**UNIT -ONE**

**Conservation and NATURAL RESOURCE Management**

* Our environment (nature) provides us with a variety of goods and services necessary for our day to day lives. We use **air, water, soil, minerals, coal, petroleum, sunlight, animals, plants, microbes etc.** in our daily life. **But do you ever think how long these precious materials of the nature will be available for our use?**
* During the last 100 years, a better health care delivery system and an improved nutritional status has led to rapid population growth, especially in the developing countries.
* Large stretches of land such as forests, grasslands and wetlands have been converted into intensive agriculture.
* Land has been taken for industry and the urban sectors i.e. several small urban centers have become large cities; some have even become giant mega-cities.
* As the human population is continuously growing the consumption of natural resources is also increasing. With the increasing industrialization and urbanization of the modern human society, the use of all the resources is rising. If they are not properly used and well managed, a serious scarcity will result. Therefore we need to conserve the natural resources. This unit therefore, defines conservation and management of natural resource and explains the need for conservation of natural resource.
  1. **Concepts and Definition**

The term **conservation** is derived from two Latin words “**con**” to mean together and “**server**” to mean keep or guard. Thus, conservation is **keeping together.**

* Conservation is the proper management of a natural resource to prevent its exploitation, destruction or degradation.
* Conservation is the sum totals of activities, which can derive benefits from natural resources but at the same time, prevent excessive use leading to destruction or degradation.
* Most people interpret conservation as a total protection or restriction on consumptive use of resource.
* Therefore, wildlife conservation to them means a total ban on killing of any animal and the forest conservation mean a complete moratorium.
* Some other people define Conservation, as it "is management of the earth's resources in a way, which aims to restore and maintain the balance between human requirements and the other species in the world."
* In 1967, the American president John F. Kennedy looked upon conservation as "***the wise use of natural environment…the prevention of waste and despoilment while preserving, improving and renewing the quality and usefulness of all our resources***"
* World conservation strategy defined conservation as*"* ***the management of human use of the biosphere so that it may yield the greatest sustainable benefits to present generation, while maintaining its potential to meet the needs and aspirations of future generations.****"*
* Therefore, Conservation is a practice embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment.
* According to conservationists, conservation is defined as the sensible and careful use of natural resources. They assert that the activities of foresters, fishers, farmers, and other natural resource users are not prudent, sustainable or wise. Therefore, foresters must prudently manage forests, hunters and fishers must harvest wild animal populations sustainably, and farmers must practice the wise use of soil and water.
* According to preservationists, conservation is defined as allowing some places and some creatures to exist without significant human interference. Most people accept the idea that conservation encompasses setting certain areas aside as parks and maintaining certain species without harvesting them.

According to Environmentalist

* Someone who is concerned about the impact of people on environmental quality and conservation to them is, using the nature without harming the environment. Air and water pollution are often the proximate concerns; human overpopulation and wasteful use of resources are the ultimate issues.
* There is enormous overlap between environmentalists and conservationists. Many environmentalists would say that environmentalism encompasses conservation, while many conservationists would say the reverse.
* The difference is a matter of emphasis. By focusing on air and water pollution and their root causes, environmentalists often emphasize urban and suburban situations where human induced problems and human well-being are paramount.
* Because conservationists focus on natural resource use they tend to emphasize rural areas and wild lands, as well as their associated ecosystems and organisms, including people.

**What is natural resource management?**

* **Natural resource management**refers to the management of [natural resources](http://en.wikipedia.org/wiki/Natural_resources) such as [**land**](http://en.wikipedia.org/wiki/Land_%28economics%29)**,** [**water**](http://en.wikipedia.org/wiki/Water)**,** [**soil**](http://en.wikipedia.org/wiki/Soil)**,** [**plants**](http://en.wikipedia.org/wiki/Plants)**,** [**animals**](http://en.wikipedia.org/wiki/Animals) etc. with a particular focus on how management  affects the [quality of life](http://en.wikipedia.org/wiki/Quality_of_life) for both present and future generations.
* **NRM** deals with managing the way in which people and natural [landscapes](http://en.wikipedia.org/wiki/Landscapes) interact.
* It brings together land use planning, water management, [biodiversity conservation](http://en.wikipedia.org/wiki/Conservation_biology) and the future sustainability of industries like [**agriculture**](http://en.wikipedia.org/wiki/Agriculture)**,** [**mining**](http://en.wikipedia.org/wiki/Mining)**,** [**tourism**](http://en.wikipedia.org/wiki/Tourism)**,** [**fisheries**](http://en.wikipedia.org/wiki/Fisheries) **and** [**forestry**](http://en.wikipedia.org/wiki/Forestry)**.**
* Natural resource management specifically focuses on a   
  scientific and technical understanding of resources and [ecology](http://en.wikipedia.org/wiki/Ecology) and the life-supporting capacity of those   
  resources.
* Conservation and Natural resource management is congruent with the concept of sustainable development, a scientific principle that forms a basis for sustainable global land management and environmental governance to conserve and preserve natural resources.
  1. **Need for conservation of natural resources**
* We know that nature provides us all our basic needs but we tend to overexploit it.
* As human consumption of natural resource goes up, the resource gets reduced and may even be completely exhausted in a very short time.
* Human interference and consequent modification of nature may cause irreparable damage to natural ecosystems that may lead to an ecological crisis.
* If we go on overexploiting the nature, there will be no more resources available for our use in future.
* Therefore, there is an urgent need to conserve the nature. Some of the needs are:
* To maintain ecological balance for supporting life.
* To preserve different kinds of species (biodiversity)
* To make the resources available for present and future generations.
* To ensure the survival of human race.

**1.3. Natural resource**

* The term **“resource”** means anything that we use from our environment to achieve our needs or objectives.
* It can also be defined as ‘any natural or artificial substance, energy or organism, which is used by human being for its welfare.
* Resources are of two types:

**a) Natural resources**

**b) Artificial resources.**

* **Natural resource** is every **living** and **non-living** thing (creature) which found naturally and human being uses these directly or indirectly for survival and welfare.
* They contain **a significant amount of material** as well as **aesthetic values** that exist relatively undisturbed by mankind, in a natural form.
* Some examples of natural resources include:
* Soil resources, Plant and animal resources
* Energy resources (fossil fuel energy, geothermal energy, solar energy…).
* Atmosphere which include air, wind
* Land that comprises of fossil fuels, rock and mineral resources.
* Range and pasture.
* Water resources that include, sea, oceans, lakes, groundwater, rivers and fishery.
* On the other hand, the resources which have been developed by human being during the growth of civilization are called **artificial resources**.
* For example, **biogas, thermal electricity, plastics,** etc., are **man-made resources**.
  1. **Types of Natural Resource**
* Natural resources are classified in different ways but in a simple way, natural resources can be categorized into various types which can be based on the **nature of their origin, stage of development, renewability and availability.**

**i. Based on nature of their origin**

1. **Biotic** - Biotic resources are obtained from the biosphere, such as **forests and their products, animals and their products, microbes and their products.**
2. **Abiotic** - Abiotic resources include non-living things such as **land, water, air and ores such as gold, iron, copper, silver** etc.

ii. **Stage of development:**

1. **Potential Resources**

* Potential resources are those that **exist in a region and may be used in the future.**

e.g. petroleum which exists in many parts of the world is   
formed naturally in sedimentary rocks.

* It is drilled out and put into use and remains a potential resource.

1. **Actual Resources**

* Actual resources are those which can also be called **developed resources, stock** and reserves are those that have been surveyed, their quantity and quality determined and **are being used in present times.**

**iii. Renewability**

**(a) Renewable resources**

* Renewable resources are those materials that can be regenerated or reproduced after consumption.
* Some of them, like sunlight, air, wind, etc., are continuously available and their quantity is not affected by human consumption.
* Many renewable resources can be depleted by human use, but may also be replenished.
* Some of these, like agricultural crops, take a short time for renewal.
* Others, like water, take a comparatively longer time, while still others, like forests, take even longer.

**b) Non-renewable resources**

* Non-renewable resources are those materials that cannot be replaced after use.
* Non-renewable resources are formed over very long geological periods.
* Minerals and fossil fuels are examples of this category.
* Since their rate of formation is extremely slow, they cannot be replenished once they get depleted.
* For instance, coal and petroleum cannot be recycled.

**iv. Availability**

* In terms of availability, resources are classified into **Inexhaustible and exhaustible.**

1. **Inexhaustible natural resources**

* Resources which are present in unlimited quantity in nature and are not likely to be exhausted easily by human activity.
* These are said to be inexhaustible natural resources.
* These include sunlight, air etc.

**(b) Exhaustible natural resources**

* The amounts of these resources are limited.
* They can be exhausted by human activity in the long run.
* e.g. Coal, Petroleum, Natural gas, etc.

**UNIT TWO**

1. **Biodiversity**

**2.1. Definition**

* Diversity refers to the range of variation or variety or differences among some set of attributes;
* Biological diversity thus refers to variety within the living world or among and between living organisms.
* It is ‘the variety of life’, and refers collectively to variation at all levels of biological organization.
* It can also be defined as the variety of plant and animal life at the ecosystem, community or species level, and even at the genetic level.
* Biodiversity refer to comprehensive umbrella term for the degree of nature’s variety or variation within the natural system; both in number and frequency.
* DeLong (1996) offered a more comprehensive deﬁnition:
* ***Biodiversity is an attribute of an area and speciﬁcally refers to the variety within and among living organisms, assemblages of living organisms, biotic communities, and biotic processes, whether naturally occurring or modiﬁed by humans.***
* ***Biodiversity can be measured in terms of genetic diversity and the identity and number of different types of species, assemblages of species, biotic communities, and biotic processes, and the amount (e.g., abundance, biomass, cover, and rate) and structure of each.***
* ***It can be observed and measured at any spatial scale ranging from microsites and habitat patches to the entire biosphere.***
* Biodiversity’ can have many interpretations. These interpretations vary from one biologist, conservationist or ecologist to another and a definition of biodiversity that is altogether simple, comprehensive, and fully operational is unlikely to be found.
* Some scientific definitions used by resource managers and ecologists which can help to develop an understanding of the broad concept of biodiversity, have been identified and are presented as:
* The variety and variability among living organisms and the ecological complexes in which they occur.
* The full range of variety and variability within and among living organisms and the ecological complexes in which they occur, and which encompasses ecosystem or community diversity, species diversity and genetic diversity.
* The variety of life and its processes including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.
* The totality of genes, species and ecosystems in a region.

**2.2. Component of Biodiversity**

* The manifestation of biodiversity is the biological resources (genes, species, organisms, ecosystems) and ecological processes of which they are part.
* Biodiversity can be seen at different basic levels which could be regarded either as a building block or as a unified component.
* Biodiversity is considered three major levels.
* Genetic diversity
* Species diversity
* Ecosystem diversity
* **Genetic diversity:**
* This is the variety of genetic information contained in all of the individual plants, animals and microorganisms occurring within populations of species.
* Simply it is the variation of gene within species and populations. OR
* Genetic diversity is the combination of different genes found within a population of a single species and the pattern of variation found within different populations of the same species.
* Each species, varying from bacteria to higher plants and animals, stores an immense amount of genetic information. For example, the number of genes is about 450-700 in mycoplasma, 4000 in bacteria (e.g. *Escherichia coli*),13,000 in Fruit fly (*Drosophila melanogaster*); 32,000 – 50,000 in rice (Oryza sativa); and 35,000 to 45,000 in human beings (*Homo sapiens sapiens*).
* This variation of genes, not only of numbers but of structure also, is ofgreat value as it enables a population to adapt to its environment and to respond to theprocess of natural selection.
* If a species has more genetic variation, it can adapt better tothe changed environmental conditions.
* New genetic variation in individuals occurs by **gene and chromosomal mutation, and in organisms with sexual reproduction** may be spread across the population by recombination.
* **Species diversity**
* This is the variety and abundance of different types of organisms which inhabit an area.
* Species diversity can be measured in terms of:

**Species Richness**

-  It refers to the number of various species in a defined area. Or it refers to the total   
 count/number of species in a defined area.

**Species abundance**

-This refers to the relative numbers among species. If all the species haves the same equal abundance, this means that the variation is high hence **high diversity**, however if one species is represented by 96 individuals, whilst the rest are represented by 1 species each, this **low diversity.**

**e.g. The number of species of plants, animals and microorganisms may be more in an area than that recorded in another area.**

* **Taxonomic or phylogenetic diversity**

This considers the genetic relationships between the **different groups of species**. The measures are based on analysis, resulting into a hierarchical classification representing the phylogenetic evolution of the taxa concerned.

**Types of Species**

* Species are of various types and some communities are more diverse than the others. For instance, tropical communities are more diverse than temperate.
* As Evolutionary Time theoryargued, Tropics are more ancient (not affected by ice age) thus, +species had so more time to develop than the Temperate region.
* Besides, Climatic Stability Theoryasserted that in unstable climate, species develop wide range of tolerance, which could make them to adapt too many niches. But in stable climate, few species specialize into niches (the physical, chemical, and biological conditions species needs to live).
* Among the divert kinds of species are:

**Alien species:**

* These are migrating into or are brought into system from elsewhere. Some die immediately because they could not adapt to the new environment. Others out-compete the natives, and eliminate them.

**Keystone species:**

* Absolutely essential for particular ecosystem

**e.g.** plankton for arctic ecosystem; ponderosa for our local forests.

**Indicator species:**

* Easily affected by loss of habitat, so serve as early warning.
* **Ecosystem diversity**
* It encompasses the variety of habitats that occur within a region.
* There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat.
* Distinctive ecosystems include landscapes such as forests, grasslands, deserts, mountains, etc., as well as aquatic ecosystems such as rivers, lakes, and the sea.
* Each region also has man-modified areas such as farmland or grazing pastures.
* An ecosystem is referred to as ‘natural’ when it is relatively undisturbed by human activities or ‘modified’ when it is changed to other types of uses, such as farmland or urban areas.

**2.3. Scope of biodiversity**

* Biodiversity has already proved itself to be a fundamental for the world in the 21st century and it will become the only purposeful scientific tool which one can bridge the social and cultural world.
* This will be the result of an increase in the globalization of information and communications, substantial movement of plants and animals to different parts of the globe through substantial human migration to different parts of the world which in turn lead to profound changes to the existing society, its culture and landscape of different parts of the world.
* **Industry**:
* It is the scope of biodiversity as different industries got their raw materials from plants and animals. In depth, knowledge of biodiversity is imperative for new industrial developments and innovations.
* Biodiversity is fast becoming the fundamental requirement for new industrial developments and innovations.
* It will provide new sources of foods, medicines, and other requirements of humans.
* Therefore, industrial development will become possible only by exploring the great potential of the still unknown biological resources.

**Agriculture:**

* It is also the scope of biodiversity which gives different agricultural products that are the products from different plants and animals.

**Medicinal field:**

* It plays important role as medicines for various diseases are derived from variety of plants and animals and
* The knowledge of these organisms provides information about their occurrences; use to cure the various types of diseases.

**Research and study**:

* Biodiversity is a back bone of most applied branches of biology such as agriculture, aquaculture, forestry, animal husbandry and others.

**Environment conservation**:

* Different living organisms interact with environmental component. So, they have also to use and have more important for them.
* Hence, they play vital role in environment conservation. It also creates job opportunity for the people by programs and project that have been launched for biodiversity conservation.
  1. **Threats to biodiversity/Biodiversity at risk**
* The last of the dinosaurs died about 65 million years ago, when a series of changes in the Earth’s climate and ecosystems caused the extinction of about half the species on Earth.
* The extinction of many species in a relatively short period of time is called a ***mass* *extinction****.* Scientists are warning that we are in the midst of another mass extinction.
* The rate of extinction is estimated to have increased by a multiple of 50 since 1800. Between 1800 and 2100, up to 25 percent of all species on Earth may have become extinct.
* The current mass extinction is different from those of the past because humans are the primary cause of the extinctions.
* An endangered a species that is likely to become extinct if protective measures are not taken immediately. A is a species that has a declining population and that is likely to become endangered if it is not protected.
* Additional categories of risk exist for certain legal and biological purposes.
* The ***International Union for Conservation of Nature and Natural resources*** (IUCN) and various international and national organizations to initiate studies into the problems involved, particularly the problem of protecting and preserving wild fauna and flora in their natural habitat/ecosystems establishing nature reserves.
* The following categories of rare species have been recognized by the IUCN
* Mainly based on

(*i*)*.* Present distribution,

(*ii*). Decline in number over time,

(*iii*). Abundance and quality of natural habitats, and

* **Extinct:** a taxon is extinct when there is no reasonable doubt that the last individual has died.
* **Critically Endangered**: When it is facing high risk of Extinction
* **Endangered (E):** Species in danger of extinction and whose survival is unlikely if the casual factors continue operating included are species whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.
* **Vulnerable (V):** Species believed likely to move into the endangered category in the near future if the casual factors continue operating. Included are species, of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental, disturbance species with populations that have been seriously depleted and whose ultimate security is not yet assured; and species with populations that are still abundant but are under threat from serious adverse factors throughout their range.
* **Rare (R):** 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 thinly scattered over a more extensive range.
* **Threatened (T):** Threatened is used in the conservation context for species which are in one of the categorizer Endangered, Vulnerable and Rare. Some species are marked as threatened where it is known that they are Endangered, Vulnerable or Rare, but there is known that they are Endangered, Vulnerable or Rare, but there is not enough information to say which of these three categories is appropriate.
* **Out of Danger (O):** Species formerly included in one of the above categories, but which are now considered relatively secure because effective conservation measures have been taken or the previous threat to their survival has been removed.
* **Indeterminate (I)**: Species that are suspected of belonging to one of the first three categories, but for which insufficient information is currently available.
  1. **Human threats to biodiversity**
* Biodiversity is threatened by the sum of all human activities.
* It is useful to group threats into the categories of over-hunting, habitat destruction, and invasion of non-native species, domino effects, pollution, and climate change.
* Human impacts on global biodiversity have been dramatic, resulting in unmatched losses in global biodiversity at all levels, from genes and species to entire ecosystems.
* If no changes are made in the ways humans use resources on earth, there will continue to be a degradation of biodiversity until human lives can no longer be sustained.
* Humans affect biodiversity by their population numbers, use of land, and their lifestyles, causing damage to habitats for species.
* It is important for humans to realize how their actions affect biodiversity and the importance of maintaining what biodiversity is left on the earth.
* Through proper education and by demanding that governments make decisions to preserve biodiversity, the human population will be able to sustain life on earth longer.
* There is no clear way of determining the total impact that humans are making on biodiversity; however, it is obvious that many actions by humans are causing a decrease in biodiversity.
* To determine the total impact that humans are making on a given environment, the area of productive land and water needed to produce the item that is being consumed and the need to account for the waste being generated by humanity must all be taken into account.
* Human activities are causing major changes in biological communities worldwide, and these changes can harmful for biodiversity and ecosystem function. Ecosystem function is important for supporting plant and animal communities, and ensuring the long-term survival of human populations.
* The impact of agricultural activities on biodiversity of plants and animals has a long history, which began when humans first started the domestication process over 7000 years ago. By selecting a few seemingly more useful or edible species, these ancient agriculturists began the selection process which still continues today as farmers, researchers and companies look for more productive plants and animals.
* This process necessarily involves a reduction and simplification of the immense biological diversity of nature, at both the species and genetic level.
* However, since the first farmers selected their preferred plants and cultivated their land with the few simple tools and mostly organic inputs available at a local (small) scale, their activities were, in general, of low impact or at least of a limited geographical scale.
* There are still examples today of cultures that continue to practice this small-scale, limited impact agriculture.
* The growth in population and the increasing urbanization led to the need to produce larger quantities of food being transported over longer distances.
* Larger areas of land were dedicated to agricultural activities, using animal traction, irrigation canals and other intensification techniques. The change in land use through clearing forested or grassland for cultivation, changes in agricultural practices such as crop rotation and mixes, grazing practices, residue management, irrigation and drainage all affect the soil environment and change the range of habitats and foods for soil organisms.
* Treatments applied to land such as liming, fertilizers, manure and other organic materials, tillage practices, the use of pesticides and so forth, all change the physical and chemical environment.
* As the population increases and the demand for goods increases, there may be a growing conflict between further economic development and the maintenance of unspoiled ecosystems
* large enough to sustain viable wildlife populations. Pollution cause by manufacturing or urbanization can change the makeup of life present in an ecosystem. Toxic discharges can inversely impact the living organisms in an ecosystem by killing them, weakening them, or affecting their ability to carry out essential biological functions.
* There are at least four types of pressure acting on aquatic and terrestrial habitats that affect both their conservation and biodiversity:

(1) Issues relating to the exploitation of species, especially stocks of fish, birds, and mammals, and to forests;

(2) The means by which land and water are managed, including the use of terrestrial ecosystems for grazing domesticated stock and aquatic ecosystems for aquaculture;

(3) Issues relating to pollutants and their long-range transport; and

(4) Development issues relating to industrial development and to the opening up of recreational purposes.

**2.6. Maintaining Biodiversity**

* Maintaining biodiversity means managing human uses of the earth's resources in a way that allows for the preservation of ecosystem, species and genetic diversity.
* Biodiversity encompasses the variety of all life forms including plants, animals, fungi, seaweed. It also includes all micro-organisms, the genes they contain and the ecosystems they form.
* Everywhere on the planet, species live together and depend on one another. Every living thing, including man, is involved in these complex networks of interdependent relationships, which are called ecosystems.
* How well our eco-system performs depends a great deal on all of the number of species that interact in the environment
* A healthy biodiversity provides a number of natural services for everyone:
* **Ecosystem services,** such as
* Protection of water resources
* Soils formation and protection
* Nutrient storage and recycling
* Pollution breakdown and absorption
* Contribution to climate stability
* Maintenance of ecosystems
* Recovery from unpredictable events
* **Biological resources,** such as
* Food
* Medicinal resources and pharmaceutical drugs
* Wood products
* Ornamental plants
* Breeding stocks, population reservoirs
* Future resources
* Diversity in genes, species and ecosystems
* **Social benefits,** such as
* Research, education and monitoring
* Recreation and tourism
* Cultural values

That is quite a lot of services we get for free!

* In general, each species has a specific niche, a specific role and function in an ecosystem.
* These roles include capturing and storing energy, providing food, predation, decomposing organic matter, cycling water and nutrients, controlling erosion, controlling pests and climate regulation.
* Species support biological production and regulation throughout the food chain in a variety of ways, such as adding to soil fertility, pollination, plant growth, predation and waste decomposition.
* The more diverse an ecosystem is, the more stable it is, the more productive it tends to be, and the better it is able to withstand environmental stress.

Therefore, maintaining biodiversity is essential for sustaining the natural ecosystems on which humans, and all life, depend. It is important to the survival and welfare of human populations because it has impacts on our health and our ability to feed ourselves through agriculture and harvesting populations of wild animals.

* 1. **Patterns and Processes of biodiversity**

What are the processes that regulate species diversity? In order to understand the processes that drive biodiversity, it must be recognized that there is diversity in space and diversity over time; addressing patterns of species biodiversity.

**2.7.1. Patterns of Species Biodiversity**

**a. Patterns in space**

* **Latitudinal gradient** – This is the most well defined and well-known pattern of biodiversity studied till date.
* According to this pattern, the species diversity follows a regular pattern as we move from the equator to the polar regions.
* The plant and animal diversity observed to be maximum at the equator and it decreases as we move towards the poles.
* There might be an exception of a few species, but apart from that, it is a generally observed trend.
* We find species richness in plants and animals at the equator.
* India, located in the tropical regions, shows high species richness.
* However, the great Amazon rainforests show maximum biological diversity in terms of the number of species residing in that region.
* It is believed that in spite of being the region with the highest biodiversity, many species in Amazon are yet to be discovered and identified.
* The reason for this increased level of biodiversity at the tropics are thought by ecologists to be as follows:

1. Tropical areas have a more stable climate compared to that of the temperate areas. As a result, the tropics succeed in supporting a higher number of species as the species do not have to keep adapting to a changing season.
2. Temperate regions have suffered a lot of glaciations in the recent past as a result of which they have had a very unstable environment. Whereas, the tropics have been comparatively stable. Thus, speciation has been more favored in the tropics compared to that of the temperate lands.
3. The tropical regions are comparatively more susceptible to solar energy. As a result, the plants in this region receive more energy during photosynthesis. This, in turn, transfers more energy to the successive trophic levels in the food chain. Thus, more energy supports more diversity.

* **Habitat Variety:** The more variable the habitat, the greater the species diversity within it. This pattern was offered as one of the reasons why there are more species in a bigger area (more area covers a greater variety of habitat).

**b. Patterns in time**

* **Seasonal patterns:** Diversity of species can vary during different seasons of the year. Good examples of organisms whose diversity varies seasonally are birds and insects. These seasonal patterns are most noticeable in temperate areas but are also documented in the tropics. Seasonal patterns can occur in both terrestrial and aquatic habitats.
* **Successional patterns:** After a disturbance (such as fire or agriculture), plant and animals species begin to reoccupy the habitat, grow, and get replaced or out-competed by other species. This pattern of gradual temporal shift in the species composition of a community is called succession. It results from a variety of processes including migration, dispersal, growth, competition and environmental change. For plants, diversity increases with succession until woody species (trees and brushes) establish, whereby diversity then decreases. For animals, diversity generally increases with succession (this has been observed for birds and insects).
* **Evolutionary patterns:** Evolutionary patterns: Over 600 million years, the number of different types of organisms has been increasing. Some clear patterns of increasing diversity have been established over evolutionary time.

**2.7.2. Neutral processes that regulate species diversity**

Neutral processes are those that occur independently of any differences among species, as though the species were genetically identical. They will, therefore, affect diversity regardless of the ecological characteristics of a region.

**I. Immigration**

Immigration provides a continual source of new diversity for a region. How important it is, depends on the balance between the number of propagules that come from outside and the number produced by resident individuals. If the area is large, most young individuals will be recruited from the resident population, but in small areas, reproduction by residents may be overwhelmed by immigration. Thus, the importance of immigration increases as the size of the area decreases.

**II. Extinction**

Extinction of a species or a population will occur as a result of accidents (environmental fluctuations) or because of population interactions.

**a) Accidents:** events that trigger extinctions for no predictable reason - volcanos, rising sea level, an ice storm, any environmental circumstance that wipes out an ecological niche.

**b) Population interactions that are not neutral processes:** predation and competition can result in negative growth rate and ultimately, extinction. However, on their own, predation and competition rarely cause extinctions directly; they cause population densities to become very low and then a random accident may drive the vulnerable population to extinction.

**2.8. Service and Values of Biodiversity**

* Humans depend for their sustenance, health, wellbeing and cultural growth on nature.
* Biotic resources provide food, fruit, seed, fodder, medicines and a host of other goods and services.
* Biodiversity also has enormous social and cultural importance.
* The various benefits of biological diversity can be grouped under different categories: **A) Ecosystem services, b) economic values, c) social benefits and d) Strategic values**

**A) Ecosystem services**

Living organisms provide many ecological services free of cost that are responsible for maintaining ecosystem health.

1. **Protection of water resources:** Natural vegetation cover helps in maintaining hydrological cycles, regulating and stabilizing water run-off and acting as a buffer against extreme events such as floods and droughts.
2. **Soil protection:** Biological diversity helps in the conservation of soil and retention of moisture and nutrients. Root systems allow penetration of water to the sub soil layer. Root system also brings mineral nutrients to the surface by nutrient uptake.
3. **Nutrient storage and cycling:** Plants are able to take up nutrients, and these nutrients then can form the basis of food chains, to be used by a wide range of life forms. Nutrients in the soil, in turn, is replenished by dead or waste matter which is transformed by micro-organisms; this may then feed others such as earthworms which also mix and aerate the soil and make nutrients more readily available.
4. **Pollution reduction:** wetlands have the ability to breaking down and absorb pollutants. Natural and artificial wetlands are being used to filter effluents to remove nutrients, heavy metals, suspended solids; reduce the BOD (Biological Oxygen Demand) and destroy harmful micro-organisms. Excessive quantities of pollutants, however, can be detrimental to the integrity of ecosystems and their biota.
5. **Climate stability:** Vegetation influences climate at macro as well as micro levels. Growing evidence suggests that undisturbed forests help to maintain the rainfall in the vicinity by recycling water vapor at a steady rate back into the atmosphere. Cooling effect of vegetation is a common experience which makes life comfortable.
6. **Maintenance of ecological processes:** Different species of birds and predators help to control insect pests thus reduce the need and cost of artificial control measures. Birds and nectar loving insects which roost and breed in natural habitats are important pollinating agents of crop and wild plants. Some habitats protect crucial life stages of wildlife populations such as spawning areas in mangroves and wetlands.

Without ecological services provided by biodiversity it would not be possible to get food, pure air to breathe and would be submerged in the waste produced.

**B) Economic values of biodiversity**

**I) Food, fiber, medicines, fuel wood and ornamental plants:** Five thousand plant species are known to have been used as food by humans. A large number of plants and animals materials are used for the treatment of various ailments. Wood is a basic commodity used worldwide for making furniture and for building purposes. Fire wood is the primary source of fuel widely used in third world countries. Wood and bamboo are used for making paper. Plants are the traditional source of fiber such as coir, hemp, flax, cotton, jute.

**II) Breeding material for crop improvement: Wild** relatives of cultivated crop plants contain valuable genes that are of immense genetic value in crop improvement programs.

**III) Future resources:** There is a clear relationship between the conservation of biological diversity and the discovery of new biological resources. Knowledge of the uses of wild plants by the local people is often a source for ideas on developing new plant products. Many presently under-utilized food crops have the potential to become important crops in the future.

**C) Social benefits**

**I) Recreation:** Forests, wildlife, national parks and sanctuaries, garden and aquaria have high entertainment and recreation value. Ecotourism, photography, painting, film making and literary activities are closely related.

**II) Cultural values:** Plants and animals are important part of the cultural life of humans. Human cultures have co-evolved with their environment and biological diversity can be imparting a distinct cultural identity to different communities.

**D) Strategic values**

Certain species may be targeted to advance the overall goal of maintaining biodiversity. This strategic species might be flagship, umbrella and indicator species.

**Flagship species:** are best known strategic valued species. They are charismatic species that have captured the public’s heart and won their support for their conservation.

E.g. Ethiopian wolf and Mountain Nyala of BMNP, Walia Ibex of Semien Mountains park etc.

**Umbrella species**: are used to undertake broad conservation based around the habitat needs of a single species, thus allowing many species, often whole ecosystems, to be conserved under the umbrella of one species.

**Indicator species:** the health of their populations is an easy to monitor indication of environmental condition or the status of other species.