Course : Plant Genetic Resources: Conservation & Sustainable Use
Chapter **:** 03 (Biodiversity Vs. Genetic resources)
Course Leader: Prof. SS Gaurav

Biodiversity: Historical perspective

1. Our knowledge of biodiversity is as old as humanity. Though we may have never recognized, our ancestors who lived in the wild as hunter-gatherers, had a subtle understanding of 'biodiversity' of sorts. Through their continuous interaction with their environment, they recognized what can be eaten, what is poisonous, what animals can be hunted or what animals pose danger.
2. The earliest known attempt to document and classify biodiversity finds its place in the ancient Greek civilisation. The Greek philosopher **Aristotle,** observed the different animals and classified them into different groups based on their **morphology, behaviour and physiology**. Aristotle's method of classification stood strong for the next 2000 years. Until the early 17th century, it was believed that all the biodiversity that was seen on the Earth then, had existed forever.
3. A key discovery in 1676 -**Robert Plot,** a British naturalist and the first keeper of Ashmolean museum, found a very large bone and documented it as the bone of a 'giant'. Little did he know that he was documenting the first ever bone of a dinosaur! Over the next 100 years, more such bones were discovered and documented which were similar to each other, but resembled none of the current animals.
4. Yet another discovery in the **1670's** also set a similar chain of events that further expanded our perception of biodiversity. This time, it was too small for the naked eye! With the help of a simple microscope, that he himself had created, **Antonie Philips van Leeuwenhoek** discovered and documented the fascinating world of microorganisms. Prior to this study of microorganisms, it was believed that grapes turning into wine and the formation of cheese was the 'hand of God' or a miracle.
5. In the 19th century, **Louis Pasture and Robert Koch independently** expanded Leeuwenhoek's work and showed that microorganisms were responsible for curdling of milk and also caused diseases. Their discoveries **debunked the theory of 'spontaneous generation'**, which stated that smaller organisms like fleas could spontaneously take birth from inanimate objects like dust. While these scientists identified some microorganisms, today, after decades of research, scientists estimate that there might be 1 trillion species of such invisible microorganisms on the planet!
6. The most famous among these voyages were those of **Charles Darwin** aboard the HMS Beagle and Alfred Wallace. Being the most well-known naturalists of their time, they explored the then remotest corner of the world including the coastline of South America, the Amazon basin and the Malay Archipelago. The specimens that were collected during various such voyages, and the documentation of organisms that were witnessed, are the basis of many of the ecological theories in science today. The idea of **speciation, evolution** through natural selection, concept of warning colouration, the Wallace effect, colonisation of remote islands by plants are some examples that form the basis of our understanding of ecosystems and evolution.
7. **1916** – The term ***biological diversity*** was **used first by J. Arthur Harris** in "The Variable Desert," .The bare statement that the region contains a flora rich in genera

and species and of diverse geographic origin or affinity is entirely inadequate as a description of its real biological diversity."

8. **1975** – The term *natural diversity* was introduced (by The Science Division of The Nature Conservancy in a 1975 study, "The Preservation of Natural Diversity.")
9. 1980 – Thomas Lovejoy introduced the term ***biological diversity*** to the scientific community.
10. 1985 – Edward O. Wilson - introduced the term *biodiversity*

BIODIVERSITY:

The term '**Biodiversity**', coined by **Walter G. Rosen** in the year 1985 (Wilson, 1988) is a relatively new compound word of the longer version 'Biological Diversity ("Bio" means life and "diversity" means variety. This variety of life on Earth—and its interdependence—is called **biodiversity**)', which was introduced by **Lovejoy** (1980) to express the number of species present in the community.

Father of Biodiversity - **Edward** O. **Wilson**. BOZEMAN -- A two-time Pulitzer Prize winner and recipient of Montana State University's Presidential Medal for Global and Visionary Leadership is known as the Father of Biodiversity

Definition:

- Biodiversity is the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.
- Biodiversity is the sum total of species richness from all sources of life.
- 1982- **Wilcox**'s definition was "Biological diversity is the variety of life forms...at all levels of biological systems (i.e., molecular, organismic, population, species and ecosystem)...
- 1992-**United Nations**(1992-The 1992 United Nations Earth Summit)- defined " biological diversity" as "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 part: this includes diversity within species, between species and of ecosystems
- **2004-Gaston and Spicer**- definition in their book "Biodiversity: an introduction" is "variation of life at all levels of biological organization".

Levels of biodiversity:

Biodiversity is commonly considered at three different /hierarchical levels :

1. **Genetic** (Intra-specific/ within spp) diversity; usually measured in terms of genetic differences between individuals or populations.
2. **Species** (Inter-specific/ between spp) diversity, measured as a combination of number and evenness of abundance of species.
3. **Ecosystem diversity** (Between communities), measured as the number of different species assemblages.

1. Genetic diversity: Genetic diversity refers to any variation in the nucleotides, genes, chromosomes, or whole genomes of organisms. This is the "fundamental currency of diversity" (Williams and Humphries, 1996) and the basis for all other organismal diversity.

- Genetic diversity is the sum total of genetic information, contained in the genes of individuals of plants, animals and microorganisms that inhabit the earth.
- It is needed by any species in order to maintain reproductive vitality, resistance to disease and the ability to adapt to changing conditions.
- It enables a population to adapt to its environment and to respond to natural selection.t
- The amount of genetic variation is the basis of speciation.
- Genetic diversity within a species often increases with environmental variability.
- Such genetic variability has made it possible to produce new breed of crops plants and domestic animals, and in the world allowed species to adapt to changing conditions.

2. Species diversity:

Species diversity - "species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups" (Mayr 1963).

• A group of organisms genetically so similar, that they can interbreed and produce fertile Off-springs is called a species.

• The species diversity is usually measured in terms of the total number of species within discrete geographical boundaries.

• Species are distinct units of diversity each playing a specific role in the ecosystem.

• In nature, the number and kind of species, as well as the number of individualsper species vary, leading to greater diversity.

3. Community/Eco-system-level diversity:

It is defined by the species that occupy a particular locality and the interactions between them. It represents the collective response of species to different environmental systems. Ex.- Biological/ ecosystem-deserts, grasslands, wetlands, and forest.

According to Whittaker (1965), **the community diversities** are of three types:

1. It could be within-community diversity (alpha diversity)

- A**lpha diversity** (**α-diversity**): is the mean species diversity in sites or habitats at a local scale. Alpha diversity refers to the diversity within a particular area or ecosystem, and usually expressed by the number of species (i.e., species richness) in that ecosystem.

2. Between-communities diversity (beta diversity) or

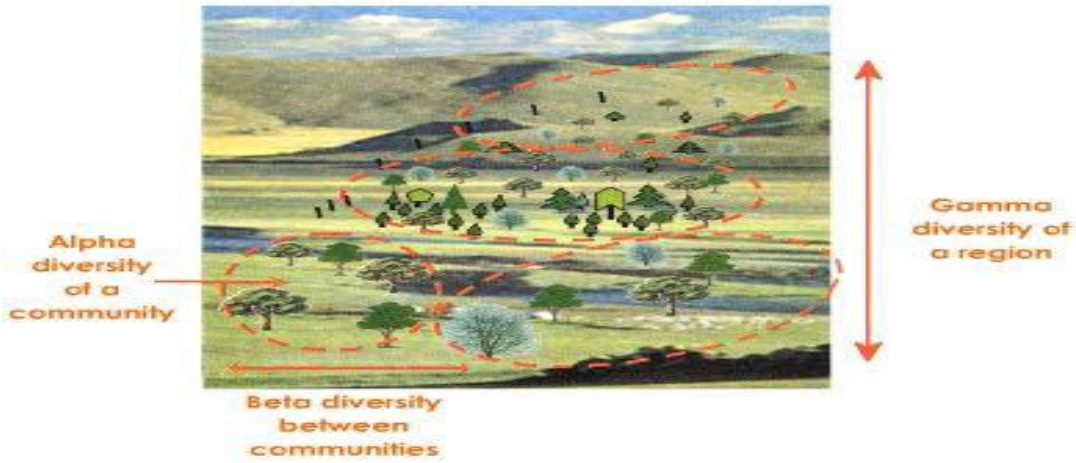
- **Beta diversity** (β-diversity or **true beta diversity**) is the ratio between regional and local species diversity. The term was introduced by R. H. Whittaker together with the terms alpha diversity (α-diversity) and gamma diversity (γ-diversity). Other formulations for beta diversity include "absolute species turnover",

- Beta diversity as a measure of species turnover overemphasizes the role of rare species as the difference in species composition between two sites or communities is likely reflecting the presence and absence of some rare species in the assemblages.

- Beta diversity: a comparison of diversity between ecosystems, usually measured asthe amount of species change between the ecosystems.

3. Diversity of the habitats over the total landscape or geographical area (Gamma diversity).
    - Gamma diversity: a measure of the overall diversity within a large region.Geographic-scale species diversity according to Hunter (2002).
    - **Gamma diversity** (γ-diversity) is the total species diversity in a landscape. According to this reasoning, alpha diversity and beta diversity constitute independent components of gamma diversity:

$$\gamma = \alpha + \beta$$



INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN);

- IUCN was established in 1948. It was previously called the International Union for the Protection of Nature (1948–1956) and the World Conservation Union (1990–2008).Officially International Union for Conservation of Nature and Natural Resources is an international organization working in the field of nature conservation and sustainable use of natural resources. It is involved in data gathering and analysis, research, field projects, advocacy, and education. IUCN's mission is to "influence, encourage and assist societies throughout the world to conserve nature and to ensure that any use of natural resources is equitable and ecologically sustainable".
- The organization is best known to the wider public for compiling and publishing the IUCN Red List of Threatened Species, which assesses the conservation status of species worldwide.
- IUCN has a membership of over 1400 governmental and non-governmental organizations. Some 16,000 scientists and experts participate in the work of IUCN commissions on a voluntary basis. It employs approximately 1000 full-time staff in more than 50 countries. Its headquarters are in Gland, Switzerland.
- IUCN has observer and consultative status at the United Nations and plays a role in the implementation of several international conventions on nature conservation and biodiversity. It was involved in establishing the World Wide Fund for Nature and the World Conservation Monitoring Centre

IUCN Red List: specified through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation.

1. Extinct (EX) – beyond reasonable doubt that the species is no longer extant.
2. Extinct in the wild (EW) – survives only in captivity, cultivation and/or outside native range, as presumed after exhaustive surveys.
3. Critically endangered (CR) – in a particularly and extremely critical state.
4. Endangered (EN) – very high risk of extinction in the wild, meets any of criteria A to E for Endangered.
5. Vulnerable (VU) – meets one of the 5 red list criteria and thus considered to be at high risk of unnatural (human-caused) extinction without further human intervention.
6. Near threatened (NT) – close to being at high risk of extinction in the near future.
7. Least concern (LC) – unlikely to become extinct in the near future.
8. Data deficient (DD)
9. Not evaluated (NE)

In the IUCN Red List, "threatened" embraces the categories of Critically Endangered, Endangered, and Vulnerable.

RED DATA BOOK

The Red Data Book is a public document which is created for recording endangered and rare species of plants, animals, fungi as well as some local subspecies which are present in a particular region.

The Red Data Book helps us in providing complete information for research, studies and also for monitoring the programs on rare and endangered species and their habits.

This book is mainly created to identify and protect those species which are on the verge of extinction.

Brief History of the Red Data Book

- The name of this book has its origins from Russia; it was originally known as the Red Data Book of the Russian Federation or the RDBRF. The book was based on research

conducted between 1961 and 1964 by biologists in Russia. Hence, it is also called as the Russian Red Data Book.

- Currently, the International Union for Conservation of Nature maintains the Red Data Book. IUCN is the world's most detailed inventory centre of the global conservation status of biological species. The Red Data Book contains the complete list of threatened species. The main aim behind this documentation is to provide complete information for research and analysis of different species.
- The Red Data Book contains colour-coded information sheets, which are arranged according to the extinction risk of many species and subspecies.

    1. **Black** represents species which are confirmed to be extinct.
    2. **Red** represents species that are endangered
    3. **Amber** for those species whose status is considered to be vulnerable
    4. **White** is assigned for species that are rare
    5. **Green** for species that were formerly endangered, but their numbers have started to recover
    6. **Grey** coloured for the species that are classified as vulnerable, endangered, or rare but sufficient information is not available to be properly classified.

Advantages of the Red Data Book

- It helps in identifying all animals, birds and other species about their conservation status.
- It is used to evaluate the population of a particular species.
- The data available in this book can be used to evaluate the taxa at the global level.
- With the help of this book, we can estimate the risk of taxa becoming globally extinct.
- Provides a framework or guidelines for implementing protective measures for endangered species.

Disadvantages of the Red Data Book

- The information available in the Red Data Book is incomplete. Many species, both extinct and extant are not updated in this book.
- The source of the book's data has been speculated and has been mired in controversy.
- This book maintains the complete record of all animals, plants, other species but it has no information about the microbes.

Red data book by IUCN:
Red data book is the document established by IUCN for documenting the rare and endangered species of plants, animals, fungi and also a few local species that exist within a state or country.

Red Data Book by **INDIA**:
The **Red Data Book** is the state document established for documenting rare and endangered species of animals, plants and fungi as well as some local sub-species that exist within the territory of the state or country.

The Botanical Survey of **India** has **published** four volumes of **Red Data Book** of **Indian** Plants, (Eds. Jain & Rao, 1984; Nayar& Sastry 1987 – 1990) and **Red** List of Threatened Vascular Plant Species in **India**

The Red data book contains three colored pages - Red, Pink and Green.

- **The Red** colored pages are symbolic of the danger that some species of both plants and animals presently experience throughout the globe.
- **The Pink** colored pages in the Red data book include the critically endangered species.
- **The Green** colored pages are used for those species that were formerly endangered, but now, they have been recovered to a point where they are no longer threatened.

Difference between red list and red data book:
Red list contains the **names** of endangered species and **red data book** contains information of endangered species. **Red List and Red Data Book** is co-related. They both are necessary for the study of endangered species.

Endangered Species of India

- **Vulnerable**: Species whose population has still not reduced but face the threat of extinction as the causal factors like reduction in habitat can be easily observed. E.g. Black Buck, Spotted deer, Golden langur, Asiatic wild ass. •
- **Rare**: Species which have small populations (less than 20,000) in the world and are confined to limited areas or are thinly distributed over a more wide area. E.g. Asiatic Pheasants, Satyr Tragopan, Temminick Tragopan.
- **Threatened**: Species which are under the threat of extinction and whose survival is unlikely, if the causal factors like habitation loss continue operating. E.g. vultures.
- **Extinct**: A particular species is considered extinct when it's last surviving member dies and has not been seen in wild for the last 50 years. E.g. dodo, passenger pigeon.

GREEN DATA BOOK:

The green databook is a small pocket-sized book containing environmental data of more than 200 economies. Agriculture, forestry, biodiversity, pollution, and sanitation are the key indicators. The Botanical Survey of India (BSI) published a Green Book which enlists rare plants growing in protected areas like botanical gardens.

BLUE BOOK:

The United Nations Environment Programme (UNEP) has compiled data on endangered species of the world in the Blue Book.

WHY: CONSERVATION OF BIODIVERSITY:

- ✓ Conservation of biodiversity is essential for the human survival, notably throughhealth, food and industry.
- ✓ All forms of life-human, animal and plants are so closely interlinked that disturbancein one give rise to imbalance in the others.
- ✓ If species of plants and animals become endangered, they signify degradation in theenvironment, which may threaten man's own existence.

- ✓ The maintenance of biodiversity at all levels is fundamentally the maintenance of viable population of species or identifiable populations.
- ✓ Approaches of biodiversity conservation should be concise with due consideration ofnational problems.
- ✓ Priority should be given first to conserve those species which have vital resourcewhich benefit to mankind at shorter duration and also to conserve threatened, endangered and rare species of the nation.
- ✓ In situ and ex situ conservation of biodiversity should be done for those species whichare threatened, rare, and endangered as well as species expenditure.
- ✓ Extraction of timber from the forest areas should be based on ecological planning bytaking into the consideration of stability of ecosystem.
- ✓ The scientific knowledge of biodiversity conservation should not be restricted onpaper that should be spread among the people through the mass communication,training, awareness programmes at the grassroots level.
- ✓ An approach of sustainable harvest or exploitation of the species will be helpful forthe conservation of biodiversity, offering all the basic necessities for the subsistenceof man's life.
- ✓ Therefore, sustainable use of resources and sustainable development are highlyneeded in order to save the loss of biodiversity.

FACTS RELATED TO BIODIVERSITY

- Total Land Area of Earth: 510,065,284 sq.km
- Forest Cover: 38.7 m. sq.km (26%) ¬ 40% of Global Forest Land is in South America, Africa and South Asia.
- There are estimated **5 million to 100 million species** on earth (most yet to be discovered).
- Only about **1.9 million species** have been **catalogued** so far.
- Total land area of **India** - 143 million ha (India occupies **2.47% of the World's** geographical area and has only **1% of the forest** and India has **16.1%** of world **human population** and **15.1% of cattle population)**

INDIA:

1. Forest Cover in India – **23.57 %** (As per laws it should be >33%)
2. India hosts -**12.53 % of world's biodiversity**
3. India has **3.9 % of grasslands**, **2.0 % of hot deserts**, **4.1 m.ha of wetland** ecosystems.
4. 45,000 + species of wild plants
5. 89,000 + species of wild animals
6. About 320 species of wild relatives of crops have centre of origin.
7. 1,39,000 species of plants, animals and microbes are recorded

PLANT SPECIES IN INDIA Vs. WORLD

Taxa	Species	
	India	World
Bacteria	850	4000
Viruses	Unknown	4000
Algae	6500	40,000

Fungi	14,500	72,000
Lichens	2000	17,000
Bryophyta	2850	16000
Pteridophyta	1100	13000
Gymnosperms	65	750
Angiosperms	17,500	250,000

ANIMAL SPECIES IN INDIA VS. WORLD

Taxa	**Species**	
	India	**World**
Insects	60,000	8,00000
Mollusca	5000	100000
Fishes	2,500	23,000
Amphibians	190	4,520
Reptiles	400	6,550
Birds	1,175	8,400
Mammals	872	4,231

BIODIVERSITY LOSS: SOME FACTS:

- **99.9% of all species that have ever lived are now extinct-**

we are currently in the middle of the 6th great mass extinction event - named the **'Halocene' extinction**.

- **Extinction rates are estimated to be 1,000-10,000 times higher than would be expected without man's presence**

A natural rate of extinction :1- 5 species per year but is now looking like anything between 500 and 5,000 species lost every year, largely as a consequence of man's poor planetary stewardship. Upper estimates put the extinction level at between 10,000 and 100,000 species per year.

- **52% decline in biodiversity since 1970**

The total population count of all species has more than halved since 1970. This massive decimation of organisms is now being called 'the **Halocene mass extinction'**. Is it too late to stop the decline?

- **30-50% of current species could be extinct or heading towards extinction by 2050**
- **99% of extinction-threatened species are at risk from human activities**

CAUSES FOR LOSS OF BIODIVERSITY:

The main cause of the loss of biodiversity can be attributed to the influence of human beings on the world's ecosystem,In fact human beings have deeply altered the environment, and have modified the territory, exploiting the species directly,for example by fishing and hunting, changing the biogeochemical cycles and transferring species from one area toanother of the Planet.

The threats to biodiversity can be summarized in the following main points:

1. Destruction of Habitat:

The natural habitat may be destroyed by man for his settlement, agriculture, mining, industries, highway construction, dam building etc. As a consequence, the species must adapt to the changes in the environment, move elsewhere or may succumb to predation, starvation or disease and eventually die. Several rare butterfly species are facing extinction due to habitat destruction in the Western Ghats. Of the 370 butterfly species available in the Ghats, around 70 are at the brink of extinction.

2. Hunting:

Wild animals are hunted for the commercial utilization of their products such as hides and skin, tusk, fur, meat, pharmaceuticals, cosmetics, perfumes and decoration purposes. In Africa, in recent years 95% of the black rhino population have been exterminated in Africa by poachers for their horn. Today, rhino horn fetches more than $15,000 in the pharmaceutical market. In the last one decade, over one-third of Africa's elephants have been killed to collect 3,000 tonnes of ivory. International regulations have, to a great extent, reduced illegal trading and poaching of African Tuskers. In 1987, the Indian Govt. also banned the trade in Indian ivory. The scarlet macaw, once common throughout South America, has been eliminated from most of its range in Central America.

Several species of spotted cats such as ocelot and Jaguar have been jeopardized by the demand for their fur. In 1962, nearly 70,000 whales were slaughtered. However, international trade in whale products is banned now. In India, rhino is hunted for its horns, tiger for bones and skin, musk deer for musk (medicinal value), elephant for ivory, Gharial and crocodile for skin and jackal for fur trade in Kashmir. One of the most publicized commercial hunts is that on whale. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed 9 Indian animal species which have been severely depleted due to international trade. These are Fin Whale (Balaenoptera physalus*)*, Himalayan Musk Deer (Moschus moschiferus), Green Turtle (Chelonia mydas), Hawksbill Turtle (Eretmochelya imbricata), Olive Ridley Turtle (Dermochelys olivacea), Salt-water Crocodile (Crocodylus porosus), Desert Monitor Lizard (Varanus griseus), Yellow Monitor Lizard (V. flavesoens) and Bengal Monitor Lizard (V. bengalensis).

Officials of Trade Record Analysis of Flora and Fauna in Commerce (TRAFFIC-India) say poaching of the Indian tiger has risen because of increasing demand from southeast Asian countries and China, where pharmaceutical factories consume the bones of 100 tigers each year. Such demand has decimated the tiger population in China and brought the Russian tiger to the brink of extinction.

As a result, in recent years much of the demand has been met by poachers in India. One kg of tiger bones fetches $ 90 in India and $300 in the international market. Hunting for sport is also a factor for loss of animal biodiversity

3. Exploitation of Selected Species:

Exploitation of medicinally important plants has resulted in their disappearance from many of their natural habitat. The pitcher plants, Nepenthes khasiana, Drosera sp., Gnetum sp., Psilotum sp. Isoetes sp. are ruthlessly sought and collected for teaching and laboratory work.

They have already become rare. Medicinal plants like Podophyllum sp., Coptis sp., Aconitum sp., Rouvolfia sp., Saussura lappa, Atropa acuminata, Dioscorea deltoidea etc. are also disappearing rapidly as a consequence of merciless over-collection. Similarly, the natural populations of a number of economically important trees like Pterocarpus santalum, Dysoxylon malabaricum, Santalum album which yield valuable timber are fast dwindling. In the category of over-exploited plants may also be placed a number of orchids producing world's most showy flowers. Plants like Paphiopedilum fairieyanum, Cymbidium aloiflium, Aerides crispum etc. are in great demand but their natural populations have almost disappeared.

Today, only nine varieties of wheat occupy more than half of United States wheat fields. Almost 95% of the old strains of wheat grown in Greece before the Second World War (1939-1945) have disappeared. They are replaced by a few new hybrid varieties. Only four varieties provide almost 72% of the entire potato harvest of the United States.

Over 2,000 varieties of apples were under cultivation during the earlier century. Today, three-fourth of entire apple production of France consists of North American varieties of which nearly 70% happens to be the Golden variety. Indonesia has lost nearly 1,500 strains of rice and nearly three fourth of its rice production comes from varieties discussed from a single maternal stock. Practically all varieties of Sorghum grown in South Africa have disappeared following introduction of high yielding hybrid varieties from Texas. In India, an estimated 50-60 thousand varieties of rice were cultivated before independence, most of which are being dropped in favour of a few high yielding varieties.

All over the world traditional varieties which together constituted a diverse mosaic, are being dropped one by one being replaced by a few high yielding strains. The reduction of genetic diversity among the cultivated species and the disappearance of their wild relatives, drastically limit possibilities of creating new cultivar in the future.

4 .Habitat Fragmentation:

Habitat fragmentation may be defined as an "unnatural detaching or separation of expansive tracts of habitats into spatially segregated fragments" that is too limited to maintain their different species for an infinite future.

This phenomenon was observed as early as 1885 when de Candolle noticed that 'the breakup of a landmass into smaller units would necessarily lead to the extinction or local extermination of one or more species and the differential preservation of others'.

Habitat fragmentation is one of the most serious causes of erosion of biodiversity. Fragmentation leads to artificially created 'terrestrial islands'. Such fragments experience microclimatic effects markedly different from those that existed in the large tracks of habitats before fragmentation. Air temperature at the edges of fragments can be significantly higher than that found in the interior; light can penetrate deep into the edge, thereby affecting the growth of existing species. Fragmentation promotes the migration and colonization of alien species. Such substantial and continuous colonization, profoundly affect the survival of native species.

The most serious effect of fragmentation is segregation of larger populations of a species into more than one smaller population. There is considerable evidence that the number of species in a fragmented habitat will decrease over time, although the probable rates at which it will happen are variable. In fact, actual data on rain forests show that forest fragments have lower species richness and fewer populations compared with continuous undisturbed forests.

An example of loss of biodiversity as the result of the fragmentation is that of the Western forest of Ecuador, which were largely undisturbed till 1960, where newly constructed network of roads led to rapid human settlements and clearance of much of the forest area, have been fragmented into small patches of one to few square kilometers.

Such a patch, about 0.8 square kilometers in area at Rio Palenque Biological station now contains only about 1,033 plant species many of which are represented by a single specimen only and are endemic to the locality. Before 1960 the intact forest had thousands of species as found in any other tropical regions of the world.

5.Collection for Zoo and Research:

Animals and plants are collected throughout the world for zoos and biological laboratories for study and research in science and medicine. For example, primates such as monkeys and chimpanzees are sacrificed for research as they have anatomical, genetic and physiological similarities to human beings

6 .Introduction of Exotic Species:

Any species which is not a natural inhabitant of the locality but is deliberately or accidentally introduced into the system may be designated as an exotic species. Native species are subjected to competition for food and space due to the introduction of exotic species.

There are many instances when introduction of exotic species has caused extensive damage to natural biotic community of the ecosystem. The introduction of Nile perch from north in Lake Victoria, Africa's largest lake, has driven almost half of the 400 original fish species of the lake to near extinction. oth Eucalyptus and Casuarina are plants introduced in India from Australia. The remarkably fast growth of these plants has made them valuable source of rough timber. However, these plants appear to be ecologically harmful as they tend to suppress the original species of the locality.

While economically useful plants are deliberately introduced a large number of exotic weeds are transferred from one locality to another accidentally. The wheat imported to India from the USA under PL-480 scheme were contaminated with seeds of Parthenium hysterophorus, the congress grass and Agrostemma githago, the corn cockle.

Both of these plants have spread throughout India as a pernicious weed in wheat fields. Parthenium was first observed growing on a rubbish heap in Pune in 1960. It is an aggressive plant which matures rapidly and produces thousands of seeds. The native grasses and other herbs are crowded out of existence. Water hyacinth, Eichornia crassipes, was introduced in 1914 in West Bengal.

The first appearance of Alligator weed, Alternanthera philexeroides, was reported near Calcutta airport in 1965, while Salvinia molesta was brought in India by an aquarist. These plants grow vigorously and result in the formation of thick mat on the water surface. They impede run off in streams and promote water logged conditions. A number of useful water plants are displaced by these vigorous but useless plants. There is an overall reduction in biodiversity wherever these exotic weeds migrate.

7 .Pollution:

Pollution alters the natural habitat. Water pollution especially injurious to the biotic components of estuary and coastal ecosystems. Toxic wastes entering the water bodies disturb the food chain and so the aquatic ecosystems. Insecticides, pesticides, sulphur and nitrogen oxides, acid rain, ozone depletion and global warming too, affect adversely the plant and animal species.

The impact of coastal pollution is also very important. It is seen that coral reefs are being threatened by pollution from industrialization, oil transport and offshore mining along the coastal areas.

Noise pollution is also the cause of wildlife extinction. This has been evidenced by the study by the Canadian Wildlife Protection Fund. According to a study, Arctic Whales are seen on the verge of extinction as a result of increasing noise of ships, particularly ice-breakers and tankers.

8. Control of Pests and Predators:

Predator and pest control measures, generally kill predators that are a component of balanced ecosystem and may also indiscriminately kill non-target species.

9. Natural Calamities:

Natural calamities, such as floods, draught, forest fires, earth-quakes, volcanic eruptions, epidemics etc. sometimes take a heavy toll of plant and animal life. Floods are frequent in moist tropical regions of the world which inundate much of the ground vegetation, trap a large number of animals while leading away soil nutrients. Failure of monsoon in succession for two or three years dries up ground vegetation and as the subsurface water table recedes trees are also affected. With plant life animals also suffer.

Forest fires in densely wooded localities often reduce to ashes a large number of plant and animal species and so do earthquakes. Volcanic eruptions may at times completely destroy plant and animal life in its surrounding areas. Epidemics sometimes destroy large portions of a natural population. In nature such episodes are usually confined to specific plant or animal populations as the pathogen is often specific to particular species or group of species.

10 Other Factors:

Other Ecological Factors that may also contribute to the Extinction of Plant and Animal Diversity are as follows:

(a) **Distribution range**—the smaller the range of distribution, the greater the threat of extinction,

(b) **Degree of specialization**— the more specialized an organism is, the more vulnerable it is to extinction,

(c) **Position of the organism in the food chain**—The higher the organism in food chain, the more susceptible it becomes,

(d) **Reproductive rate**—large organisms tend to produce fewer off springs at widely intervals.

IMPORTANCE OF BIODIVERSITY:

The living organisms on earth are of great diversity, living in diverse habitatsand possessing diverse qualities and are vital to human existence providingfood, shelter, clothing's, medicines etc.

The biodiversity has the following importance's:

1. **Productive values:** Biodiversity produces a number of products harvested from nature and sold in

Commercial markets. Indirectly it provides economic benefits to people whichinclude water quality soil protection, equalisation of climate, environmentalmonitoring, scientific research, recreation etc.

2. **Consumptive value:**The consumptive value can be assigned to goods such as fuel woods, leaves,forest products etc. which may be consumed locally and do not figure in nationaland international market.

3. **Social value:**The loss of biodiversity directly influences the social life of the country possiblythrough influencing ecosystem functions (energy □ow and biogeochemicalcycle). This be easily understood by observing detrimental effects of globalwarming and acid rain which cause an unfavourable alteration in logicalprocesses.

4. **Aesthetic value:**Aesthetic values such as refreshing fragrance of the flowers, taste of berries,softness of mossed, melodious songs of birds, etc. compel the human beings topreserve them. The earth's natural beauty with its colour and hues, thick forest,and graceful beasts has inspired the human beings from their date of birth totake necessary steps for its maintenance. Similarly, botanical and zoologicalgardens are the means of biodiversity conservation and are of aesthetic values.

5. **Legal values:**Since earth is homeland of all living organisms, all have equal right to coexist onthe surface of earth with all benefits. Unless some legal value is attached tobiodiversity, it will not be possible to protect the rapid extinction of species.

6. **Ethical value:**Biodiversity must be seen in the light of holding ethical value. Since man is themost intelligent amongst the living organisms, it should be prime responsibilityand moral obligation of man to preserve and conserve other organisms whichwill directly or indirectly favour the existence of the man.

7. **Ecological value:**Biodiversity holds great ecological value because it is indispensable to maintainthe ecological balance. Any disturbance in the delicately fabricated

ecologicalbalance maintained by different organisms, will lead to severe problems, whichmay threaten the survival of human beings.

8. **Economic value:** Biodiversity has great economic value because economic development dependsupon efficient and economic management of biotic resources.

In the day to day life, human beings are maintaining their lifestyle at thesacrifice of surrounding species which come from diversity of plants andanimals struggling for their existence.

So, it is highly essential for the human beings to take care of their surroundingspecies and make optimum use of their service, for better economicdevelopment. Thus, it is rightly told, survival of the man depends upon thesurvival of the biosphere.
