UNIT 4
Biodiversity and its conservation

What is biodiversity? What are its various levels/kinds ?

Answer: Biodiversity is a contraction of “biological diversity”. As per IUCN (International Union for Conservation of Nature) Biodiversity/ biological diversity is a term used to describe the variety of life on Earth. It refers to the wide variety of ecosystems and living organisms: animals, plants, their habitats and their genes. ***OR*** It can be defined as the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

Biodiversity is studied on three levels: Genetic diversity, Species diversity and Ecosystem diversity.

What are the three classes of biodiversity according to Whittaker?

OR

What do you mean by Alpha (species), Beta (habitat) and Gamma (landscape) diversity?

Answer: Whittaker (1972) stated three levels of diversity:

(a) Alpha (α) diversity: It refers to the diversity within a habitat or a community.

(b) Beta (β) diversity: It refers to the intercommunity diversity or inter-habitat diversity. OR the change in the species composition along with the environmental gradient.

(c) Gamma (γ) diversity: It comprises of the diversity of the total landscape in large geographical area.

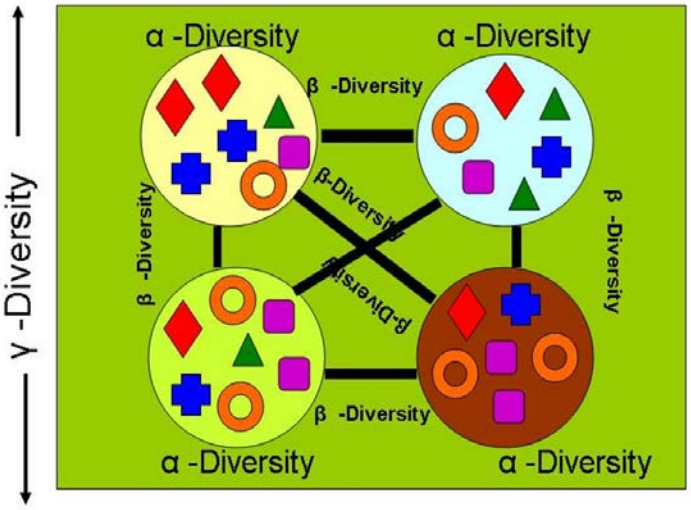


Fig: 4.1 Different classes of Biodiversity

What do you understand by Genetic diversity, species diversity and ecosystem diversity?

Answer: Biodiversity is studied on three levels:

(a) Genetic diversity
(b) Species diversity and
(c) Ecosystem diversity

Genetic diversity is the diversity of genes within and among species. Genes define the qualities and actions shared by a species and also explain the differences found among the individuals within the species. For example: The different varieties of mangoes we relish, variety of roses we appreciate in a rose garden, the red and yellow capsicum we buy in the market, and the diverse hair textures and eye colors we see among our friends. These diverse characteristics stem from the differing genetic make-up found within individual organisms.

The total variety of genes found within a species or a population of that species is referred to as its gene pool. Genetic diversity can also be used to assess the consequences of wildlife introductions, transplantations, stockings, and harvests.

Species diversity is the variety and number of different species which inhabit a particular area. For example: the diversity of species will higher in a tropical rain forest in comparison to a desert. The diversity of plants we have in a terrestrial ecosystem or a mountain ecosystem. It is also called as taxonomic diversity so, some areas may be rich in closely related taxa, having evolved from a common ancestor that was also found in that same area, whereas other areas may have an array of less closely related species descended from different ancestors

Species richness and species evenness are probably the most frequently used measures of the total biodiversity of a region. A greater species richness and diversity may cause ecosystems to function more efficiently and productively by making more resources available for other species within the ecosystem

Ecosystem diversity is the diversity of ecosystem. Ecosystems are the blend of communities of living things with the physical environment in which they survive. For example there are many diverse kinds of ecosystems, from deserts to mountain slopes, the ocean floor to the Antarctic, with coral reefs and rainforests being amid the richest of these systems.

Each ecosystem provides many different types of habitats or living places. The living things and the inorganic environment (earth forms, soil, rocks and water) interact constantly and in complex ways that change over time, with no two ecosystems being the same.

Fig. 4.2: Genetic diversity in Roses

Fig. 4.3: Species diversity in Flowering plants

Fig. 4.4: Ecosystem diversity

What is the importance of biodiversity?

Answer: It is important to preserve genetic diversity because all species depend on other species to survive and if one species is lost it could negatively impact other species. In broader sense importance of biodiversity can be grouped in following services:

(a) **Environmental services**

- Water purification: Forests provide wildlife with habitat, help maintain stable water levels, control salinity, and act as filters against contaminants to improve water quality.
- Pollution breakdown and absorption: Plants and trees are a source of oxygen, and also absorb carbon dioxide and some pollutants.
- Soils formation and protection: Trees and other vegetation helps in the formation and maintenance of soil structure and the retention of moisture and nutrient levels. They reduce soil erosion and provide wildlife habitat at the same time.
- Waste management: Soils rich in organisms, such as fungi, bacteria and arthropods, are healthier because these organisms break down organic matter and minerals into parts that can be utilized by other organisms, such as food for plants.
- Climate stability: Vegetation influences climate at the macro and micro levels. Forest helps to maintain the rainfall in its immediate vicinity by recycling water vapour at a steady rate back into the atmosphere and through the canopy's effect in promoting atmospheric turbulence. At smaller scales, vegetation has a moderating influence on local climates

(b) **Economic services**

- Free pollination—many insects and birds provide the valuable service of pollinating crop plants for free.
- Pest control—natural predators can act as controls for agricultural pests.
- Erosion control—soil erosion can be reduced by planting vegetation.
- Water purification—keeping water sources free from livestock reduces contamination of the water and helps improve herd heath.
- Stress resistance—healthy ecosystems have a greater resistance to stressors such as drought, diseases, overgrazing and fire.
- Genetic resources—wild plant and animal species are a source of genetic resources that may possess desirable traits for breeding programs.

(c) **Social services**

- Outdoor recreation—hiking, camping, bird watching, canoeing, and other outdoor activities provide enjoyment for many people.
- Revenue from tourism—tourists who want to experience nature contribute revenue to the economy, which means jobs for many Canadians.
- Cultural benefit: The cultural value of biological diversity conservation for present and future generations is an important reason for conserving it today. Human cultures co-evolve with their environment, and the conservation of biological diversity can be important for cultural identity throughout Earth.
- Other benefits—biodiversity provides fulfillment to people simply because of its beauty as well as for spiritual reasons.

What are the direct and indirect values of biodiversity?

OR

What are the instrumental values of Biodiversity?

OR

What do you mean by consumptive value, productive value, social value, ethical value, aesthetic value and optional value of biodiversity?

Answer*:* ***Direct* value*:*** refers to products or commodities which are consumed directly such as food or timber.

Indirect value: refers to the services that support the products that are consumed, this includes ecosystems services like climate control, pollution attenuation, water purification, flood control, nutrient cycling and soil formation.

The value of biodiversity can studied under the following titles:

(a) Consumptive:

These are the values of biodiversity where its products can be harvested and consumed directly. Example: Food, fuel and drugs. These goods are consumed in the surrounding areas.

(a) Food:

(i) Plants: The most essential value of biological resources particularly plants are providing is food for humans and fodder for animals. Chiefly three crops i.e. wheat, maize and rice compose more than two–third of the food requirement all over the world.

(ii) Fish: Fish and fish products have been the largest source of protein in the world since ages.

(b) Fuel:

Forests provide wood which is used as a fuel. Additionally fossil fuels like coal, petroleum, natural gas are also product of biodiversity which are consumed directly by humans.

(c) Drugs and medicines:

The traditional system of medicine like ayurveda Unani and Siddha utilizes plants or their extracts directly. In Homeopathy, the many drugs are derived from plants. E. g. Quinine (anti malaria drug) is obtained from cinchona tree; Penicillin (antibiotic) is derived from *Pencillium*, a fungus. Vinblastin and vincristine (anti cancer drugs) have been obtained from catharanthus plant which has anti cancer alkaloids.

(b) Productive:

These are the direct use values where the products from biodiversity are commercially sold in market. Many industries are dependent upon these products. Example- Paper, pulp, silk, textile and leather industry etc.

(c) Social:

Many plants and animals are considered holy and sacred in India and are worshipped like Tulsi, peepal, cow, snake etc. In Indian society great cultural value is given to

forest and as such tiger, peacock and lotus are named as the national animal, bird and flower respectively.

(d) Ethical:
Apart from the economic importance of conserving biodiversity, there are several other values which have their foundations in religions, philosophies, and cultures which are associated with the sanctity of all forms of life. Thus, provide justification for preserving life-forms which have no direct importance to humans. These reasons are: “Each species have right to exist; all species are interdependent and Humans must live within the same ecological limitations as other species do.”

(e) Aesthetic:
The aesthetic beauty of nature is something that enchants people. Environment gives an immense sense of satisfaction when we experience nature. Natural landscapes at serene places provide opportunities for recreational activities like bird watching, nature photography etc. It also promotes eco-tourism which further generates revenue. By scheming zoological, botanical gardens, national parks, wild life conservation etc Government supports conservation of biodiversity as well as offer places for eco-tourism. There are also cultural or spiritual meanings attached to the landscape, whereas for others it is simply the aesthetic value of the natural environment which they benefit from so much.

(f) Optional:
UNEP defined optional value as “Potential value of the resource for future (direct and indirect) use”. The wild relatives of cultivated plants that are yet to be explored are cited as examples of optional value of biodiversity. Thus, these values include the unexplored or unknown potentials of biodiversity. This relates mainly to the prospect of new findings of plant and animal functions or species that could indicate novel drugs and treatments. This ‘bioprospecting’ can have importance to pharmaceutical industry but depends upon the natural environments around the world to maintain biological resources and permit their discovery.

What are sacred groves? Give their Biological and Ecological importance?

OR

Why sacred groves are considered important from the point of view conservation of biodiversity?

Answer: A sacred grove is natural sacred sites with a presiding deity or God that is maintained through traditional methods of community based conservation. Such sites cover a wide variety of habitats and are often located in biodiversity rich regions.They were maintained by local communities with hunting and logging strictly prohibited within these patches.

Sacred groves considered important from the point of view conservation of biodiversity due to following reasons:

Biological Importance:

- Great heritage of diverse gene pool of many forest species
- Habitat of rare, endemic and endangered species of flora and fauna.
- Help in conservation of rare and endemic species
- Act as a nursery and storehouse of many of the ayurvedic, tribal and folk medicines.

Ecological Importance:

- Help in aquifer recharging
- Conservation of soil and nutrient cycling
- Conservation of biodiversity

Justify the statement "India is a Mega Diversity Nation"

OR

Why India is known as a Mega Diversity nation?

OR

Give an account of India's biodiversity demonstrating the fact that India is a Mega Diversity Nation.

Answer: India ranks sixth among twelve Mega biodiversity countries in the world. The varied edaphic, climatic and topographic conditions and years of geological stability have resulted in a wide range of ecosystems and habitats such as forests, grasslands, wetlands, deserts, and coastal and marine ecosystem. The unique Biogeographic position of the Indian subcontinent is responsible for the greater diversity in India's wildlife. Although it's total land area is only 2.4 percent of the total geographical area of the world, the country accounts for eight percent of the total global biodiversity with an estimated 45000 species of plants of which 4900 are endemic. The total number of species in the world is estimated to be around 5 millions to 30 millions. Out of which, about 1.4 million species have been described. The total number of plant species in India is estimated to be about 45,000 (15,000 flowering plants, 64 gymnosperms, 2843 bryophytes, 1,012 pteridophytes, 1,940 lichens and 23,000 fungi.) Nearly 4900 of these species are endemic to India out of which, 1,500 are highly threatened. The faunal wealth of India comprises of 81,000 species (5,000 molluscs, 57,000 arthropods, 2,546 fishes, 204 amphibian, 428 reptiles, 1,228 birds & 372 mammals. Out of which, 62% species are endemic to India. Besides, these hosts of microorganisms are yet to be described.

Throughout the globe 34 hot spots have been identified for conservation of biodiversity. And out of these India has 4 hot spots. These are Western Ghats, Eastern Himalayas North–East India and Andaman & Nicobar Islands. All of these areas are inhabited by a variety of flowering plants, reptiles, mammals, amphibian and insects.

What do you understand by Biodiversity at Global, National and Local levels?

OR

Why and how diversity can be studied at Global, National and Local levels?

Answer: Biodiversity refers to the diversity of species and habitats, as calculated at a number of scales: global, regional and local. However, conceptualizing biodiversity exclusively in terms of the numbers of species and locations within a specified area, or in terms of the range of populations at risk of extinction, often gives a relatively static feeling of biodiversity.

Ecosystems are a complex set of dynamic inter-relationships between species and between species and habitats. The threat to biodiversity occurs when these dynamics are disturbed beyond the point of recovery.

There are two main ways in which this can occur:

(a) Change in management practices in an area where there has been no change in the actual land use.
For example: Rubber tapping in the Brazilian rainforest, intensive agro-industry in the European countryside, nomadic hunting in Africa or provision for leisure activities in the North American National Parks, increased numbers of leisure visitors or larger amounts of poaching, the use of new pesticides or most controversially the introduction of genetically modified organisms into conventional agriculture – can push the ecosystem beyond its threshold and tip it into degradation.

(b) Changes in land use itself.
For example: the clear felling of the rainforest, the urban development of the countryside, the shift from transitory to more permanent settlement, the introduction of primary industries (such as mining) into previously unexploited areas. Logging trees in the ecologically unique rainforests is a biodiversity disaster.

For the above mentioned rationale, it is important to be able to measure the existing biodiversity value of sites that are likely to be developed and undergo significant change of land use. The designation of sites of special significance under various headings makes a contribution here. Surveys of species diversity across local areas can also be helpful. These kinds of designation and information can feed into regulatory processes that seek to control development and land-use change. Many governments, research institutes and non-governmental organizations (NGOs) are, therefore, investing considerable resources in expanding the knowledge base of biodiversity in their area of influence.

Enlist the direct and indirect value of biodiversity.

Answer***: Direct Values:***

(a) Food
(b) Medicinal plants
(c) Fresh air for breathing

Indirect Values:

(a) Photosynthesis to fix atmospheric carbon
(b) Purification of water
(c) Soil formation

What is a keystone species?

Answer: The term Keystone was coined by T. Paine in 1969. It refers to individual species or cluster of species whose deletion from the ecosystem may bring dramatic changes in the structure and functioning of that ecosystem.

If the removal of a single species can cause major changes to the structure, function or diversity of a community, it follows that a key-stone dependent communities are perhaps more vulnerable and potentially unstable than communities where keystone are absent.

The keystone role for a species can arise in several different ways. Here we differentiate ***four types*** of organism on the basis of their functional role as keystone:

(a) ***Organism controlling potential dominants:*** It is an organism that controls the population of a potentially dominating species thereby promoting co-existence by reducing competition amongst other species for a limiting resource. For example in terrestrial ecosystems, herbivores play a major role in maintaining the structure and species composition of the vegetation.

(b) ***Resource providers:*** Those who provide a vital resource to a range of organisms at time of insufficiency. A fig genus (*Ficus*) stands out being of central importance as a keystone resource provider in many tropical forests. One reason is the continuous aseasonal fruiting in the genus.

(c) ***Mutualists:*** It is the case where two species are mutually dependent; the elimination of one will result in the demise of the other. In this sense they act as a keystone for each other. For example– a relation between pollinator and flowering plants.

(d) ***Ecosystem engineers:*** Certain organisms can also act as keystone by modifying the physical environment in ways that release resources for other species. The activities of many organisms provide habitats that would not otherwise be available, often means of disturbance to the physical habitat. Because of the structural alterations they bring about, such organisms have been referred to as ecosystem engineers. For example: the long term engineering effect of earthworm action in soil.

Main features of Keystone species are:

(a) The activity of the species establishes the community composition.

(b) They can create or transform habitats and can control the inter–specific interactions among the community
(c) They sustain the organization and diversity of their communities
(d) The effects are inconsistent to the biomass or relative abundance of the species.
(e) The species need not to be dominant at all times.
(f) Elimination of keystone species results in loss in the biodiversity of the community.

What is the significance of keystone species? Enlist the causes of their loss.

Answer: Significance of Keystone species:

(a) Maintains a healthy natural balance.
(b) If the keystone species thrive in an ecosystem, then all the other species, which depend on them, will also flourish.
(c) May directly or indirectly affect energy flows, and hydrological and nutrient cycling and recycling.
(d) Identification of the species, which would function as keystone species in an ecosystem can help in the conservation of that ecosystem.

The following could be the reasons behind the loss of keystone species from an area:

(a) Over–hunting, over–fishing, or over–harvesting; pollution;
(b) Habitat infringement from housing developments, agriculture, mining operations, or logging;
(c) Invasion of non-native species (which are often introduced unconsciously via shipping or intentionally via illegal trade in exotic species);
(d) Loss of predator species (which allows populations of prey species to explode);
(e) Habitat change due to unnatural temperature changes in the environment (such as with global warming).

What are wetlands? Give their types.

Answer: Wetlands are areas the water table (the groundwater level) is very near to the soil surface or is present either at or near the surface of the soil all year or for varying periods of time during the year. Thus, the wetlands encompass diverse and heterogeneous grouping of habitats ranging from lakes, estuaries, river flood plains, mangroves, coral reef and other related ecosystems. The wetlands are of following types:

A. Marine and coastal wetlands

Wetland landscape units that are influenced by river flows include:

• **Estuaries and tidal flats,** where rivers meet the sea and salinity is intermediate between salt and freshwater. Habitat types include deltas, mudflats and salt marshes.

- **Mangroves and other tidal forests.** These very productive plant communities adapted to living in dynamic estuarine and coastal conditions are found only in the tropics and subtropics: mangroves are the only woody plants tolerant of salt waters.

Wetland units not influenced by river flows include:

- **Marine and open coasts.** Where the coastal energy from waves and currents is low, coastal zones may contain a complex of habitat types, including open shores, coastal lagoons and mangrove areas interspersed with mudflats and sandbanks.

- **Coral reefs.** These are the physical structures created by the growth of the reef community, especially corals, which are colonial animals producing a calcium carbonate structure. They come within the definition of wetlands as they start from very shallow inter–tidal waters (less then six meters deep) but also extend far out to sea to great depths.

B. Inland wetlands

Within this category, distinctions can be drawn between habitat types that are seasonally or permanently covered by water and between those with significant or negligible water flow.

- **Riverine wetlands** include floodplains, deltas, water meadows, flooded forests and oxbow lakes which may have small areas of permanent water during the dry season but which are periodically inundated as a result of seasonal rainfall or melt waters from mountain snow.

- **Palustrine wetlands** have more or less permanent water, fed by groundwater, surface springs, streams or run-off, and tend to be dominated by herbaceous plants such as grasses, sedges and rushes. They are among the most widespread and important wetland types and include papyrus swamps, marshes and fens.

- **Swamp forests and peat bogs** also tend to form in areas of still water, often in association with marsh and swamp around lake margins and in floodplains and coastal regions.

- **Lacustrine wetlands** are areas of permanent water with little flow, such as ponds, kettle lakes and volcanic crater lakes. Lakes and ponds occur in many different types resulting from geological processes, such as the faulting in the Earth's crust, or impeded flow in rivers, such as alluvial fan lakes. Margins of large lakes may house other wetland types, such as marshes and swamps, whereas the open waters may resemble inland seas and house important lake fisheries.

What are important features of wetlands? Give their importance.

Answer: Some important features of Wetlands are:

a) Water saturation largely determines how the soil develops and the types of plant and animal communities living in and on the soil.
b) Wetlands may support both aquatic and terrestrial species.

c) The prolonged presence of water creates conditions that favor the growth of specially adapted plants and promote the development of characteristic wetlands soils.

Wetlands are considered important from the following viewpoints:

a) They are the life support systems.
b) They act as winter resorts for a variety of birds for shelter and feeding.
c) Suitable habitats for fish and other flora and fauna.
d) Valuable for their educational and scientific interest (especially their high diversity or species richness).
e) They help in water storage or supply.
f) Wetlands play a key function in Flood control, water purification, and retention of pollutants/nutrients/sediments.
g) They are vital for Ground water recharge or discharge, maintenance of underground water tables.
h) They present a ground for waterfowl, nurseries for fisheries and wildlife
i) They assist in Stabilization of local climate.
j) They are important for protecting bio-diversity.
k) They are a source for Recreation, tourism and cultural heritage.
l) Provide livelihoods to local people.

Write an explanatory note on the Biogeographic zones of India.

Answer: The Biogeographic classification of India. (Rodgers and Pawar 1990)

- Trans-Himalayas. An extension of the Tibetan plateau, harboring high-altitude cold desert in Laddakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.
- Himalayas. The entire mountain chain running from north-western to northeastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.
- Desert. The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. 6.9% of the country's landmass.
- Semi-arid. The zone between the desert and the Deccan plateau, including the Aravalli hill range. 15.6 % of the country's landmass.
- Western Ghats. The hill ranges and plains running along the western coastline, south of the Tapti River, covering an extremely diverse range of biotic provinces and biomes. 5.8% of the country's landmass.
- Deccan peninsula. The largest of the zones, covering much of the southern and south central plateau with predominantly deciduous vegetation. 4.3 % of the country's landmass.
- Gangetic plain. Defined by the Ganges river system, these plains are relatively homogenous. 11% of the country's landmass.
- Coasts. A large coastline distributed both to the west and east, with distinct differences between the two; Lakshyadweep islands are included in this with the percent area being negligible.
- North-east India. The plains and non- Himalayan hill ranges of northeastern India, with a wide variation of vegetation. 5.2% of the country's landmass.
- Islands. The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes. 0.03% of the country's landmass.

Write a note on climate of India.

Answer: India is mainly a tropical country but due to great altitudinal variations, almost all climatic conditions from hot deserts to cold deserts exist. There are four seasons:

(i) Winter (December-February),
(ii) Summer (March-June),
(iii) South-west monsoon season (June-September), and
(iv) Post monsoon season (October-November).

During the post monsoon season, commonly known as winter monsoon, monsoon rains begin over north India and pass over the Bay of Bengal before reaching the Andamans and the South-east coast. However, the south-west or the summer monsoon is the main source of rainfall in the country providing 80% of the precipitation.

What is meant by endemism?

Answer: An endemic species id defined as a ***species restricted to a given region/ location/geographic area and nowhere else in the world.***

The geographical area can be defined by political boundaries, such as country endemic, or by ecological boundaries such as a species endemic to a forest. (A species can be endemic in various contexts. Site endemic, national / country endemic or geographic range endemic.).

It is the environment only, which is instrumental in the operation of the process of natural selection. This makes the habitats in which endemic species thrive very important. Recognizing the importance of endemism to conservation, a number of conservationists has analyzed distributions of endemic species to provide guidance on where an investment in conservation can yield important results in terms of numbers of species saved from extinction. For example, Myers (1988, 1990) examined endemic plant species worldwide and showed that protecting 746,400 km2, an area representing 0.5% of the Earth's land surface, in 18 sites worldwide would conserve 50,000 species of endemic plants (20% of all known plant species).This study introduced the **'hotspots'** concept that is still in use today as a guiding principle to conservation.

What are hotspots of biodiversity? Which are the hotspots found in India? Discuss salient features.

Answer: The world's most remarkable places are also the most threatened. These are the Hotspots: the richest and most threatened reservoirs of plant and animal life on Earth.

Specific location that has enormous species diversity but is also under threat from human activities is known as a biodiversity hot spot. Norman Myers in 1988 first coined the word "hotspots" and according to him to qualify for a biodiversity hotspot a region must meet two strict criteria:

(i) It must contain at least 1,500 species of vascular plants (> 0.5 percent of the world's total) as endemics.

(ii) It has to have lost at least 70 percent of its original habitat.

Myers identified ten tropical forest characterized both by exceptional levels of plant endemism and by serious levels of habitat loss in 1988. The updated analysis of biodiversity hotspots reveals the existence of 34 hotspots which once covered 15.7 percent of the Earth's land surface. Over 50 percent of the world's plant species and 42 percent of all terrestrial vertebrate species are endemic to the 34 biodiversity hotspots. India shows a good number of endemic species in two hotspots present in its boundaries namely eastern Himalayas and western ghats.. About 62% of amphibians and 50% of lizards are endemic to India. Western Ghats are the site of maximum endemism.

a) Eastern Himalayas: They display an ultra-varied topography that fosters species diversity and endemism. Recent studies have shown that North East India along with its contiguous regions of Burma and Chinese provinces of Yunnan and Schezwan is an active center of organic evolution and is considered to be the cradle of flowering plants. Out of the world's recorded flora 30% are endemic to India of which 35000 are in the Himalayas.

b) Western Ghats: It extends along a 17000 km² strip of forests in Maharashtra, Karnataka, Tamilnadu and Kerala and has 40% of the the total endemic plant species. The major centers of diversity are Agastyamalai Hills and Silent valley- the new Amambalam Reserve Basin. It is reported that only 6.8% of the original forests are existing today while the rest has been deforested or degraded, which raises a serious cause of alarm, because it means we have already lost a huge proportion of the biodiversity.

What is the status of Biodiversity hotspots all over the world?

Answer: The updated analysis of biodiversity hotspots reveals the existence of **34 hotspots** each holding at least 1,500 endemic plant species, and having lost at least 70 percent of its original habitat extent. The Hotspots of Biological Diversity are:

The hotspots hold at least 150,000 plant species as endemics, 50 percent of the world's total plant species. The total number of terrestrial vertebrates endemic to the hotspots is 11,980, representing 42 percent of all terrestrial vertebrate species. Reptiles and amphibians, are more prone to hotspot endemism than are the more wide-ranging mammals and birds, but the overall similarity between taxonomic groups is remarkable. Overall, 22,022 terrestrial vertebrate species call the hotpots home, 77 percent of the world's total. The hotpots already hold 29 percent of the world's freshwater fish species as endemics, with 55 percent of species occurring.

What is IUCN and what are the different categories and criteria of IUCN Red List?

Answer:IUCN, the **International Union for Conservation of Nature**, helps the world find pragmatic solutions to our most pressing environment and development challenges by supporting scientific research; managing field projects all over the world; and bringing governments, NGOs, the UN, international conventions and companies together to develop policy, laws and best practice. The world's oldest and largest global environmental network, IUCN is a democratic membership union with more than 1,000 government and NGO member organizations, and almost 11,000 volunteer scientists and experts in some 160 countries. IUCN's work is supported by over 1,000 professional staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world. IUCN's headquarters are located in Gland, near Geneva, in Switzerland.

Extinct (Ex)

A taxon is Extinct when there is no reasonable doubt that the last individual has died.

A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycles and life form.

Extinct In The Wild (Ew)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.

A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (Cr)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered (En)

A taxon is endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable (Vu)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

Near Threatened (Nt)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Least Concern (Lc)
A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Data Deficient (Dd)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.

Not Evaluated (Ne)
A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

What are the threats to biodiversity?

OR

What are the various causes for the loss of biodiversity?

Answer: THREATS TO BIODIVERSITY:

Extinction or elimination of a species is a natural process of evolution. In the geologic period the earth has experienced mass extinctions. During evolution, species have died out and have been replaced by others. However, the rate of loss of species in geologic past has been a slow process, keeping in view the vast span of time going back to 444 million years. The process of extinction has become particularly fast in the recent years of civilization. In this century the human impact has been so severe that thousands of species are becoming extinct annually. One of the estimates by the noted ecologist puts figure of extinction at 10000 species per year or 27 per day. These amazing figures raise an alarm regarding the serious threat to biodiversity. Over the last 150 years the rate of extinction has escalated more dramatically. If the present 43 trend continues we would lose 1/3rd to 2/3rd of our current biodiversity by the middle of twenty first century.

Following are the major causes and issues related to threats to biodiversity:

1. **Loss of habitat:**

Destruction and loss of natural habitat is the single largest cause of biodiversity loss. Billions of hectares of forests and grasslands have been cleared over the past years for conservation into agriculture lands, pastures, settlement areas or development projects. These natural forests and grasslands were the natural homes of thousands of species which perished due to loss of their natural habitat. Severe damage has been caused to wetlands thinking them to be

useless ecosystems. The unique rich biodiversity of the wetlands, estuaries and mangroves are under the most serious threat today. The wetlands are destroyed due to draining, filling and pollution thereby causing huge biodiversity loss. Sometimes the loss of habitat is in installments so that the habitat is divided into small and scattered patches, a phenomenon known as habitat fragmentation.

There are many wild life species such as bears and large cats that require large territories so subsist. They get badly threatened as they breed only in the interiors of the forests. Due to habitat fragmentation many song birds are vanishing. There has been a rapid disappearance of tropical forests in our country also, at a rate of about 0.6% per year. With the current rate of loss of forest habitat, it is estimated that 20-25% of the global flora would be lost within few years. Marine diversity is also under serious threat due to large scale destruction of the fragile breeding and feeding grounds of our oceanic fish and other species, as a result of human intervention.

2. POACHING

Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars per year continues, The developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife. The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of the wildlife products or wildlife itself. The trading of such wild life products is highly profit making for the poachers who just hunt these prohibited wild lives and smuggle it to other countries mediated through mafia. The worst part is that for every live animal that actually gets into the market about 50 additional animals are caught and killed.

3. MAN-WILDLIFE CONFLICTS

We have discussed about the need to preserve and protect wildlife. However, sometimes we come across conflicting situations when wildlife starts causing immense damage and danger to man and under such conditions it becomes very difficult for the forest department to pacify the affected villages and gain local support for wildlife conservation. Instances of man animal conflicts keep on coming to lime light from several states in our country. In Sambalpur, Orissa 195 humans were killed in the last 5 years by elephants. In retaliation the villagers killed 95 elephants in the border region of Kote-Chamarajanagar belt in Mysore have been reported recently. The man-elephant conflict in this region has arisen because of massive damage done by the elephants to the farmer's cotton and sugarcane crops. The agonized villagers electrocute the elephants and sometimes hide explosives in the sugarcane fields, which explode as the elephants intrude into their fields. In fact, more killings are done by locals than by poachers. Recently, in early 2004, a man-eating tiger reported to kill 16 Nepalese people and one 4 year old child inside the Royal Chitwan National Part, 240 Km South-west of Kathmandu. The park renowned for its wildlife conservation effort has become a zone of terror for the locals. Similar incidents were reported near Sanjay Gandhi National Park, Borivali, and Mumbai where similar incidents of human killings especially small children was reported. At

times, such conflicting situations have been reported from the border regions of Corbett, Dudhwa, Palamau and Ranthambore National Parks in our country as well.
A total of 14 persons were killed during 19 attacks since January by the leopards from the Sanjay Gandhi National Park, Mumbai which has triggered a panic among the local residents.

Causes of Man-animal conflicts:

1. Dwindling habitats of tigers, elephants, rhinos and bears due to shrinking forests cover are compelled to move outside the forests and attack the field or sometimes even humans. Human encroachment into the forest areas has rendered all forest living animals to trespass the borders of human civilizations. This is because the conflicts between man and the wildlife have increased since it is an issue of survival of both.

2. Usually the ill, weak and injured animals have a tendency to attack man. Also, the female tigress attacks the human if she feels that her newborn cubs are in danger. But the biggest problem is that if human-flesh is tested once then the tiger does not eat any other animal. At the same time, it is very difficult to trace and cull the man-eating tiger and in the process many innocent tigers are also killed.

3. Earlier, forest department used to cultivate paddy, sugarcane etc. within the sanctuaries when the favourite staple food of elephants i.e. bamboo leaves were not available. Now due to lack of such practices the animals move out of the forest in search of food. It may be noted that, one adult elephant needs 2 quintals of green fodder and 150 kg of clean water daily and if it is not available, the animal strays out.

4. Very often the villagers put electric wiring around their ripe crop fields. The elephants get injured, suffer in pain and turn violent.

5. Earlier there used to be wild-life corridors through which the wild animals used to migrate seasonally in groups to other areas. Due to development of human settlements in these corridors, the path of wildlife has been disrupted and the animals attack the settlements.

6. The cash compensation paid by the government in lieu of the damage caused to the farmers crop is not enough. In Mysore, a farmer gets compensation of Rs.400/- per quintal of expected yield while the market price is Rs.2400/- per quintal. The agonized farmer therefore gets revengeful and kills the wild animals.

Remedial Measures to Curb the Conflict:

1. Tiger Conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc. to tactfully deal with any imminent danger.

2. Adequate crop compensation and cattle compensation scheme must be started, along with substantial cash compensation for loss of human life.
3. Solar powered fencing should be provided along with electric current proof trenches to prevent the animals from straying into fields.

4. Cropping pattern should be changed near the forest borders and adequate fodder, fruit and water should be made available for the elephants within forest zones.

5. Wild life corridors should be provided for mass migration of big animals during un-favourable periods. About 300 km² area is required for elephant corridors for their seasonal migration.

6. In Similipal Sanctuary, Orissa there is a ritual of wild animal hunting during the month of April-May for which forest is burnt to flush out the animals. Due to massive hunting by people, there is a decline in prey of tigers and they start coming out of the forest in search of prey. Now there is WWF-TCP initiative to curb this ritual of “Akhand Shikar” in Orissa.

What are the different ways of biodiversity conservation?

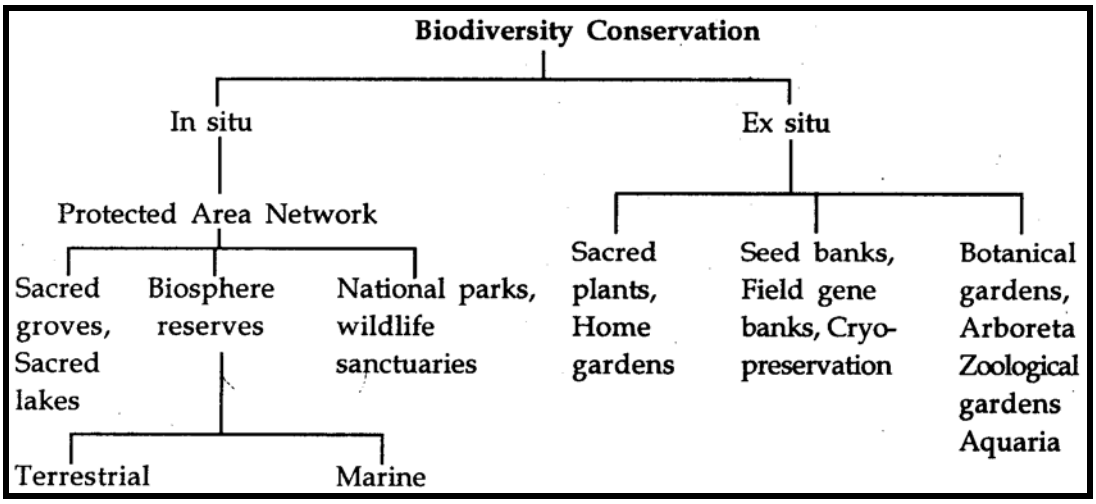
Answer: CONSERVATION OF BIODIVERSITY:

The enormous value of biodiversity due to their genetic, commercial, medical, aesthetic, ecological and optional importance emphasizes the need of its conservation. Gradually we are realizing that wildlife is not just ‘a game to be hunted’, rather it is a gift of nature to be nurtured and enjoyed. There are two approaches to biodiversity conservation:

a) In situ conservation: In situ conservation (within habitat): In-situ conservation, the conservation of species in their natural habitats, is considered the most appropriate way of conserving biodiversity. Conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity. That's why protected areas form a central element of any national strategy to conserve biodiversity. This is achieved by protection of wild flora and fauna in nature itself e.g. Biosphere Reserves, National Parks, Sanctuaries, Reserve Forests etc

b) Ex situ conservation (outside habitats): *Ex-situ* conservation literally means, "Off-site conservation". It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans. While *ex-situ* conservation comprises some of the oldest and best known conservation methods, it also involves newer, sometimes controversial laboratory methods.

Ex situ conservation, using sample populations, is done through establishment of gene banks, which include genetic resources centres, zoo’s, botanical gardens, cultue collections etc.



What are the advantages of *In situ* and *Ex situ* conservation?

Answer: Advantages of in situ conservation

- It aids in maintaining gene banks.
- It is vital for Maintenance of species and checks its extinction.
- It helps in preservation of genetic variability.
- It helps in preserving the quality of life for millions of forest dwellers.
- In situ conservation helps to supply materials to restore plants.
- Advantages of ex-situ conservation
- Efficient and reproducible.
- Feasible for medium and long-term secure storage.
- Wide diversity of each target taxonomy conserved.
- Easy access for characterization, evaluation, and utilization little maintenance.
- Supply material for various purposes to remove or reduce pressure from wild collecting.
- Produce material for reintroduction, reinforcement, habitat restoration and management.

Write a detailed note on Biosphere Reserve?

Answer: Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a world network: the World Network of Biosphere Reserves (WNBR).

The idea of `Biosphere Reserves' was initiated by UNESCO in 1973-74 under its Man and Biosphere (MAB) Programme. The MAB, launched in 1970 by UNESCO, is a broad based ecological programme aimed to develop within the natural and social sciences a basis for the rational use and conservation of the resources of the biosphere and for the improvement of the relationship between man and the environment; to predict the consequences of today's

actions on tomorrows world and thereby to increase man's ability to manage efficiently the natural resources of the biosphere.

The characteristic features of Biosphere Reserves are:

(1) Each Biosphere Reserves are protected areas of land and/or coastal environments wherein people are an integral component of the system. Together, they constitute a world wide network linked by International understanding for exchange of scientific information.
(2) The network of Biosphere Reserves includes significant examples of biomes throughout the world.
(3) Each Biosphere Reserves includes one or more of the following categories:-

(i) Biosphere Reserves are representative examples of natural biomes.
(ii) Biosphere Reserves conserve unique communities of biodiversity or areas with unusual natural features of exceptional interest. It is recognized that these representative areas may also contain unique features of landscapes, ecosystems and genetic variations e.g. one population of a globally rare species; their representative ness and uniqueness may both be characteristics of an area.
(iii) Biosphere Reserves have examples of harmonious landscapes resulting from traditional patterns of land-use.
(iv) Biosphere Reserves have examples of modified or degraded ecosystems capable of being restored to more natural conditions.
(v) Biosphere Reserves generally have a non-manipulative core area, in combination with areas in which baseline measurements, experimental and manipulative research, education and training is carried out. Where these areas are not contiguous, they can be associated in a cluster.

Functions of Biosphere Reserves

Conservation
• To ensure the conservation of landscapes, ecosystems, species and genetic variations.
• To encourage the traditional resource use systems;
• To understand the patterns and processes of functioning of ecosystems;
• To monitor the natural and human-caused changes on spatial and temporal scales;

Development
• to foster economic and human development which is socio-culturally and ecologically sustainable;
• To develop the strategies leading to improvement and management of natural resources;

Logistics support
• To provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development
• Sharing of knowledge generated by research through site specific training and education; and
• Development of community spirit in the management of natural resources.

Structure and Design of Biosphere Reserves

In order to undertake complementary activities of biodiversity conservation and development of sustainable management aspects, Biosphere Reserves are demarcated into three inter-related zones. These are (I) natural or core zone (ii) manipulation or buffer zone and (iii) A transition zone outside the buffer zone.

The Core Zone:
The core zone is kept absolutely undisturbed. It must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. Core areas often conserve the wild relatives of economic species and also represent important genetic reservoirs. It often contains places of exceptional scientific interest. A core zone secures legal protection and management and research activities that do not affect natural processes and wildlife are allowed. Strict nature reserves and wilderness portions of the area are designated as core areas of Biosphere Reserve and should be kept free from all human pressures external to the system.

The Buffer Zone:
The area surrounding the core zone is the buffer zone. In this zone, uses and activities are managed in ways that protect the core zone. These uses and activities include restoration, demonstration sites for enhancing value addition to the resources, limited recreation, tourism, fishing and grazing, which are permitted to reduce its effect on core zone. Research and educational activities are to be encouraged. Human activities, are likely to be permitted to continue if these do not adversely affect the ecological diversity.

The Transition Zone:
The Transition Zone is the outermost part of a Biosphere Reserve. This is usually not delimited one and is a zone of cooperation where conservation, knowledge and management skills are applied and uses are managed in harmony with the purpose of the Biosphere Reserve. This includes settlements, crop lands, managed forests and area for intensive recreation, and other economic uses characteristic of the region.

In Buffer Zone and the Transition Zones, manipulative macro-management practices are used. Experimental research areas are used for understanding the patterns and processes in the ecosystem. Modified or degraded landscapes are included as rehabilitation areas to restore the ecology in a way that it returns to sustainable productivity.

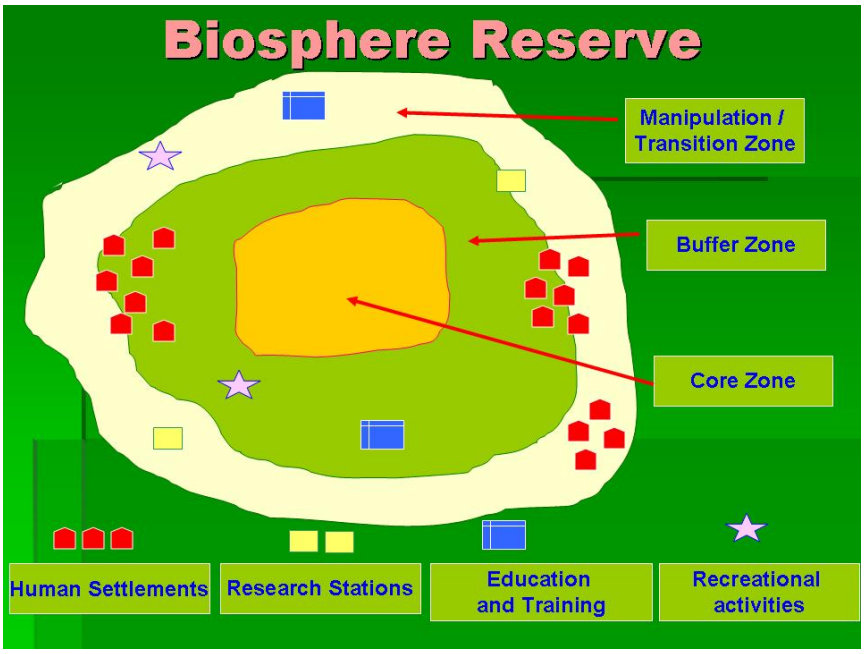


Fig. 4.7 Structure of a Biosphere Reserve

What is the difference between National park wildlife sanctuary and Biosphere reserve?

Answer: National park wildlife sanctuary and Biosphere reserve can be distinguished in the following ways:

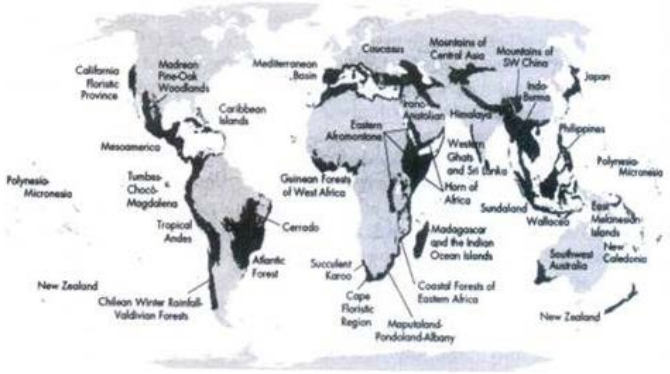
S. No.	National Park	Sanctuary	Biosphere Reserve
1.	Attention is not given on biotic community as a whole e.g. conservation being connected to habitat for particular wild animal species such as lio, tiger, rhino etc.	Attention is not given on biotic community i.e. conservation is species oriented.	Attention is focused on biotic community as a whole i.e. conservation is ecosystem oriented.
2.	The size ranges from 0.04 to 3162 sq. km. the usual size being between 100 to 500 sq km and between 500 to 1000sq km.	The size ranges from 0.61 to 7818 sq. km., usual size being between 500 to 1000 sq. km	The size is well over 5670 sq. km.
3.	Boundaries are circumscribed by state legislation.	Limits are not circumscribed.	Boundaries are circumscribed by state legislation.
4.	There occurs no biotic interference except in buffer	There occurs limited biotic interference.	There occurs no biotic interference

	zone.		except in buffer zone.
5.	Tourism is permissible but often discouraged.	Tourism is permissible	Tourism is not permissible
6.	Research and scientific management are lacking.	Research and scientific management are lacking	Research and scientific management are carried out.
7.	Proper attention is not given to gene pool conservation of economic species, particularly plants.	Proper attention is not given to gene pool conservation of economic species, particularly plants.	Due attention is given to conservation of plants and animal species.

Biodiversity Hotspots in India

Biodiversity Hotspots: Meaning and Hotspots found in India!

A biodiversity hotspot is a biogeographic region with a significant reservoir of biodiversity that is under threat from humans. A hotspot is an area which faces serious threat from human activities and supports a unique biodiversity (endemic, threatened, rare species) with representatives of evolutionary of speciation and extinction.



Biodiversity hotspots worldwide

The concept of biodiversity was given by Norman Myers (1988).

To qualify as a biodiversity hotspots on Myers 2000 edition of the hotspot map, a region must meet two strict criteria:

1. It must contain at-least 0.5% or 1500 species of vascular plants of the world.

2. It has to have lost at least 70% of its primary vegetation.

Myers originally recognised 25 hotspots but recently the Conservation International has added 9 more biodiversity hotspots which make the present number to 34. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of endemic species.

Hotspots in India:

India has two major hotspots. The rate of deforestation in these areas is very high and ecosystems have reached at a fragile stage.

1. The Western Ghats:

About the region:

The Western Ghats are a chain of hills that run along the western edge of peninsular India. They are also known as Sahyadri Mountains. They receive high rainfall. It run parallel to the west coast of India and constitute more than 1600 km strip of forests in the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala.

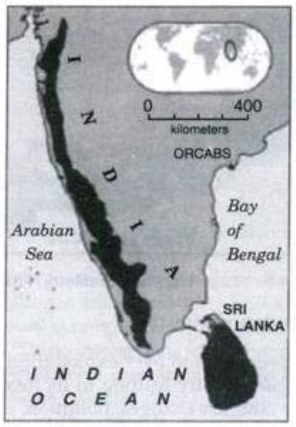
Flora:

These regions have moist deciduous forest and rain forest. The region shows high species diversity as well as high levels of endemism. There are over 6000 vascular plants belonging to over 2500 genera in this hotspot, of which over 3000 are endemic.

Much of the world's spices such as black pepper and cardamom have their origins in the Western Ghats. Many economically important plants such as banana, rice, ginger etc. have spread to other parts of the country from here.

Fauna:

Nearly 77% of the amphibians and 62% of the reptile species found here are found nowhere else. The region also harbours over 450 bird species, about 140 mammalian species, 260 reptiles and 175 amphibians. Over 60% of the reptiles and amphibians are completely endemic to the hotspot. Remarkable as this diversity is, it is severely threatened.



Indian Hotspot – Western Ghats

2. The Eastern Himalayas:

About the region:

The Eastern Himalayas is the region encompassing Bhutan, northeastern India, and southern, central, and eastern Nepal. The region is geologically young and shows high altitudinal variation. Together, the Himalayan mountain system is the world's highest, and home to the world's highest peaks, which include Mount Everest and K2.

Flora:

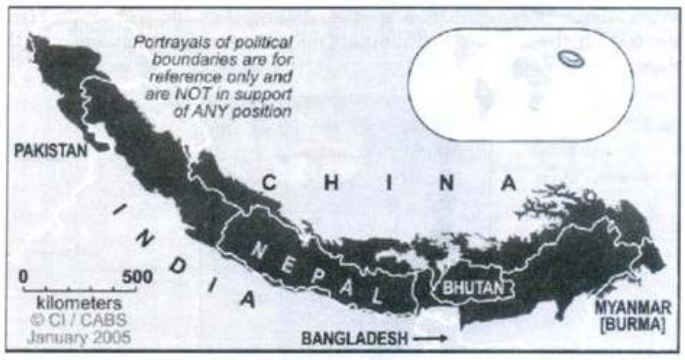
There are an estimated 10,000 species of plants in the Himalayas, of which one-third are endemic and found nowhere else in the world. Five families —Tetracentraceae, Hamamelidaceae, Circaesteraceae, Butomaceae and Stachyuraceae — are completely endemic to this region.

Many plant species are found even in the highest reaches of the Himalayan Mountains, For example, a plant species Ermania himalayensis was found at an altitude of 6300 metres in northwestern Himalayas.

Fauna:

Few threatened endemic bird species such as the Himalayan Quail, Cheer pheasant. Western tragopan are found here, along with some of Asia's largest and most endangered birds such as the Himalayan vulture and White-bellied heron.

The Eastern Himalayan hotspot has nearly 163 globally threatened species including the One-horned Rhinoceros (Rhinoceros unicornis), the Wild Asian Water buffalo (Bubalus bubalis) and in all 45 mammals, 50 birds, 17 reptiles, 12 amphibians, 3 invertebrate and 36 plant species. The Relict Dragonfly (Epiophlebia laidlawi) is an endangered species found here with the only other species in the genus being found in Japan.



Indian Hotspot—Eastern Himayas

Threats to Biodiversity:

Increasing population pressure and over-exploitation of the biotic resources is taking their toll on biodiversity leading to its loss. The major threats to biodiversity decline are land use changes, pollution, changes in atmospheric CO_2concentrations, changes in the nitrogen cycle and acid rain, climate alterations, and the introduction of exotic species, all coincident to human population growth.

For rainforests, the primary factor is land conversion. Climate will probably change least in tropical regions, and nitrogen problems are not as important because growth in rainforests is usually limited more by low phosphorus levels than by nitrogen insufficiency.

The introduction of exotic species is also less of a problem than in temperate areas because there is so much diversity in tropical forests that newcomers have difficulty becoming established.

Let us consider some of the major causes and issues related to threats to biodiversity:

1. Habitat destruction:

As recently as 30 years ago, most of the regions in these biodiversity hotspots were inaccessible and remote. Now, due to better infrastructure, contact of these areas with humans has increased. Activities such as logging of wood, increased agriculture, increased human habitation has led to destruction of forests and pollution of rivers.

These factors are causing species ranges to reduce and habitats to become choppy. The government planned to establish habitat corridors, but these plans have not yet materialized in most areas. Activities such as mining, construction of large dams, highway construction has also caused significant destruction of habitats.

2. Resource mismanagement:

Increased tourism without proper regulation has led to pollution and environmental degradation. Prime examples are pilgrimage destinations like Rishikesh and hill stations like Dehradoon.

These spots, once nestled in the pristine ranges of the Himalayas, are now dirty commercial destinations. Places like Dehradoon are even experiencing a construction boom so large that illegal immigrants from Bangladesh are also flocking there.

3. Poaching:

Large mammals such as the tiger, rhinoceros and the elephant once faced the distinct possibility of complete extinction due to rampant hunting and poaching. However, efforts by conservationists since the 1970s have helped stabilize and grow these populations. Still, the trade in tiger hides, elephant tusks, tiger teeth, and rhinoceros horn remains profitable and rampant.

4. Global Warming:

There is recent evidence that climate changes are having effects on tropical forest ecology. Warming in general (as distinct from the effects of increasing concentrations of CO2 and other greenhouse gases) can increase primary productivity, yielding new plant biomass, increased organic litter, and increased food supplies for animals and soil flora (decomposers).

Temperature changes can also alter the water cycle and the availability of nitrogen and other nutrients. Basically, the temperature variations which are now occurring affect all parts of forest ecosystems, some more than others. These interactions are unimaginably complex.

While warming may at first increase net primary productivity (NPP), in the longer run, because plant biomass is increasing, more nitrogen is taken up from the soil and sequestered in the plant bodies. This leaves less nitrogen for the growth of additional plants, so the increase in NPP over time (due to a rise in temperature or CO_2 levels) will be limited by nitrogen availability.

The same is probably true of other-mineral nutrients. The consequences of warming-induced shifts in the distribution of nutrients will not be seen| rapidly, but perhaps only over many years. These events may affect changes] in species distribution and other ecosystem processes in complex ways.

We know little about the reactions of tropical forests, but they may differ from those of temperate forests. In tropical forests, warming may be more important because of its effects on evapotranspiration and soil moisture levels than because of nutrient redistribution.

The migratory patterns of some birds which live in both tropical and temperate regions during the year seem to be shifting, which is dangerous for these species, as they may arrive at their breeding or wintering grounds at an inappropriate time.

Or they may lose their essential interactions with plants which they pollinate or their insect or plant food supplies. Perhaps for these reasons, many migratory species are in decline, and their inability to coordinate migratory clues with climatic actualities may be partly to blame.

Also, as temperatures rise, some bird populations have shifted, with lowland and foothill species moving into higher areas. The consequences for highland bird populations are not yet clear. And many other organisms, both plant and animal, are being affected by warming.

An increase in infectious diseases is another consequence of climate change, since the causative agents are affected by humidity, temperature change, and rainfall. Many species of frogs and lizards have declined or disappeared, perhaps because of the increase in parasites occasioned by higher temperatures.

As warming continues, accelerating plant growth, pathogens may spread more quickly because of the increased availability of vegetation (a “density” effect) and because of increased humidity under heavier plant cover. As mentioned above, the fungus Phytophtora cinnamon has demolished many Eucalyptus forests in Australia.

In addition, the geographical range of pathogens can expand when the climate moderates, allowing pathogens to find new, and non-resistant hosts. On the other hand, a number of instances of amphibian decline seem to be due to infections with fungi, which flourish at cooler temperatures.

5. Forest Fragmentation:

The fragmentation of forests is a general consequence of the haphazard logging and agricultural land conversion which is occurring everywhere, but especially in tropical forests.

When forests are cut into smaller and smaller pieces, there are many consequences, some of which may be unanticipated:

(i) Fragmentation decreases habitat simply through loss of land area, reducing the probability of maintaining effective reproductive units of plant and animal populations. Most tropical trees are pollinated by animals, and therefore the maintenance of adequate pollinator population levels is essential for forest health.

When a forest becomes fragmented, trees of many species are isolated because their pollinators cannot cross the unforested areas. Under these conditions, the trees in the fragments will then become inbred and lose genetic variability and vigor.

Other species, which have more wide-ranging pollinators, may suffer less from fragmentation. Most species are not so tolerant, however. Animals, particularly large ones, cannot maintain themselves in small fragmented forests.

Many large mammals have huge ranges and require extensive areas of intact forest to obtain sufficient food, or to find suitable nesting sites. Additionally, their migrations may be interrupted by fragmentation.

These animals are also much more susceptible to hunting in forest fragments, which accounts for much of the decline in animal populations in rainforests. Species extinctions occur more rapidly in fragments, for these reasons, and also because species depend upon each other.

(ii) When forests are cut down or burned, the resulting gaps are too large to be filled in by the normal regeneration processes. This permits the ascendancy of rapid-growing, light-tolerant species and grasses. Large gaps may then be converted to scrub or grassland.

(iii) The use of herbicides and the introduction of exotic species into areas surrounding forest fragments are detrimental to forest health. Herbicides blow from cleared agricultural areas into forests, and exotic species introduced by farmers and ranchers spread, often displacing native species. These exotic organisms interrupt the forest ecosystem and, since they have few or no natural enemies in their new environment, they are difficult to eradicate.

(iv) The fragmentation of forests by logging and agricultural conversion also exaggerates the probability of major epidemics. Pathogens introduced through human activities by land use practices in areas surrounding the forest can be lethal to forest plants and animals.

(v) Rainforests are losing species, not only because of the disappearance of their habitat, but also because essential ecological processes are being interrupted by fragmentation. Fragments are much more easily accessible to human incursions than are intact forests. This leads to a variety of extractive activities within the forest interior.

Intensive hunting, by depleting animal populations, inhibits plant reproduction, since many seeds can neither be dispersed, nor flowers be pollinated without them. Where these seed dispersers have been eliminated, are at low population densities, or cannot move between forest fragments, seed dispersal will be very limited, and as a result tree species dependent upon animal dispersers may become locally extinct.

6. Introduction of exotic species:

Human beings, by introducing exotic species (species belonging to some other place) whether intentionally or accidentally, have created ecological crisis in many regions. Sometimes, the exotic species disrupt local ecosystems and, in some cases, even drive the native species to extinction.

7. Overgrazing:

The feeding of the worlds livestock is a major problem as fodder is not available in plenty throughout the year, in many areas. The poor people allow their livestock to graze the forests and grasslands, which also causes biodiversity loss.

8. Natural Calamities:

Catastrophic events like floods, droughts, cyclones, volcanoes, fires, etc. cause severe biodiversity loss from time-to-time.

Endangered and Endemic Species of India:

The population has the potential to extend forward in time, but various factors may prevent the perpetuation of the species. Of the well-known species, there are several which are under threat by human activity. International Union for Conservation of Nature and Natural Resources (IUCN) categorized these species as vulnerable, rare, threatened and endangered species.

Several plant and animal species in the country are now found in only one or a few protected areas. Among the important endangered animals are charismatic species such as the tiger, the elephant, the rhino, etc. The less well-known major mammals restricted to a single area include the Indian wild ass, the Hangul or Kashmir stag, the Golden langur, the pygmy hog and a host of others.

There are also endangered bird species such as the Siberian crane, the Great Indian Bustard, the Florican and several birds of prey. During the recent past, vultures which were common a decade ago, have suddenly disappeared and are now highly threatened. Equally threatened are several species of reptiles and amphibia. Many invertebrates are also threatened, including a large number of species that inhabit our coral reefs.

Many plant species are now increasingly threatened due to changes in their habitats induced by human activity. Apart from major trees, shrubs and climbers that are extremely habitat specific and thus endangered, there are thousands of small herbs which are greatly threatened by habitat loss.

Several orchids are yet another group of plants that are under threat. Many plants are threatened due to overharvesting as ingredients in medicinal products.

Biodiversity Hotspots in India

India has two biodiversity hot spots, namely: Himalaya **(Eastern Himalayas) &The Western Ghat.**

1. Eastern Himalaya Phyto-geographically, the Eastern Himalaya forms a distinct floral region and comprises of Nepal, Bhutan, states of East and North-East India, and a contiguous sector of Yunnan province in South-Western China.
2. In the whole of Eastern Himalaya, there are an estimated **9,000 plant species, out of which 3,500 (i.e. 39 per cent) are endemic.**
3. In the Indian portion, there occurs some **5,800 plant species, roughly 2,000 (i.e. 36 per cent) of which are endemic.**
4. At least **55 flowering plants endemic** to this area are recognized as rare, for example, the Pitcher Plant (Nepenthes khasiana).

5. The area has long been recognized as a rich centre of primitive flowering plants and is popularly known as the **'Çradle of Speciation'.**

6. Species of several families of monocotyledons, Orchidaceae, Zingiberaceae and Arecaceae are found in the area. Gymnorperms and Pteridophytes (ferns) are also well represented here.

7. The area is also rich in wild relatives of plants of economic significance e.g. rice, banana, citrus, ginger, chilli, jute and sugarcane.

8. It is also regarded as **the centre of origin and diversification of five palms of commercial importance, namely coconut, arecanut, palmyra palm, sugar palm and wild date palm.**

9. **Tea (Thea sinensis) has been cultivated in this region for the last 4,000 years**. Many wild and allied species of tea, the leaves of which are used as a substitute for tea, are found in the North East, in their natural habitats.

10. **The Taxol plant (Taxus wallichiana) is sparsely distributed in the region and is listed under the red data category** due to its overexploitation for extraction of a drug effectively used against cancer.

11. As regards faunal diversity, **63 per cent of the genera of land mammals in India are found in this region**. During the last four decades, two new mammals have been discovered from the region – **Golden Langur from** Assam-Bhutan region, and **Namdapha Flying Squirrel from Arunachal Pradesh**, indicating the species richness of the region.

12. The region is also a rich centre of avian diversity – **more than 60 per cent of the bird species found in India have been recorded in the North East.**

13. The region also hosts two endemic **genera of lizards, and 35 endemic reptilian species, including two turtles**.

14. Of the **240 Indian amphibian species, at least 68 species** are known to occur in the North East**, 20 of which are endemic.**

15. **From Namdapha National Park itself, a new genus of mammal, a new subspecies of a bird, six new amphibians' species, four new species of fish, at least 15 new species of beetles and six new species of flies have been discovered.**

Western Ghats

1. The Western Ghats region, which is spread into 6 states of India, is considered to be one of the most important bio-geographic zones of India, as it is one of the richest centers of **endemism.**

2. Due to varied topography and microclimatic regimes, some areas within the region are considered to be active zones of speciation. The **region has 490 arborescent taxa, of which as many as 308 are endemic**.

3. About **1,500 endemic species of dicotyledonous** plants are reported from the Western Ghats.

4. **245 species of orchids belonging to 75 genera are found here, of which 112 species** in ten genera are endemic to the region.

5. As regards the fauna, as many as **315 species of vertebrates belonging to 22 genera are endemic**, including **12 species of mammals, 13 species of birds, 89 species of reptiles, 87 species of amphibians and 104 species of fish.**

6. The extent of endemism is high amongst amphibian and reptile species. There occur **117 species of amphibians in the region, of which 89 species (76 per cent) are endemic. Of the 165 species of reptiles found in Western Ghats, 88 species are endemic.**

7. **Nearly 235 species of endemic flowering plants are considered endangered**.

8. Rare fauna of the region include – **Lion Tailed Macaque, Nilgiri Langur, Nilgiri Tahr, Flying Squirrel, and Malabar Gray Hornbill.**

http://www.gktoday.in/biodiversity-hotspots-in-india/

Biogeographical classification of India

India has different climate and topography in different parts and hence is termed as a *mega diversity country.* India occupies ***10th place among plant rich countries of the world.*** It is essential to acquire knowledge about the distribution and environmental interaction of flora and fauna of India. Biogeographers have classified India into ten biogeographic zones with each zone having characteristic climate, soil and biodiversity. These zones are described below:

1. **Trans-Himaylayas** The trans-himalayas is an extension to the Tibetean plateau. This region harbors the high-altitude cold desert in ladakh (Jammu and Kashmir) and Lahaul Spiti (Himachal Pradesh). It accounts for 5.7% of the country's landmass.
2. **Himayalas** The Himalayas are the northern boundaries of India. The entire mountain chain is running from Kashmir in the North-west to Assam in the north-east. The Himalayas comprise of a diverse range of biotic provinces and biomes. The himalayas cover 7.2% of the country's landmass
3. **Desert** The extremely dry area west of the Aravalli hill range, is comprising both the salty desert of Gujarat and the sandy desert of Rajasthan. Deserts occupy around 6.9% of the country's land mass. The kinds of deserts found in India are:
    1. The desert of western Rajasthan
    2. The desert of Gujarat
    3. The high-altitude cold desert of Jammu & Kashmir and Himachal Pradesh. The Indian deserts have more diversified fauna.
4. **Semi-arid** This zone lies between the desert and the Deccan plateau. It includes the Aravalli hill range. It overs approximately 15.6% of the country's landmass.
5. **Western Ghats** The western ghats are a mountain range that runs along the western cost of India. They are a range extending north-south from southern tip of Gujarat in the north to Kanyakumari in the south.The mountains cover an area of about 160,000 sq. km. This ghat section covers an extremely diverse range of biotic provinces and biomes. It covers about 5.8% of the country's landmass.
6. **Deccan plateau** It is a large triangular plateau south of the Narmada valley. Three sides of the plateau are covered by mountains slopes towards east. Satpura mountains cover the north while western ghats cover the west side and eastern ghats cover the eastern side of the plateau. It is the one of largest zones covering the southern and south-central plateau with mostly deciduous trees. It covers 4.3% of the country's land mass.
7. **Gangetic plain** This plain covers the area between the south himalayas to the tropic of cancer. These plains were formed by the Ganges river system and are relatively homogeneous. This region experience 600 mm rainfall annually. *Sunderbans* forests are located in this region and it covers 11% of the country's land mass.
8. **North-east India** These are pains and non-himalayan ranges of northeastern India and have a wide variety of vegetation. It covers around 5.2% of the country's land mass.
9. **Islands** The Andaman and Nicobar Islands in the Bay of Bengal has almost 300 big and small islands. Among these, only five islands are inhabited. Only tribes are found in the island of Nicobar. These islands have a highly diverse set of biomes and occupy 0.03% of the country's biomass.
10. **Coasts** India has a large coastline distributed both to the east and west with distinct differences between the two. The Lakshwadeep islands are included in this but the area of these islands is negligible.