

Biodiversity & its conservation

NOTES

DEFINITION

Biological diversity or biodiversity refers to the different life forms and habitats found in a defined area. UNEP (1992) defines it "as the variety and variability of all animals, plants and micro-organisms and the ecological complexes of which they are a part".

The convention on Biological Diversity defines 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 a part; this includes diversity within species, between species and of ecosystems". The term biodiversity was coined by W.G. Rosen (1985). Norman Myers introduced the concept of biodiversity.

It may also be defined as the sum total of species richness, i.e., the number of species of plants, animals and microorganisms occurring in a given region, country, continent of the entire globe. The great variety of life on earth has provided for man's needs over thousands of years. This diversity of living creatures forms a support system which has been used by each civilization for its growth and development. Those that used this "bounty of nature" carefully and sustainably survived.

OR

The term biodiversity (from "biological diversity") refers to the variety of life on Earth at all its levels, from genes to ecosystems, and can encompass the evolutionary, ecological, and cultural processes that sustain life. It includes not only species we consider rare, threatened, or endangered but also every living thing—from humans to organisms we know little about, such as microbes, fungi, and invertebrates.

- ***Biodiversity is the measure of the variety of earth's animal, plant and microbial species; of genetic differences within species; and of the ecosystems that support the species. Out of an estimated 30 million species on earth, only one-sixth has been identified and authenticated in the past 200 years.***
- Biodiversity is the part of nature which includes the difference in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally in a region, in the country and the world and various types of ecosystems, both terrestrial and aquatic within a defined area. It deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organisation of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

- **Scientists have estimated that there are around 8.7 million species of plants and animals in existence. However, only around 1.5 million species have been identified and described so far, most of which are insects which means that millions of other organisms remain a complete mystery.**
- Over generations, all of the species that are currently alive today have evolved unique traits that make them distinct from other species and these differences are what scientists use to tell one species from another. The United Nations designated 2011-2020 as the United Nations Decade on Biodiversity. To increase the understanding and awareness of biodiversity issues, May 22 was proclaimed as the International Day for Biological Diversity.

Significance of biodiversity

1. Biodiversity protects the fresh air, clean water and productive land.
 2. It is also important for forestry, fisheries and agriculture, which depend on a rich water variety of various biological resources available in nature.
 3. Loss of biodiversity exerts heavy economic and social costs for any country.
 4. It is very important for human life; we depend on plants, microorganisms and earth's animals for our food, medicine and industrial products.
 5. All the organisms are important links in the food chains operating in different habitats. If any of the links is removed then the whole ecosystem faces the consequences.
 6. It acts as a source of gene pool or gene bank for various breeding programs. For example, one of the rice species resistant to the rice pest *Nilaparvata lugens* (Brown planthopper) was discovered from the wildlife gene pool and cultivated. This way serious damage due to this pest was prevented.
 7. Drugs have been developed from the raw materials obtained from plants and other organisms.
- Biodiversity is of great ecological, economic and aesthetic value.

TYPES OF BIODIVERSITY

Genetic Diversity:

It refers to the variation of genes that occur within the species. Each member of any plant or animal species is distinct from others in its genetic makeup. Each organism has its own specific characteristics due to the large number of combinations possible in the genes. Genes are the basic unit of hereditary information, transmitted from one generation to the other. Within individual species, there are a number of varieties, which are slightly different from one another. These differences are due to differences in the combination of genes.

Example: all rice varieties belong to the species "*Oryza sativa*"; but there are thousands of wild and cultivated varieties of rice, which show variations at the genetic level and are different in their colour, size, shape, nutrient content of the plant.

1. Each member of any animal or plant species differs widely from other individuals in its genetic makeup because of the large number of combinations possible in the genes that give every individual specific characteristic. Thus, for example, each human being is very different from all others.

2. It includes variation within a population and diversity between populations that are associated with adaptation to local conditions.
3. Genetic variations lead to individual differences within species. Such variation leads to evolution.
4. They also improve the chances of continuation of species in the changing environmental conditions or allow the best adapted to survive.
5. **Existence of subspecies**, races are examples of genetic diversity. E.g. 100 varieties of mangoes 50,000 varieties of rice or wheat. Today the variety of nature's bounty is being further harnessed by using wild relatives of crop plants to create new varieties of more productive crops and to breed better domestic animals. Modern biotechnology manipulates genes for developing better types of medicines and a variety of industrial products. **Another case of genetic diversity** is a medicinal plant Rauwolfia vomitoria which secretes active components reserpine is found in different Himalayan ranges. This plant shows variations in terms of potency and concentration of active chemicals from location to location.
6. Genetic diversity is essential for the healthy breeding population of a species. If the number of breeding individuals is reduced, the dissimilarity of genetic makeup is reduced and in-breeding occurs. The diversity in wild species forms the 'gene pool' from which our crops and domestic animals have been developed over thousands of years.

Species Diversity:

It is the variability found in the number of species of plants and animals present in a region and their diversity, in the given space. It is measured by species richness. The richness in species differs widely from one area to another. These areas that are rich in species diversity are called hotspots of diversity. India is among the world's 15 nations which have rich species diversity. It represents broadly the species richness and their abundance in a community. The sum of varieties of all living organisms at the species level is known as species diversity.

Species diversity: Species diversity is the diversity between different species.

(a) **Species richness** - It refers to the number of different species per unit area in an ecological community. Here neither abundance nor distribution of species is taken into account. For example, if an area has birds, amphibians, herbivores, insects, small carnivores, reptiles and plants of various types then it is species rich.

(b) **Species abundance** - refers to the relative numbers among species. For example, .It is the relative abundance with which each species is represented in an area. This aspect focuses on how many members of different species are present in an area as the number of species of plants, animals and microorganisms may be more in an area than that recorded in another area. Many new species are being identified, especially in the flowering plants and insects. Areas that are rich in species diversity are called 'hotspots' of diversity. India is among the world's 15 nations that are exceptionally rich in species diversity.

For example if in an area the number of wolves, foxes and wild dogs is 1000, 90 and 700 respectively then the area is uneven in species richness. But if the same species are in 1000, 950 and 970 respectively then it is relatively even in species richness. The number and variety of individuals determine the level of diversity in an ecosystem. The Western Ghats have a greater

diversity of amphibian species than the Eastern Ghats. Approximately 181 amphibian species are recorded in the Western Ghats.

1. At the global level, an estimated 1.7 million species of living organisms have been described to date and many more are yet to be discovered. It has been currently estimated that the total number of species may vary from 5 - 50 millions. **Plant species:** Apple, Mango, Wheat, Grapes, Rice etc. **Animal species:** Lion, Tiger, Elephant, Deer etc.
2. Species diversity is not evenly distributed across the globe. The overall richness of species is concentrated in equatorial regions and tends to decrease as one moves from equatorial to polar regions.
3. In addition, biodiversity in land ecosystems generally decreases with increasing altitude. The other factors that influence biodiversity are the amount of rainfall and nutrient level in soil. In marine ecosystems, species richness tends to be much higher in continental shelves.
4. This diversity is seen both in natural ecosystems and in agricultural ecosystems. Some areas are richer in species than others. Natural undisturbed tropical forests have much greater species richness than plantations.

Ecosystem or Community Diversity:

It is the variation in different types of found ecosystems found within a particular region.

Ecosystem diversity can be specified for a geographical region, country or state. **Eg: Sunderban forests which include forests, wetlands, estuaries and rivers.** The diversity at the ecological or habitat level is known as "ecosystem diversity". A large region with different ecosystems can be considered as ecosystem diversity. It is a set of biotic components [such as plants, animals and microorganisms] interacting with one another and with abiotic components [such as soil, air, water, etc.

1. The ecosystem also shows variation with respect to physical parameters like moisture, temperature, altitude, precipitation, etc.
 2. It can be described for a specific geographical region, or a political entity such as a country, a state or a taluka. Distinctive ecosystems include landscapes such as forests, grasslands, deserts, mountains, etc., as well as aquatic ecosystems such as rivers, lakes, and the sea.
 3. India has greater ecosystem diversity than a Scandinavian country like Norway; and has several ecosystems or biomes like rain forests, deserts, wetlands, mangroves, coral reefs, estuaries and alpine meadows. There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat.
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1. There may be one or many different types of ecosystems in the region.
 2. The western ghats show great ecosystem diversity while regions like Ladakh and Rann of Kutch do not show variance like we observe in Western ghats.

IMPORTANCE OF BIODIVERSITY

Environmental services from species and ecosystems are essential at global, regional and local levels. Production of oxygen, reducing carbon dioxide, maintaining the water cycle, and protecting soil are important services.

The world now acknowledges that the loss of biodiversity contributes to global climatic changes. Forests are the main mechanism for the conversion of carbon dioxide into carbon and oxygen. The loss of forest cover, coupled with the increasing release of carbon dioxide and other gases through industrialization contributes to the 'greenhouse effect'.

Global warming is melting ice caps, resulting in a rise in the sea level which will submerge the low lying areas in the world. It is causing major atmospheric changes, leading to increased temperatures, serious droughts in some areas and unexpected floods in other areas

Biological diversity is also essential for preserving ecological processes, such as fixing and recycling of nutrients, soil formation, circulation and cleansing of air and water, global life support (plants absorb CO₂, give out O₂), maintaining the water balance within ecosystems, watershed protection, maintaining stream and river flows throughout the year, erosion control and local flood reduction.

Direct values:

These are those ways by which we can directly use biodiversity for our benefit. For example we can use plants as food for deriving medicines in the laboratory. Economic value and recreational value comes under this category.

Direct values are further classified into:

CONSUMPTIVE VALUE: Consumptive use value is the value put on the products of nature which are consumed directly without passing through a market. For example, if we use firewood by cutting down a tree or consume an animal after hunting it.

Biodiversity is an essential requirement for the maintenance of global food supply. The main sources of human food include animals, fish and plant produces. A large number of plants are consumed by human beings as food. A few animal species are consumed by people which come from cattle, pigs, sheep, goats, buffaloes, chickens, ducks, geese and turkey species. These are directly used values where the biodiversity products are harvested and consumed

directly. The direct utilisation of timber, food, fuelwood, fodder by local communities.

Example:-food, drug, fuel etc.

Food:- A large number of wild plants are consumed by human beings as food.

Drugs:- Around 70% of modern medicines are derived for plant and plant extracts.

"periwinkle" plant, which possesses anticancer alkaloids.

- Morphine (painkiller) is all plant origin.
- The purple tree leaves, trunk and roots are used as effective medicines for curing diseases like fever, cough, stomach-ache and skin diseases.
- **"Caffeine"** is obtained from fox grove, which is an effective cure for heart stimulation.

Fuel:- our forest has been used since ago for fuel wood. The forest fossil fuel like coal, petroleum and natural gas.

- The wonderful drug penicillin is used as an antibiotic. It is derived from a fungus called

"pencillinium".

- Life saving drugs like 'quinine' come from the cinchona tree (used to treat malaria).
- "Vin blast in" and "Vin Christine" two anticancer drugs have obtained from

Fish: Many freshwater fish can be grown in ponds. Israel and China already get about half of their fish from aquaculture.

Drugs & medicines: About 75% of the world's population depends upon plants or plant extracts for medicines. The drug Penicillin used as an antibiotic is derived from a fungus called Penicillium. Likewise, Tetracycline from bacteria which is used to cure malaria is obtained from the bark of cinchona trees. .

Fuel: The fossil fuels like coal, petroleum products and natural gas are the products of Biodiversity.

Productive use value: Productive use value is the value put on the products of nature which are consumed after passing through a market. These products are marketed and sold. These products may be derived from animals and plants. Many industries are dependent upon the productive use values of biodiversity.

Example:- paper and pulp industry, plywood, silk industry, textile industry, leather industry, pearl industry.

For example, if we buy fish from the market then it will have productive use value.

ANIMALS	ANIMAL PRODUCER
Silk worm	Silk
Sheep	Wool
Musk deer	Musk
Elephant	Tusk
Lac insects	Lac

Indirect values or Non-Consumptive value:

These are those ways by which we don't physically use a plant or animal, but by virtue of its existence it provides services that keep the ecosystem healthy. Indirect values would include ethical or moral value, existence value, ecological value, aesthetic value, cultural or spiritual value, option value and scientific or educational value.

Ecological Value :

- (a) Safeguarding water resources through maintenance of the water cycle.
- (b) Recycling of nutrients and storing.
- (c) Degradation of Pollutants and its incorporation.
- (d) Restoring Climate and preserving ecosystem.
- (e) Protection of Soil.
- (f) Resilience from unpredictable events like Tsunami, earthquakes and wildfires.

Economic Value :

- (a) Direct utilisation of timber, food, fuel wood and fodder by local communities.
- (b) Biodiversity contained in the ecosystem provides forest dwellers with their daily needs food, material, medicines and other products.
- (c) Dried biomass and the petrified products of coal, petroleum and natural gas that serve as fuel are all derived from biodiversity.
- (d) Different varieties of cereals, pulses, vegetables, spices etc. comes directly from the diverse forms of wildlife.
- (e) Wildlife trade, farming and extraction of medicinal products are other benefits.

Social Value :

- (a) Biodiversity has been presented by traditional societies till today. For example, many of the plants like banyan, peepal, tulsi etc. and animals like cows, snakes etc. are regarded as holy and served.
- (b) Policy measures and resources utilisation should be implemented in the aspect of social value.
- (c) Indian lifestyle, songs, dance, scriptures and customs are closely related with wildlife.

Ethical Value :

- (a) Ethical values related to biodiversity are based on the importance of protecting all forms of life.
- (b) All species were created equal and have the moral right to live, procreate and grow. However, being at the top of the food chain, humans have played havoc with the fragile ecosystems.
- (c) Humans should take a holistic view of the consequences of their actions and do things that are sustainable, inclusive and honour the rights of every living organism.

Aesthetic Value :

- (a) The appreciation of the presence of biodiversity for its inherent value and beauty.
- (b) Biodiversity is instrumental in promoting the tourism industry. Tourists from all parts of the world spend a lot of money to visit the wilderness. They enjoy the tranquillity, the natural and the aesthetic beauty of the forests and wildlife.
- (c) Aesthetic aspects include ecotourism, bird-watching, wildlife, pet keeping, gardening etc. The beauty of nature is something many people are enthralled by. Plants and animals are often used as symbols in paintings, flags, sculptures, stamps etc.
- (d) There is something within the natural environment which people really connect to, and gives them an immense sense of satisfaction when they experience nature. For some, there are cultural or spiritual meanings attached to the landscape, whereas for others it is simply the aesthetic quality of the natural environment which they enjoy so much.
- (e) Species like Asiatic lion, panda are chosen as flagship species for their attractiveness and distinctiveness to represent an environmental cause.

Ecosystem services

Biodiversity is essential for the maintenance of ecosystem services and their sustainable utilisation. These services include maintenance of gaseous composition of the atmosphere, climate control by forests and oceanic systems, natural pest control, pollination of plants by insects and birds, formation and protection of soil, conservation and purification of water and nutrient cycling etc.

i) Protection of water resources: Natural vegetation cover helps in maintaining hydrological cycles, regulating and stabilising water run-off and acting as a buffer against extreme events such as floods and droughts. Vegetation removal results in siltation of dams and waterways. Wetlands and forests act as water purifying systems, while mangroves trap silt thereby reducing impacts on marine ecosystems.

ii) Soil protection: Biological diversity helps in the conservation of soil and retention of moisture and nutrients. Clearing large areas of vegetation cover has been often seen to accelerate soil erosion, reduce its productivity and often result in flash floods. Root systems allow penetration of water to the subsoil layer. Root system also brings mineral nutrients to the surface by nutrient uptake.

iii) Nutrient storage and cycling: Ecosystem perform the vital function of recycling nutrients found in the atmosphere as well as in the soil. Plants are able to take up nutrients, and these nutrients then can form the basis of food chains, to be used by a wide range of life forms. Nutrients in the soil, in turn, is replenished by dead or waste matter which is transformed by microorganisms; this may then feed others such as earthworms which also mix and aerate the soil and make nutrients more readily available.

iv) Pollution reduction: Ecosystems and ecological processes play an important role in maintenance of gaseous composition of the atmosphere, breakdown of wastes and removal of pollutants. Some ecosystems, especially wetlands have the ability to breaking down and absorb pollutants. Natural and artificial wetlands are being used to filter effluents to remove nutrients, heavy metals, suspended solids; reduce the BOD (Biological Oxygen Demand) and destroy harmful microorganisms. Excessive quantities

v) Climate stability: Vegetation influences climate at macro as well as micro levels. Growing evidence suggests that undisturbed forests help to maintain the rainfall in the vicinity by recycling water vapour at a steady rate back into the atmosphere. Vegetation also exerts moderating influence on micro climate. Cooling effect of vegetation is a common experience which makes living comfortable. Some organisms are dependent on such microclimates for their existence.

vi) Maintenance of ecological processes: Different species of birds and predators help to control insect pests, thus reduce the need and cost of artificial control measures. Birds and nectar-loving insects which roost and breed in natural habitats are important pollinating agents of crops and wild plants. Some habitats protect crucial life stages of wildlife populations such as spawning areas in mangroves and wetlands.

Prevention and mitigation of natural disasters

Forests and grasslands protect landscapes against erosion, nutrient loss, and landslides through the binding action of roots. Ecosystems bordering regularly flooding rivers (floodplain forests and wetlands) help to absorb excess water and thus, reduce the damage caused by floods.

Source of economically important products

Food: About 150 crops feed most of the human population at present, but just 12 of them provide about 80% of food energy (with wheat, rice, maize and potato alone providing about 60%). Also, about 30 mammalian and bird species are used extensively, but just 15 of them account for over 90 percent of global livestock production. Biodiversity increases the range of food products suitable for human consumption. Wild biodiversity provides a wide variety of important foodstuffs, including fruits, meats, nuts, mushrooms, honey, spices and flavourings. These wild foods are especially important when agricultural supplies fail. Indeed, wild biodiversity guards against the failure of even the most advanced agricultural systems. For example, the productivity of many of the developed world's agricultural crops is maintained through the regular assimilation of new genes from wild relatives of these crops. These wild genes offer resistance to the pests and diseases that pose an ever-evolving threat to harvests.

Medicines: Biodiversity is also a rich source of substances with therapeutic properties like morphine (used as an analgesic), quinine (used for the treatment of malaria) and taxol (an anticancer drug). A significant proportion of drugs are derived, directly or indirectly, from biological sources. Moreover, only a small proportion of the total diversity of organisms has been thoroughly investigated for potential sources of new drugs.

Industrial materials: A wide range of industrial materials are derived directly from biological resources. These include building materials, fibres, dyes, resins, gums, adhesives, rubber and oil. There is enormous potential of obtaining economically important materials from a wider diversity of organisms.

(vi) Option values: These values include the potentials of biodiversity that is presently unknown and needs to be explored. There is a possibility that we may have some potential cure for AIDS or cancer existing within the depths of a marine ecosystem, or a tropical rainforest. Thus option value is the value of knowing that there are biological resources existing in this biosphere that may one day prove to be an effective option for something important in the future. Thus, the option value of biodiversity suggests that any species may prove to be a miracle species someday. biodiversity is like the precious gifts of nature presented to us. We should not commit the folly of losing these gifts even before unwrapping them. The option value also includes the values, in terms of the option to visit areas where a variety of flora and fauna, or specifically some endemic, rare or endangered species exist.

BIODIVERSITY CONSERVATION

Conservation is the protection, preservation, management, or restoration of wildlife and natural resources such as forests and water. Through the conservation of biodiversity and the survival of many species and habitats which are threatened due to human activities can be ensured. There is an urgent need, not only to manage and conserve the biotic wealth, but also restore the degraded ecosystems.

Humans have been directly or indirectly dependent on biodiversity for sustenance to a considerable extent. However, increasing population pressure and developmental activities have led to large scale depletion of the natural resources.

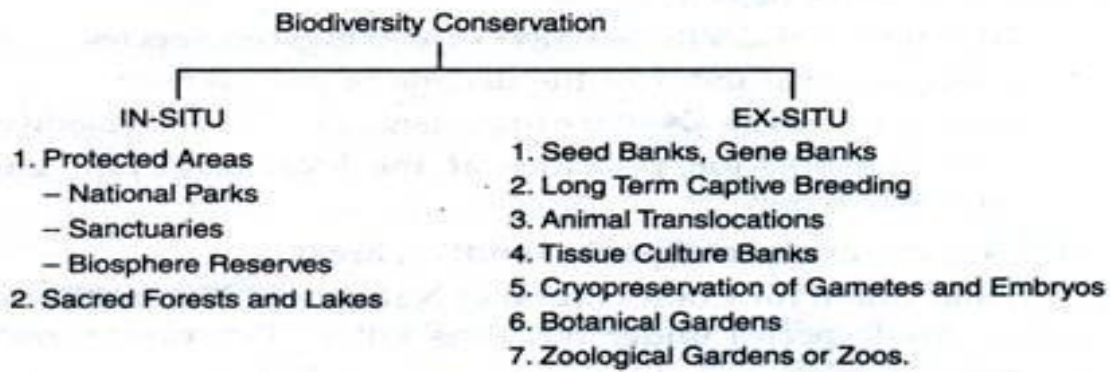
Need to conserve biodiversity:

1. To preserve and protect the species in their habitat.
2. To maintain an essential ecological process so that there is no ecological imbalance created.
3. To use the species and ecosystem sustainably without exploiting them.
4. To preserve flora and fauna, natural parks, sanctuaries, biosphere reserves, etc. are created.
5. To conserve genetic biodiversity by establishing the zoological gardens (zoos), botanical gardens, nurseries, etc.
6. To ensure proper planning of land use and other natural resources so as to conserve biodiversity.
7. To prohibit the hunting, poaching of animals, fishing etc., beyond the productive capacity of the ecosystem.
8. To ensure biodiversity maintenance by enforcing the acts, laws of legislative controls such as India forests act, endangered species act, etc.,
9. To create public awareness about sustainable use of the species without affecting the biodiversity.
10. To delineate the particular areas as "reserved" so that no activity is permitted in that zone. Example: reserve forests.
11. To conserve biodiversity with regard to plants and animals, a number of measures are now being taken the world over.

Types of Conservation:

Conservation can broadly be divided into two types:

1. **In-situ conservation**
2. **Ex-situ conservation**



In-situ Conservation:

Protection of habitat: The main strategy for conservation of species is the protection of habitats in representative ecosystems. Currently, India has 106 National Parks, 567 Wildlife Sanctuaries, 18 Biosphere Reserves, twenty seven Tiger Reserves and eleven Elephant Reserves covering an area of 15.67 million hectares or 4.7 % of the geographical area of the country. Twenty one wetlands, thirty mangrove areas and four coral reef areas have been identified for intensive conservation and management purposes by the Ministry of Environment and Forests, Govt. of India.

In-situ conservation is on site conservation or the conservation of genetic resources in natural populations of plant or animal species, such as forest genetic resources in natural populations of tree species.

It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or cleaning up the habitat itself, or by defending the species from predators.

It is applied to conservation of agricultural biodiversity in agroforestry by farmers, especially those using unconventional farming practices.

In-situ conservation is being done by declaring an area as a protected area

- I. **Protected areas (PAs)** A protected area is a geographically defined area that is designated or regulated and managed to achieve specific conservation objectives. It may be set aside for the protection of biological diversity, and of natural and associated cultural resources and is managed through legal or other effective means. This includes national parks and nature reserves, sustainable use reserves, wilderness areas and heritage sites.

Protected areas (PAs) have been widely used as a conservation tool in order to maintain a representative sample of unaltered species and ecosystems for the future, and to limit the potential for environmental degradation through human mismanagement of resources.

At present, approximately 8,500 PAs exist throughout the world in 169 countries. This covers about 750 million hectares of marine and terrestrial ecosystems, which amounts to 5.2 % of the Earth's land surface. In India following types of natural habitats are being maintained: INDIA has over 600 protected areas, which includes over 105 national parks, over 500 animal sanctuaries and 18 biosphere reserves.

1. National parks

A national park is an area which is strictly reserved for the betterment of the wildlife and where activities like forestry, grazing on cultivation are not permitted. In these parks, even private ownership rights are not allowed.

Their boundaries are well marked and circumscribed. They are usually small reserves spreading in an area of 100 Sq. km. to 500 sq. km. In national parks, the emphasis is on the preservation of a single plant or animal species.

List of some major National Parks of India:

Name	State	Established	Area (in km ²)
Jim Corbett National Park	Uttarakhand	1921	1318.5
Dudhwa National Park	Uttar Pradesh	1977	490.29
Gir National Park	Gujarat	1965	258.71
Kanha National Park	Madhya Pradesh	1955	940
Kaziranga National Park	Assam	1974	471.71
Nanda Devi National Park	Uttarakhand	1982	630.33
Sundarbans National Park	West Bengal	1984	1330.12

2. Wildlife sanctuaries

A sanctuary is a protected area which is reserved for the conservation of only animals and human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with the well-being of animals. Boundaries of sanctuaries are not well defined and controlled biotic interference is permitted, e.g., tourist activity.

Name	State	Established	Area (in km ²)
Ghana Bird Sanctuary	Rajasthan	1982	28.73
Hazaribagh Wildlife Sanctuary	Jharkhand	1954	183.89
Mudumalai Wildlife Sanctuary	Tamil Nadu	1940	321.55
Jaldapara Wildlife Sanctuary	West Bengal	2012	216
Mount Abu Wildlife Sanctuary	Rajasthan	1960	288.84
Anamalai Wildlife Sanctuary (Indira Gandhi Wildlife Sanctuary and National Park)	Tamil Nadu	1989	117.10

Many National Parks and Sanctuaries have been established to preserve wildlife in their natural environment. Some of them are given below along with important species found there.

- Kaziranga sanctuary (Assam) - One-horned rhinoceros
- Manas sanctuary (Assam) - Wild buffaloes
- Gir forest (Gujarat) - Lions, chital, sambar, wild bears
- Kelameru bird sanctuary (Andhra Pradesh) - Pelicans and marine birds
- Dachigam sanctuary (Jammu and Kashmir) - Kashmir stags, Himalayan tahr, wild goats, sheep, antelopes.
- Bandipur sanctuary (Karnataka) - Indian bison, elephants, langurs
- Periyar sanctuary (Kerala) - Elephants, barking deer, sambhar
- Kanha National Park (Madhya Pradesh) - Tiger, leopards, wild dogs
- Simlipal National Park (Orissa) - Mangroves, marine turtles lay eggs
- Bharatpur bird sanctuary (Rajasthan) - Ducks, herons
- Corbett National Park (Uttaranchal) -Tigers, barking deer, sambar, wild bear, rhesus monkey.
- Jaldapara sanctuary (West Bengal) - Rhinoceros

3. Biosphere reserves

It is a special category of protected areas where human population also forms a part of the system. They are large protected areas of usually more than 5000 sq.km. A biosphere reserve has 3 parts- core, buffer and transition zone.

1. Core zone is the inner zone; this is an undisturbed and legally protected area.
2. Buffer zone lies between the core and transition zone. Some research and educational activities are permitted here.

3. Transition zone is the outermost part of biosphere reserves. Here cropping, forestry, recreation, fishery and other activities are allowed.

The main functions of Biosphere reserves are:

1. **Conservation:** To ensure the conservation of ecosystem, species and genetic resources.
2. **Development:** To promote economic development, while maintaining cultural, social and ecological identity.
3. **Scientific Research:** To provide support for research related to monitoring and education, local, national and global issues.

Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity.

Name	State	Established	Area (in km ²)
Nanda Devi	Uttarakhand	1982	5,860.69
Manas	Assam	1990	2837
Gulf of Mannar	Tamil Nadu	1980	10,500
Great Nicobar	Andaman and Nicobar Islands	1989	885
Pachmarhi	Madhya Pradesh	1999	4,926.28

II. **Sacred forests and sacred lakes:** A traditional strategy for the protection of biodiversity has been in practice in India and some other Asian countries in the form of sacred forests. These are small forest patches protected by tribal communities due to **religious sanctity**. These have been free from all disturbances. Sacred forests are located

in several parts of India i.e. **Karnataka, Maharashtra, Kerala, Meghalaya** , Similarly, several water bodies for example, **Khecheopalri lake in Sikkim**, have been declared sacred by the people, leading to protection of aquatic flora and fauna.

Scared Forests: These are the undisturbed forests without any human intervention and have a special religious importance to a particular culture. The area is usually dedicated to a local deity. In India these sacred groves were brought under the Wildlife protection Act, in 2002 Such forests include a number of rare, endangered and endemic species.

Sacred Groves in India: Khasi and Jaintia hills in Meghalaya. Western Ghat regions of Karnataka and Maharashtra. Aravalli Hills of Rajasthan. Sarguja, Chanda and Bastar areas of Madhya Pradesh.

Advantages of in-situ conservation:

1. The flora and fauna live in natural habitats without human interference.
2. The life cycles of the organisms and their evolution progresses in a natural way.
3. In-situ conservation provides the required green cover and its associated benefits to our environment.
4. It is less expensive and easy to manage.
5. The interests of the indigenous people are also protected.

Ex-Situ Conservation:

Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated species, and draws on a diverse body of techniques and facilities. Such strategies include establishment of botanical gardens, zoos, conservation strands and gene, pollen seed, seedling, tissue culture and DNA banks

i. Seed gene bank:

These are cold storages where seeds are kept under controlled temperature and humidity for storage and this is the easiest way to store the germ plasm of plants at low temperature. Seeds preserved under controlled conditions (minus temperature) remain viable for long durations of time.

ii. Gene bank:

Genetic variability also is preserved by gene banks under normal growing conditions. These are cold storages where germplasm are kept under controlled temperature and humidity for storage; this is an important way of preserving the genetic resources. The National Bureau of Plant Genetic Resources (NBPGR), New Delhi preserves seeds of wild relatives of crop plants as well as cultivated varieties; the National Bureau of Animal Genetic Resources at Karnal, Haryana maintains the genetic material for domesticated animals, and the National Bureau of Fish Genetic Resources, Lucknow for fishes.

iii. Cryopreservation:

This is the newest application of technology for preservation of biotic parts. This type of conservation is done at very low temperature (196°C) in liquid nitrogen. The metabolic activities of the organisms are suspended under low temperature, which are later used for research purposes.

iv. Tissue culture bank:

Cryopreservation of disease free meristems is very helpful. Long term culture of excised roots and shoots are maintained. Meristem culture is very popular in plant propagation as it's a virus and disease free method of multiplication.

v. Long term captive breeding:

The method involves capture, maintenance and captive breeding on long term basis of individuals of the endangered species which have lost their habitat permanently or certain highly unfavourable conditions are present in their habitat.

vi. Botanical gardens:

A botanical garden is a place where flowers, fruits and vegetables are grown. The botanical gardens provide beauty and a calm environment. Most of them have started keeping exotic plants for educational and research purposes. The Indian Botanical Garden in Howrah (West Bengal) is over 200 years old. Other important botanical gardens are in Ooty, Bangalore and Lucknow. The most recent one is The Botanical Garden of Indian Republic established at NOIDA, near Delhi in April, 2002. The main objectives of this garden are -

- ex-situ conservation and propagation of important threatened plant species,
- serve as a Centre of Excellence for conservation, research and training,
- build public awareness through education on plant diversity and need for conservation.

vii. Animal Translocation:

Release of animals in a new locality which come from anywhere else. Translocation is carried in following cases:

1. When a species on which an animal is dependent becomes rare.
2. When a species is endemic or restricted to a particular area.
3. Due to habitat destruction and unfavourable environmental conditions.
4. Increase in population in an area

viii. Zoological Gardens:

In zoos wild animals are maintained in captivity and conservation of wild animals (rare, endangered species). The oldest zoo, the Schonbrunn zoo which exists today also, was established in VIENNA in 1759.

In India, the 1st zoo came into existence at BARRACKPORE in 1800. In the world there are about 800 zoos. Such zoos have about 3000 species of vertebrates. Some zoos have undertaken captive breeding programmes.

Advantages of ex-situ preservation:

1. It is useful for the declining population of species.
2. Endangered animals on the verge of extinction are successfully bred.
3. Threatened species are bred in captivity and then released in the natural habitats.
4. Ex-situ centres offer the possibilities of observing wild animals, which is otherwise not possible.
5. It is extremely useful for conducting research and scientific work on different species.

Difference between "In-situ Conservation" and "Ex-situ Conservation"

Some of the major Differences between In-situ and ex-situ Conservation are as follows:

In situ Conservation:

1. It is conservation of endangered species in their natural habitats.
2. The endangered species are protected from predators.
3. The depleting resources are augmented.
4. The population recovers in the natural environment.

Ex situ Conservation:

1. It is conservation of endangered species outside their natural habitats.
2. The endangered species are protected from all adverse factors.
3. They are kept under human supervision and provided all the essentials.
4. Offspring produced in captive breeding are released in natural habitat for acclimatisation.

REASONS FOR CONSERVING BIODIVERSITY

Narrowly utilitarian reasons -Humans are reaping material from biodiversity. It may be deriving resources for basic needs such as food, clothes, shelter or industrial products like resins, tannins, perfume base etc. For aesthetic use as in ornaments or artefacts. Medicinal use of plants and animals is another major factor. It shares 25 % of the global medicine market. Around 25000 species are put to use by tribals worldwide as traditional medicines

Broadly utilitarian reasons -Natural giving us oxygen in free Animals play a crucial role in pollination and seed dispersal. Amazon forest is estimated to produce 20 % of the total oxygen of earth's atmosphere. We need to consider the recreational use of diversity to the devastating fires in the Amazon rainforest in August 2019. These are mainly caused in Brazil and are more manmade than natural. The slash and burn policy of locals to reclaim forestland has caused a towering 906000 hectares of forest devastation only in the year 2019.

Ethical reasons - We have no right to destroy diversity simply because we share the earth with them. All living beings have an equal right to survive irrespective of their known or prospective economic use.

TOPIC-2

INDIA AS A MEGA DIVERSITY NATION

Mega diversity refers to a country's ability to exhibit a high level of biodiversity. A biologically diverse nation has at least 5,000 plant species and must be bordered by marine ecosystems.

1. India is one of the world's megadiverse countries, with 45,000 plant species and twice as many animal species. India has only 2.4 per cent of the world's land area, but it has 8.1 per cent of the world's species diversity, making it one of the world's 12 mega diversity countries. India is exceptionally rich in biodiversity and is one of the twelve mega diversity centres of the world. With 10 biogeographic zones and 25 biotic provinces, all major ecosystems are represented.
2. Based on a survey of about two-third of the geographical area of the country, the Ministry of Forests and Environment (MOEF) reports that India has at present 89,451 species of fauna and 45,364 species of flora representing about 7.31% of the world fauna and 10.88% the world flora described so far.
3. Of the estimated 5-50 million species of the world's biota, only 1.7 million have been described to date, and the distribution is highly uneven. About seven per cent of the world's total land area is home to half of the world's species, with the tropics alone accounting for 5 million. India contributes significantly to this latitudinal biodiversity trend. With a mere 2.4% of the world's area, India accounts for 7.31% of the global faunal total with a faunal species count of 89,451 species.
4. India is a land mass of nearly 33 lakh sq.km with a coastline of 7,616 km and 14 different types of climatic forests and the total forest coverage in India is about 6,50,000 sq.km. India is the home land of 13,000 species of flowering plants, 20,000 species of fungi, 50,000 species of insects, 65,000 species of fauna including 2000 species of birds, 350 mammals and 420 of reptiles. The Zoological Survey of India which is headquartered in Kolkata is responsible for surveying the faunal resources of India.
5. India has 105 National parks that constitute about 1% of the landmass and 567 sanctuaries that constitute 3.5% of the area. India is a home of over 35,000 tigers and the umbrella of project tiger 23 specially demarcated project tiger reserves covering 33,000 sq.km representing different climatic forests are spread across the country.
6. India has a diverse climate, topology, and habitat are known to have the richest flora in the world with over 47000 species of flowering plants and 89000 Animal Species. These plant species constitute 6-7% of the world's plant species. There are 8 main floristic regions in India- the Western and the Eastern Himalayas, Indus and Ganges, Assam, the Deccan, Malabar, and the Andaman Islands which is home to 3000 Indian plant species. The forests in India cover ranges from the tropical rainforest including Andaman, Western Ghats, and northeast India to the coniferous forests of the Himalayas. The deciduous forests can be found in the eastern, central, and southern parts of India.

7. India is one of the 12 mega-diversity nations of the world and one of the 12 centres of origin of cultivated plants accounting for 7.31% of the global faunal and 10.88% of the global floral total species.
8. India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. India figured with two hotspots - the Western Ghats and the Eastern Himalayas - in an identification of 18 biodiversity hotspots carried out in the eighties. **Recently, Norman Myers and a team of scientists have brought out an updated list of 25 hotspots. In the revised classification, the 2 hotspots that extend into India are The Western Ghats/Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas); and they are included amongst the top eight most important hotspots.**
9. India has 26 recognised endemic centres that are home to nearly a third of all the flowering plants (angiosperms) identified and described to date. India has six Ramsar Wetlands. They are - Chilika Lake, Harike Lake, Loktak Lake, Keoladeo National Park, Wular Lake and Sambhar Lake.
10. India has 5 world heritage sites namely, **Kaziranga National Park, Keoladeo Ghana National Park, Manas Wildlife Sanctuary, Nanda Devi National Park and Sundarban National Park.** India has twelve biosphere reserves, namely Nilgiri, Nanda Devi, Nokrerik, Manas, Sunderbans, Gulf of Mannar, Great Nicobar, Similipal, Dibru-Saikhowa, Dehang Debang, Pachmarchi and Kanchenjunga.
11. India is 10th among the plant rich countries of the world, fourth among the Asian countries, eleventh according to the number of endemic species of higher vertebrates (amphibia, birds and mammals), and tenth in the world as far as richness in mammals is concerned. Out of the 10 'Hot spots' identified in the world, India has four. These are Eastern Himalaya, North East India, Western Ghats and Andaman & Nicobar Islands.
12. India has ten biogeographic regions including the Trans-Himalayan, the Himalayan, the Indian desert, the semi-arid zone(s), the Western Ghats, the Deccan Peninsula, the Gangetic Plain, North-East India, and the islands and coasts
13. India has 17 biosphere reserves, and 19 Ramsar wetlands. Amongst the protected areas, India has 105 national parks and 567 sanctuaries covering an area of 1.53 lakh sq. km. The wildlife sanctuaries in India are home to around two thousand different species of birds, 3500 species of mammals, nearly 30000 different kinds of insects and more than 15000 varieties of plants
14. Aside from the high biodiversity of Indian wild plants and animals, the country also has a wide range of cultivated crops and livestock breeds. India is a centre of crop diversity - the homeland of 167 cultivated species and 320 wild relatives of crop plants. The highest diversity of cultivars can be found in the Western Ghats, Eastern Ghats, Northern Himalayas, and North-Eastern hills, which receive a lot of rain. This is the result of the Indian subcontinent's civilizations evolving and flourishing over thousands of years. Further,

India is considered to be the centre of origin of 30,000 to 50,000 varieties of rice, pigeon-pea, mango, turmeric, ginger, sugarcane, gooseberries, etc. and ranks seventh in terms of contribution to world agriculture.

15. India also boasts of rich marine biodiversity, along the coastline of 7516.5 km with exclusive economic zone of 202 million sq.km, supporting the most productive ecosystems such as mangroves, lagoons and coral reefs. There are over 45 species of mangrove plants. Over 342 species of corals belonging to 76 genera have been reported and about 50% of the world's reef building corals are found in India.
16. Coral reefs in Indian waters surround the Andaman and Nicobar Islands, the Lakshadweep Islands, and the Gulf areas of Gujarat and Tamil Nadu. They are nearly as rich in species as tropical evergreen forests. India's record in agro-biodiversity is equally impressive. There are 167 crop species and wild relatives. India is considered to be the centre of origin of 30,000-50,000 varieties of rice, pigeon-pea, mango, turmeric, ginger, sugarcane, gooseberries etc and ranks seventh in terms of contribution to world agriculture.
17. There are 2200 species of flowering plants and 120 species of ferns in the Andaman and Nicobar Islands alone. 85 (63%) of the 135 land mammal genera are found in the Northeast. There are 1,500 endemic plant species in the Northeast States. The Western Ghats are home to a large number of amphibian and reptile species, particularly snakes, as well as over 1,500 endemic plant species.
18. The endemism of Indian biodiversity is high. About 33% of the country's recorded flora are endemic to the country and are concentrated mainly in the North-East, Western Ghats, North-West Himalaya and the Andaman and Nicobar islands. Of the 49,219 plant species, 5150 are endemic and distributed into 141 genera under 47 families corresponding to about 30% of the world's recorded flora, which means 30% of the world's recorded flora are endemic to India. Of these endemic species, 3,500 are found in the Himalayas and adjoining regions and 1600 in the Western Ghats alone.

HOTSPOTS OF BIODIVERSITY

A biodiversity hotspot is a biogeographic region that is both a significant reservoir of biodiversity and is threatened with destruction.

The term biodiversity hotspot specifically refers to 36 biologically rich areas around the world that have lost at least 70 percent of their original habitat.

Currently, 36 biodiversity hotspots have been identified, most of which occur in tropical forests. They represent just 2.3% of earth's land surface, but between them they contain around 50% of the world's endemic plant species and 42% of all terrestrial vertebrates. Overall, Hotspots have lost around 86% of their original habitat and additionally are considered to be significantly threatened by extinctions induced by climate change.

The British biologist **Norman Myers** coined the term "**biodiversity hotspot**" in 1988 as a biogeographic region characterised both by exceptional levels of plant endemism and by serious levels of habitat loss. In 1990, Myers proclaimed eight hotspots, including four Mediterranean-type ecosystems.

Biodiversity hot spots are a method to identify those regions of the world where attention is needed to address biodiversity loss and to guide investments in conservation. The CI adopted hotspots of Myers as its institutional blueprint in 1989, and in 1999, the organisation undertook an extensive global review, which introduced quantitative thresholds for the designation of biodiversity hotspots. A reworking of the hotspots analysis in 2004 resulted in the system in place today.

New hotspots: Only 25 hotspots were mentioned in the original proposal. Later on new biodiversity hotspots were periodically added based on scientific assessments of new regions. For example, the Forests of East Australia are the latest hotspot to have been added after research showed that the area fulfilled all criteria. Changing circumstances such as sustained habitat loss or the discovery of new species may mean that areas previously not considered as biodiversity hotspots could qualify in a future re-assessment.

Current biodiversity hotspots in the world

North and Central America

1. California Floristic Province
2. Madrean Pine-oak Woodlands
3. Mesoamerica

North American Coastal Plain

4. Atlantic Coastal Plain & Gulf Coastal Plain•36•

The Caribbean

5. Caribbean Islands

South America

6. Atlantic Forest
7. Cerrado
8. Chilean Winter Rainfall-Valdivian Forests
9. Tumbes-Chocó-Magdalena
10. Tropical Andes

Europe

11. Mediterranean Basin

Africa

12. Cape Floristic Region
13. Coastal Forests of Eastern Africa
14. Eastern Afromontane
15. Guinean Forests of West Africa
16. Horn of Africa
17. Madagascar & the Indian Ocean Islands
18. Maputaland-Pondoland-Albany
19. Succulent Karoo

Central Asia

20. Mountains of Central Asia

South Asia

21. Eastern Himalaya, Nepal, India
22. Indo-Burma(Eastern Himalayas)
23. Western Ghats Of India & Sri Lanka

South East Asia and Asia-Pacific

24. East Melanesian Islands
25. New Caledonia
26. New Zealand
27. Philippines
28. Polynesia-Micronesia
29. Eastern Australian temperate forests
30. Southwest Australia
31. Sundaland & Nicobar islands of India
32. Wallacea ·

East Asia

33. Japan
34. Mountains of Southwest China

West Asia

35. Caucasus
36. Irano-Anatolian

Characteristic features of hotspots

1. Hotspots are of global importance and are the hosts of priceless gifts of nature.
2. They are very rich in biodiversity, genetic diversity, species diversity (or a combination of all).

3. Being the habitats of endemic and endangered species. They are having a high level of endemism and are under threat of habitat destruction that again leads to extinction of species.

INDIA'S BIODIVERSITY HOTSPOT

The rich flora and wildlife of India are well-known. India is home to about 500 mammalian species, over 200 avian species, and over 30,000 insect species. The Zoological Survey of India, headquartered in Kolkata, is in charge of surveying India's faunal resources.

India has a diverse temperature, topography, and habitat, and is noted for having the world's richest flora, with over 18000 blooming plant species. These plant species account for about 7% of all plant species on the planet. The Western and Eastern Himalayas, Malabar, Assam, the Deccan, Indus and Ganges, and the Andaman Islands are the eight main floristic zones in India, which are home to 3000 Indian plant species.

Four regions in India are classified as mega diversity hotspots, as they constitute a majority of different species of plants, animals and aquatic species in the ecosystem. Here are the 4 regions of Diversity hotspots in India:

India is known for its rich biodiversity and has around 24.46% of the geographical area covered by forests and trees.

Coined by Norman Myers, the term "Biodiversity hotspots" can be defined as the regions which are known for their high species richness and endemism.

there are major four biodiversity hotspots in India:

1. **The Himalayas**
2. **Indo-Burma Region**
3. **The Western Ghats**
4. **Sundaland**

The Himalayas

Considered the highest in the world, the Himalayas (overall) comprises North-East India, Bhutan, Central and Eastern parts of Nepal.

The Himalayas are the world's highest mountain range, with nine of the ten highest peaks, including Mount Everest. These mountains, known as the Third Pole, are the source of some of Asia's major rivers and also aid in climate regulation.

The Himalayas (overall) include North-East India, Bhutan, and the central and eastern regions of Nepal, and are considered the world's highest mountains. There are 163 endangered species in this region, including the Wild Asian Buffalo and One-horned Rhino. There are over 10,000 plant species found here, 3160 of which are indigenous. This mountain range spans almost 750,000 square kilometres.

The Himalayas are confronted with numerous challenges, and governments are under pressure to provide for their people while also safeguarding their natural legacy. Forests are being stretched as demand for lumber and food crops continues to rise. International criminal networks are depleting forests of unique wildlife to serve the insatiable illegal market, and protected regions are becoming isolated pockets. Global climate change is melting the once-mighty Himalayas at a rate never before seen in human history, putting a key source of freshwater for billions of people in Asia at jeopardy.

Indo - Burma Region

The Indo-Burma Region is stretched over a distance of 2,373,000 km². In the last 12 years, 6 large mammal species have been discovered in this region: the Large-antlered Muntjac, the Annamite Muntjac, the Grey-shanked Douc, the Annamite Striped Rabbit, the Leaf Deer, and the Saola. This hotspot is also known for the endemic freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss. There are also 1,300 different bird species, including the threatened White-eared Night-heron, the Grey-crowned Crocias, and the Orange-necked Partridge.

The Western Ghats

The Western Ghats run along the western end of the Indian Region, encompassing the majority of India's deciduous and rain forests. It extends along a 17,000 km strip of forests in Maharashtra, Karnataka, Tamil Nadu and Kerala. It has 40% of the total endemic plant species 62% amphibians and 50% lizards are endemic to Western Ghats.

The hotspots are characterised by endemism. Interestingly, a few species are common to both the hotspots in India.

Some common plants include Ternstroemia japonica, Rhode drum and hyponym.

They are home to approximately 325 species of globally vulnerable flora, animals, birds, amphibians, reptiles, and fish, according to UNESCO.

In the lower parts, the climate is humid and tropical, tempered by the proximity to the sea. A more temperate climate can be found at elevations of 1,500 m (4,921 ft) and above in the north and 2,000 m (6,562 ft) and above in the south. The annual average temperature is roughly 15 degrees Celsius.

The natural vegetation is mostly dense tropical evergreen and semi-evergreen forest along the west coast, with shola grassland at higher elevations.

The flora in this region used to cover 190,000 km², but it has now been decreased to 43,000 km². 229 plant species, 31 animal species, 15 bird species, 43 species of amphibians, 5 reptile species, and various fish species are among the region's globally vulnerable flora and fauna. According to UNESCO, of the total 325 internationally critically endangered in the Ghats, 129 are classified as Endangered, 145 as Endangered, and 51 are listed as Critically Endangered.

Sundaland

The Sundaland hotspot lies in South-East Asia and covers Singapore, Thailand, Indonesia, Brunei, and Malaysia. In the year 2013, the Sundaland was declared as a World Biosphere Reserve by the United Nations. This region is famous for its rich terrestrial and marine ecosystem. Sundaland is one of the biologically richest hotspots in the world which comprises 25,000 species of vascular plants, of which 15,000 are found only in this region.

BIODIVERSITY ON A GLOBAL, NATIONAL AND LOCAL

Biodiversity at Global Level

Species are not uniformly distributed over the Earth; diversity varies greatly from place to place. In terms of the number of basic kinds of organisms and number of species of each kind, biodiversity has varied markedly through geological time; and, in terms of present day species richness, biodiversity varies greatly between one part of the earth and another.

The present global patterns in biodiversity indicate that the species richness tends to vary geographically according to a series of fairly well defined rules.

Following the 1992 "earth summit" at Rio de Janeiro (Brazil) , it became evident that there is a growing need to know about the huge number of species, which are still unknown on this earth.

1. **tropical rain forests** are the centres of the world much of the earth's contemporary flora and fauna originated in the humid tropics. For millions of years, tropical rain forests have been factories of evolutionary diversity from which plants and animals, capable of adapting to more difficult environments, have gone forth to populate the subtropical and temperate regions. It is essential to maintain areas of tropical rain forest large enough for this evolution to continue. The tropical forests are regarded as the richest in biodiversity. Species diversity in tropics is high. Example: **Tropical rain-forests are inhabited by millions of species of plants, birds, amphibians, insects and mammals. They are the earth's largest storehouse of biodiversity. About 50-80% of global biodiversity lies in these rain-forests. 3,000 plants, identified by national cancer research institute [NCRI], are marvellous sources of cancer fighting chemicals.**
2. Very recently extract from one of the creeping vines in the rain forests at Cameroon has proved effective in the inhibition of replication of 'AIDS' virus. Tropical forests have much less biodiversity, but there is much better documentation of the species at global level, representing about 170,000 of flowering plants, 30,000 of vertebrates and about 250,000 of other groups of species.
3. About 2.1 million species have been identified till date, while many more species are believed to exist. According to UNEP (1993-94) (UN convention on environment protection) estimate, the total number of species that might exist on Earth range between 9.0 - 52 million
4. Out of 2.1 million species which have been identified so far, there are about 120000 species of animals and 400000 plant species including microorganisms. There are about 34 hotspots of biodiversity at the global level.
5. Twelve megadiversity nations which are highly rich in biodiversity. These include Brazil, Columbia, Ecuador, China, Mexico, Australia, South Africa, Indonesia, Venezuela, Peru,

India and Malaysia. About 70 per cent biodiversity of the world is present in these megadiversity centres.

6. An estimated biodiversity covers 400,000 higher plants. Most of the world's bio-rich nations are in the South, which are the developing nations. In contrast, the majority of the countries capable of exploiting biodiversity are Northern nations, in the economically developed world.
7. The developing countries, located in subtropical/tropical belts are far richer in biodiversity than the industrial countries in the temperate region. The Vavilovian Centres of diversity of crops and domesticated animals are also located in the developing countries.
8. About 70% of all known species are invertebrates (animals without backbones such as insects, sponges, worms, etc.); while, about 15% are plants. Mammals, the animal group to which man belongs, comprise a comparatively small number of species. Of all the world's species, only 10 to 15% live in North America and Europe. By contrast, the centres of greatest biodiversity tend to be in the tropics.
9. **Tropical areas receive more solar energy over the year. Therefore, tropical communities are more productive resulting in a greater resource base that can support a wider range of species.** Over geological times, the tropics have had a more stable climate than the temperate areas.
In tropics, therefore, local species continued to thrive and live there itself; whereas, in temperate zones, they tend to disperse to other areas.
There has been more time for tropical communities to evolve as they are older than temperate ones. This could have allowed tropical communities greater degree of specialisation and local adaptation to occur. In tropics, higher rates of outcrossing among plants may lead to higher levels of genetic variability.
In tropics, the greater pressure from pests, parasites and diseases does not allow any single species to dominate. Thus, there is opportunity for many species to coexist. In temperate areas, on the other hand, there is reduced pressure from pests, parasites and diseases due to cold, and there is one or a few dominating species that exclude many other species.
10. In a much more simplified way, it can be said that there are much more species, both per unit area and overall, in the tropics than in temperate regions and for more in the latter (temperate regions) than in Polar Regions.
11. The moist tropical forests, in general, are the most species rich areas or environments on earth. Though they cover just about 7% of the world's surface; but it is estimated that they may hold more than 90% of the world's species, if the yet unknown tropical forest micro fauna (mainly insects) are accepted. If small tropical forest insects are discounted, then the areas that may be similarly rich in species are: **Coral reefs; and Areas of Mediterranean climate in South Africa and Western Australia.** These areas are rich in species, especially for flowering plants (angiosperms). The centres of greatest biodiversity tend to be in the tropics.
12. The reasons for greater biodiversity in the tropics are as under: Warm temperatures and high humidity of tropical areas provide favourable environmental conditions for many species that are unable to survive in the temperate areas

Biodiversity at National Level

1. According to the International Union for Conservation of Nature, "India accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals.
2. India is greatly rich in biodiversity.
3. A variety of climatic and altitudinal conditions present in India.
4. About 40 per cent of land is under cultivation in India.
5. There are 105 national parks, 567 wildlife sanctuaries, 17 biosphere reserves and 4 hot spots.
6. India's sovereignty over its biological diversity cannot be compromised without a revolutionary change in world thinking about sharing of all types of natural resources. Biodiversity of 89 countries with diversities higher than India are located in South America such as Brazil, and South East Asian countries such as Malaysia and Indonesia.
7. The species found in these countries, however, are different from our own. This makes it imperative to preserve our own biodiversity as a major economic resource. While few of the other 'mega-diversity nations' have developed the technology to exploit their species for biotechnology and genetic engineering, India is capable of doing so.
8. The crops which first grew in India and spread throughout the world include rice, sugarcane, Asiatic vinas, jute, mango, citrus, and banana, several species of millets, spices, medicinal, aromatics and ornamentals. India ranks sixth among the centres of diversity and origin in terms of agro-biodiversity.

Biodiversity at Local Level

1. It includes various species found in a small region.
2. It has three basic components like compositional aspects, structural aspects and functional aspects.
3. Compositional aspects include the genetic constitution of a population in a particular area.
4. Structural aspects govern the physical features and vegetation found in a habitat.
5. Functional aspects refer to hydrological, geographical, ecological, climatic and evolutionary aspects that help maintain biodiversity.
6. Biodiversity at regional level is better understood by categorising species richness into four types.
 - 1) Point richness:- It refers to the number of species that can be found at a single point in a given space.
 - 2) Alpha (α) richness:-It refers to the number of species found in a small homogeneous area. (α) richness is strongly correlated with physical environmental variables
 - 3) Beta (β) richness:-It refers to the change of rate of species in composition across different habitats.. β richness means that the cumulative number of species increases as more heterogeneous habitats are taken into consideration.
 - 4) Gamma (γ) richness:- It refers to the rate of change across large land scrape gradients.

For example:-the ant species found in the local species region of North Pole is merely 10. As we kept on moving towards the equator and adding more and more habituates. The number of species of ants reaches as high as 2000 on the equatorial region.

TOPIC-3

IUCN Red List

IUCN is an organisation working in the field of nature conservation and sustainable use of natural resources. It is located in Gland, Switzerland and is also known as the World Conservation Union.

IUCN was founded in October, 1948 as the International Union for the Protection of Nature (or IUPN) following an international conference in Fontainebleau, France. The organisation changed its name to the IUCN in 1956.

It is a membership union, composed of both government and civil society organisations. It is involved in data gathering and analysis, research projects and education on conservation, sustainable development and biodiversity. IUCN Red List: In 1964, IUCN established the IUCN Red List of Threatened Species, which put forth a comprehensive data source on the global extinction risk of species and their conservation status in the world.



The IUCN Red List of Threatened Species (also known as the IUCN Red List or Red Data List), founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species (Animal, fungus and plant species).

The International Union for the Conservation of Nature (IUCN) is the world's main authority on the conservation status of species.

- The IUCN Red List now includes 134,425 species of which 37,480 are threatened with extinction.

Founded in 1964, the IUCN Red List also known as the Red Data List evaluates the biological species in the world which are at the risk of extinction. IUCN aims to focus on the conservation of the world's species to reduce species extinction. More than 77,300 species have been assessed on the IUCN Red List. A series of Regional Red Lists are produced by countries or organisations, which assess the risk of extinction to species within a political management unit. The IUCN Red List is based upon precise criteria to evaluate the rate of extinction of thousands of species and subspecies. These criteria are relevant to all species and all regions of the world.

The IUCN Red List can be divided into the following 9 categories:

1. Extinct (EX) - No known individuals remaining.
2. Extinct in the wild (EW) - Known only to survive in captivity, or as a naturalised population outside its historic range.
3. Critically endangered (CR) - Extremely high risk of extinction in the wild.
4. Endangered (EN) - High risk of extinction in the wild.
5. Vulnerable (VU) - High risk of endangerment in the wild.
6. Near threatened (NT) - Likely to become endangered shortly.
7. Least concern (LC) - Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.
8. Data deficient (DD) - Not enough data to assess its risk of extinction.
9. Not evaluated (NE) - Has not yet been evaluated against the criteria

Objectives of IUCN

The International Union for Conservation of Nature works to achieve the following goals:

1. To provide scientific data on the status of species and subspecies at a global level.
2. To address the factors of concern and spread awareness regarding the species and biodiversity extinction.
3. To plan a layout for the conservation of biodiversity.

IUCN Red List Users

The IUCN Red List provides accurate data on the status of different species on the Earth. This information is used by various departments, institutes, and organisations.

The users of the IUCN Red List are given below:

- **Government agencies (National & International)**
- **Wildlife organisations and departments**
- **Conservation-related NGOs**
- **Natural resource planners**
- **Educational organisations**
- **Zoos and aquariums**
- **Media**
- **Business communities**

Purpose of the IUCN Red List Data

The information cited in the IUCN Red List is used by various organisations in the following ways:

- International Agreements such as CITES, Ramsar Convention use the Red List data to make important decisions in sync with the status of nature as and when required.
- The World Bank Group performance standard uses the IUCN Red List data to evaluate the risk of damage to biodiversity due to large-scale infrastructures and global projects.
- Zoos and National parks use this information to upgrade important policies like parks regulations from time to time

ENDANGERED AND ENDEMIC SPECIES

The growing human population and other influences combine to eliminate some wild animals and plants; hence, there is a rising concern for preserving wild species all over the world. Natural causes of wild species destruction include evolutionary replacement and mass extinction. The direct threats are over-harvesting of animals and plants for food or various industrial and commercial products. **India is known to be home for 6.5% of the world's species which includes 7.6% of all mammals and 12.6% of all bird species. But with the rapid loss of biodiversity, many species are becoming extinct or at risk of becoming critically endangered.** The species that are at risk of extinction due to the sudden decrease in their population and habitat are known as endangered species.

The World Conservation Union (IUCN) (formerly known as International Union for the Conservation of Nature and Natural Resources, IUCN) has recognized eight Red List categories according to the conservation status of species. It publishes the Red Data Book which includes a list of endangered species of plants and animals.

The RED-data book contains a list of endangered species of plants and animals. It contains a list of species that are endangered but might become extinct in the near future if not protected.

The 2000 Red List is the latest available. It uses a set of criteria, relevant to all species and all regions of the world, to evaluate the extinction risk of species. The 2000 Red List contains assessments of more than 18,000 species; 11,000 of which are threatened (5,485 animals and 5611 plants).

Out of these, 1,939 are listed as critically endangered (925 animals, and 1,014 plants). According to the Red List, in India, 44 plant species are critically endangered, 113 endangered and 87 vulnerable. Amongst animals, 18 are critically endangered, 54 endangered and 143 Vulnerable. A few examples of these plant and animals are given below :

Endangered or threatened species is one whose number has been reduced to a critical number. Unless it is protected and conserved, it is in immediate danger of extinction.

Vulnerable species is one whose population is facing continuous decline due to habitat destruction or over exploitation. However, it is still abundant.

Rare species are localised within a restricted area or are thinly scattered over an extensive area. Such species are not endangered or vulnerable.

Endangered Species of India

A plant, animal or microorganism that is in immediate risk of biological extinction is called **endangered species or threatened species**. In India, nearly 450 plant species have been identified in the category of endangered, threatened or rare. Existence of about 150 mammals and 150 species of birds is estimated to be Threatened while an unknown number of species of insects are endangered.

India's biodiversity is threatened primarily due to: Habitat destruction, Degradation and Over exploitation of resources.

Some of the rarest animals found in India are:

Asiatic cheetah

Asiatic Lion

Asiatic Wild Ass

Bengal Fox

Gaur

Indian Elephant

Indian Rhinoceros

Marbled Cat

Some of the top 5 endangered species in India are listed in the table below:

Endangered Animal Species	Endangered Plant Species
The Royal Bengal Tiger	Ebony tree
The Great Asiatic Lion	Indian Mallow
The Snow Leopard	Malabar Lily
The Pig Nosed Frog	Assam Catkin Yew
The Pink Headed Duck	Milkwort

Extinct species: A species is said to be extinct when it is not seen in the world for 50 years in the abstract.

Example: dodo, passenger pigeon

The **Zoological Survey of India (ZSI)** reported that cheetah, pink headed duck and mountain quail have already become extinct from India.

1. A species is said to be **endangered** when its number has been reduced to a critical level.
2. A species is said to be **vulnerable** if its population is facing continuous decline due to over exploitation (or) habitat destruction.
3. The species which are not endangered (or) vulnerable at present but are at risk are categorised as **rare species**.

The examples of direct threats to biological resources are habitat destruction, introduction of exotic species, diseases, environmental pollution and genetic assimilation (environmentally induced genetic and phenotypic changes in species). The international union for conservation of nature and natural resources (IUCN) publishes a periodical the "RED DATA BOOK" which includes the list of endangered species of plants and animals; some of the examples are given below:

Reptiles: garial, green seat rile, python

Birds: great Indian bustard peacock, great Indian hornbills

Carnivores: leopard, striped hyena, Indian lion, gold cat, desert cat, red panda

Plants: orchids, medicinal plants like Ravioli serpentina, sandalwood tree (*Santalum album*).

Endemic species of India

Endemic species are plants and animals that exist only in one geographic region. The species can be endemic to large or small areas of the earth; some are endemic to a particular continent, some to part of a continent, and others may be endemic to a single island. India has two biodiversity hotspots and thus possesses a large number of endemic species. **Out of about 47000 species of plants in our country, 7000 are endemic. Some of the important endemic floras include orchids and species like Sepia himalayan, Ovarian lardier, Nepenthes khans land, etc.**

A large number, out of the total 81000 species of animals in our country, is endemic to Western Ghats; they are particularly rich in amphibians and reptiles. Different species of monitor lizards, relictured pythons and Indian surrender are some important endemic species of our country.

Endemic species of India

Endemic Plant species

Sapria Himalayana

Ovaria Lurida

Nepenthes khasiana etc

Endemic animals in the western ghats

Lion tailed macaque

Nilgiri langur

Brown palm civet and

Nilgiri tahr

Endangered species in the world

West Virginia Spring Salamander (U.S.A)

Giant Panda (China)

Golden Lion Tamarin (Brazil)

Siberian Tiger (Siberia)

Mountain Gorilla (Africa)

Pine Barrens Tree Frog (Male)

Arabian Oryx (Middle East)

African Elephant (Africa)

West Virginia Spring Salamander (U.S.A)

Giant Panda (China)

Golden Lion Tamarin (Brazil)

Siberian Tiger (Siberia)

Mountain Gorilla (Africa)

Pine Barrens Tree Frog (Male)

Arabian Oryx (Middle East)

African Elephant (Africa)

Other important endangered species are:

Tortoise, Green sea Turtle , Gharial, Python (Reptiles)

Peacock, Siberian White Crane, Pelican, Indian Bustard (Birds)

Hoolock gibbon, Lion-tailed Macaque, Capped monkey, Golden monkey (Primates)

Rauvolfia serpentina (medicinal plant), Sandalwood tree, etc

BIOGEOGRAPHIC CLASSIFICATION OF INDIA

Biogeography is the study of geographical distributions of organisms, their habitats and the environmental factors that produce them. Biogeographic classification of India was done by **Rodgers and Panwar (1988)**. Within India the classification recognizes 10 zones, divided into 26 provinces. The classification was done using various factors such as altitude, moisture, topography, rainfall, etc. **Biogeographic zones** are large distinctive units of similar ecology, biome representation, community and species e.g. The Himalaya, The Western Ghats, whereas the biotic province is the secondary units within a zone, giving weight to particular communities separated by dispersal barriers or gradual change in environmental factors e.g. North West and West Himalaya on either side of the Sutlej River. Biogeographic zones of India are:

1. **Trans-Himalaya:** This region covers around a km² of area within and outside of India. It is a vast stretch of cold, mountainous snow - covered region covering the entire Tibetan plateau, Ladakh and Lahaul - Spiti district of Himachal Pradesh (India).

Vegetation is sparse in this area. The mountains here have the richest habitat of wild sheep and goats. The region has a herbivore community (rabbits) consisting of Tibetan antelope, gazelle, wild yak and blue sheep. Other characteristic animals found are snow leopard, Tibetan wolf, ibex, marbled polecat, Himalayan marmot etc.

2. Himalaya:

This region extends from Jammu and Kashmir covering Himachal Pradesh, Sikkim, WB, Arunachal Pradesh, Mizoram and Assam to Manipur. They represent the world's youngest and highest mountain chains. The western Himalayas stretch from the central region of Kumaon to the North West region of Kashmir. On the other hand, the Eastern Himalayas extend from Sikkim to NEFA. Rainfall is higher and conditions are warmer in the eastern part of Himalayas. Species diversity is also higher in the eastern part. Thus, there is a lot of variation in geology and climatic conditions in this zone.

Flora present in this region consists of Coniferous - pine forests, birch forests, oaks, magnolias, rhododendrons, chestnut, fir, junipers etc. Alpine pastures are predominant in the western Himalayas.

Fauna present in this region include Red panda, ibex, Hangul stag, snow leopard, serow, Goral, Himalayan Tapir, badgers, tapir, shrew etc. A large and rich diversity of animals are found in the Himalayas However, they are endangered as a result of habitat destruction.

3. Indian Desert: This region consists of parts of Rajasthan, Kutch, Delhi and parts of Gujrat. The Climate is characterised by extremely hot and dry summers and cold winters. Rainfall is less than 70 cm. Kutch, Thar, Ladakh and parts of Delhi comprises the desert.

Xerophytic plants are found in this region such as *Acacia nelotica*, *Tecomella* spp. *Salvadora oleoides*, *prosopis cineraria*, Babul, Kikar and wild palms.

Fauna present are Great Indian Bust and (endangered) blackbuck, camels, desert fones, Chinkara, nilgai, Indian desert Cat, Lizards etc. Flamingoes are extensively found in Rann of Kutch.

4. Semi-arid: This zone comprises the states of Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujrat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. Floral components include grasses, shrubs, thorny shrubs and bamboo trees. Trees include *Tectonia grandis*, *Acacia*, *Anogeisus*, *Capparis*, and *Caltrops* etc.

Herbivores like blackbuck, nilgai gazelle etc. are present. Other animals include jackals, leopards, fones, snakes, lions etc. The Asiatic lion is the endemic species found in the air national reserve.

5. Western Ghats

Western Ghats, also called Sahyadri, north-south-running range of mountains or hills in western India that forms the crest of the western edge of the Deccan plateau parallel to the Malabar Coast of the Arabian Sea. The Western Ghats are a biodiversity hot spot, a

biologically rich but threatened region, and a UNESCO World Heritage site. They play a huge role in India's monsoon weather pattern. The eastern edge of the Deccan plateau is formed by another of the Ghats, the Eastern Ghats.

Biotic Province : Malabar plain (5a) and Western Ghats mountains (5b).

Biome : Evergreen, moist deciduous, wetlands, Montane forests, grasslands.

Wildlife : Lion-tailed macaque, Malabar civet, Hornbill, Draco.

6. Deccan Peninsula: The Deccan plateau covers the largest area in the country among all biogeographic zones. It comprises Deccan plateau (south), Central plateau, East plateau, Chota Nagpur and Central Highland. It consists of dry deciduous forests and produces many forest products. Evergreen forests are very rare in this area. Trees like Sal, teak, and Acacia are mainly found here.

Fauna present here consists of Tigers, sloth bear, nilgai, sambar, chital, elephant, wild buffaloes, barasingha and gaur. It is the catchment area for rivers like Narmada, Tapti, Mahanadi and Godavari.

7. Gangetic Plains: The Gangetic Plains are the most fertile region and comprises the regions of Uttar Pradesh, Bihar and Bengal. The plains are fertile due to alluvium sediments deposited across the region by rivers. The region has a high population density and agriculture is an important occupation. Ganga is the main river system here along with Brahmaputra. Rainfall varies across the region.

Important trees found in this region include sal, mahua, arjun, teak, shishan, neem, khair, tendu etc. Animals found are elephant, black buck, buffalo, gazelle, chinkara, freshwater turtle, Bengal florican etc.

8. Coasts: India has a vast and elaborate coastline of approximately 7,500 km along the Arabian Sea in the west and the Bay of Bengal in the east.

The western coast is much narrower than the East coast. They have an average width of about 65 km. It extends from the Gulf of Cambay in the north to Cape Comorin (Kanyakumari). It is characterised by the presence of estuaries, lagoons and backwaters. The largest lake present is Vembanad lake. The eastern coastal plains extend from Subarnarekha river to Kanyakumari. It is formed by alluvial fillings of rivers like Mahanadi, Godavari, Krishna and Kaveri. They are wider and extensive than the western coasts with an average width of 120 km. The Coastal plains are covered by fertile soils on which a variety of crops are cultivated. Rice is the main crop of these areas. Coconut trees grow along the coast.

This region has a high tiger population along with the presence of animals like Dugong, dolphins, salt-water crocodile, marine turtles, tortoises, hump - back dolphins etc.

9. North-East India:

This is one of the hotspots of India and is richest in terms of vegetation and species. It is distributed in the states of Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura. The region is actually a transition zone between the Indian, Indo - Burma and Indo - Chinese region. Rainfall is high and the presence of evergreen and semi - evergreen forests are abundant. Animals found here are rhinoceros, buffalo, elephant, swamp deer, pygmy hog, elephants, hornbill and many more. Floral species include orchids, bamboo, ferns, bananas, diverse fruits etc.

10. Islands: This zone comprises the islands of Lakshadweep and Andaman and Nicobar. The Andaman and Nicobar Islands are situated in the Bay of Bengal. It is one of the hotspots of India. They have a wide variety of mangroves, evergreen, and deciduous forests. Species richness is the characteristic of the island with distinct faunal species. Animals residing in this region include Andaman water monitor, Nicobar macaque, Narcondam hornbill, Nicobar parakeet etc. Lakshadweep Islands are located in the Arabian Sea and exhibit evergreen forests. They form a distinct botanical region and contain many coral reefs. Faunal species include sea turtles, pygmy blue, orca, crabs, lobsters and pelagic birds.

BIODIVERSITY LOSS

- Recent changes in climate have already had significant impacts on biodiversity and ecosystems in certain regions. As climate change will become more severe, the harmful impacts on ecosystem services are expected to outweigh possible benefits, such as a longer growing season, in most regions of the world.
- The current loss of biodiversity and the related changes in the environment are now faster than ever before in human history and there is no sign of this process slowing down. Many animal and plant populations have declined in numbers, geographical spread, or both. Species extinction is a natural part of Earth's history. Human activity has increased the extinction rate by at least 100 times compared to the natural rate. Comparing different types of measurements of biodiversity loss is not simple.
- Climate change is expected to exacerbate risks of extinctions, floods, droughts, population declines, and disease outbreaks. Many drivers affecting biodiversity are stronger today than they were in the past and are also occurring together. Because exposure to one threat often makes a species more susceptible to another, multiple threats may have unexpectedly dramatic impacts on biodiversity. Drivers of extinction range from local to global in scope and from immediate to long-term in their effects. For example, the extinction of species due to habitat loss can be rapid for some species, while it may take hundreds of years for others.
- Biodiversity is crucial to the maintenance of many ecosystem services such as regulation of chemical composition of the atmosphere, food production, supply of raw materials, water provision, nutrients' recycling, biological control of populations

of flora and fauna, use of genetic resources, leisure activities and others.

Biodiversity continues to decrease at unprecedented rates as human development and expansion result in the fragmentation and loss of habitat for flora and fauna.

- The loss of biodiversity is expected in most scenario studies to continue at an increasing pace in the coming decades - with projections estimating a decrease from about 70% in 2000 to about 63% by 2050 - as key underlying causes such as economic and market failures are unlikely to be eliminated in the short run.
- The loss of Biodiversity can be defined as the loss of a particular species, genes, or ecosystem because of natural or manufacturing activities. **The loss of Biodiversity is documented in the IUCN Red Data book.** It has recorded 784 extinct species (87 plants, 359 invertebrates, and 338 vertebrates). It has reported the loss of 30 biodiversities (approx) in the last 20 years. As per the Living Planet report:
 - **The present species extinction rate is up to 100 to 1000 species extinction per 10,000 species in 100 years. This is almost 1000 times more than the natural rate of extinction.**
 - **The living planet index, which measures the biodiversity abundance levels, shows a persistent downward trend. The monitored species population has declined by 58% since 1970.**
 - **There has been a 40% decline in species in tropical forests since 1970. In temperate grasslands, the species population has declined by 18%, and in freshwater habitats, the species population has declined by 81% since 1970.**

IUCN Red List (2004) documents the extinction of 784 species in the last 500 year that includes 359 invertebrates, 338 vertebrates and 87 plants.

Some of the animals that have become extinct in recent times are given below:

- **Steller's sea cow (Russia)**
- **Dodo (Mauritius)**
- **Thylacine (Australia)**
- **Quagga (Africa)**

27 species have become extinct in the last twenty years alone. Amphibians are more vulnerable to extinction. At present the percentage of threat of extinction among organisms is given below:

- **31% of gymnosperms**
- **32% of amphibians**
- **12% of bird species**
- **23% of mammals**

There have been five episodes of mass extinction since the origin of life, but current rate of extinction is 100-1000 times faster due to human activities. Loss of biodiversity in a region can lead to the following:

- **Decrease in plant production.**
- **Lowered resistance to environmental perturbation.**
- **Increased variability in ecosystem processes like water use, pest or disease cycles, plant productivity, etc.**

A number of frameworks for assessing the complex interplay of pressures and drivers affecting biodiversity have been developed in the past. The common thread amongst these frameworks is that most of the pressure on biodiversity stems from human-induced disturbance to ecosystems via a number of complicated pathways across different physical and temporal scales. Specific mechanisms whereby biodiversity is lost differ according to biome, geography, climate, type of pressure (i.e. over-exploitation of wildlife as opposed to habitat conversion), economic context in the biodiversity host country, trade patterns, type of governance structure, and other factors.

Some important points on biodiversity loss

- The most serious threat to biodiversity worldwide is the current destruction of large areas of wilderness habitats, particularly in the super diverse tropical forests and coral reefs. Mangroves have been cleared for fuelwood and prawn farming, resulting in a reduction in the habitat required for marine fish breeding.
- Scientists estimate that by 2050, human activities will have wiped out approximately 10 million species. Approximately 1.8 million species of plants and animals, both large and small, are currently known to science. However, the number of species is likely to be multiplied by at least ten. Plants and insects, as well as other forms of life previously unknown to science, are constantly being discovered in the world's diverse "hotspots."
- Unfortunately, at the current rate of extinction, about 25% of the world's species will perish relatively quickly. This could happen at a rate of tens of thousands of species per year, a thousand to ten thousand times faster than the natural rate. Within the next twenty or thirty years, human actions could obliterate 25% of the world's species. Human population growth, industrialization, and changes in land-use patterns are all contributing to this mass extinction.
- Tropical forests, wetlands, and coral reefs will account for a significant portion of these extinctions.
- Rapid global biodiversity destruction is exacerbated by the loss of wild habitats as a result of rapid human population growth and short-term economic development.

- Human activity has so far had the greatest impact on island flora and fauna with high endemism in small isolated areas surrounded by sea, which has already resulted in the extinction of many island plants and animals (the dodo is a famous example).
- Man's introduction of species from one area to another disrupts the balance of existing communities, resulting in habitat loss. Many local species have been wiped out as a result of the intentionally or accidentally introduced organisms (Eupatorium, Lantana, Hyacinth, Congress grass, or Ruthenium).
- Species extinction occurs as a result of the destruction of natural ecosystems, whether as a result of conversion to agriculture or industry, over-exploitation of resources, or pollution of the air, water, and soil. Forests and grasslands in India are constantly being converted to agricultural land.
- Encroachments have been legalised on a number of occasions.
- Natural wetland systems have also been drained to make way for croplands, resulting in the extinction of aquatic species.

Virtually all of Earth's ecosystems have been dramatically transformed through human actions and ecosystems continue to be converted for agricultural and other uses. The rate of change in one aspect of biodiversity, such as loss of species richness, does not necessarily reflect the change in another, such as habitat loss. Moreover, some aspects of biodiversity loss are not easily measured, for instance the fact that the same species are increasingly found at different locations on the planet and that overall biodiversity is decreasing.

THREATS TO BIODIVERSITY

Biodiversity is declining rapidly due to factors such as land use change, climate change, invasive species, overexploitation, and pollution. Such natural or human-induced factors - referred to as drivers - tend to interact and amplify each other.

While changes in biodiversity are more clearly linked to direct drivers such as habitat loss, they are also linked to indirect drivers that are at the root of many changes in ecosystems. The main indirect drivers are changes in human population, economic activity, and technology, as well as socio-political and cultural factors.

Different direct drivers have been critically important in different ecosystems over the past 50 years. For example, in terrestrial ecosystems, the main driver has been land cover change such as the conversion of forest to agriculture.

In marine systems, however, fishing, and particularly overfishing, have been the main drivers of biodiversity loss. Overall, the main factors directly driving biodiversity loss are: habitat change, such as fragmentation of forests; invasive alien species that establish and spread outside their normal distribution; overexploitation of natural resources; and pollution, particularly by excessive fertiliser use leading to excessive levels of nutrients in soil and water.

Major Factors posing threat to biodiversity are:

1. **Habitat (natural home) destruction and fragmentation** may result from clearing and burning forests, draining and filling of wetlands, converting natural areas for agricultural or industrial uses, human settlements, mines, building of roads and other developmental projects. This way the natural habitat of organisms are changed or destroyed. These changes either kill or force out many species from the area causing disruption of interactions among the species. Fragmentation of large forest tracts (eg. the corridors) affects the species occupying the deeper part of the forest and are first to disappear. Apart from the direct loss of species during the development activities, the new environment is unsuitable for the species to survive.

- Habitat degradation is an important cause of known extinction. As deforestation precedes in tropical forests this becomes the cause of mass extinctions caused by human activity.
- Billions of hectares of forests and grasslands have been cleared for conversion into agricultural lands, or into settlement areas or for development projects.
- The unique rich biodiversity of the wetlands, estuaries and mangroves are under the most serious threat today. Grasslands that were once sustainably used by a smaller number of people and their cattle are now either converted to other uses or degraded due to overgrazing.
- Sometimes the loss of habitat proceeds in instalments so that the habitat is divided into small and scattered patches, a phenomenon known as habitat fragmentation.
- There are many wildlife species such as bears and large cats that require large territories to manage to survive. They get badly threatened; so, they breed in the interiors of the forests. Due to habitat fragmentation, many songbirds are vanishing.
- The wetlands have been destroyed due to draining, filling and pollution, resulting in a huge biodiversity loss.
- Marine biodiversity is also under serious threat due to large scale destruction of the fragile breeding and feeding grounds of our oceanic fish and other species.

2. **Over exploitation** reduces the size of the population of a species and may push it towards extinction. The term overexploitation refers to the human activities connected with excessive capturing and harvesting (hunting, fishing, farming) of organisms. According to IUCN, it is an exploitation of (removal of individuals or biomass from) a natural population at a rate greater than the population is able to match with its own recruitment, thus tending to drive the population towards extinction. The decline of the Earth's largest terrestrial The African elephant is a classic example of the impact of overhunting. Largely Because of the trade in ivory, elephant populations have been declining in most of Africa.

2. **Introduction of exotic species:** Seeds catch on people's clothes. Mice, rats and birds hitch-hike on ships. When such species land in new places, they breed extra fast due to absence of any enemy

and often wipe out the native species already present there. Exotic species (new species entering geographical regions) may wipe out the native ones.

A few examples are-

- (i) **Parthenium hysterophorus** (Congress grass- a tropical American weed) has invaded many of the vacant areas in cities, towns and villages in India leading to removal of the local plants and the dependent animals.
- (ii) **Nile perch**, an exotic predatory fish introduced into Lake Victoria (South Africa) , threatened the entire ecosystem of the lake by eliminating several native species of the small Cichlid fish that were endemic to this freshwater aquatic system.
- (iii) **Water hyacinth** clogs lakes and riversides and threatens the survival of many aquatic species. This is common in Indian plains.
- (iv) **Lantana camara** (an American weed) has invaded many forest lands in various parts of India and wiped out the native grass species.

3. Pollution: Air pollution, acid rain destroy forests. Water pollution kills fishes and other aquatic plants and animals. Toxic and hazardous substances drained into waterways kill aquatic life. Oil spills kill coastal birds, plants and other marine animals. Plastic trash entangles wildlife. It is easy to see how pollution is a big threat to biodiversity.

4. Population growth and poverty: Over six billion people live on the earth. Each year, 90 million more people are added. All these people use natural resources for food, water, medicine, clothes, shelter and fuel. Need of the poor and often greed of the rich generate continuous pressure resulting in over-exploitation and loss of biodiversity

5. Alien species invasions: When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species. E.g. environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia). The recent illegal introduction of the African catfish *Clarias gariepinus* for aquaculture purposes are posing a threat to the indigenous catfishes in our rivers.

6. Climate Change: A changing global climate threatens species and ecosystems. The distribution of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes).

Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust. The pace of climate change almost certainly will be more rapid than most plants are able to migrate. For these reasons, some species and ecosystems are likely to be eliminated by climate change. Agricultural production likely will show regional variation in gains and losses, depending upon crop and climate.

7. Co-extinctions: When a particular species becomes extinct, the plants and animals associated with it in an obligatory way also comes the danger of becoming extinct. For example, When a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate.

8.Natural causes: Floods, earthquakes, and other natural disasters also cause biodiversity loss.

9,Poaching: Hunting is a passion for some people and for others it is needed for getting food. Poaching is another threat to wildlife. Catching animals without their knowledge is called "poaching"; so, human beings, at places, act as hunters and poachers. These two activities also result in the destruction of habitat and animals, due to which the species may disappear from their own areas. Smuggling of wildlife items like furs, hides, horns, etc of animals and herbal products, worth millions of dollars per year, is also a great threat to species survival. The developing nations in Asia, Latin America and Africa are the richest sources of biodiversity and have enormous wealth of wildlife.

The trading of such wild life products is highly profit-making for the poachers, who hunt the wildlife species and smuggle them to other countries. National parks and sanctuaries have been developed to protect animals and birds from such dangers of hunters and poachers.

Tiger Conservation in India

Since a large number of the tiger population in India is entering into the list of endangered species, the conservation of tigers has become a crucial point in India. One of the initiatives taken by the Government of India for the protection of the tigers is the '**Project Tiger**'. This project was launched in April 1973 and was administered by the National Tiger Conservation Authority.

Project Tiger aims at protecting the tiger population in India, preventing them from the risk of extinction and preserving areas of biological importance as a natural heritage.

The list of major threats to Tiger Population are:

Man- animal conflict

Hunting, poaching and illegal trade

Habitat and loss of prey species

It is due to this initiative that India's tiger population has risen to 2,967 in 2018 within a span of 12 years. As per the latest data, the largest survey conducted by the government to map the Tiger Population in India till date was over 381,400 km of forested habitats across 20 states.