

Biodiversity and its Conservation

Biodiversity refers to the variety and variability among all groups of living organisms and the ecosystem components in which they occur.

- **In the Convention of Biological Diversity (1992) held in Rio de Janeiro biodiversity has been defined as variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part**

SPECIES DIVERSITY

- This is the variability found within the population of a species or between species of a community.
- It represents broadly the species richness and their abundance in a community. The two popular indices of measuring species diversity known as **Shannon-Wiener** and **Simpson index**

- The Shannon diversity index (a.k.a. the Shannon–Wiener diversity index) tells you how diverse the species in a given community are based with the number of species and the evenness of their abundance – Randomness Index
- Tells us about the Richness and Evenness of species, e.g., rich of nightingales
- Simpson's Diversity Index is a measure of which takes into account the number of species present, as well as the relative abundance of species - Dominance index.

- **The Shannon-Wiener Species Diversity** calculated by taking the number of each species, dividing by the total number of individuals, to get the proportion each species is of the total, and then summing the proportion times the natural log of the proportion for all species.
- **Simpson's Diversity Index** is used to calculate a measure of diversity, taking into account the number of species as well as its abundance.

Faunal Analysis-Remains of Animal Bones- Food Access and Consumption

- **The Shannon-Wiener Diversity Index** is calculated using the following equation: $-\sum P_i(\ln P_i)$ where P_i is the proportion of each species in the sample. Given a very large sample size, with more than 5 species, the S-W index values (H') can range from 0 to infinity using the natural log (\ln).

Species Richness and Relative Abundance

- **Example**
- **Problem Statement:**
- **The samples of 5 species are 60,10,25,1,4. Calculate Shannon diversity index and Evenness for these values.**
- **Sample Values (S) = 60,10,25,1,4 number of species**
- **First, let us calculate the sum of the given values**
- **Sum = $(60+10+25+1+4) = 100$**

Example

- Species (i)
- No. in sample p_i $\ln(p_i)$ $p_i \times \ln(p_i)$
- Big bluestem 60 0.60 -0.51 -0.31
- Partridge pea 10 0.10 -2.30 -0.23
- Sumac 25 0.25 -1.39 -0.35
- Sedge 1 0.01 -4.61 -0.05
- Lespedeza 4 0.04 -3.22 -0.13
- $S = 5$, Sum = 100 Sum = -1.07
- $H = 1.07$, $H_{\max} = \ln(S) = \ln(5) = 1.61$,
- $E = H/H_{\max} = 1.07/1.61 = 0.66$ i.e., Evenness (E) = 0.66
- $H = 1.07$ i.e., Shannon diversity index (H) = 1.07
- Good Shannon-Wiener index value is between 1.5 and 2.0

Calculation of Simpson's I

- Simpson's Diversity Index Calculation

1. Add the **individual species populations** to

2. Determine $N \times (N - 1)$.

3. Where **n** is the number of individuals in each species. Work out $n \times (n - 1)$ for each species.

4. Sum all the values in step 3.

5. Divide the sum obtained in step 4 by the value obtained in step 2.

$$D = 1 - \left[\frac{n(n-1)}{N(N-1)} \right]$$

Simpson's Diversity Index = $1 - D$.

Simpson's diversity index- How different types.

- **Sum all the values in step 3.**
- **Divide the sum obtained in step 4 by value obtained in step 2. As a result get Simpson's index D.**
- **Evaluate Simpson's diversity index a**

ECOSYSTEM DIVERSITY

- This is the diversity of ecological communities showing variations in ecological niches, trophic structure, food-webs, nutrient cycles, etc.
- The ecosystems also show variation with respect to physical parameters like temperature, altitude, precipitation etc.

Saving the Humanity from Environmental Disasters and Dangers

- The diversity has developed over millions of evolution. If we destroy this diversity, it will disrupt the ecological balance and ultimately the balance and of course our Environment will be affected and we do not wish to experience or face problems such as, diseases or other natural disasters and may finally result in the elimination of Life on this Terrestrial Ball like dinosaurs.
- These are mainly due to variations in the physical factors such as moisture, temperature, and precipitation etc.

CAUSES OF BIODIVERSITY

- Climate change- Temperature, Storms, Earth C
- Pollution.
- Destruction of habitats.
- Invasive alien species.
- Overexploitation of the natural environment.
- Hunting
- Habitat Fragmentation
- Collection for Zoo and Research
- Control of Pests and Predators
- Genetic Mutations
- Co-extinction – When related or dependent s vanishes.

VALUE OF BIODIVERSITY

- The value of biodiversity in terms of commercial utility, ecological services and aesthetic value is enormous.

1. Consumptive use value:

- These are direct use values where the biodiversity product can be harvested and consumed directly e.g. fuel, food, drugs etc.

Medicines derived from the natural products

- **Drugs and medicines:** About 75% of the world's population depends upon plant extracts for medicines.
- The wonder drug Penicillin used as an antibiotics is derived from fungus called **Penicillium**. Likewise, we get Tetracycline from a bacterium. **Quinine**, the cure for malaria is obtained from the bark of **Cinchona**.

- Digitalin is obtained from **foxglove (plant)** which is an effective cure for **ailments**. Recently vinblastin and vincristine, two **anti-cancer drugs**, have been obtained from **Periwinkle (Catharanthus) plant** which possesses anti-cancer alkaloids. A large number of marine animals/algae etc. are supposed to possess **anti-cancer properties** which are yet to be explored systematically.

Fuel:

Our forests have been used since ages for firewood. The fossil fuels coal, petroleum and natural gas are also products of fossilized biomass and biodiversity.

Firewood collected by individuals are normally marketed, but are directly consumed by tribals and local villagers, hence far less consumptive value.

2. Productive use values:

- These are the commercially usable values where the product is marketed and may include lumber or wild gene resources that can be traded for use by scientists introducing desirable traits in the crops and domesticated animals.

- These may include the animal products such as **tusks of elephants**, **musk from musk deer**, **silkworms from silk-worm**, **wool from sheep**, **feathers from many animals**, **lac from lac insects** etc. which are traded in the market.
- Many industries are dependent upon the productive use values of biodiversity. **Paper and pulp industry, Plywood industry, etc.**

- Railway sleeper industry, Silk industry, industry, ivory-works, leather industry Industry etc.
- Despite international ban on trade in p from endangered species, smuggling o horns, tusks, live specimen etc. worth dollars are being sold every year.
- Developing countries in Asia, Africa an America are the richest biodiversity ce

**Wild life products are smuggled and n
in large quantities to some rich weste
countries and also to China and Hong
where export of cat skins and snake s
fetches a booming business.**

Donkeys from Pakistan to China

3. Social Value: These are the values associated with the social life, customs, religion and psycho-spiritual aspects of the people. Some of the plants are considered holy and sacred in our country like Tulsi (holy basil), Peepal (Ficus), Mango, Lotus, Bael Patthar (Santalum album) etc. The leaves, fruits or flowers of these plants are used in worship or the plant itself is worshipped.

- Their social life, songs, dances and o are closely woven around the wildli animals like Cow, Snake, Bull, Peacco etc. also have significant place in ou psycho-spiritual arena and thus hold social importance. Thus biodiversity distinct social value, attached with o societies.
- Snakes in Samastipur

Video on Nagpanchami festival Bihar

- Snakes are very dangerous and we should be careful of them. And we should not kill them.
- <https://www.instagram.com/reel/DLWrN/>

4. Ethical value: It is also sometimes known as existence value. It involves ethical issues like biodiversity must be preserved . It is based on the concept of

Live and Let Live

If we want our human race to survive, then we must protect all biodiversity, because biodiversity is essential for our survival – Interdependence.

Role of each species on this earth to keep it in a working condition by maintaining natural balance. Life on earth has evolved over the millions to billions of years.

- The ethical value means that we may not use a species, but knowing the very fact that a species exists in nature gives us pleasure. **feel sorry when we learn that passenger pigeon or dodo is no more on this earth.**
- You may see the video of birds at Kruger National Park, South Africa.
- <https://www.youtube.com/watch?v=U10c> , accessed on August 23, 2023.

Songs of Birds

- We are not deriving anything direct from Kangaroo, Zebra or Giraffe, but we all strongly believe these species should exist in nature. This means, **ethical value or existence value** attached to each species. Why the Horses and not Zebras were domesticated or Zebras ?

Zebras are normally vulnerable to cardiac disorders. The damage due to capture and handling are less suitable for domestication.

Nightingale, Cuckoo and several **colourful birds** in zoos and gardens .

People from far and wide spend a lot of time and money to visit wilderness where they can enjoy the aesthetic value of biodiversity and this type of tourism is known as eco-tourism. The willingness to pay for such eco-tourism gives us even a rough estimate for aesthetic value of biodiversity.

What are Safaris?

Ecotourism Market

- Ecotourism is estimated to generate **Rs. 8.32 Crores in India in 2020-21** d that roughly gives the aesthetic value biodiversity.
- Ecotourism Market was valued at **US\$ 355.8 Bn. in 2021** and is estimated to reach of **US\$ 355.8 Bn. in 2027.** (Internet

5. Option values: These values include potentials of biodiversity that are presently unknown and need to be explored. There is a possibility that we may have some potential cure for AIDS or cancer exist within the depths of a marine ecosystem **tropical rainforest** - Natural Products Bioinformatics, Computational Biology (Computer aided drug design) etc.

- **The biodiversity is like precious gifts of nature presented to us. We should not commit the folly of losing these gifts before unwrapping them.**
- **The option value also includes the value in terms of the option to visit areas with a variety of flora and fauna, or specifically some endemic, rare or endangered species that exist.**

Ecosystem service value

It refers to the services provided by ecosystems like prevention of soil erosion, prevention of floods, maintenance of soil fertility, cycling of nutrients, fixation of nitrogen, cycling of carbon, their role as carbon sinks, pollutant absorption and reduction of the threat of global warming **etc.**

- **Different categories of biodiversity clearly indicate that ecosystem, species and genetic diversity all have enormous value and a decline in biodiversity will lead to enormous economic, ecological and socio-cultural losses.**

GLOBAL BIODIVERSITY

- Following the 1992 The Earth Summit in Rio-de Janeiro, it became evident that there is a growing need to know and science the name, the huge number of species which are still unknown on this earth. Roughly 1.5 million species are known till date which is perhaps 1% or may be just 2% of the total number.

Tropical deforestation alone is reducing the biodiversity by half a percent every year. Mapping biodiversity has become important for Terrestrial Biodiversity.

This is described as Biomes.

Examples of Terrestrial Biodiversity are tropical rainforests, tall grass prairies, savannas, tundra etc.

Biome

This is known as a major life zone, is a geographical area that includes communities of plants and animals that have a common adaptation to that particular environment.

This includes various communities which are named after the dominant features of the region – like grasslands, deserts or forests.

Tropical Rainforests

- The tropical rainforests are inhabited by teeming millions of species of plants, amphibians (frogs, toads etc.), insects as well as mammals (having mammary glands). They are the Earth's largest storehouse of biodiversity.
- About 50 to 80% of global biodiversity is found in these rainforests.

Floral Analysis – Seeds and

- There is an estimated 1,25,000 flowering plant species in tropical forests. However, now we know only 1-3% of these species.
- Several drugs are derived from plants found here.

Temperate Forests

- Temperate forests have much less biodiversity, but there is much better documentation of the species.

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Globally, we have roughly 1,70,000 flowering plants, 30,000 vertebrates and about 1,00,000 other groups of species that have been described.

- It is interesting to know that marine biodiversity is even much higher than terrestrial biodiversity and ironically, they are known and described.
- Out of the 35 existing phyla (categories of multicellular animals, 34 are marine and 1 of these are exclusively marine.

BIOLOGICAL DIVERSITY AT NATIONAL LEVEL

(Indian Biodiversity)

India ranks 10th among the plant rich of the world, 11th in terms of number of endemic species of higher vertebrates among the centers of diversity and on agricultural crops

The total number of living species identified in our country is 1,50,000.

REGIONAL OR LOCAL BIODIVERSITY

- Biodiversity at regional level is better understood by categorizing species into three types, based upon their distribution :

(i) Point (α -) richness refers to the number of species that can be found at a single point in a given space.

Diversity on a local scale, such as a pond, a field, or a patch of forest.

(ii) Beta (β -) richness refers to the rate of species composition across different habitats. It quantifies how species diversity changes from one habitat to another, providing insights into patterns of biodiversity i.e., between any two habitats and their community.

(iii) Gamma (γ -) richness refers to the rate of species composition across large landscape gradients.

Gamma diversity is a measure of the overall species diversity for the different ecosystems within a region. It represents the species diversity along the entire range of environmental gradients, such as a mountain slope.

Originally, beta diversity was defined as the ratio of gamma diversity to alpha diversity. β diversity = γ/α (sensu Whittaker, 1972).

INDIA AS A MEGA-DIVERSITY

- India is one of the 12 mega-diversity countries in the world.
- The Ministry of Environment and Forests, Government of India (2004) reported 47,000 species of plants and 81,000 species of animals which is about 7% and 6% respectively of global flora and fauna.

Endemism:

- Species which are restricted only to a particular area are known as endemics. India shows a good number of endemic species.
- About 62% of amphibians (frogs, toads, newts, salamanders etc.) and 50% of reptiles are endemic to India.
- Western ghats are the site of maximum endemism.

Center of origin - India

: A large number of species are known to have originated in India. Nearly 5000 flowering plants had their origin in India.

India has been the center of origin of many species of crop plants and 320 species of relatives of cultivated crops – lemon, eggplant (brinjal), Indian gooseberry (amla in Hindi), mango etc.

- **Marine diversity:** Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, backwaters etc. exists a rich biodiversity. More than 600 species of corals of the world are found here.
- The marine diversity is rich in mollusks, crustaceans (crabs etc.).

HOT SPOTS OF BIODIVERSITY

- Areas which exhibit high species richness as well as high species endemism are termed **hotspots of biodiversity**. The term was introduced by Myers (1988).
- There are 25 such hotspots of biodiversity at a global level out of which two are present in India, namely the **Eastern Himalaya** and **Western Ghats**.

- **These hotspots covering less than 2% of the world's land area are found to have 50% of the terrestrial biodiversity.**
- **According to Myers et al. (2000) an area is designated as a hotspot when it contains at least 0.5% of the plant species as endemics.**
- **About 40% of terrestrial plants and vertebrate species are endemic and found in these hotspots.**

- **These hotspots lie in India extending to the neighbouring countries namely, Indo China region (covering Eastern Himalayas), Western Ghats - Sri Lanka region.**
- **The Indian hotspots are not only rich in floral wealth and endemic species of plants but also reptiles, amphibians, swallow butterflies and some mammals.**

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- **Eastern Himalayas:** There are numerous **and semi-isolated valleys in Sikkim** which **extremely rich in endemic plant species.** **of 7298 Km² of Sikkim about 4250 plant** **found of which 60% are endemic**
- **Western Ghats:** It extends along a **17,0** **strip of forests in Maharashtra, Karnat** **Nadu and Kerala and has 40% of the to** **endemic plant species. 62% amphibian** **lizards are endemic to Western Ghats**

THREATS TO BIODIVERSITY

- Extinction or elimination of a species is a natural process of evolution.
- In the geologic period the earth has experienced several mass extinctions.
- However, the rate of loss of species in the recent past has been a slow process, keeping in mind the vast span of time going back to 444 million years.
- **ALARMING SITUATION** : The process of species extinction has become particularly fast in the recent years of human civilization.

Extinction

- One of the estimates by the noted ecologist, E.O. Wilson, is a figure of extinction at 10,000 species per year or 27,000 per decade.
- If the present trend continues we would lose 1/3rd of our current biodiversity by the middle of twenty first century.
- This would be very sad situation as this would disturb the balance of the nature and related natural phenomena, keeping the mankind alive and ecosystems active and healthy.

SAVE PLANET – SAVE HUMANITY

- We may face extinction like dinosaurs and the human race on this very earth. We may lose our history.
- This is a Wake Up Call and that makes the issue at B.Tech level very urgent and important.

Video on Environmental Challenges on Earth

- https://www.google.com/search?q=video+on+environme+that+can+be+alarming&sca_esv=8c966bae1d54a914&rlz=045IN1045&sxsrf=AE3TifPuI_QO_5D6IZ_T0U5ouZWvjNLDM221461&ei=vc23aPL3G6XgseMPkfCE0Ak&ved=0ahUKEwiY GwGHRE4AZoQ4dUDCBE&uact=5&oq=video+on+environ es+that+can+be+alarming&gs_lp=Egxnd3Mtd2l6LXNlc nAilGVudmlyb25tZW50YWwgY2hbbGxlbmdlcyB0aGF0IGNhbiE ZzIFECEYoAEyBRAhGKABSN3nAVAAWK_hAXABeACQAQCY BjAuNDkuM7gBA8gBAPgBAZgCNaAC8E5oAgrCAGcQIxgnG QYkQIYigXCAggQABiABBixA8ICcxAAAGIAEGLEDGIMBwglIEC gQLhiABBjIBMICChAjGIAEGCcYigXCAgQQIxgnwglREC4YgA YrwHCAGsQLhiABBiRAhiKBclCChAAGIAEGEMYigXCAhAQLh cBGloFwglNEAAYgAQYQxjJAxiKBclCCxAAAGIAEGJIDGloFwgl AcICBRAAGIAEwglGEAAYFhgewglIEAAYgAQYogTCAGUQAB GIYDGloFwglIECEYFclCBRAhGJ8FmAMR8QWj-wUgDgMd5 AH_8oCsgcGMC40OC40uAffRMIHCzAuMTYuMzQuMi4xyA ws-wiz-serp#fpstate=ive&vld=cid:324ca3c6,vid:nPCOlCwZ

LOSS OF HABITAT AND CA

- Billions of hectares of forests and grasslands have been cleared over the past 10,000 years for conversion into agriculture land, pastures, settlement areas or development projects.
- The wetlands are destroyed due to filling and pollution thereby causing biodiversity loss.

- Sometimes the loss of habitat is in installments so that the habitat is divided into small and scattered patches, a phenomenon known as habitat fragmentation.

- **POACHING**

Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife.

- Despite international ban on trade in products from endangered species, **smuggling of items like furs, hides, horns, tusks, live specimens and herbal products. worth billions of dollars per year continues.**
- The developing nations in **Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife.**

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The cost of elephant tusks can go up to \$1000 per kg; the leopard fur coat is sold at \$1000 in Japan.

While bird catchers can fetch upto \$1000 a rare hyacinth macaw, a beautiful colorful bird, from Brazil.

MAN-WILDLIFE CONFLICT

- Sometimes we come across conflicting when wildlife starts causing immense and danger to man and under such conditions becomes very difficult for the forest department to pacify the affected villagers and gain support for wild-life. Human killing by leopards/tigers killing human in Sitapur recently (2025).
- Menace of street dogs?

ENDANGERED SPECIES OF

- The International Union for Conservation of Nature (IUCN) publishes the Red Data Book which includes the list of endangered species of plants and animals.

In India, nearly 450 plant species have been identified in the categories of endangered, threatened or rare. Existence of about 300 mammals and 150 species of birds is also expected to be threatened while an unknown number of species of insects are endangered.

ENDEMIC SPECIES OF INDIA

Out of about 47,000 species of plants in the country 7000 are endemic. Thus, India subcontinent has about 62% endemic species restricted mainly to Himalayas, Khasi and Western Ghats.

- Some of the important endemic flora include orchids and species like *Sapria himalaica*, *Uvaria lurida*, *Nepenthes khasiana*, *Pedicularis perroter* etc.

- A large number out of a total of 81,000 animals in our country is endemic. The ghats are particularly rich in amphibians (toads etc.) and reptiles (lizards, crocodiles). About 62 amphibians and 50% lizards are endemic to Western Ghats.

Different species of monitor lizards (Varanus), reticulated python and Indian Salamander Viviparous toad Nectophryne are some of the endemic species of our country.

CONSERVATION OF BIODIVERSITY

- The enormous value of biodiversity due to its genetic, commercial, medical, aesthetic, ecological and optional importance emphasizes the need to conserve biodiversity.
- There are two approaches of biodiversity conservation:
 - **(a) In situ conservation (within habitat)** achieved by protection of wild flora and fauna in nature itself. e.g. Biosphere Reserves,

Biodiversity Conservation

- **National Parks, Sanctuaries, Reserves etc.**

(b) Ex situ conservation (outside habitat)
is done by establishment of gene banks, seed banks, zoos, botanical gardens, culture collections etc.

- **At present we have 7 major Biosphere Reserves, 80 National Parks, 420 wildlife sanctuaries and 120 Botanical gardens in the country covering 4% of the geographical area.**
- **The Biosphere Reserves conserve some of the representative ecosystems as a whole in long-term in situ conservation.**

Biosphere Reserves

- In India we have Nanda Devi (U.P.), (Meghalaya), Manas (Assam), Sunder (West Bengal), Gulf of Mannar (Tamil Nadu), Nilgiri (Karnataka, Kerala, Tamil Nadu), Nicobars and Similipal (Orisa/Odisha) Biosphere Reserves.
- Different Zones : Core - Buffer –Transition Area- Human Settlement-Research Station-Monitoring- Education Training Tourism
- Image in the Next Slide

The three zones that characterise a Biosphere Reserve are



- **Within the Biosphere reserves we may find one or more National Parks.**

For example, Nilgiri Biosphere Reserve contains two National Parks viz. Bandipur and Nagarhole National Park

- **A National Park is an area dedicated for the conservation of wildlife along with its environment.**

- **It is also meant for enjoyment through tourism but without impairing the environment.**
- **Grazing of domestic animals, all private rights and forestry activities are prohibited within a National Park.**
- **There are Monitoring stations, Research, Training, Human settlement etc. as**

Tree transplantation – Cur deforestation

- For plants, there is one gene sanctuary (Lemon family) and one for pitcher plant (insect eating plant) in Northeast India.
- For the protection and conservation of animals, there have been specific projects in the country e.g. Project Tiger, Gir Lion Project, Crocodile Breeding Project, Project Elephant, Leopard Project.

Ex - situ Conservation

- This type of conservation is mainly done for conservation of crop varieties, the wild relatives of crops and all the local varieties with the objective of conserving the total genetic diversity of the crop species for future crop improvement and afforestation programmes, e.g., even Bonsai are used to conserve genes. Bonsai are not genetically modified. Any tree can be made bonsai.
- Gene bank/seed bank facilities:

- (i) National Bureau of Plant Genetic Resources (NBPGR) is located in New Delhi. Here agricultural and horticultural crops and their wild relatives are preserved by cryo-preservation of seeds, pollen etc. using liquid nitrogen at a temperature as low as - 196°C.

- Varieties of rice, pearl millet, Brassica, radish, tomato, onion, carrot, chilli, poppy etc. have been preserved successfully in liquid nitrogen for several years without losing seed viability

- **(ii) National Bureau of Animal Genetic Resources (NBAGR) located at Karnal, Haryana.**
- **It preserves the semen of domestic bovine animals.**

- (iii) **National Facility for Plant Tissue Repository (NFPTCR) for the development of a facility of conservation of varieties of plants/trees by tissue culture. This facility has been created within the NBPGR, Delhi.**

G 15 Countries

- The G-15 countries have also resolved to set up a network of gene banks to facilitate the collection of various varieties of aromatic and medicinal plants for which India is the networking co-ordinating country.
- The founder-members were Argentina, Chile, Brazil, Mexico, Jamaica and Venezuela from the Americas; Egypt, Algeria, Senegal, Nigeria and Zimbabwe from Africa; and India, Malaysia and Indonesia from Asia.
- The first G-15 summit was held in Malaysia.

Related Material

- Life of earth = 4.6 million years.
- Total number of species on the earth is 8.7 million or 8.7 million ?
- Total number of animals = 1.6 million
- In the world, some 900 thousand different kinds of living insects are known. The representation approximates 80 per cent of the world's species.