Biodiversity and Conservation

1. Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots.
2. India as a mega-biodiversity nation; Endangered and endemic species of India.
3. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity
4. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Biodiversity is the variety of life on Earth; it includes all organisms, species, and populations; the genetic variation among these; and their complex assemblages of communities and ecosystems. It also refers to the interrelatedness of genes, species, and ecosystems and their interactions with the environment.

The word Biodiversity is thought to have first been coined as a contraction of the term "biological diversity" in 1985 and then popularized by a number of authors.

Biodiversity is defined as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

- (United Nations Earth Summit (1992)

Therefore, in other words, Biodiversity or Biological diversity includes the different plants, animals and microorganisms, the genes they contain and the ecosystems of which they form a part.

India is a recognized as one of the mega-diverse countries, rich in biodiversity and associated traditional knowledge. With just 2.4% of the land area, India accounts for nearly 7% of the recorded species even while supporting almost 18% of human population. Conservation and

sustainable use of biodiversity is fundamental to ecologically sustainable development. Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend.

Three levels at which biodiversity has been identified:

Genetic diversity – diversity of genes within a species. There is a genetic variability among the populations and the individuals of the same species.

Species diversity – diversity among species.

Ecosystem diversity – diversity at a higher level of organization, the ecosystem (richness in the different processes to which the genes ultimately contribute).

The 1992 Earth Summit in Rio de Janeiro defined biodiversity 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.*

Biodiversity found on Earth today is the result of 3.5 billion years of evolution. Until the emergence of humans, the Earth supported more biodiversity than in any other period in geological history. Since the advent of humans, however, biodiversity has begun a rapid decline, with one species after another suffering extinction.

Estimates of global species diversity vary from 2 million to 100 million species, with a best estimate to somewhere near 12.5 million.

New species are regularly discovered (on an average about three new species of birds each year) and many, though discovered, are not yet classified (an estimate gives that about 40% of freshwater fishes from South America are not classified yet). Most of the diversity is found in tropical forests.

Biodiversity is everywhere, in deserts, oceans, freshwater bodies, tropical rainforests, temperate zone forests and your backyard. The rainforests of Central and South America, equatorial Africa, and Southeast Asia may house at least half of the world's species. A large number of plant and animal species call coral reefs – the "rainforests of the seas" – their home. Lakes, estuaries, the deep ocean floor and the soil beneath your feet are also rich in

biodiversity, while extreme arctic climates and torrid deserts contain some of the most unusual living organisms.

Levels of Biodiversity

Biodiversity is considered to exist at three levels: genetics, species, and ecosystems.

(a) ***Genetic diversity***:

#. It is concerned with the variation in genes within a particular species

#. It is the total number of genetic characteristics in the genetic makeup of a species.

#. Genetic diversity allows species to adapt to changing environments.

#. This diversity aims to ensure that some species survive drastic changes and thus carry on desirable genes.

#. The survival of individuals ensures the survival of the population.

#. The genetic diversity gives us beautiful butterfly's roses, parakeets or coral in a myriad hues, shapes and sizes.

#. It is estimated that there are about 109 different genes distributed throughout the world's biota (i.e. living component).

#. Genetic diversity between species becomes greater with increasing distance in the relationship of species. Consequently more distantly related species will represent a higher range of genetic diversity than closely related species.

The problem of Cheetah Survival

Once quite widespread throughout Asia and Africa, there has been a large reduction of the cheetah's habitat and numbers though it is still seen in widely separated areas of Africa. Recent surveys of cheetah populations have shown that there is almost no genetic variation among individuals, even among those taken from the furthest points of its range. This is due to an evolutionary "bottleneck" caused by the fact that at one point cheetah populations crashed to very low numbers and then expanded from the same stock. As a result cheetahs in the wild, as well as in captivity, show several problems due to inbreeding which is threatening its future

survival. The problems encountered are low sperm counts leading to reproductive difficulties, low survival of juveniles, morphological aberrations and high susceptibility to diseases because of low genetic diversity in the immune system. Thus, even when numbers seem relatively adequate for a given species, a low genetic diversity can increase its vulnerability to extinction.

b) Species Diversity:

#. It refers to the variety of living organisms on earth.

#. Species diversity means the differences between species (both domesticated and wild).

#. Species differ from one another, markedly in their genetic makeup, do not inter-breed in nature.

#. Closely-related species however have in common much of their hereditary characteristics. For instance, about 98.4 per cent of the genes of humans and chimpanzees are the same.

#. It is the ratio of one species population over total number of organisms across all species in the given biome.

#. 'Zero' would be infinite diversity, and 'one' represents only one species present.

The biological species concept

A biological species as defined by Ernst Mayr are "groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups". For example there are some species called sibling species that are reproductively isolated although they have extremely minute genetic differences. This definition assumes that a species cannot interbreed with other species due to a variety of isolating mechanisms that are behavioural, physiological, genetic, etc. Thus, according to the biological species concept, individuals within a species have a gene pool available for recombination through sexual reproduction within the group, and is not inhibited by pre- or post-mating reproductive isolation.

The main criticism of this definition is that it applies only to organism (i.e. life forms) that have sexual reproduction, and ignores the fact that sometimes gene flow occurs between closely related, sympatric species (species whose geographical ranges overlap). For example, significant gene exchange has happened between bison and bus (domestic cattle). Such

occurrences violate the basic notion of the biological species concept. Nevertheless, this definition of a species continues to be widely used even today.

The phylogenetic species concept

Taxonomists (scientists who compare, classify and name organisms) tend to describe a species by studying their physical characteristics and behaviour, and also their genetic and chemical similarities and divergences as a result of evolution. Based on this concept Cracraft proposed the Phylogenetic

Species Concept (PSC) in 1983. Here he defines a species as "the smallest diagnostic cluster of individual organisms within which there is parental pattern of ancestry and decent." However, it can be argued that a population, subspecies, stage or a morph can then be elevated to species status. Consequently the number of species recognized becomes highly dependent on the analytical tools used.

Even so, the PSC is considered as the most valuable tool for working taxonomists.

There are less widely accepted methods of defining a species such as:

(a) The evolutionary species concept which identifies a species as a "lineage (i.e. ancestor descendant sequence of population) evolving separately from others with its own unitary role and tendencies." This is similar to the PSC, without the criterion of interbreeding, but it is less practicable.

(b) The ecological species concept: This identifies a species as a population that occupies a distinct ecological niche, whence it's reproductive and general biological cohesion over time. This was never widely accepted and is very hard to operationalize.

There are different estimates of extant (i.e. currently existing) species on earth which range from about five to 100 million, but a figure of about 12.5 million is the most widely accepted. Of these, only about 1.7 million species have been described as yet. In terms of sheer numbers alone, insects and microorganisms are the most abundant life forms on earth.

(c) Ecosystem/ Community diversity:

#. This refers to the different types of habitats. A habitat is the cumulative factor of the climate, vegetation and geography of a region.

#. There are several kinds of habitats around the world. Corals, grasslands, wetland, desert, mangrove and tropical rain forests are examples of ecosystems.

#. Change in climatic conditions is accompanied by a change in vegetation as well. Each species adapts itself· to a particular kind of environment.

#. As the environment changes, species best adapted to that environment becomes predominant. Thus the variety or diversity of species in the ecosystem is influenced by the nature of the ecosystem.

Measurement of Biodiversity

Diversity is a single statistic in which the number of species richness and evenness are compounded.

Biodiversity is measured by two major components:

i. **Species richness**
ii. **Species evenness**

(i). Species richness - It is the measure of number of species found in a community

a) Alpha diversity - It refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.

b) Beta diversity - It is a comparison of diversity between ecosystems, usually measured as the change in amount of species between the ecosystems

c) Gamma diversity - It is a measure of the overall diversity for the different ecosystems within a region.

(ii) Species evenness- It measures the proportion of species at a given site, e.g. low evenness indicates that a few species dominate the site.

Services provided by Biodiversity

Biodiversity provides a number of natural services for human beings:

(a) Ecosystem services

- 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

(b) ***Biological services***

• Food

• Medicinal resources and pharmaceutical drugs

• Wood products

•Ornamental plants

• Breeding stocks, population reservoirs

• Future resources

• Diversity in genes, species and ecosystems

(c) ***Social services*** □

• Research, education and monitoring '·

• Recreation and tourism

• Cultural values

Causes for Biodiversity Loss

(a) Natural causes □

• Floods,

• Earthquakes

• Landslides,

• Rivalry among species

• Lack of pollination and diseases.

(b) Man-Made causes □

• Habitat destruction

• Uncontrolled commercial exploitation

• Hunting & poaching

• Conversion of rich bio-diversity site for human settlement and industrial development

• Extension of agriculture • Pollution • Filling up of wetlands • Destruction of coastal areas.

Biodiversity conservation

Conservation of biological diversity leads to conservation of essential ecological diversity to preserve the continuity of food chains.

#. The genetic diversity of plants and animals is preserved.

#. It ensures the sustainable utilization of life support systems on earth.

#. It provides a vast knowledge of potential use to the community.

#. A reservoir of wild animals and plants is preserved, thus enabling them to be introduced, if need be, in the surrounding areas.

Biodiversity conservation assures sustainable utilization of potential resources.

Modes of Conservation

(a) ***Ex-situ conservation***: Conserving biodiversity outside the areas where they naturally occur is known as ex-situ conservation.

#. Here, animals are reared or plants are cultivated like zoological parks or botanical gardens.

#. Reintroduction of an animal or plant into the habitat from where it has become extinct is another form of ex-situ conservation.

For example, the Gangetic gharial has been reintroduced in the rivers of Uttar Pradesh, Madhya

Pradesh and Rajasthan where it had become extinct.

Seed banks, botanical, horticultural and recreational gardens are important centres for ex-situ conservation.

(b) In-situ conservation: Conserving the animals and plants in their natural habitats is known as in-situ conservation. The established natural habitats are:

#. National parks

#. Sanctuaries

#. Biosphere reserves and

#. Reserved forests

#. Protected forests

#. Nature reserves

Constraints in biodiversity conservation

#. Low priority for conservation of living natural resources.

#. Exploitation of living natural resources for monetary gain.

#. Values and knowledge about the species and ecosystem inadequately known.

#. Unplanned urbanization and uncontrolled industrialization.

Botanical garden- Botanical garden refers to the scientifically planned collection of living trees, shrubs, herbs, climbers and other plants from various parts of the globe. Purpose of botanical gardens

1. To study the taxonomy as well as growth of plants.

2. To study the introduction and acclimatization process of exotic plants.

3. It acts as a germplasm collection.

4. It helps development of new hybrids.

5. It augments conserving rare and threatened species.

6. It facilitates training of staff.

7. It acts as a source of recreation.

Zoo- Zoo is an establishment, whether stationary or mobile, where captive animals are kept for exhibition, to the public and includes a circus and rescue centres but does not include an establishment of a licensed dealer in captive animals - CZA .

The initial purpose of zoos was entertainment, over the decades, zoos have got transformed into centers for wildlife conservation and environmental education.

Apart from saying individual animals, zoos have a role to play in species conservation too {through captive breeding).

Zoos provide an opportunity to open up a whole new world, and this could be used in sensitizing visitors regarding the value and need for conservation of wildlife.

DRUG	PLANT SOURCE	USE
Atropine	Belladonna	Anticholinergic: reduces intestinal pain in diarrhoea.
Bromelain	Pineapple	Controls tissue inflammation due to infection.
Caffeine	Tea, Coffee	Stimulant of the central nervous system.
Camphor	Camphor tree	Rebefacient: increases local blood supply.
Cocaine	Cocoa	Analgesic and local anesthetic: reduces pain and prevents pain during surgery.
Codeine	Opium poppy	Analgesic: reduces pain.
Morphine	Opium poppy	Analgesic: controls pain.
Colchicine	Autumn crocus	Anticancer agent.
Digitoxin	Common foxglove	Cardiac stimulant used in heart diseases.
Diosgenin	Wild yams	Source of female contraceptive: prevents pregnancy.
L-Dopa	Velvet bean	Controls Parkinson's Disease which leads to jerky movements of the hands
Ergotamine	Smut-of-rye or ergot	Control of haemorrhage and migraine headaches.
Glaziovine	ocotea glaziovii	Antidepressant: Elevates mood of depressed patients.
Gossypol	Cotton	Male contraceptive.
Indicine N-oxide	heliotropium indicum	Anticancer agent.
Menthol	Mint	Rubefacient: increases local blood supply and reduces pain on local application.
Monocrotaline	Cotolaria sessiliflora	Anticancer agent.
Papain	Papaya	Dissolves excess protein and mucus, during digestion.
Penicillin	Penicillium fungi	General antibiotic, skills bacteria and controls infection by various micro-organisms.
Quinine	Yellow cinochona	Antimalarial.
Reserpine	Indian snakeroot	Reduces high blood pressure.
Scopolamine	Thorn apple	Sedative.
Taxol	Pacific yew	Anticancer (ovarian).
Vinblastine, vincristine	Rosy periwinkle (Vinca rosea) (Sadaphali)	Anticancer agent: Controls cancer in children.

Indian Biodiversity

India is one of the recognized megadiverse countries of the world. In terms of species richness, India ranks seventh in mammals, ninth in birds and fifth in reptiles. In terms of endemism of vertebrate groups, India's position is tenth in birds with 69 species, fifth in reptiles with 156 species and seventh in amphibians with 110 species.

India's share of crops is 44% as compared to the world average of 11 %. India also has 23.39% of its geographical area under forest and tree cover. Of the 34 globally identified biodiversity hotspots, India harbours two hotspots, i.e., Eastern Himalayas, Western Ghats and Sri Lanka.

India represents:

1. Two Realms
2. Five Biomes
3. Ten Bio-geographic Zones
4. Twenty five Bio-geographic provinces

Realms

Biogeographic realms are large spatial regions within which ecosystems share a broadly similar biota.

Realm is a continent or subcontinent sized area with unifying features of geography and fauna & flora.

The Indian region is composed of two realms. They are:

1) The Himalayan region represented by Palearctic Realm and

2) The rest of the sub-continent represented by Malayan Realm.

In world eight terrestrial biogeographic realms are typically recognized. They are 1. Nearctic realm 2. Palaearctic realm 3. Africotropical realm 4. Indomalayan realm 5. Ocenaia realm 6. Australian realm 7. Antarctic realm 8. Neotropical realm

Biomes of India

The term biome means the main groups of plants and animals living in areas of certain climate patterns.

It includes the way in which animals, vegetation and soil interact together.

The plants and animals of that area have adapted to that environment. The five biomes of India are:

1. Tropical Humid Forests
2. Tropical Dry or Deciduous Forests (including Monsoon Forests)
3. Warm deserts and semi-deserts
4. Coniferous forests and
5. Alpine meadows.

Biogeographic zones of India

Biogeography deals with the geographical distribution of plants and animals. There are 10 biogeographic zones which are distinguished clearly in India.

They are as follows

1) Trans Himalayas- An extension of the Tibetan plateau, harbouring high-altitude cold desert in Laddakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.

2) Himalayas-The entire mountain chain running from north-western to north-eastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.

3) ***Desert***. The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. 6.9% of the country's landmass.

4***) Semi-arid***. The zone between the desert and the Deccan plateau, including the Aravalli hill range. 15.6 % of the country's landmass. ,

5) ***Western Ghats***. The hill ranges and plains running along the western coastline, south of the Tapti River, covering an extremely diverse range of biotic provinces and biomes. 5.8% of the country's landmass.

6) ***Deccan Peninsula***. The largest of the; zones, covering much of the southern and south-central plateau with a predominantly deciduous vegetation, 4.3 % of the country's landmass.

7) ***Gangetic plain***. Defined by the Ganges river system, these plains are relatively homogenous, 11 % of the country's landmass.

8) ***North-east India***. The plains and non-Himalayan hill ranges of north-eastern India, with a wide variation of vegetation. 5.2% of the country's landmass.

9) ***Islands***. The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes. 0.03% of the country's landmass.

10) ***Coasts.*** A large coastline distributed both to the west and east, with distinct differences between the two; Lakshadweep islands are included in this with the percent area being negligible.

Bio-geographic provinces

S.No.	Biogeographic Zones (10 nos)	Biogeographic Provinces (25 nos)
1.	Trans Himalaya	1A: Himalaya -Ladakh Mountains 1B: Himalaya -Tibetan Plateau 1C: Trans - Himalaya Sikkim
2.	The Himalaya	2A: Himalaya - North West Himalaya 2B: Himalaya - West Himalaya 2C: Himalaya - Central Himalaya 2D: Himalaya - East Himalaya
3.	The Indian Desert	3A: Desert – Thar 3B: Desert – Katchchh
4.	The Semi Arid	4A: Semi - Arid - Punjab Plains 4B: Semi - Arid - Gujarat Rajputana
5.	The Western Ghats	5A: Western Ghats - Malabar Plains 5B: Western Ghats -Western Ghats Mountains
6.	The Deccan Peninsula	6A: Deccan Peninsular - Central Highlands 6B: Deccan Peninsular - Chotta Nagpur 6C: Deccan Peninsular - Eastern Highlands 6D: Deccan Peninsular - Central Plateau 6E: Deccan Peninsular - Deccan South
7.	The Gangetic Plains	7A: Gangetic Plain - Upper Gangetic Plains 7B: Gangetic Plain - Lower Gangetic Plains
8.	The Coasts	8A: Coasts - West Coast 8B: Coasts - East Coast 8C: Coasts – Lakshdweep
9.	Northeast India	9A: North - East - Brahamputra Valley 9B: North - East – North East Hills
10.	Islands	10A: Islands – Andamans 10B: Islands – Nicobars

Bio-geographic Province is an ecosystematic or biotic subdivision of realms. India is divided into 25 bio geographic zones.

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Biogeographic classification of India was done by Rodgers and Panwar (1988), describing 10 biogeographic zones in India, further divided into 25 biogeographic provinces. The classification was done using various factors such as altitude, moisture, topography, rainfall, etc. Biogeographic zones were used as a basis for planning wildlife protected areas in India.

Values of Biodiversity

Understanding the value of biological diversity is vital to maintain the enormous range of genes, species and ecosystems that the earth supports. This can be looked at in many ways. One way would be to understand the "resource" or "use" value of various components of biodiversity which are used by humans. Biodiversity has also, however, great "non-resource" or "non-use" value such as maintaining ecosystem functions. Biodiversity can also be viewed in terms of economic and non-economic values.

The economic value of a biological resource may be broken down into a range of use and non-use values that are of direct or indirect benefit of humans.

Values are also dynamic; they change over time, and they depend on a specific situation.

The value of biodiversity is often divided into two main categories:

1. Utilitarian (also known as instrumental, extrinsic, or use) value, and
2. Intrinsic (also known as inherent) value.

A living thing's utilitarian value is determined by its use of function. Usually utilitarian value is measured in terms of its use for humans, such as for medicine or food. However, it can also represent the value of an organism to other living things or its ecological value; native bees, for example, serve as pollinators for many plants. In contrast, intrinsic value describes the inherent worth of an organism, independent of its value to anyone or anything else. In other words, all living things have a right to exist – regardless of their utilitarian value.

Determining the value or worth of biodiversity is complex. Economists typically subdivide utilitarian or use values of biodiversity into direct use value for those goods that are consumed directly, such as food or timber, and indirect use value for those services that support the items that are consumed, including ecosystem functions like nutrient cycling.

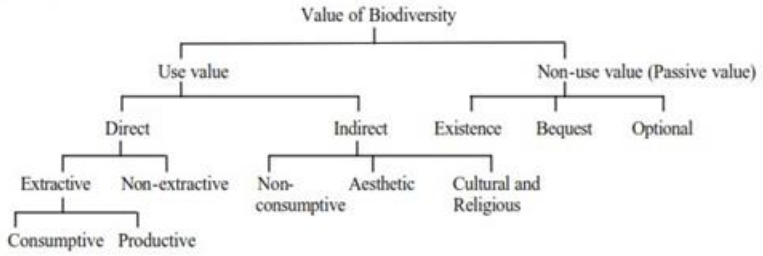
There are several less tangible values that are sometimes called non -use or passive values, for things that we don't use but would consider as a loss if they were to dis appear; these include existence value, the value of knowing something exists even if you will never use it or see it, and bequest value, the value of knowing something will be there for future generations.

Potential or Option value refers to the use that something may have in the future; sometimes this is included as a use value, we have chosen to include it within the passive values here based on its abstract nature.

Direct Use Value (Goods)	Indirect Use Value (Services)	Non-Use Values	
Food, medicine, building material, fibre, fuel	Atmospheric and climate regulation, pollination, nutrient recycling	Potential (or Option Value)	Future value either as a good or a service
	Cultural, Spiritual, and Aesthetic	Existence Value	Value of knowing something exists
		Bequest Value	Value of knowing that something will be there for future generations

Classification of values of diversity is provided in a key form below for your easy understanding.

The Value of Biodiversity



Direct Use Value

Direct use values are for those goods that are ensured directly e.g. food and timber.

Direct use values could be due to extractive use where resources are extracted and consumed, or due to non -extractive use when there is no extraction or removal of the resource that is used (e.g. bird watching, scientific research in an ecosystem, etc.).

Extractive use - This includes direct use such as harvesting of wild plant species for use as food, fuel, fodder, fibre, shelter or medicine and hunting animals for food or sport and fisheries.

Extractive use can be further divided as consumptive use values and productive use values.

Consumptive use values - This means the non-market value of natural products such as firewood, game and fodder that do not pass through a market or product preparation.

Productive use values - This is the value of natural products harvested through commercial logging, agriculture or fisheries and medicines that generated products that are of commercial value.

Non -extractive use values - Some activities that make use of biological resources, without involving their extraction or destruction, denote non -extractive use of biological resources.