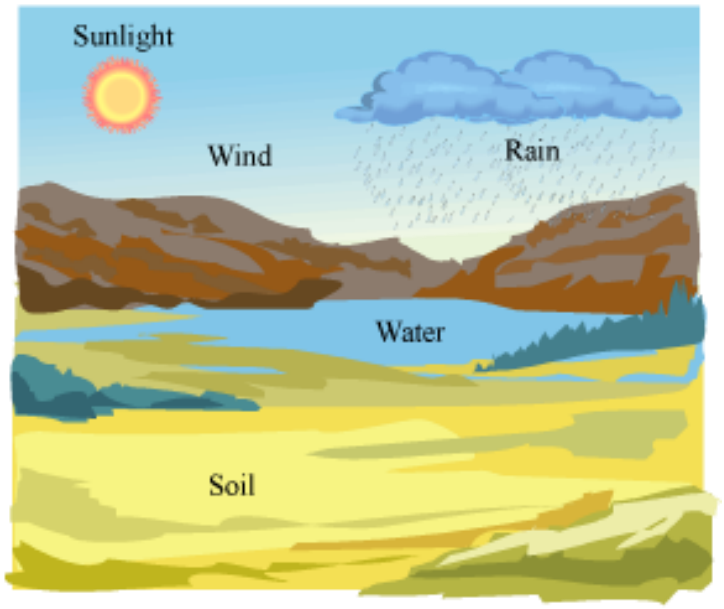
The teacher explained the students that an **ecosystem** includes both living and non-living components of an area. Thus, an ecosystem includes both the biological community and non-living components of an area. Ponds, forests, grasslands, etc. are a few examples of ecosystems.

The students were divided into two groups. **Group I** collected data about the non-living components found in the environment while **Group II** collected data about the living components in the environment.

Let us understand the components constituting the environment.

Group I listed the non-living components as water, air, soil, inorganic nutrients, etc. One of the students started feeling hot and wanted to drink water. He wondered whether temperature is also a component of the environment. The teacher explained that temperature, light, and other physical factors that affect life are also non-living components of the environment.

- **Sunlight**: Source of energy for sustenance of life on earth; required for production of food through photosynthesis
- **Air**: Provides oxygen for respiration and carbon dioxide for photosynthesis; act as a medium to disperse seeds and pollens
- **Water**: Important constituent of all living cells; act as medium for all the biochemical reactions occurring inside a cell; consumed by plants and animals to sustain life
- **Temperature**: Temperature conditions of an area influence the body functions of plants and animals living at that area.
- **Soil**: Contains water and minerals required for the growth of plants; act as dwelling place for several microbes, and burrowing animals like rats, snakes, and earthworms. The type of soil and its nature influence the type of vegetation found in an area.



Group II listed the living components of an ecosystem, which included the following organisms:

Autotrophs are organisms that can manufacture their own food from inorganic raw materials. They are also known as producers. They include all green plants and some bacteria.

Heterotrophs: The organisms which cannot synthesise their own food and are therefore, dependent upon other organisms are known as **heterotrophs**.

Heterotrophs are classified further as shown below:

- Heterotrophs
  - Consumers
    - Herbivores
    - Carnivores
  - Decomposers

Consumers: These organisms mainly obtain food either directly from autotrophs or indirectly from other heterotrophs. They include animals that generally ingest and then digest their food.

Consumers are divided into herbivores, carnivores, and omnivores.

Herbivores	Carnivores	Omnivores

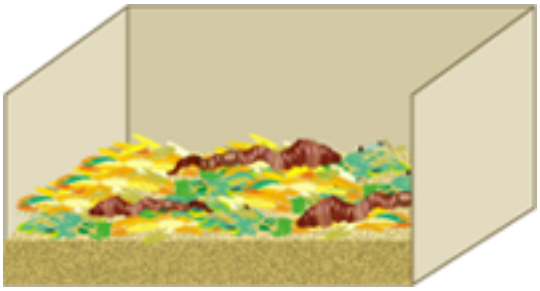
The animals that feed only on plants are called herbivores. They are also known as primary consumers.	The animals that eat other animals are called carnivores. They are also known as secondary consumers. Those carnivores, which feed on herbivores, are called primary carnivores.	There are some animals that feed on both plants and animals.
Examples include deer, rabbit, goat, horse, sheep, etc.	Examples include frog, cat, spider, etc.	Examples include bear, turtle, monkey, mice, squirrel, humans, etc.

Decomposers: This group includes microorganisms such as bacteria and fungi, which obtain nutrients by breaking down the remains of dead plants and animals.

Do you know that cats are purely obligate carnivores? They cannot digest fruits, vegetables, pulses, grains, etc. They require a high level of protein in their diet. They lack an efficient system for digesting plant products. A cat's digestive system is specialized to suit a carnivorous eating habit.

Decomposition can be better understood by the following activity.

Vermicomposting



Take a wooden box. Place it where it is neither too hot nor too cold. Put a layer of sand (about 2-3 cm thick) at the bottom of the wooden box.

Then, spread some vegetable waste, plant parts, weeds, and garden waste over the sand.

Sprinkle some water on this layer and place a few earthworms on it. Water is sprinkled to provide moisture for the survival of earthworms. Cover the wooden box with a sheet of cloth. After 2 - 3 days, gently mix the top layers of matter in the wooden box. After 3 - 4 weeks, observe the contents of the wooden box.

Precautions:

- Do not add plastic bags, broken glass, or other such materials.
- Do not add food items containing salt, oil, vinegar, meat, etc. These items can lead to the growth of disease-causing organisms.
- Do not add excess water.
- Keep the layer of wastes loose, so that it has enough air and moisture for the earthworms to survive.

After 3 - 4 weeks, you will observe that the vegetable waste is converted into a loose soil-like material. This soil-like material is the nutrient-rich castings left behind by the earthworms. This is called v**ermicomposting.** This can be used as a natural fertilizer, after being dried in the sun.

Do you know why vegetable waste was added to the box?

The earthworms use this waste as food. They grind this food with the help of a structure called gizzard and break it down into smaller fragments.

Conclusion:

Organic home waste can be easily converted into a great natural fertilizer. The organic matter or biomass involved in decomposition includes dead plants and animals.

Therefore, biotic and abiotic components can be summarized as follows:

Abiotic factors	Biotic factors
Sunlight Temperature Water Air Soil Humidity	Autotrophs Heterotrophs: Consumers (Herbivores, Carnivores); Decomposers

What will happen if an aquarium contains dead plants and animals and is not cleaned properly?

In nature, scavengers and decomposers such as bacteria and fungi recycle matter by breaking down the organic remains and waste products of plants and animals.

However, this does not occur in a man-made ecosystem. Thus, an aquarium will have a high growth of bacteria and fungi.

This can lead to the death of fishes. The turbidity in water will not allow light to penetrate and without light, plants will die. Thus, the stability of an ecosystem i.e., of the aquarium will be disturbed.

Are all environments similar? Can we identify different types of environments?

Ecosystems can be divided into **natural** and **man-made ecosystems**.

Lakes, forests, grasslands, etc. constitute **natural ecosystems**.

An aquarium or a crop field is a **man-made ecosystem**. Since humans control the type of organisms, amount of light, water, etc. in an aquarium or a crop field, they are called man-made ecosystems.

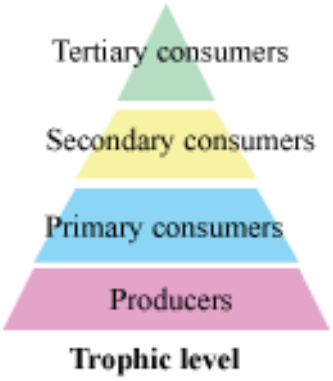
We learned about the various components of the ecosystem. Now let us find out how these components interact with each other and how energy flows within an ecosystem.

Interactions within an ecosystem

If a carnivore eats an herbivore, then does it mean that the carnivore has higher energy than the herbivore?

Producers (all green plants and some bacteria) convert solar energy into chemical energy in the form of organic compounds. The primary consumers derive nutrients from the producers. Therefore, energy passes to the next trophic level from the producers.

A trophic level is the level of species in an ecosystem based on its main source of nutrition. Producers, herbivores, primary carnivores, secondary carnivores, etc. are at different trophic levels.



The producers form the first trophic level as they manufacture food. The primary consumers form the second trophic level, the secondary consumers form the third, and the tertiary consumers form the fourth trophic level.

These trophic levels are connected through **food chains.** A food chain is a linear sequence of organisms in which each organism is eaten by the next member in the sequence. This interaction among organisms involves the transfer of energy from one organism to another.

Do you know that detrivores are animals such as sea urchins, crabs, starfishes, etc., which feed on dead parts of organisms (detritus)? A food chain that starts with this dead organic matter is called a detritus food chain.

For example, tree leaves → detrivores → small fishes → large fishes

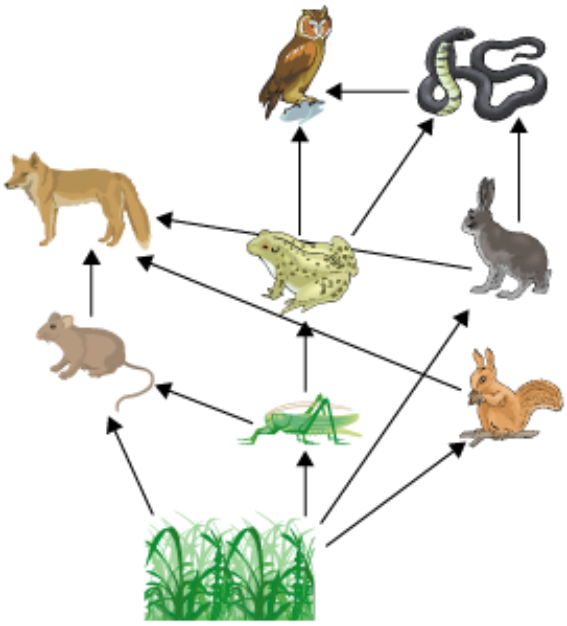
Do you know that parasites are the organisms that live on or inside the body of other living organisms called host and obtain food from them. The food chain that involves the transfer of energy through series of parasites is called **parasitic food chain.**

For example, Trees → parasitic bird → bird lice → flagellate protozoans.

Food web

Food chains are not isolated, but rather interconnected with each other.

An interconnected network of food chain, which forms a multitude of feeding connections among different organisms of a biotic community, is called a **food web**.



Depending upon the constituent organism and environment, many different food webs exist.

The given illustration shows a common food web.

Flow of energy in an ecosystem

Energy enters the ecosystem from the sun. Solar radiations pass through the atmosphere. Most of these radiations are absorbed by the Earth's surface, which helps in the process of photosynthesis as well as maintaining a temperature suitable for the survival of living organisms.

Let us discuss the 10% law of energy transfer.

Thus, 1,000 kg of plant material converts into 100 kg of herbivore tissue. This converts into 10 kg of carnivore tissue and 1 kg of second level carnivore tissue.

Therefore, the maximum energy is present in plants, followed by the herbivores, then the carnivores. Hence, the top predator or the tertiary consumer has the least amount of energy. The graphical representation of energy exchange in the ecosystem is known as "**Pyramid of energy**".

Biomagnification

Do you know that a larger amount of pesticides are accumulated in top carnivores?

Let us study why this happens.

A large number of pesticides and chemicals are used to protect crops from several pests and diseases. These pesticides reach the soil because of rain or sprinkling of water on crops and are absorbed by plants along with water and minerals from the soil.

Due to rain, these chemicals enter the water sources and bodies of aquatic plants and animals. This is how these chemicals enter the food chain.

Since these chemicals cannot decompose, they accumulate continuously at each trophic level. As the food chain proceeds, concentrations of the pesticides also increase. Thus, their maximum concentration is among the top carnivores. The increase in the concentration of pollutants or harmful chemicals with each step of the food chain is called **biomagnification**.

Conservation of Forests and Wildlife

Forests

A forest is a large area of land which is covered with different kinds of plants, trees, and undergrowths. Forests also sustain a large number of microorganisms, insects, birds, reptiles, and various other animals. On the basis of their location and vegetation found, forests are classified into various types.

Type of Forests	Areas	Organisms Found

Tropical rain forests	Western coast of India, North East Himalayas	**Flora**: Evergreen trees, ferns, shrubs, bamboos, etc **Fauna**: Leopards, monkeys, jungle cats, snakes, many insects and snails, etc
Temperate deciduous forests	North China, Korea, Japan, Australia, North Eastern America, etc	**Flora**: Pine, oak, birch, etc **Fauna**: Moths, deer, beetles, wolves, foxes, etc
Coniferous forests	North America, North Eurasia, Himalayas	**Flora**: Pine and fir trees **Fauna**: Very few animals are found, include squirrels, deers, wolves, goats,, etc

Wildlife

All the species of plants, animals and other organisms living in the wild is referred to as **wildlife.** It includes the different variety of living organisms that inhabit forests, oceans or seas.

Biodiversity

The variety of plants, animals and other orgainsms that inhabit the earth is collectively known **biodiversity**.

Destruction of Wildlife

More and more animals are being added day by day to the list of endangered and extinct species. This is taking place because of the following reasons:

- In last few decades, animals have been mercilessly hunted for fun.
- Various body parts are illegally obtained from animals such as bones, skin, hides, and teeth of animals.
- Due to deforestation, the natural habitat of animals is being destroyed, which in turn is leading to the loss of animals also.
  If the destruction of nature proceeds at the same rate, then a day will come when humans themselves will become extinct.

To avoid this from taking place, we have to protect our environment.

Each one at our individual level can contribute towards the protection of the environment.

Ways in which we can contribute to protect our environment:

- Planting a tree in our neighbourhood and taking care of it
- Avoiding plastic bags and instead using paper bags or jute bags
- Preventing noise pollution by playing music at low volume
- Avoiding wastage of water and other natural resources
- Using carpools to lessen the crowd of vehicles on roads, which lead to pollution
- Spreading awareness about the protection of environment amongst others also

You know that increased human activity in the forests is causing harm to our forests and wildlife. Also, wildlife in these forests is poached or captured mercilessly for global markets**.**

But how can we conserve our forests and wildlife? Let us explore the methods for conservation of forests and wildlife.

Biosphere Reserves

Do you know what biosphere reserves are?

Biosphere Reserves are large areas for conservation of biodiversity, which include both wildlife and plants. It also preserves the traditional life of tribes living in the area. For example, Nanda Devi Biosphere Reserve in Uttaranchal.

Pachmarhi biosphere reserve is another biosphere located in Madhya Pradesh. It consists of trees like *sal*, teak, *jamun,* and silver ferns. Animals like *Chinkara*, leopards, wild dogs, wolves etc. are also found here. Plants and animals which are present in a particular area are known as the **flora and fauna** of that area.

Biosphere reserves also help in the protection of endemic species. **Do you know what they are?**

Endemic species are those species which are restricted to a particular area and are unique to that area. For example, Indian giant squirrel, bison, and flying squirrel in Pachmarhi Biosphere Reserve are endemic to that area.

Wildlife Sanctuary

Do you know what a wildlife sanctuary is?

Wildlife Sanctuary is an area which is free from disturbances from human activities, and is devoted for the conservation and protection of wildlife. Wildlife sanctuaries are under the jurisdiction of the state government, for example, the Mudumalai wildlife sanctuary in Tamil Nadu.

National Parks

National Parks are those reserved areas where no human activity is allowed at all. The purpose of a national park is to preserve the flora, fauna, landscape, and the historic objects of that area. For example, Kaziranga National Park in Assam helps in the protection of the great one-horned Indian Rhinoceros.

Do you know that Satpura national park in Madhya Pradesh was the first forest reserve in India?

It consists of the finest Indian teak and also has a tiger reserve, which was launched under **Project Tiger** by the government of India. The main objective of Project Tiger is to ensure the survival of tigers and to maintain their population.

But why is there a need to protect tigers?

Tigers are very important to the ecosystem as they occupy the top level of the food chain. They keep the population of herbivores in control and hence ensure that overgrazing does not destroy forests.

They are a source of employment to a number of people in the form of forest tourism. Being the National Animal of India, they are a source of pride for the countrymen, who associate them with values such as strength and courage.

Unfortunately their fur are used to make carpets and their claws as well as teeth are ground to powder and sold off as medicines with supposedly magical properties, due to which they are being hunted in large numbers.

Combined with this is the fact that a sharp increase in human population has led to a shortage of space and forests are being cut down. Their numbers are hence dwindling so fast that they are threatened with extinction in the near future.

What is Project Tiger?

Project Tiger is an effort by the Central Government of India to revive the declining population of tigers in the country. It was started in 1973.

The main objective of the project is to ensure a sustainable population of the tiger in India for scientific, economic and cultural values and to provide total protection to its natural habitat for as long as possible to do so.

Under this scheme the Government aims to provide protection for all wildlife inhabiting a Tiger reserve and to reduce the dependency of people on the natural resources found in such a reserve. This will prevent clashes between tigers and humans for space and the tigers can stay peacefully in their habitat.

Project Tiger has been started in a number of wildlife parks that have been designated Tiger reserves. Some of the popular ones include Ranthambhore National Park and

Sariska Sanctuary in Rajasthan, Jim Corbett National Park in Uttarakhand, Bandhavgarh National Park in Madhya Pradesh and the Sunderbans in West Bengal.

What is an endangered species?

Endangered species are those species whose numbers are rapidly diminishing to a level of **extinction.**

Therefore, endangered species like *gharial*, blackbuck, Siberian crane, forest owlet, rhinoceros, and tigers are being protected and preserved in Wildlife reserves.

Do you know that a record of all plants and animals, which are listed in the endangered list, is maintained in a Red Data Book? This book keeps a record of all endangered animals as well as plants and is separate for plants and animals.

Do you know what migratory birds are?

Migratory birds are those birds which travel long distances to reach other lands to escape the harsh conditions of their native place. Birds migrate in response to changes in food availability, habitat, or weather conditions. Every year at a particular time birds undertake their migratory journeys. Many species of birds like ducks, geese, cranes etc. migrate from their distant homes in Europe and Siberia to India.

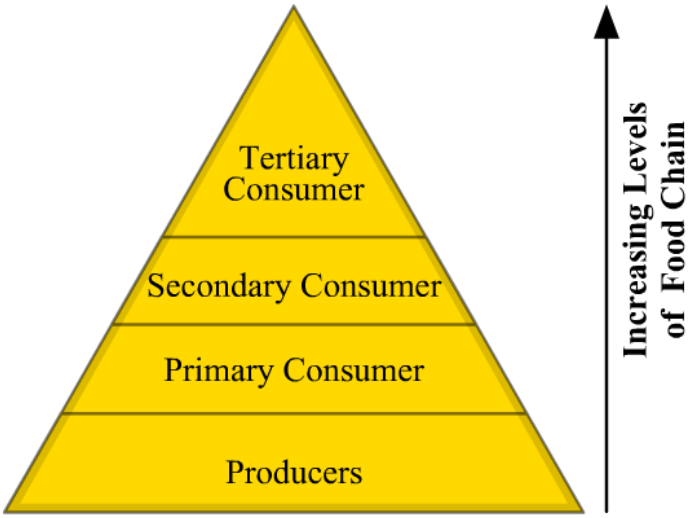
Collect and gather information about various protected areas in India which conserve forests and wildlife. **Which animals do you think need protection?**

Food Pyramids and Interdependence between Organisms

Food Pyramids

Pyramid is a figure or shape that has a large base which continues narrowing as we move up until it finally ends as a small point.

A food pyramid/ecological pyramid is a graphical representation designed to show the biomass and productivity at different trophic levels. These pyramids can be studied with help of food chains that exist in the ecosystem.



Ecological Pyramid

In an ecosystem, there are three kinds of ecological pyramids:
1. Pyramid of number
2. Pyramid of biomass
3. Pyramid of energy

Pyramid of number

The pyramid of number represents a relationship between producers, herbivores and carnivores in terms of their number or abundance. In most of the cases, the number of individuals decrease as we move from bottom to top in this kind of pyramid.
Let us understand this with the help of given food chain.

Grass → Grasshopper → Rat → Snake → Hawk

In this, the producer or grass occupies the lowest trophic level. Since grass is highly abundant in number, the bar of the pyramid would be wider. Next trophic level is occupied by grasshoppers. As they are less abundant than grass, the bar occupied by them would be less wider than previous one.

The next level is occupied by rats as they feed on grasshoppers. Becaue of their small population, their bar would be even less wider than that occupied by grasshoppers.

The next level is occupied by snakes as they feed on rats and the top of pyramid is occupied by hawks who feed on snakes. So we see that as we move upward, the number of individuals decrease with the increase in trophic levels.

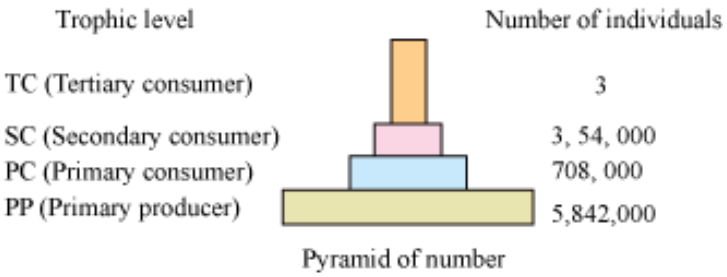
Pyramid of biomass

Biomass is expressed in terms of dry and fresh weight. Pyramid of biomass represents the amount of biomass available at each trophic level. In this kind of pyramid, the amount of biomass is maximum for producers which occupy the lowest trophic level, for

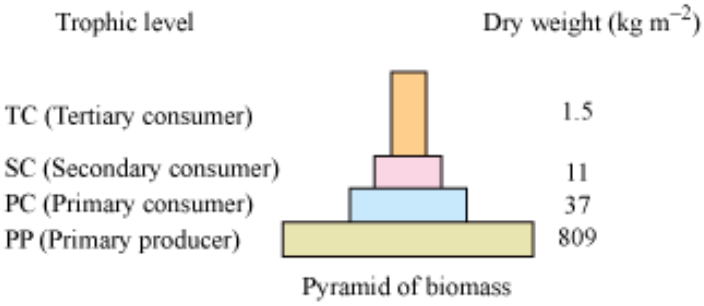
example grass. As we move to the next level, the amount of biomass gradually decreases. The biomass is minimum for the species occupying the top level.

Pyramid of energy

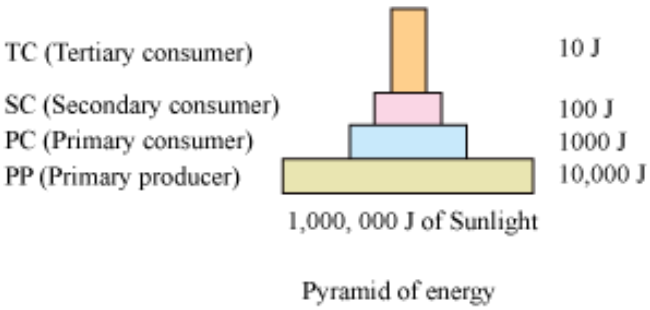
Pyramid of energy represents the amount of energy at each trophic level and the amount of energy lost at each transfer to the next trophic level. The pyramid of energy is always upright with the maximum amount of energy present at the base.



Pyramid of number



Pyramid of biomass



Pyramid of energy

Interdependence between Organisms

There are no such species on earth who can survive on their own. As all the living organisms inhabit an ecosystem, there is an interdependence of species on each other. For example, plants which are primary producers cannot survive alone and require water, soil, microorganisms for their survival. Not only this, they require insects or animals for their pollination.

Thus we can say that all the species are interdependent on each other and the survival of one is difficult without the other.

Interdependence between organisms arise from interactions between populations of two different species. These interactions can be beneficial, harmful or neutral.

Some examples of interdependence of organisms are:

Symbiosis

In this kind of interaction, both the species are benefited. Example: Lichens represent a symbiotic relationship between a fungus and a photosynthetic algae. The algae provides fungus with food, whereas the fungus provides algae with shelter and absorbs nutrients and moisture from the environment.

Another example is that of plants and animals where plants are pollinated by animals, whereas animals get nutritious fruits from plants.

Parasitism

In parasitism, one partner is benefited while the other is harmed. The partner who is benefited is called the parasite while the partner who is harmed is called the host. The parasite survives on the expense of host usually without killing them.

The parasites have a complex life cycle and usually require one or more intermediate host. For example, lice living in the hair of humans. Another example is of malarial parasite *Plasmodium* which requires an intermediate host like mosquito to spread to other hosts.

Predation
In predation also, one organism is benefited while the other is harmed. However, unlike parasite, the predator kills the prey to fulfil its energy requirement. This is also a way of nature to transfer fixed energy. Example: tiger preying on deer, etc.

Risk to Ecosystem

Increased industrialisation, increasing population and increased scientific approach have posed a great risk to the ecosystem. In order to fulfil our requirements, natural resources are being used at a great speed. This poses a risk of extinction of these resources. Inhabitation and deforestation have posed a threat for the species surviving in that region. Changes in environment, such as increased cases of floods, melting of polar ice caps, increased temperatures, etc have led to the extinction of many species. If these changes continue to occur, it may lead to the destruction of mankind on earth.

There is an urgent need to take appropriate steps at both national and international forums in order to save our environment. We need to bring about a radical change in the mindset of people that we cannot survive if the ecosystem is continued to be destroyed.