ENVIRONMENTAL STUDIES

Unit 4: Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Bio-geographic zones of India; Biodiversity patterns and global biodiversity Hotspots

WHAT IS BIODIVERSITY?

Biodiversity is the variety and variability of life forms on Earth. It is typically a measure of variation at the genetic, species, and ecosystem level. The term '*Biodiversity*' is the shortened form of two words '*Biological Diversity'* or '*Biotic Diversity*' which came into use in scientific literature early in 1968 in the book *A Different Kind of Country*, authored by scientist and conservationist Raymond F. Dasmann. However, it was only in the 1980s that its use became more common in scientific jargon. It was Thomas Lovejoy, a biologist active in the World Wildlife Fund (WWF) in 1980, who rescued the term for the scientific community. It refers to all the variety of life that can be found on Earth (plants, animals, fungi and micro-organisms) as well as to the communities that they form and the habitats in which they live. But the term *'Biodiversity'* was first coined by Walter G. Rosen in the year 1986 to express the number of species present in the community.

According to Edward Wilson (1988) "*Biodiversity is the combined diversity at all the levels of biological organization"*. Denny (1997) defined "*Biodiversity includes assemblages of plant, animals and micro-organisms, their genetic variability expressed and populations, their habitats, ecosystems and natural areas, the mosaic of which constitutes the landscape which gives the richness to the natural environment*".

As defined in Article 2 of the Convention on Biological Diversity (CBD) singed at Rio De Jenerio (Brazil) in 1992 by 154 countries, the '*Biodiversity'* defined as "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes biological diversity within species and ecosystems*".

According to International Union for Conservation of Nature (IUCN) in 1998, *"the variety and variability of species of their population, the variety of species of their life forms,*

the diversity of the complex association with species with their interaction and their ecological process which influences perform".

LEVELS OF BIODIVERSITY:

Biodiversity is commonly explored at three levels- genetic diversity, species diversity and ecosystem diversity. These three levels work together to create the complexity on Earth.

A) Genetic Diversity

Genetic diversity is the variety of genes within the species. Each species is made up of individuals that have their own particular genetic composition. This means a species may have different populations, each having different genetic compositions. Such different composition or variation may found in the nucleotides, genes, chromosomes, or whole genomes of organisms. Specifically genetic diversity is the sum total of genetic information, contained in the genes of individuals of plants, animals and microorganisms that inhabit the earth. So, genetic diversity refers to the variation of genes within a species. The genetic diversity enables the population to adapt to its environment and respond to natural selection. If a species has more genetic diversity, it can adapt better to the changed environmental conditions. The amount of genetic variation is the basis of speciation. It has a key role in the maintenance of diversity at the species and community levels. Genetic diversity within a species often increases with environmental variability. To conserve genetic diversity, different populations of a species must be conserved.

For example, there are about 5000 recorded varieties of mango (*Mangifera indica*); 88000 recorded varieties of rice (*Oryza sativa*). Western and Eastern gray squirrels (*Sciurus griseus* and *Sciurus carolinensis* respectively) are great examples in this case. Western gray squirrels, which inhabit the west side of the Rocky Mountains, have more similarities than differences with the eastern gray squirrels. However, these two types of squirrels don't share a common mating behavior. Even when placed in the same environment, eastern and western squirrels don't mate because they are two different species.

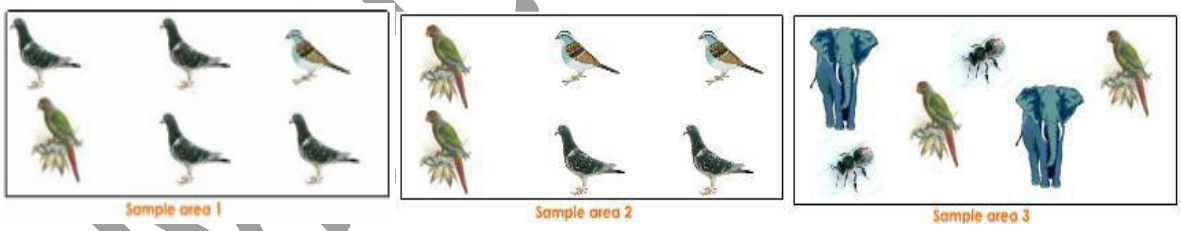


Similarly, humans show a lot of diversity among themselves. That is why every human also looks different from each other.

B) Species Diversity:

A group of organisms genetically so similar, that they can interbreed and produce fertile offsprings is called a **species**. According to Mayr's definition, *"species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups"*. Species diversity refers to the variety of species within a region. Simplest measure of species diversity is species richness, i.e. the number of species per unit area. The number of species increases with the area of the site. Generally, greater the species richness greater is the species diversity. However, number of individuals among the species may also vary resulting into differences in evenness, or equitability, and consequently in diversity.

Suppose we are having three sample areas. In the sample area one, there are three species of birds. Two species are represented by one individual each, while the third species has four individuals (see plates given below). In the second sample area that has the same three species, each species is represented by two individuals. This sample area shows greater evenness, and there are equal chances for a species being represented in a sample. The second sample area will be considered more diverse than the first. In the third sample area, the species are represented by an insect, a mammal and a bird. This sample area is most diverse, as it comprises taxonomically unrelated species. In this example, we find equal number of species but varying number of individuals per species. In nature, both the number and kind of species as well as the number of individuals per species vary, leading to greater diversity.



C) Ecosystem Diversity:

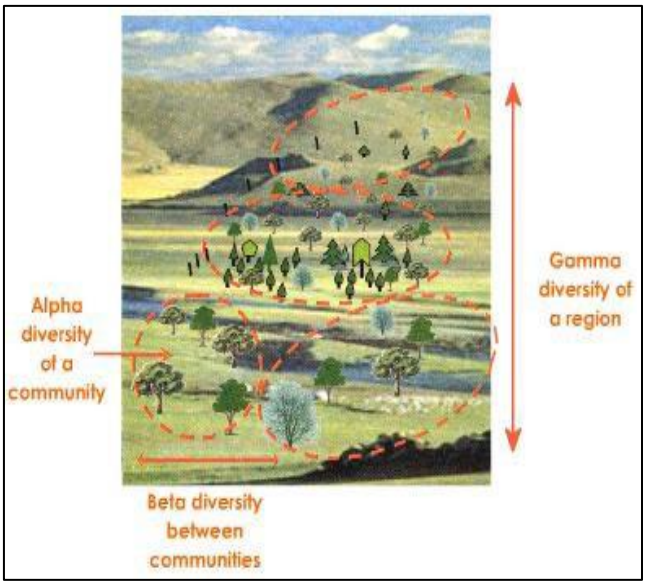
Ecosystems include all the species, plus all the abiotic factors characteristic of a region. For example, a desert ecosystem has soil, temperature, rainfall patterns, and solar radiation that affect not only what species occur there, but also the morphology, behaviour and the interactions among those species. Ecosystem diversity describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food webs and the recycling of nutrients. It has a focus on various biotic as well as abiotic interactions among every unit of an ecosystem.

An ecosystem can cover a small area, like a pond, or a large area, like an entire forest. The primary source of energy in virtually every ecosystem is the sun whose radiant energy is transformed into chemical energy by the plants. Animals eat the plants, allowing the energy to flow through the systems. The animals are, in turn, eaten by other animals. Fungi decompose organisms to obtain energy and in the process recycle nutrients back into the soil.

Hence, an ecosystem is a collection of living components and non-living components that are connected by energy flow. The number of habitats or ecosystems can vary within a geographical area. The number of habitats/ecosystems present in a region is also a measure of biodiversity.

RH Whittaker (1972) described three terms for measuring biodiversity over spatial scales: **alpha**, **beta**, and **gamma** diversity.

- ***Alpha Diversity*** refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., *species richness*) in that ecosystem. For example, if we are monitoring the effect that British farming practices have on the diversity of native birds in a particular region of the country, then we might want to compare species diversity within different ecosystems, such as an undisturbed deciduous wood, a well-established hedgerow bordering a small pasture, and a large arable field. We can walk a transect in each of these three ecosystems and count the number of species we see; this gives us the alpha diversity for each ecosystem;



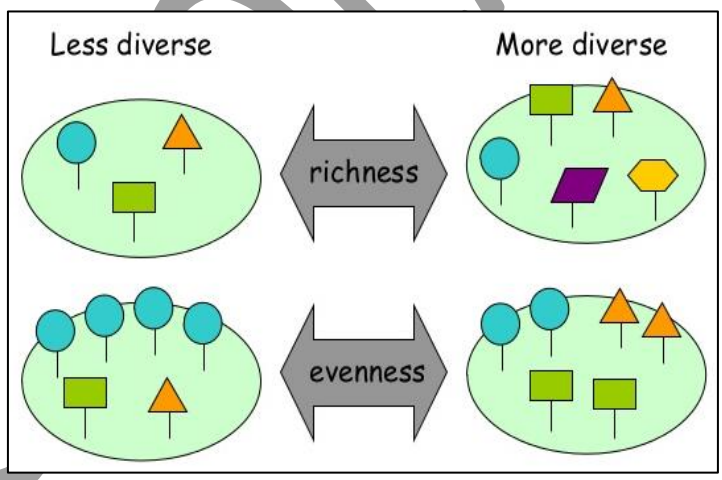
- ***Beta diversity****:* a comparison of diversity between ecosystems, usually measured as the amount of species change between the

ecosystems. For example, the beta diversity between the woodland and the hedgerow habitats is 7 (representing the 5 species found in the woodland but not the hedgerow, plus the 2 species found in the hedgerow but not the woodland). Thus, beta diversity allows us to compare diversity between ecosystems.

- ***Gamma diversity****:* a diversity of the habitats over the total landscape or geographical area. Hunter (2002) defines gamma diversity as "*geographic-scale species diversity*". For example, the total number of species for the three ecosystems 14, which represent the gamma diversity.

Species Richness and Evenness

Species richness is only one aspect of diversity. Not all species exist in equal numbers: some are rare, some are common but not numerous, and others are very abundant. Imagine two forests, both of which contain a total of 100 individuals belonging to 5 different species. In one forest, there are 20 individuals of each species. In the other, one species has 60 individuals, while each of the other four species has 10 individuals. These two samples differ in a property called evenness. The first, in which the species are represented by the same number of individuals, is more even, and thus, has high overall species diversity. Thus, the species diversity of a community depends on both its richness as well as evenness: higher species numbers, with the individuals more evenly distributed among them, contribute to higher community diversity.

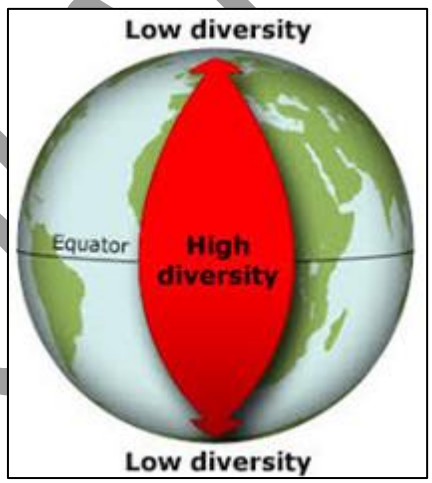


BIODIVERSITY PATTERN

Biodiversity is the variety observed in organisms at every level of biological organization. As ecologists studied biodiversity in the environment, they observed a regular pattern in which diversity was distributed over the entire area of the planet. Ecologists discovered two broad kinds of diversity patterns, namely:

A) Latitudinal Gradient:

This is the most well-defined and well-known pattern of biodiversity studies till date. According to this pattern, the species diversity follows a regular pattern as we move from the equator to the polar regions. The plant and animal diversity are observed to be maximum at the equator and it decreases as we move towards the poles. There might be an exception to a few species, but apart from that, it is a generally observed trend. We find species richness in plants and animals at the equator. India, located in the tropical regions, shows high species richness. However, the great Amazon rainforests show maximum biological diversity in terms of the number of species residing in that region. It is believed that in spite of being the region with the highest biodiversity, many species in Amazon are yet to be discovered and identified. The reason for this increased level of biodiversity at the tropics is thought by ecologists to be as follows:



- Tropical areas have a more stable climate compared to that of the temperate areas. As a result, the tropics succeed in supporting a higher number of species as the species do not have to keep adapting to a changing season.
- Temperate regions have suffered a lot of glaciations in the recent past as a result of which they have had a very unstable environment. Whereas, the tropics have been comparatively stable. Thus, speciation has been more favored in the tropics compared to that of the temperate lands.
- The tropical regions are comparatively more susceptible to solar energy. As a result, the plants in this region receive more energy during photosynthesis.

This, in turn, transfers more energy to the successive trophic levels in the food chain. Thus, more energy supports more diversity.

B) Species-Area Relationships (SAR):

The great German geographer and naturalist, Alexander von Humboldt observed the relation between an area and the species richness found in it. He found that as he increased the area of observation, the plant and animal diversity increased but up to a certain level.

There are many factors that can impact and influence SAR, which include:

- **Habitat heterogeneity**: the variation of physical characteristics of a specific habitat, including weather, vegetation, and soil
- **Speciation**: the formation of a new species due to evolution; increased speciation leads to more species in a specific area of land
- **Fragmentation**: dividing a larger habitat into several smaller habitats that are isolated from one another
- **Dispersal**: the movement of members of a species to a different location from where they were born or originated

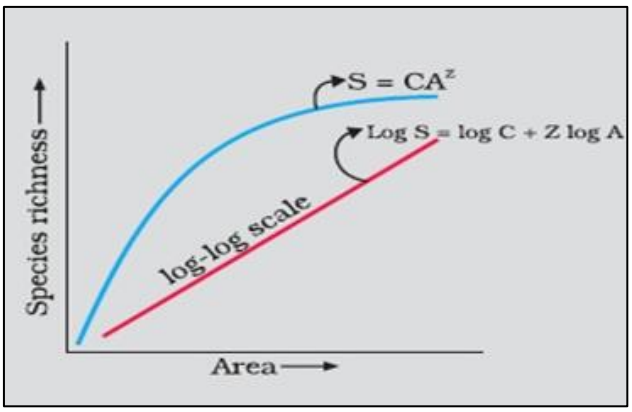
Studying and examining SAR is important because it can help with understanding the structure and inner workings of a habitat, as well as the factors that impact the survival of a species. Knowing these factors can help with creating more effective conservation strategies.

SAR can also used to describe/study the number of species on an island. Just as with the mainland, larger islands typically have more species of plants and animals. Additionally, islands that are closer to the mainland typically have more species of plants and animals as well.

Mathematically, it can be explained by the equation-

log S = log C + Z log A
where,
S = richness of species
C = Y-intercept
Z = regression coefficient
A = Area

The equation can be represented by the following diagram:



BIO-GEOGRAPHIC ZONES OF INDIA

Biogeography is the study of the distribution of species (biology), organisms, and ecosystems in geographic space and through time. Distribution of flora and fauna at any place is largely governed by the latitude, longitude, altitude, geology and climate of that region. Specific areas can be marked on the basis of distribution of distinctive flora and fauna and are known as Biogeographic zones. Each biogeographic zone has several habitats, biotic communities and ecosystems. Biogeography is divided into 2 parts:

a) Phyto-geography that deals with origin, distribution, & environmental relationships of plant and
b) Zoo-geography that deals with the migration & distribution of animals.

Bio-Geographical Classification of India

India is one of the 12th Mega diverse regions of world with only 2.4% of the total land area (Mexico, Columbia, Madagaskar, Ecuador, Cameroon, Peru, Brazil, Jaira, China, Malaysia, Indonesia and India). The biological diversity of India contributes 8% to the known global biological diversity. The bio-geographical regions are identified, determined and represented on the map on the basis of some common characteristics that are held by plants and animals. In a broad and fundamental sense a bio-geographical region may be described as an area possessing a particular set of climatic conditions i.e., its own distinctive temperature and rainfall regime and its own diurnal and seasonal changes which give rise to a particular kind of vegetation which in turn give rise to a particular kind of animal life. The bio-geographical regions with respect to plant and animal are studied separately such as floral regions and faunal regions because both vary in their characteristics as it has already been mentioned above.

India can be conveniently divided into ten major regions based on geography, climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, amphibians, insects and other invertebrates that live in them. Each of these regions contains a variety of ecosystems such as forests, grasslands, lakes, rivers, wetlands, mountains and hills which have specific plants and animal species. Further these 10 bio-geographic zones in India are divided into 25 secondary units called *biogeographic provinces* giving weight to particular communities separated by dispersal barriers or gradual change in environmental factors. The classification was done using various factors such as altitude, moisture, topography, rainfall, etc. Biogeographic zones were used as a basis for planning wildlife protected areas in India.

Table 1: Biogeographic zones and biotic provinces of India.

	Biogeographic Zone	Biotic Provinces
1.	Trans-Himalaya	Upper reaches of Himalaya
2.	Himalaya	North-west Himalaya, West Himalaya, Central Himalaya, East Himalaya
3.	Desert	Kutchh, Thar, Ladak
4.	Semi-arid	Central India, Gujarat Rajwara
5.	Western Ghats	Malabar Coast, Western Ghats Mountains
6.	Deccan Peninsula	Deccan Plateau, South Central Plateau, Eastern Plateau, Chhota Nagpur, Central High Lands
7.	Gangetic Plain	Upper Gangetic Plain, Lower Gangetic Plain
8.	North-East India	Brahmaputra Valley, North-Eastern Hills
9.	Islands	Andaman Islands, Nicobar Islands, Lakshadweep Islands
10	Coasts	West Coast, East Coast

Source: Ecology environment and resource conservation, Table 7.4 (Part 7) Singh *et al* (2006)

Table 4.1 Biogeographic Zones of India and their Spatial Extent

Zone No.	Zone Name	Zone Area Sq km	Percentage of India's land area
1.	Trans-Himalaya	184823	5.62
2.	Himalaya	210662	6.41
3.	Desert	215757	6.56
4.	Semi-Arid	545850	16.60
5.	Western Ghats	132606	4.03
6.	Deccan Peninsula	1380380	41.99
7.	Gangetic Plain	354782	10.79
8.	Coasts	82813	2.52
9.	Northeast	171341	5.21
10.	Islands	8249	0.25
	Grand Total	**3287263**	**100.00**

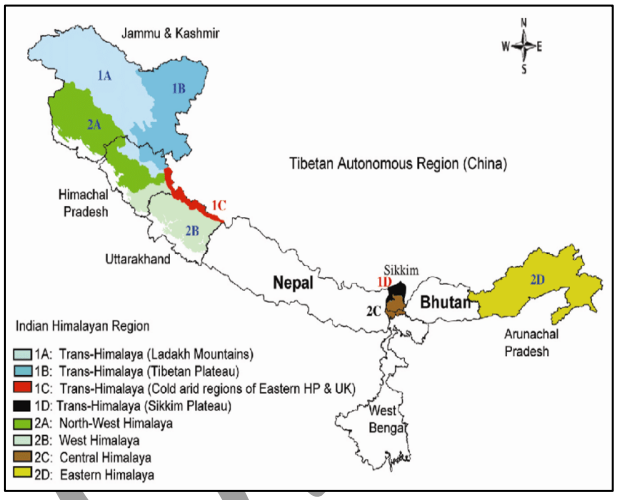
Source: Rodgers et. al., 2002

Rodgers *et. al.* (2002) recognise ten biogeographic zones divided into twenty-six biotic provinces in India: (*see*

The details of bio-geographic zones of India are given below:

1) **Trans- Himalayan**

Area and Distribution: Trans-Himalayas, meaning beyond the Himalayas, covers an estimated land area of 184,823 km^2 (5.6%) and includes the Indian region of Ladakh in Jammu & Kashmir State, and Lahaul-Spiti of Himachal Pradesh.



Landscape: The entire zone is a high-altitude (4,500 to 6,600 m above mean sea level), it includes high altitude cold and arid mountain areas, including cold deserts. An extension of the Tibetan Plateau, this zone has sparse alpine steppe vegetation.

Diversity: The landscape is characterized by a high degree of endemism. The largest number of wild sheep and goats in the world found here. The common animals found in this zone are great Tibetan sheep (*Ovis ammon hodgsoni*), the urial or shapu (*Ovis orientalis*), the bharal or blue sheep (*Pseudois nayaur*), the *ibex (Capra ibex*), the Tibetan antelope (*Pantholops hodgsoni*, which is better known as the chiru) the Tibetan gazelle (*Procapra picticaudata*), pikas, marmots and Tibetan hares, the snowleopard or ounce and the Pallas cat, Indian wolf and the lynx.

2) **Himalayan**

Area and Distribution: The zone extending some 210,662 km^2 (6.4%) in the Indian region and accounting for nearly seven per cent of the country's total surface area, this zone extends over the states of Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Sikkim and Arunachal Pradesh. Outside India, Pakistan, Nepal and Bhutan also fall within this zone.

Landscape: Intense rainfall, steep slopes and infirm soils make the Himalayan Mountains extremely vulnerable. In addition to this cultivation of steep slopes, livestock grazing, tourism and deforestation for fuel and timber combine to devastate the Himalayas. The Himalayas, generally divided into four sectors: the north west, west, central and east, encompasses extreme habitat types, ranging from arid

Mediterranean and temperate in the western parts, to warm, moist, evergreen forests in the east.

Diversity: The Himalayan zone has diverse habitats for a range of species including endangered ones such as Hangul (*Cervus eldi eldi*) and Musk Deer (*Moschus moschiferus*). In lower subtropical belt mixed deciduous forests occupy lowest elevations, they are replaced by chir pine (*Pinus roxburgii*) and then by banj oak (*Quercus leucotrichophora*) at around 2000m elevations.

3) The Indian Desert

Area and Distribution: Biogeographically, it is the eastward extension of the Sahara-Arabian desert system which spread through Iran, Afghanistan and Baluchistan to the Thar area on the Indo-Pakistan border. This arid zone falls west of the Aravalli hill range and comprises both the salt and sand deserts of northwestern India. It constituting about 215,757 km^2 (6.6%) of the country's geographical area.

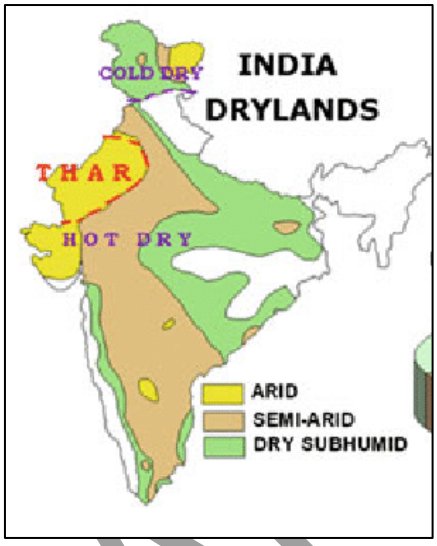
Landscape: The Indian desert zone has been divided into two distinct sub-divisions, the larger Thar Desert region which covers 180,000 km km2 in the state of Rajasthan, and the Rann of Kutchh, covering some 45,000 km2 of western Gujarat. This zone also has large expanses of grasslands that support several endangered species.

Diversity: The zone has habitats for a range of species including the Great Indian Bustard (*Ardeotis nigriceps*). The plant species are *Acacia nilotica*, *Prosopis cineraria*, *Salvadora oleoides* and *Tecomella* spp. *Prosopis juliflora* and other species are becoming increasingly widespread.

4) The Semi- Arid

Area and Distribution: The Semi-arid zone, a transition from true desert to semidesert, scrub and stunted forests, is spread over low mountain ranges. East of the Indian desert and west of the Gangetic Plain, the Semi-arid Zone encompasses a total area of 545,850 sq. km^2, covering nearly 16.60% of India's area. Included are the

extreme southern portions of Jammu and Kashmir, a narrow belt of lower Himachal Pradesh, the states of Punjab and Haryana, Rajasthan (west of the desert), Gujarat (west of the Great Rann) and the western parts of Madhya Pradesh.



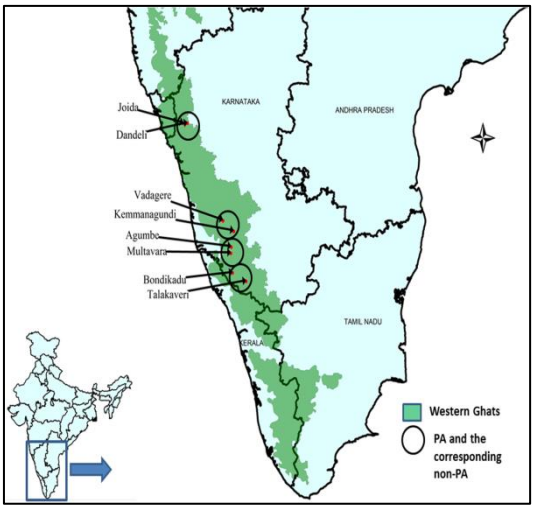
Landscape: This zone also has several lakes and marshlands. The grasses and palatable shrub layer of this zone support the highest wildlife biomass. This zone can broadly be divided in northern region and southern region. The northern region of this zone houses the flat, alluvial deposits of the Indus river drainage system. Intensely irrigated and cultivated, this northern stretch, known as the Punjab Plains, includes Haryana and Punjab, the southern margins of Jammu & Kashmir and Himachal Pradesh or what are the western most parts of the Bhabar and the Shivalik mountains.

Diversity: Many plant taxa have African affinity: *Acacia*, *Anogeissues*, *Balanites*, *Capparis*, *Grewia*. *Anogeissues pendula* forest community occurs only in this zone, on gentler slopes of the Aravalli and associated hill ranges. The endangered Asiatic Lion (*Panthera leo persica*) is also found in this zone, in the Gir forests of Gujarat. The largest herbivores are Blackbuck, Chowsingha, Nilgai, and Gazelle.

5) Western Ghats

Area and Distribution: Western Ghats is a mountain range running along the western coast of peninsular India, from Tapti River in the north to Kanyakumari in the south.

Landscape: The moist evergreen forests are most extensive in the Western Ghats. Constituting 4% of the country's geographical area, this zone supports tropical evergreen forests that are home to approximately 15,000 species of higher plants, of which around 4,000 (27%) are endemic. The rainfall is heavy; possibly



more than 2,000mm in most areas but can exceed 5,000mm in some areas.

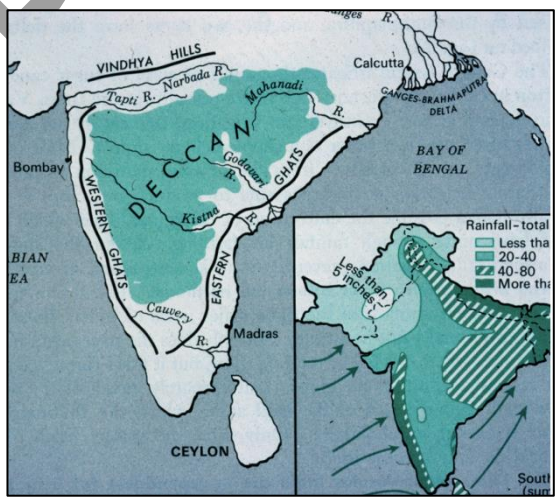
Diversity: Though this zone has healthy populations of much of the animal species characteristic of peninsular India e.g. tiger, elephant, gaur, sloth bear, panther and several species of deer, it also exhibits a fairly good degree of endemism among primates, ungulates, carnivores, rodents, squirrels and several birds. Amongst amphibia, most of the species and nearly half the genera are endemic, while a good degree of endemism is visible also amongst reptiles, fish and insects, most faunal endemism and restriction being only in the central and and southern parts of the zone.

Presently, of all the Bio-geographic zones, The Western Ghats with 44 Sanctuaries and National Parks, covering some 15,935 km2 has the highest percentage of protected areas.

6) The Deccan Peninsula

Area and Distribution: With an area of 13,80,380 km^2, the Deccan Peninsula extends over 42% of India's landmass, spreading over eight states.

Landscape: The Deccan highlands constitute the principle catchment for a number of South India's main river systems (Narmada, Tapti, Mahanadi, and Godavari). This zone is more or less homogeneous, at least three principal habitat types are easily recognized. These are deciduous forests, thorn forests and scrublands. Additionally there are pockets of semi-evergreen and evergreen forests, mainly in the mountain range known as the Eastern Ghats.



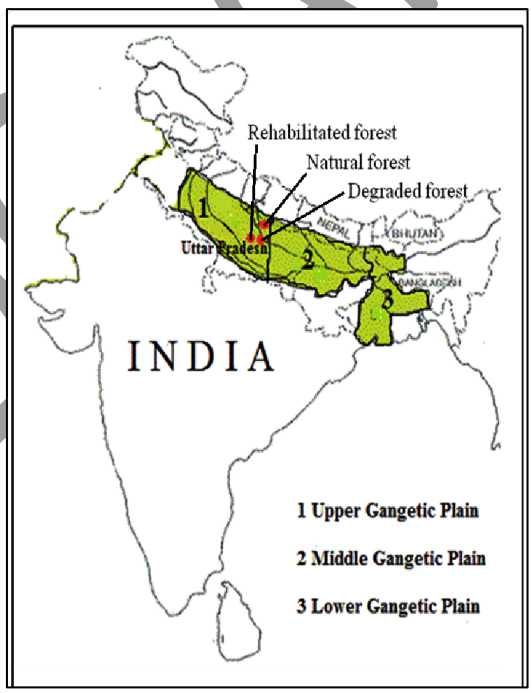
Diversity: In the north, the dominant deciduous tree species are *Shorea robusta* (sal), *Tectona grandis* (teak), *Terminalia* , *Anogeissus* and *Chloroxylon* etc. South of the river Krishna, in the Karnataka plateau, Tamil Nadu plains and adjoining mountains, dry, thorny species such as *Acacia*, *Hardwickia* and *Albizia* dominate the landscape.

The zone with abundant populations of deer and antelope species such as Chital (*Axis axis*), Sambar (*Cervus unicolor*) and Four-horned Antelope (*Tetracerus quadricornis*). There are small populations of Asian Elephants (*Elephas maximus*)

and Wild Water Buffaloes (*Bubalus arnee*) as well. Gharhial is restricted to some rivers.

7) The Gangetic plain

Area and Distribution: The Gangetic Plain extends along the foothills of the Himalayas, from Uttar Pradesh eastwards through Nepal, Bihar, West Bengal and parts of coastal Orissa. The entire area comprises a vast, flat, alluvial expanse, both to the north and south of the river Ganges, and its many tributaries that cut southward through the Himalayas. Eastwards, this zone extends into Bangladesh and coastal Burma. With an area of 354,782 km^2, roughly 11% of India's total landmass, the Gangetic Plain is one of the largest distinctive habitat zones of the subcontinent. The central hill ranges of the Vindhyas and Aravallis form the southern boundary of the Gangetic Plain into which the Shivaliks and the Bhabar regions of the Himalayan foothills to the north have also been included.



Landscape: The area known to be one of the world's most fertile regions, the Gangetic Plain is the most densely populated of the 10 habitat zones. Nearly 300 million people, accounting for over 30 per cent of India's population reside in this zone. Only in the narrow northern belt, flanking the Himalayan massif in the Shivaliks and Bhabar, can one still see bits of natural forests and grasslands. The region is dotted with innumerable lakes and marshes. Nearly 90 per cent of the Gangetic Plain has been significantly altered, the natural vegetation having long been converted into cropland.

Diversity: This zone supports many large and charismatic mammals such as One-horned Rhinoceros (*Rhinoceros unicornis*), Asian Elephant and Wild Water Buffalo. Other characteristic fauna includes Swamp Deer (*Cervus duvauceli*), Hog Deer (*Axis porcinus*) and Hispid Hare (*Carprolagus hispidus*). Sal (*Shorea robusta*) forest represents potential vegetation along the Himalaya and mixed dry deciduous forests in

plains. Western areas hold relict populations of Rhino, Elephant, Buffalo, Swamp deer, etc. A good part of the last surviving populations of Bengal florican are to be found in this zone. In the wetland habitat of this zone are found over 20 species of turtles, non-gregarious Gangetic dolphin, crocodiles and alligators, and several species of migratory waterfowls only during the winters.

8) Coasts

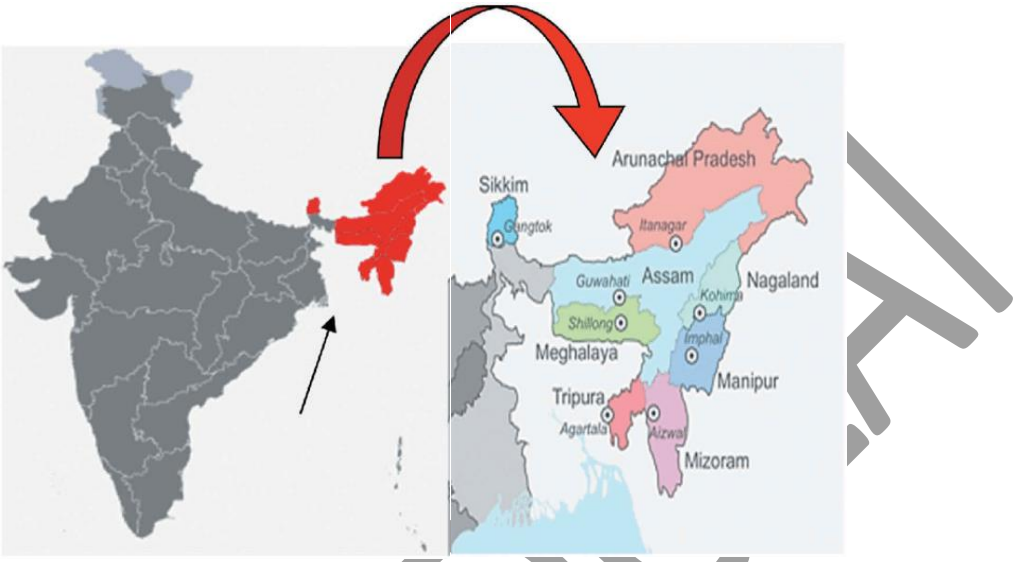
Area and Distribution: Starting at the Pakistan border, the Indian shoreline extends over nearly 5,500 km, from Gujarat in the west, down along the Konkan and Malabar coasts, around Kanyakumari and then up along the Coromandel coast to Bengal's Sundarbans, to continue into Bangladesh.

Landscape: This zone exhibits unparalleled topographical diversity throughout its length with Mangrove swamps, tidal creeks, mudflats, sandy beaches, coral shores, cliffs and jagged rocky stretches adorn the Indian subcontinent.

Diversity: Several species of dugongs (sea cow), marine turtles, estuarine crocodiles and myriad waders are found on the shore and near-shore habitat. Species of crabs, lobsters, oysters, jellyfish, puffer fish, octopus, sea slugs, mudskippers, several species of snakes and monitors are found extensively. Salt tolerance is a vital characteristic of the plants of coastal belts and mangroves are unquestionably the most successful examples of such adaptation. Over 2,000 species of organisms, ranging from bacteria, fungi, lichens, plants, protozoa, crustaceans, insects, reptiles, birds and mammals are closely associated with the Indian mangroves, and many are yet to be recorded.

9) North- East

Area and Distribution: Contiguous with the Gangetic Plain, the northeast comprises six of the famous 'Seven Sisters'- the states of Assam, Manipur, Mizoram, Meghalaya, Nagaland and Tripura. The total area of the Northeast is 171,341 km^2, or about five per cent of India's land area.



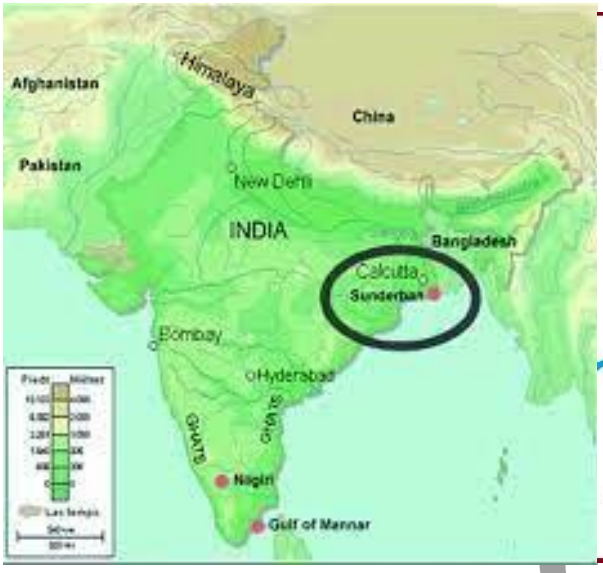
Landscape: Nearly 40 per cent of the area of this zone, amounting to just under 70,000 km2, is presently forested. The northeast is amongst the most biodiversity rich regions of the world. Ironically, the northeast also happens to house the largest number of endangered species out of all the zones in India. The Brahmaputra valley, a continuation of the Gangetic plain of Bengal in the west, is the dominating feature of this zone, its periphery being dotted with moist grasslands, swamplands and forests. It is in this region that protected areas such as Manas and Kaziranga are found.

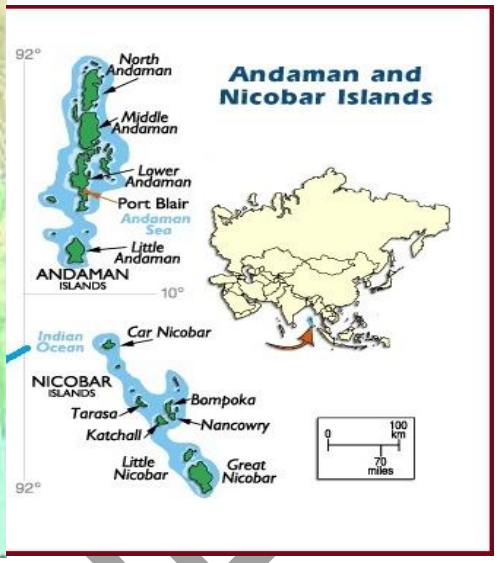
Diversity: It is only in the north-east that the full richness of the large herbivore fauna typical of alluvial grasslands can still be found: rhinoceros, buffalo, elephant, swamp deer, hog deer, pygmy hog and hispid hare. The region represents an important fly away for waterfowl and other herds seasonally migrating. Manas and Kaziranga hold appreciable populations of herbivores including rhinoceros, wild buffalo, gaur, swamp deer, hog deer, pygmy hog, elephant and the rare and endangered hispid hare.

10) The Islands

Area and Distribution: Although this zone covers only 0.3 percent of the country's geographical area, it is nonetheless important from the biodiversity perspective. The Andaman and Nicobar group is the major and better known of the Indian islands. This is a largely north-south running archipelago, with a total of 348 islands, stretching

over a length of nearly 600 km. The total land area of these islands is 8,249 km^2. The Lakshadweep group consists of 25 islands in three clusters, with a total land area of a mere 109 km^2.





Landscape: The Andaman and Nicobar Islands have some of India's finest tropical evergreen moist forests and show high degree of endemism in flora and fauna. The importance of this zone is its species richness and endemism of plants and birds. Because of isolation of islands and their relatively small size, mammal fauna is poor. Most species are of rodents and mammals.

Diversity: The Andaman and Nicobar islands are one of the three dominant tropical, moist evergreen bio-zones of the subcontinent and their biological diversity, and endemism, is best observed in the variety of plants, birds and perhaps insects although they are poorly documented. The dominant mammal groups are bats and rodents. The principal endemic mammals are the dugong or sea-cow, the Nicobar crab-eating macaque and the Nicobar tree shrew, of which there are different races in the Little and the Greater Nicobar islands. Of the 255 species and subspecies of birds recorded in the islands, as many as 112 are endemic. Some of these are the Nicobar Megapode, the highly endangered Andamans Grey Teal, the Narcondam Hornbill, the Nicobar Pigeon, the Nicobar Parakeet, Andaman Wood Pigeon and Crested Serpent Eagle.

BIODIVERSITY HOTSPOTS

A biodiversity hotspot is a bio-geographic region with significantly high levels of biodiversity that is threatened by human activities. The concept of biodiversity *'hotspots'* originated with British ecologist and writer Norman Myers in 1988. A biodiversity hotspot is a relatively small area with an exceptional concentration of endemic species and a large number of endangered and threatened species. There is altogether, 36 areas around the world qualify as hotspots. They represent just 2.4% of Earth's land surface, but they support more than half of the world's plant species as endemics — i.e., species found no place else — and nearly 43% of bird, mammal, reptile and amphibian species as endemics.

According to **Conservation International** (CI), to qualify as a hotspot a region must meet two strict criteria:

a) It must contain at least 1,500 species of vascular plants (at least 0.5% of the world's total) as endemics - which is to say, it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is irreplaceable.
b) it has to have lost at least 70% of its original habitat or It must have **30% or less of its original natural vegetation**. In other words, it must be threatened.

Thus, hotspots are areas with the richest and most threatened reservoirs of plants and animals life on Earth. Norman Myers developed the hotspot concept to designate priority areas for in-situ conservation.

Many of the biodiversity hotspots exceed the two criteria. For example, both the Sundaland Hotspot in Southeast Asia and the Tropical Andes Hotspot in South America have about 15,000 endemic plant species. The loss of vegetation in some hotspots has reached a startling 95 percent.

Global Biodiversity Hotspots:

IUCN prepared '**Red Data Book'** where they enlisted **36 areas** around the world which are qualified as **Biodiversity hotspots**. These hotspots represent only 2.3% of the total Earth's land surface. The Biodiversity Hotspots of the World are given below:

North and Central America:

1) California Floristic Province
2) Madrean pine-oak woodlands
3) Mesoamerica
4) North American Coastal Plain

The Caribbean:

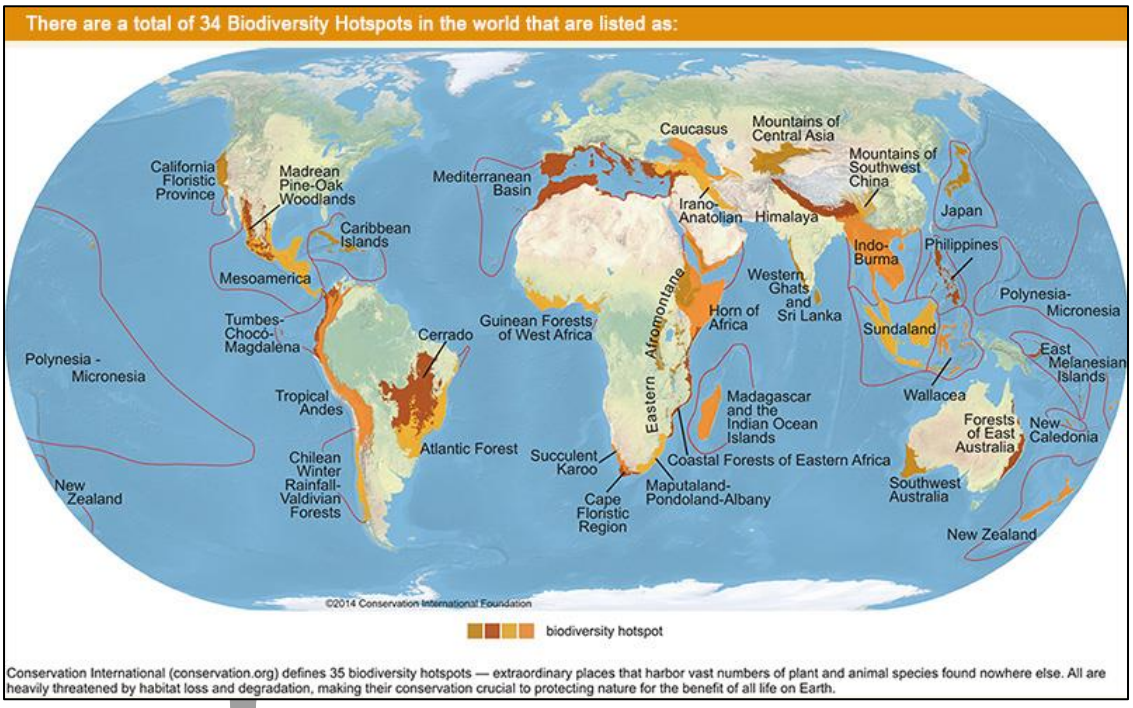
5) Caribbean Islands

South America:

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

Europe:

11) Mediterranean Basin



Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

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 and the Indian Ocean Islands
18) Maputaland-Pondoland-Albany
19) Succulent Karoo

Central Asia:

20) Mountains of Central Asia

South Asia:

21) Himalaya
22) Indo-Burma, India and Myanmar
23) Western Ghats and 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 and Nicobar islands of India

32) Wallacea

East Asia:

33) Japan

34) Mountains of Southwest China

West Asia:

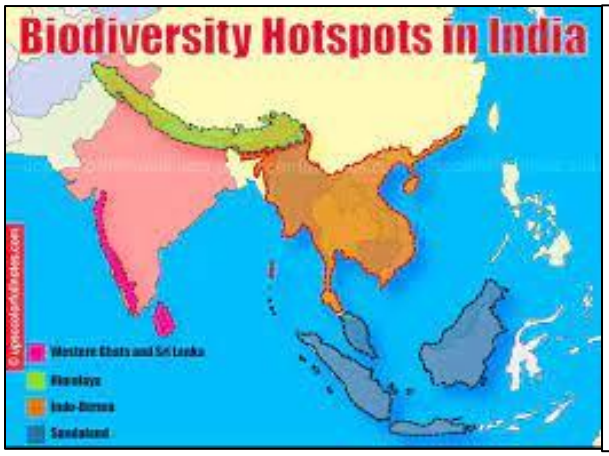
35) Caucasus

36) Irano-Anatolian

India's Biodiversity Hotspots:

India has four biodiversity hotspots:

A) Eastern Himalaya: It encompasses eastern Nepal across Northeast India, Bhutan, the Tibet Autonomous Region to Yunnan in China and northern Myanmar. The Himalaya Hotspot is home to the world's highest mountains, including Mt. Everest. The mountains rise abruptly, resulting in a diversity of ecosystems that range from alluvial grasslands and subtropical broadleaf forests to alpine meadows above the tree line. Vascular plants have even been recorded at more than 6,000 m. The hotspot is home to important populations of numerous large birds and mammals, including vultures, tigers, elephants, rhinos and wild water buffalo.



SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	10,000	3,160	31.6
Mammals	300	12	4.0
Birds	977	15	1.5
Reptiles	176	48	27.3
Amphibians	105	42	40.0
Freshwater Fishes	269	33	12.3

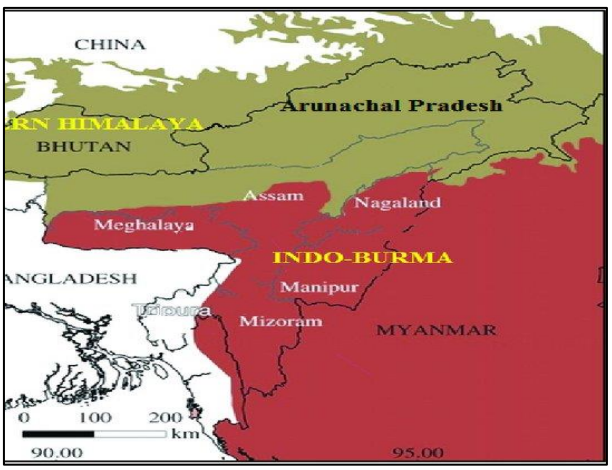
VITAL SIGNS

Hotspot Original Extent (km²)	741,706
Hotspot Vegetation Remaining (km²)	185,427
Endemic Plant Species	3,160
Endemic Threatened Birds	8
Endemic Threatened Mammals	4
Endemic Threatened Amphibians	4
Extinct Species†	0
Human Population Density (people/km²)	123
Area Protected (km²)	112,578
Area Protected (km²) in Categories I-IV*	77,739

†Recorded extinctions since 1500. *Categories I–IV afford higher levels of protection

B) Indo-Burma: The region-encompasses eastern Bangladesh and then extends across north-eastern India, south of the Brahmaputra River, nearly all of Myanmar, part of southern and western Yunnan Province in China, all of the Lao People's Democratic Republic, Cambodia and Vietnam, the vast majority of Thailand and a small part of Peninsular Malaysia. In addition, the hotspot covers the coastal lowlands of southern China (in southern Guangxi and Guangdong), as well as several offshore islands, such as Hainan Island (of China) in the South China Sea and the Andaman Islands (of India) in the Andaman Sea.

Encompassing more than 2 million km² of tropical Asia, Indo-Burma is still revealing its biological treasures. Six large mammal species have been discovered in the last 12 years: the large-antlered muntjac, the annamite muntjac, the grey-shanked douc, the annamite striped rabbit, the leaf deer, and the saola. This hotspot



also holds remarkable endemism in freshwater turtle species, most of which are threatened with extinction, due to over-harvesting and extensive habitat loss. Bird life in Indo-Burma is also incredibly diverse, holding almost 1,300 different bird species, including the threatened white-eared night-heron, the grey-crowned crocias, and the orange-necked partridge.

VITAL SIGNS

Hotspot Original Extent (km²)	2,373,057
Hotspot Vegetation Remaining (km²)	118,653
Endemic Plant Species	7,000
Endemic Threatened Birds	18
Endemic Threatened Mammals	25
Endemic Threatened Amphibians	35
Extinct Species†	1
Human Population Density (people/km²)	134
Area Protected (km²)	235,758
Area Protected (km²) in Categories I-IV*	132,283

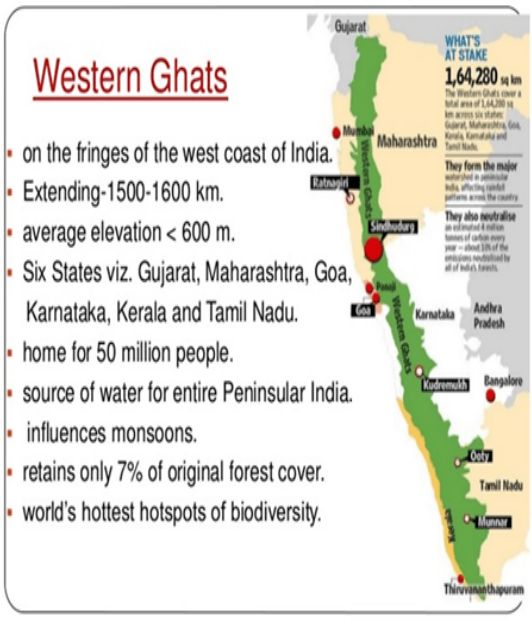
†Recorded extinctions since 1500. *Categories I-IV afford higher levels of protection.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	**13,500**	**7,000**	**51.9**
Mammals	433	73	16.9
Birds	1,266	64	5.1
Reptiles	522	204	39.1
Amphibians	286	154	53.8
Freshwater Fishes	1,262	553	43.8

C) Western Ghats and Sri Lanka:

The Western Ghats, also known as Sahyadri (Benevolent Mountains), are a mountain range that extends parallel to the western coast of the Indian peninsula, traversing the states of Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra and Gujarat. It is a UNESCO World Heritage Site and is one of the eight "*hottest hotspots*" of biological diversity in the world. Wildlife of Sri Lanka has one of the highest rates of biological endemism (16% of the fauna and 23% of flowering plants are endemic in the world.



Faced with tremendous population pressure, the forests of the Western Ghats and Sri Lanka have been dramatically impacted by the demands for timber and agricultural land. Remaining forests of the Western Ghats are heavily fragmented; in Sri Lanka, only 1.5% of the original forest remains. Population levels are also applying increased stress on the fringes of protected areas where many farms, loggers, and poachers use the resources illegally. Due in part to the varying effect of the yearly monsoons and the high mountain regions, this hotspot is home to a rich endemic assemblage of plants, reptiles, and amphibians. Sir Lanka alone may be home to as many as 140 endemic species of amphibians. The region also houses important populations of Asian Elephants, Indian Tigers, and the Endangered Lion-tailed Macaque. Freshwater fish endemism is extremely high as well, with over 140 native species.

VITAL SIGNS

Hotspot Original Extent (km²)	1,501,063
Hotspot Vegetation Remaining (km²)	100,571
Endemic Plant Species	15,000
Endemic Threatened Birds	43
Endemic Threatened Mammals	60
Endemic Threatened Amphibians	59
Extinct Species†	4
Human Population Density (people/km²)	153
Area Protected (km²)	179,723
Area Protected (km²) in Categories I-IV*	77,408

†Recorded extinctions since 1500. *Categories I–IV afford higher levels of protection.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	**25,000**	**15,000**	**60.0**
Mammals	380	172	45.3
Birds	769	142	18.5
Reptiles	452	243	53.8
Amphibians	244	196	80.3
Freshwater Fishes	950	350	36.8

D) Sundaland and Nicobar islands of India: Sundaland (also called the Sundaic region) is a bio-geographical region of Southeastern Asia that includes the Malay Peninsula on the Asian mainland, as well as the large islands of Borneo, Java, and Sumatra and their surrounding small islands.

The Nicobar Islands are an archipelagic island chain in the eastern Indian Ocean located in Southeast Asia. UNESCO has declared the Great Nicobar Island as one of the World Network of Biosphere Reserves.

The spectacular flora and fauna of the Sundaland Hotspot are succumbing to the explosive growth of industrial forestry in these islands and to the international animal trade that claims tigers, monkeys, and turtle species for food and medicine in other countries. Populations of the orangutan, found only in this hotspot, are in dramatic decline. Some of the last refuges of two Southeast Asia rhino species are also found on the islands of Java and Sumatra. Like many tropical areas, the forests are being cleared for commercial uses. Rubber, oil palm, and pulp production are three of the most detrimental forces facing biodiversity in the Sundaland Hotspot.

VITAL SIGNS

Hotspot Original Extent (km²)	189,611
Hotspot Vegetation Remaining (km²)	43,611
Endemic Plant Species	3,049
Endemic Threatened Birds	10
Endemic Threatened Mammals	14
Endemic Threatened Amphibians	87
Extinct Species†	20
Human Population Density (people/km²)	261
Area Protected (km²)	26,130
Area Protected (km²) in Categories I-IV*	21,259

†Recorded extinctions since 1500. *Categories I-IV afford higher levels of protection.

SPECIES DIVERSITY AND ENDEMISM

Taxonomic Group	Species	Endemic Species	Endemism (%)
Plants	**5,916**	**3,049**	**51.5**
Mammals	140	18	12.9
Birds	458	35	7.6
Reptiles	267	174	65.2
Amphibians	178	130	73.0
Freshwater Fishes	191	139	72.8

WHY ARE BIODIVERSITY HOTSPOTS IMPORTANT?

Species are the building blocks of Earth's life-support systems. We all depend on them. But our planet's "*biodiversity*," the vast array of life on Earth, faces a crisis of historic proportions. Development, urbanization, pollution, disease — they're all wreaking havoc on the tree of life. Today, species are going extinct at the fastest rate since the mass extinction of the dinosaurs.

To stem this crisis, we must protect the places where biodiversity lives. But species aren't evenly distributed around the planet. Certain areas have large numbers of endemic species — those found nowhere else. Many of these are heavily threatened by habitat loss and other human activities. These areas are the biodiversity hotspots, 36 regions where success in conserving species can have an enormous impact in securing our global biodiversity.

Yet the hotspots remain important in our work for two important reasons:

✍**Biodiversity underpins all life on Earth.** Without species, there would be no air to breathe, no food to eat, no water to drink. There would be no human society at all. And as the places on Earth where the most biodiversity is under the most threat, hotspots are critical to human survival.

✍**The map of hotspots overlaps extraordinarily well with the map of the natural places that most benefit people.** That's because hotspots are among the richest and most important ecosystems in the world — and they are home to many vulnerable populations who are directly dependent on nature to survive. By one estimate, despite comprising 2.4% of Earth's land surface, forests, wetlands and other ecosystems in hotspots account for 35% of the *"ecosystem services"* that vulnerable human populations depend on.

Significance of Biodiversity:

- ✍ Biodiversity is very important for human life, as we depend on plants, micro organisms, earth's animals for our food, medicine and industrial products. ž
- ✍ It protects the fresh air, clean water and land. ž
- ✍ It is important for forestry, fisheries and agriculture, which depend on rich variety of various biological resources available in nature. ž
- ✍ Loss of biodiversity has serious economic and social cost for any country.

ENVIRONMENTAL STUDIES

Unit 4: Biodiversity and Conservation

India as a mega---biodiversity nation; Endangered and endemic species of India

MEGADIVERSITY

What is Megadiversity?

'Megadiversity' refers to countries with an extremely high level of species richness, usually found in the tropical realm; one or two orders higher in magnitude than in most temperate zone countries. This concept complements that of Biodiversity Hotspots and High-Biodiversity Wilderness Areas to achieve significant coverage of the world's biological resources and was first proposed in 1988 by **Russell Mittermeier**. Megadiversity is now used to raise awareness to the protection of natural biodiversity, and particularly in the countries where this is more abundant and threatened.

More than any academic differentiation, however, the term megadiversity was recently taken up and promoted at the political level, particularly under the Convention of Biological Diversity (CBD), as well as the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). Following the original meeting in Cancun, Mexico, in February 2002, 15 countries formed a group of 'Like-Minded Megadiverse Countries' (LMMC) as a forum to address the specific challenges for biodiversity conservation and sustainable use faced by countries with disproportional high levels of biodiversity, later joined by Australia and the USA.

The World Conservation Monitoring Centre (WCMC) of the United Nations Environment Program has identified a total of 17 mega-diverse countries in 1998 located near tropical areas or in isolated areas of Africa, America, Asia and Oceania like **Australia, Brazil, China, Colombia, Ecuador, United States, Philippines, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, Democratic Republic of Congo, South Africa** and **Venezuela.**

In accordance with the WCMC, for a country to be considered mega-diverse, it must:

- Have at least **5,000 endemic plants.**
- Have **marine ecosystems within its borders.**

For their part, according to the **Group of Similar Mega-diverse Countries**, mega-diverse countries contain one or more of the following characteristics:

- **Geographic position:** most are in tropical areas, where there is a large diversity of species.
- **Diversity of countries:** the complexity of mountain scenery brings forth the diversity of atmospheres, soils and climates.
- **Isolation:** the progressive separation of islands and continents has allowed the development of unique flora and fauna.
- **Size:** the larger the size, the greater the diversity of scenery and species.
- **Evolutionary history:** some of the countries are on crossroads between two biogeographic regions, producing a mixture of fauna and flora with different histories.
- **Culture:** the domestication of plants and animals has contributed to the natural wealth.

India: A Mega Biodiversity Nation:

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. 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. It covers nearly 7% of world's flora and 6.5% of world's fauna of which 33 % flora and 62% fauna are endemic. India has over 30 National parks that constitute about 1% of the landmass and 441 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.

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 four hotspots - the Western Ghats, the Eastern Himalayas, the Western Ghats-Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas).

Whereas, the important features of India's biodiversity are as followed:

- India has two major realms called the **Palaearctic** and the **Indo-Malayan**, and three biomass, namely the **tropical humid forests**, the **tropical dry/deciduous forests**, and the **warm desert/semi-deserts**.
- As of date, there are 911 properties under the World Heritage List, which cover 711 cultural sites, 180 natural sites and 27 mixed properties encompassing 152 countries, including India. India is one of the 12 centres of origin of cultivated plants.
- India has 17 biosphere reserves, and 19 Ramsar wetlands. Amongst the protected areas, India has 102 national parks and 490 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.
- 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 is endemic to India. Of these endemic species, 3,500 are found in the Himalayas and adjoining regions and 1600 in the Western Ghats alone. About 62% of the known amphibian species are endemic with the majority occurring in the Western Ghats. Nearly 50% of the lizards of India are endemic with a high degree of endemicity in the Western Ghats. India is a centre of crop diversity - the homeland of 167 cultivated species and 320 wild relatives of crop plants.

- Corals 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.

When a species is considered critically endangered?

Critically endangered is the highest risk category assigned by the IUCN (International Union for Conservation of Nature) Red List to wild species. There are five quantitative criteria to determine whether a taxon is threatened. A taxon is critically endangered when the best available evidence indicates that it meets any of the following criteria:

- ✓ Populations have declined or will decrease, by greater than 80% over the last 10 years or three generations.
- ✓ Have a restricted geographical range.
- ✓ Small population size of less than 250 individuals and continuing decline at 25% in 3 years or one generation.
- ✓ Very small or restricted population of fewer than 50 mature individuals.
- ✓ High probability of extinction in the wild.

Endangered and Endemic Species of India

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, 450 plant species have been identified as endangered species. 100 mammals and 150 birds are estimated to be endangered.

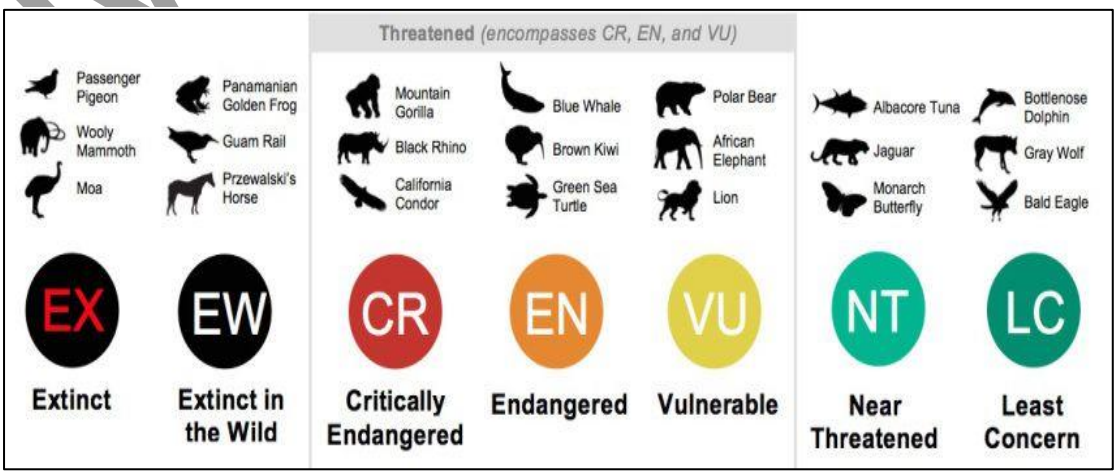
The **RED-data book** is a public document contains a list of endangered species of plants, animals, fungi as well as some local subspecies that are present in a particular region.

- The Red Data Book helps us in providing complete information for research, studies and also for monitoring the programs on rare and endangered species and their habitats.
- This book is mainly created to identify and protect those species which are on the verge of extinction.

The Red Data Book contains colour-coded information sheets, which are arranged according to the extinction risk of many species and subspecies.

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

Threatened Species Categories (According to IUCN)



Extinct (E)	**A taxon is Extinct totally, even the last individual has died.**
Critically Endangered (CR)	**A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.**
Endangered (EN)	**A taxon is Endangered when it is not Critically Endangered but facing a very high risk of extinction in the wild in near future.**
Vulnerable (VU)	**A taxon is Vulnerable when it is not Critically Endangered but facing a high risk of extinction in wild in medium-term future.**
Lower Risk (LR)	**Does not satisfy the criteria for any of categories CR, E, or VU.**

Endangered

A species, whose numbers are so small that the species is at risk of extinction. To be defined as endangered, a species must meet any of the following criteria.

• Population reduction: 50-70% population decline

• Geographic range Extent of occurrence: <5,000 km2

Area of occupancy: <500 km2

• Population size: <2,500 mature individuals

• Extinction probability (in the wild): at least 20% within 20 years or 5 generations.

Example: Red panda, Snow leopard, Bengal Tiger, One horned rhinoceros and Black buck.

Vulnerable

A species is vulnerable when it is not critically endangered or endangered, but is facing a high risk of becoming endangered in the near future.

• Population reduction: ≥30-50% population decline

• Geographic range

Extent of occurrence: <20,000 km2

Area of occupancy: <2,000 km2

• Population size: <10,000 mature individuals

• Extinction probability (in the wild): at least 10% within 100 years.

Near Threatened

A category on the IUCN Red List of threatened species which indicates that a taxon has been evaluated against the Red List criteria does not qualify for critically endangered,

endangered and vulnerable status now but it is close to qualify or likely to qualify for a threatened category in the near future.

Least Concern

A category on the IUCN Red List which indicates that a taxon has been evaluated against the Red List criteria and does not qualify for critically endangered, endangered, vulnerable or near threatened. Widespread and abundant taxa are included in this category.

Advantages of the Red Data Book

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

Red Data Book of India

- Red Data Book of India includes the conservation status of animals and plants which are endemic to the Indian subcontinent.
- The data for this book is provided through surveys which are conducted by the *Zoological Survey of India* and the *Botanical Survey of India* under the guidance of the Ministry of Environment, Forest and Climate Change.

A few endangered species in the **world** are listed below:

1. West Virginia Spring Salamander (U.S.A)
2. Giant Panda (China)
3. Golden Lion Tamarin (Brazil)
4. Siberian Tiger (Siberia)
5. Mountain Gorilla (Africa)
6. Pine Barrens Tree Frog (Male)
7. Arabian Oryx (Middle East)
8. African Elephant (Africa)

Some of the **endangered animals** found in **India** are:

1. Asiatic cheetah
2. Asiatic Lion
3. Asiatic Wild Ass
4. Bengal Fox
5. Gaur
6. Indian Elephant

7. Indian Rhinocerous
8. Marbled Cat
9. Markhor

Other important endangered species are:

1. Tortoise, Green sea Turtle , Gharial, Python (Reptiles)
2. Peacock, Siberian White Crane, Pelican, Indian Bustard (Birds)
3. Hoolock gibbin, Lion-tailed Macaque, Capped mokey, Golden monkey (Primates)
4. Rauvol fia serpentina (medicinal plant), Sandal wood tree, etc.

Some of the **endangered plants** found in **India** are:

1. *Amentotaxus assamica* (catkin yew)
2. *Kingiodendron pinnatum (*Malabar Mahagony*)*
3. *Pterospermum reticulatum (*Malavuram)
4. *Commiphora wightii (*guggul *)*
5. *Decalepis hamiltonii* (Swallow root)
6. *Santalum album* (Sandal wood)
7. *Pterocarpus marsupium* (Indian Kino)

Factors Affecting Endangered Species

1) Human beings dispose wastes indiscriminately in nature thereby polluting the air, land and water. These pollutants enter the food chain and accumulate in living creatures resulting in death.
2) Over-exploitation of natural resources and poaching of wild animals also leads to their extinction.
3) Climate change brought about by accumulation of green houses gases in the atmosphere. Climate change threatens organisms and ecosystems and they cannot adjust to the changing environmental conditions leading to their death and extinction.

Endemic Species in India

Species that are found only in a particular region are known as **endemic species**. Almost 60% the endemic species in India are found in Himalayas and the Western Ghats. Endemic species are mainly concentrated in:

1. North-East India
2. North-West Himalayas

3. Western Ghats and
4. Andaman & Nicobar Islands.

Examples of endemic Flora species are:

1. Sapria Himalayana
2. Ovaria Lurida
3. Nepenthis khasiana etc

Example of Endemic fauna species are:

1. Lion tailed macaque
2. Nilgiri langur
3. Brown palm civet and
4. Nilgiri tahr

Factors Affecting Endemic Species:

1) Habitat loss and fragmentation due to draining and filling of inland wetlands.
2) Pollution also plays an important role. For example, frog eggs, tadpoles and adults are extremely sensitive to pollutants especially pesticides.
3) Over-hunting and
4) Populations can be adversely affected by introduction of non active predators and competitors. Disease producing organisms also play an important adversary in reducing populations of endemic species.

Protection of Endangered/ Endemic Species

Steps taken by the Government to protect these species are as follows:

- The Centrally Sponsored Scheme **'Integrated Development of Wildlife Habitats'** has been modified in 2008-09 by including a new component namely 'Recovery of Endangered Species' and 16 species have been identified for recovery viz. Snow Leopard, Bustard (including Floricans), Dolphin, Hangul, Nilgiri Tahr, Marine Turtles, Dugong, Edible Nest Swiftlet, Asian Wild Buffalo, Nicobar Megapode, Manipur Brow-antlered Deer, Vultures, Malabar Civet, Indian Rhinoceros, Asiatic Lion, Swamp Deer and Jerdon's Courser.
- Under the **'Recovery of Endangered Species'** component of the Centrally Sponsored Scheme 'Integrated Development of Wildlife Habitats' Rs 377.7 lakhs for the recovery of endangered species viz. Hangul in Jammu and Kashmir, Snow

Leopard in Jammu and Kashmir and Uttarakhand, Vulture in Punjab, Haryana and Gujarat was provided during 2008-09. During 2009-10, an amount of Rs 72.95 lakhs was provided for recovery of endangered species viz. Swiftlet in Andaman and Nicobar Islands, Nilgiri Tahr in Taml Nadu, Sanghai Deer in Manipur and Snow Leopard in Arunachal Pradesh. During 2010-11, an amount of Rs. 184.052 lakh was provided for recovery of endangered species viz. Vulture in Punjab, Swiftlet in Andaman and Nicobar Islands, Snow Leopard in Himachal Pradesh and Jammu and Kashmir and Hangul in Jammu and Kashmir.

- Legal protection has been provided to endangered wild animals and plants against hunting and commercial exploitation under the provisions of the Wild Life (Protection) Act, 1972.
- **The Wild Life (Protection) Act, 1972**, has been amended and made more stringent. The punishment in cases of offences have been enhanced. The Act also provides for forfeiture of any equipment, vehicle or weapon that is used for committing wildlife offence.
- Protected Areas, viz, National Parks, Sanctuaries, Conservation Reserves and Community Reserves all over the country covering the important habitats have been created as per the provisions of the Wild Life (Protection) Act, 1972 to provide better protection to wildlife, including threatened species and their habitat.
- Financial and technical assistance is extended to the State Governments under various Centrally Sponsored Schemes, viz, '**Integrated Development of Wildlife Habitats', 'Project Tiger'** and **'Project Elephant**' for providing better protection and conservation to wildlife.
- The Central Bureau of Investigation (CBI) has been empowered under the Wild Life (Protection) Act, 1972 to apprehend and prosecute wildlife offenders.
- The State Governments have been requested to strengthen the field formations and intensify patrolling in and around the Protected Areas.
- The Wildlife Crime Control Bureau has been set up for control of poaching and illegal trade in wildlife and its products.
- Strict vigil is maintained through effective communication system.

ENVIRONMENTAL STUDIES

Unit 4: Biodiversity and Conservation

Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions

THREATS TO BIODIVERSITY

For most of modern history, human actions have proceeded without people giving much thought to the sustainability of ecosystems. These actions often include things that drastically alter the conditions in an ecosystem, such as draining wetlands, cutting down trees, and damming rivers. Sometimes, these actions threaten biodiversity within a community or ecosystem and on Earth as a whole. Recall that one measure of biodiversity is the variety of ecosystems on Earth. If human actions lead to the destruction of entire ecosystems, such as wetlands or rainforests, biodiversity on Earth could decrease. As scientists learn more about the effects of human actions on ecosystems, we are paying more attention to decreasing human impact on ecosystems and restoring ecosystems that have already been altered.

- Growing human population- specific types of human actions that threatened biodiversity and ecosystems and causes to extinction of many species are:
- Over-hunting/over-exploitation
- Habitat loss/ degradation/fragmentation
- Deforestation
- Invasion of non-native species
- Pollution
- Climate change
- Cultural impacts

A) Habitat loss/degradation/fragmentation:

It is an important cause of known extinctions. As deforestation proceeds in tropical forests, this promises to become the cause of mass extinctions caused by human activity. All species have specific food and habitat needs. The more specific these needs and localized the habitat, the greater the vulnerability of species to loss of habitat to agricultural land, livestock, roads and cities. In the future, the only species that survive are likely to be those whose habitats are highly protected, or whose habitat corresponds to the degraded state associated with human activity.

One of the most devastating threats to biodiversity is the outright loss of habitat due to human activity. Habitat loss typically involves conversion of land for other uses, including urban and agricultural areas. Once removed, a natural habitat is often permanently lost, although natural or artificial restoration of some habitats is possible over time. Terrestrial ecosystems suffer habitat destruction in a variety of ways, such as deforestation, desertification, urbanization and artificial burning. Many terrestrial ecosystems have been converted to urban and agricultural areas. Temperate regions in Europe and North America have lost almost all primary vegetation over the last few centuries, often for the inefficient purpose of raising crops to feed animals for human consumption – although some areas have since regenerated secondary forests. The situation is different in many tropical regions, where most primary vegetation losses have occurred over the last century. In the tropics, where most necessary nutrients are contained in the living biomass, loss of vegetation over large areas can result in permanent land transformation, as soils are relatively poor in nutrients. For example, historically Madagascar was largely forested, but over the course of the last thousand years or so, humans have cleared the majority of forests, typically using fire. This has resulted in the island's interior being mostly converted to grassland, agricultural fields and denuded land, with virtually no forest regeneration.

Reasons of habitat loss by humans:

- ❑ agriculture, farming
- ❑ harvesting natural resources for personal use
- ❑ for industrial and urbanization development
- ❑ Habitat destruction is currently ranked as the primary causes of species extinction world wide…!!!

❖ There are natural causes too. Habitat destruction through natural processes such as volcanism, fire and climate change is well documented in the fossil record. One study

shows that fragmentation of tropical rainforest in euro 3000 million years ago lead to a great loss of amphibian diversity.

Solutions on for this..

- Protecting remaining intact section of natural habitat.
- Reduce human population and expansion of urbanization and industries.
- Educating the public about the importance of natural habitat and bio diversity.
- Solutions to habitat loss can include planting trees, planting home gardens so as to reduce need for man to need large lands for agricultural farms which lead to habitat loss.

B) Overexploitation

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. Overexploitation of a particular species reduces the size of its population to an extent that it becomes vulnerable to extinction. The decline of the Earth's largest terrestrial animal, 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.

C) Introduction of invasive species

An invasive species (also called *introduced*, *exotic*, *non-native*) can be any kind of living organism that is not native to an ecosystem and which has a tendency to damage the ecosystem.

- **Common characteristics of invasive species include:**
  - *rapid reproduction and growth,*
  - *high dispersal ability,*
  - *phenotypic plasticity (ability to adapt physiologically to new conditions) and*
  - *ability to survive on various food types and in a wide range of environmental conditions.*
- These species grow and reproduce quickly, and spread aggressively, with potential to cause harm.

- Invasive species are capable of causing extinctions of native plants and animals by competing with them for limited resources and altering habitats. Thus, leading to loss of biodiversity.
- The sudden introduction of invasive species to a given ecosystem (especially on islands and in freshwater habitats) causes disastrous consequences for native.

D) Climate Changes

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.

Over the past 140 years, the global average surface temperature has increased 0.6ºC +/-0.2ºC. Combustion of heattrapping gases such as coal, oil and natural gas to fuel the activities of our surging population is causing warming of the globe at unprecedented rate. Such warming may be altering the climate, leading to more intense heat and cold in certain locations, and more extreme weather events such as floods, droughts and ice storms. Because ecosystems are so closely associated with particular biophysical constraints unique to particular locales, sudden climate change potentially threatens them. Species unable to evolve, adapt or disperse fast enough to cope with these changes will go extinct.

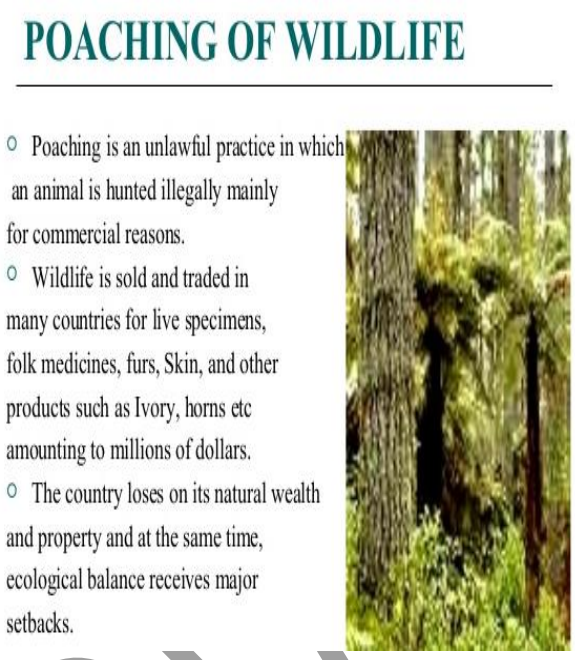
E) Pollution

Pollution is a word that gets used a lot in relation to environmental impacts. Most frequently people are referring to pollution of the air or water but the word actually covers any form of contaminant that enters the natural environment and causes unwanted effects.

The fact is, the majority of pollution will affect wildlife in a negative way, whether directly (e.g breathing in toxic chemicals from the air) or indirectly (e.g habitat loss due to climate change caused by an increase in certain air pollutants).

Types of pollution that might affect wildlife include, air pollution, water pollution, plastic pollution, soil pollution, light pollution, and noise pollution.

F) Poaching of Wildlife



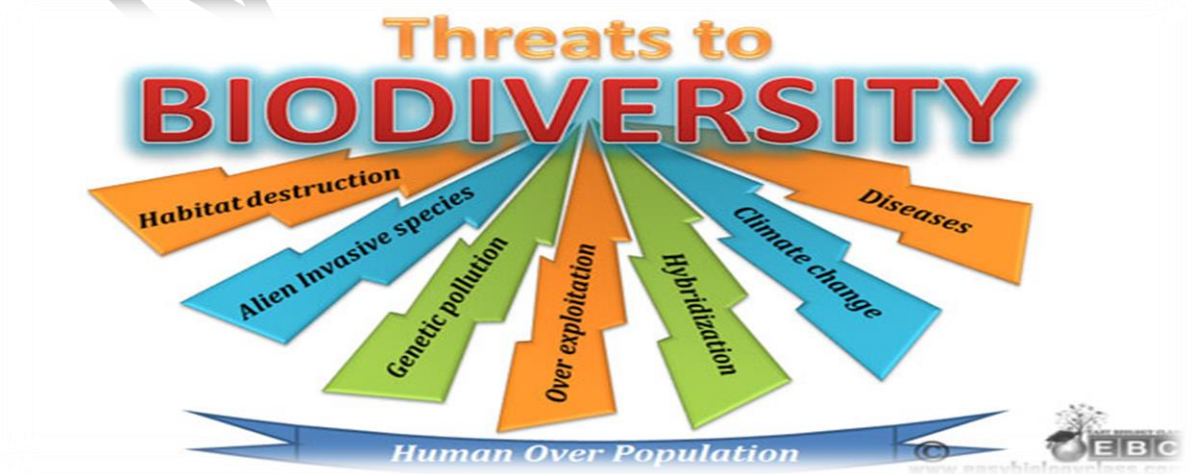
Poaching is the hunting and harvesting taking of wild plants or animals, such as through hunting, harvesting, fishing, or trapping. Wildlife poaching presents a significant threat to large-bodied animal species. It is one major driver of the population declines of key wildlife species such as tigers, elephants, and rhinos, which are crucial to the functioning of natural ecosystems as well as local and national economies. Poachers illegally catch wildlife by placing snares or hunting. To combat poaching, both government and non-government agencies send well-trained patrollers to wildlife conservation areas. In this work, we focus on snare poaching. The patrollers conduct patrols with the aim of preventing poachers from poaching animals either by catching the poachers or by removing animal traps set by the poachers. Signs of poaching are collected and recorded during the patrols, including snares, traps and other signs such as poacher tracks, which can be used together with other domain features such as animal density or slope of the terrain to analyze and predict the poachers' behavior. It is critical to learn the poachers' behavior, anticipate where the poachers would go for poaching, and further use such information to guide future patrols and make them more effective. Poachers' behavior is adaptive to patrols as evidenced by multiple studies. Instead of falling into a static pattern, the distribution of poaching activities can be affected by ranger patrols as the poachers will take the patrol locations into account when making decisions. As a result, the rangers should also consider such dynamics when planning the patrols. Such strategic interaction between the conservation agencies and the poachers make game theory an appropriate framework for the problem.

Why Poaching is done?

Poaching is done for large profits gained by the illegal sale or trade of animal parts, meat and pelts. Exists because there is a demand for these products, caused by a lack of education or disregard for the law amongst the buyers ~ Many cultures believe that certain animal parts have medicinal value.

How does poaching affect the environment?

Poaching or illegal hunting causes animals endangered of being extinct. If more animals becomes extinct there's a disruption in the food chain, and that will cause major problems in our ecosystem, resulting eventually in new adaptations of animals, and or species beyond human control.

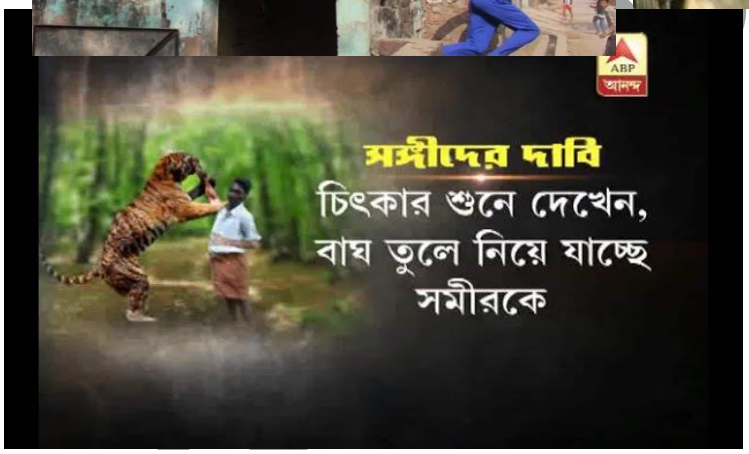


Man-Animal Conflict

Human-Wildlife Conflict (HWC) occurs when animals pose a direct and recurring threat to the livelihood or safety of people, leading to the persecution of that species. Any conflict that arises where the behavior of one (human or wildlife) is unacceptably disadv antageous to other. Increase in man wildlife conflict is due to resource limitation like:

1. Space 2. Food 3. Shelter

It is also due to Increasing population of human beings , Loss of forest, decrease in q uality of forest and development activities. HWC affects most large carnivores, as well as many other species groups including, but not limited to, elephants, pigs, deer, primates, sharks, seals, birds of prey, crocodiles, rhinos, otters.

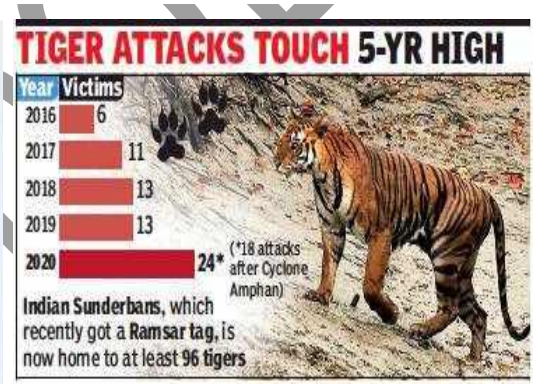


A new report by WWF and the UN Environment Programme (UNEP) warns that human-wildlife conflict is the main threat to the long-term survival of some of the world's most emblematic species. The report, ***A future for all - the need for human-wildlife coexistence,*** highlights that globally, conflict-related killing affects more than 75% of the world's wild cat species, as well as many other terrestrial and marine carnivore species such as polar bears and Mediterranean monk seals, and large herbivores such as elephants.

Wildlife faces numerous threats, among them, effects of climate change,

loss of habitat from deforestation, illegal wildlife trade, infrastructure and now conflict with humans, factors that have led to a significant decline of wildlife species and to the possible extinction of species whose numbers were really low already.

The report states that while it's not possible to completely eradicate human-wildlife conflict, there are approaches that involve the full participation of local communities that can help reduce it and lead to coexistence between humans and wildlife. One success story is the Kavango Zambezi Transfrontier Conservation Area in Southern Africa where communities reported that most of their livestock losses through predation by lions occurred where free-ranging, unprotected cattle roamed in the evenings and at night. The installation of fixed and mobile lion-proof corrals for night-time protection in risk-prone areas led to a 95% reduction in livestock killings in 2016, and there were zero retaliatory killings of lions in 2016 (compared to 17 killed in 2012 and 2013), allowing previously threatened lion populations to recover.



Ways to reduce the Conflicts:

- Government is working on improvement of habitat to augment food and water availability and to reduce movement of animals from the forests to the habitations.
- Training forest staff and police to tackle these situations and creating awareness among the people about the Do's and Don'ts to minimize conflicts.
- Construction of boundary walls and solar fences around the sensitive areas to prevent the wild animal attacks.
- Some devices of Information Technology, viz., radio collars with Very High Frequency, Global Positioning System and Satellite uplink facilities can be used to track the movements of wild animals.

ENVIRONMENTAL STUDIES

Unit 4: Biodiversity and Conservation

Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Conservation of Biodiversity

Biodiversity is a source of significant economic, aesthetic, health and cultural benefits which form the foundation for sustainable development. However, there is general scientific consensus that the world is rapidly becoming less biologically diverse in terms of genes, species and ecosystems. The reason for this is clearly anthropogenic. The scale of human impact on biological diversity has been increasing exponentially primarily because of world-wide patterns of consumption, production, trade; agricultural, industrial and settlement development; and human population growth.

Neither the economic nor the ecosystem value of biodiversity is as yet well understood. In particular, there is insufficient knowledge of the interdependence of species within ecosystems and the impact of the extinction of one species on others. Hence, reducing the rate of biodiversity loss and conserving still existing biodiversity as the basis of sustainable development remains a major global challenge.

Conservation is the protection, preservation, management or restoration of wildlife and natural resources such as forests and water. Through the conservation of biodiversity, the survival of many species and habitats which are threatened due to human activities can be ensured.

'*Conservation of biodiversity is an active management of the biosphere to ensure the survival of the maximum diversity of species and the maintenance of genetic variability within species.*

It includes the maintenance of biosphere function e.g. nutrient cycling and ecosystem

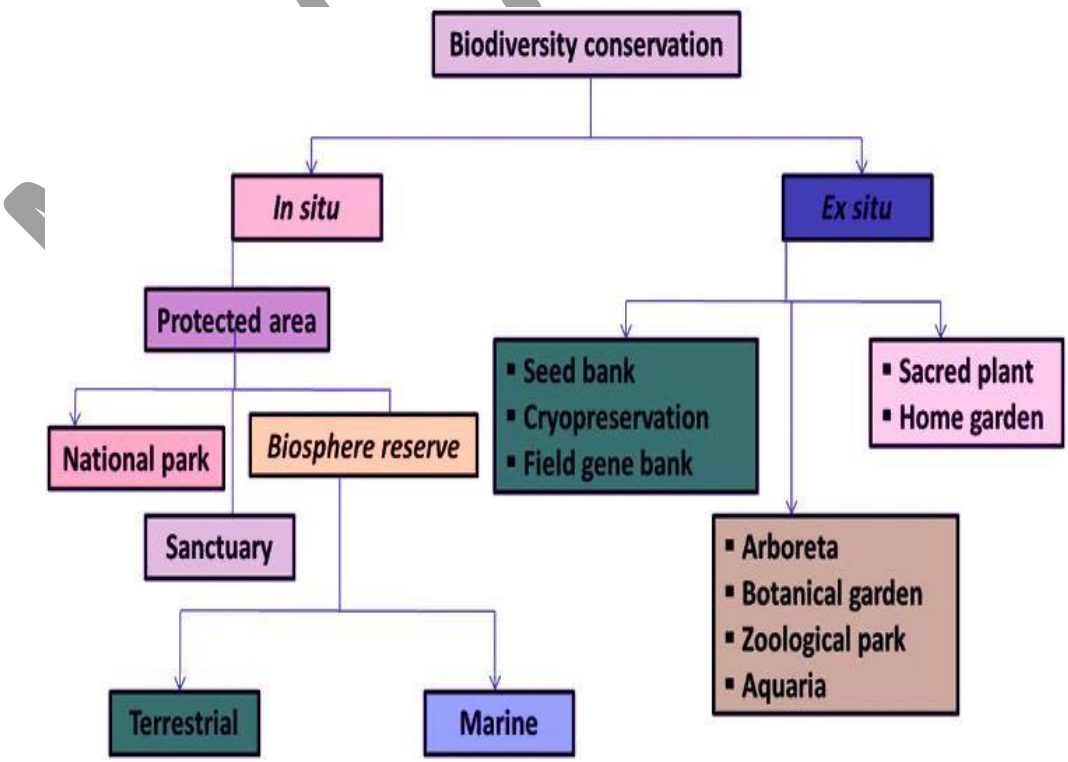
function. The term also includes the concept of sustainable resource use so that the environment may yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations. Conservation of species and biological processes must be simultaneous with conservation of abiotic resources or it is unlikely to succeed.'

Adapted from International Union for Conservation of Nature (IUCN) & United Nations Environment Programme (UNEP) 1992.

Need of biodiversity conservation

1. It serves as a immediate benefits to the society such as recreation and tourism.
2. Drugs, herbs, food and other important raw materials can be derived from plants and animals.
3. It also preserves the genetic diversity of plants and animals.
4. Ensures the sustainable utilization life supporting systems on earth.
5. It leads to conservation of essential ecological diversity.

Bio-Diversity Conservation Methods



Ex-situ and In-situ Conservation

In-situ conservation means maintenance of biodiversity in natural habitat whereas *ex-situ conservation* emphasises the conservation of biodiversity outside natural habitat.

In-situ ('on site') is conservation of habitats and ecosystems where organisms naturally occur i.e. the on-site conservation. The conservation of organisms in Biosphere Reserves (terrestrial and marine), National parks, Wildlife sanctuaries, Sacred groves, Biodiversity hotspots are all examples of *in-situ conservation*.

In situ **conservation**– Faced with the conflict between development and conservation, many nations find it unrealistic and economically not feasible to conserve all their biological wealth. Invariably, the number of species waiting to be saved from extinction far exceeds the conservation resources available. On a global basis, this problem has been addressed by eminent conservationists. They identified for maximum protection certain 'biodiversity hotspots' regions with very high levels of species richness and high degree of endemism (that is, species confined to that region and not found anywhere else). Initially 25 biodiversity hotspots were identified but subsequently nine more have been added to the list, bringing the total number of biodiversity hotspots in the world to 34.

Ex-situ ('off site') conservation is a set of conservation techniques involving the transfer of a target species away from its native habitat to a place of safety, such as a *zoological garden, botanical garden* or *seed bank*. Its primary objective is to support conservation by ensuring the survival of threatened species and the maintenance of associated genetic diversity. To do so, ex-situ institutions preserve the genetic or reproductive material of a target species, or take care of the living target species for the purpose of reintroduction.

Ex situ **Conservation**– In this approach, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care. Zoological parks, botanical gardens and wildlife safari parks serve this purpose. There are many animals that have become extinct in the wild but continue to be maintained in zoological parks. In recent years *ex situ* conservation has advanced beyond keeping threatened species in enclosures. Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques, eggs can be fertilised *in vitro*, and plants can be propagated using tissue culture methods. Seeds of different genetic strains of commercially important plants can be kept for long periods in seed banks.

Biodiversity knows no political boundaries and its conservation is therefore a collective responsibility of all nations. The historic Convention on Biological Diversity ('The Earth Summit') held in Rio de Janeiro in 1992, called upon all nations to take appropriate measures for conservation of biodiversity and sustainable utilisation of its benefits. In a follow-up, the World Summit on Sustainable Development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels.

These hotspots are also regions of accelerated habitat loss. Three of these hotspots – Western Ghats and Sri Lanka, Indo-Burma and Himalaya – cover our country's exceptionally high biodiversity regions. Although all the biodiversity hotspots put together cover less than 2 percent of the earth's land area, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the ongoing mass extinctions by almost 30 per cent.

In India, ecologically unique and biodiversity-rich regions are legally protected as biosphere reserves, national parks and sanctuaries. India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries. India has also a history of religious and cultural traditions that emphasised protection of nature. In many cultures, tracts of forest were set aside, and all the trees and wildlife within were venerated and given total protection. Such sacred groves are found in Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants.

Gene banks are biorepositories where biological material is collected, stored, catalogued and made available for redistribution. Gene banks are also known as *germplasm banks*. It functions as *ex-situ* conservation, where a sample containing *genetic material* is preserved in an artificial environment, outside of its normal habitat. The germplasm is stored in the form of seeds, pollen or *in vitro* cultures. A *seed bank* preserves dried seeds by storing them at a very low temperature. In general, the seeds of plant species are stored in environments at low temperature and humidity. In these conditions, their viability can be preserved for several decades.

IN SITU CONSERVATION VERSUS EX SITU CONSERVATION

Onsite conservation	Offsite conservation
Conservation of species in a natural ecosystem in an attempt to protect endangered plants and animals.	Conservation of endangered species outside their habitat (artificial habitat)
Natural environment	Artificially created environment
National parks, biosphere reserves, parks, sanctuaries	Zoo, aquarium, seed banks
Dynamic	Static
Captive breeding is not effective in case of all species	Captive breeding can easily increase the numbers (Only in case of some species)
It is cheap and convenient	It is meant for commercial purposes.
Rhododendrons	Kew Botanical gardens in London

Difference Between.net

Parameter	National Park	Wildlife Sanctuary	Biosphere Reserve
Protection type	Protection of wildlife	Reserved for species-oriented plant or animal	Ecosystem oriented-reserves all forms of life
Legislation	Wildlife Protection Act 1972	Wildlife Protection Act 1972	UNESCO's Man and Biosphere (MAB)
Level of Protection	Greater degree of protection than sanctuaries	Lesser degree of protection	Greater Degree of Protection
Regulation of Human Activities	Activities like grazing, hunting, forestry or cultivation etc. are strictly prohibited.	Allowed to a limited extent in the wildlife sanctuaries	No interference except in buffer and transition zone
Boundaries	Clearly delineated by legislation	Not sacrosanct	Clearly delineated by legislation
Upgradation and Down gradation	Cannot be downgraded to a Wildlife Sanctuary upgrade	Can be upgraded to a Wildlife Sanctuary NP BR	National Parks and wildlife Sanctuaries may become a part of Biosphere Reserve
IUCN Status	Category II of the protected areas	Category IV of protected areas.	Roughly corresponds to IUCN Category V of protected areas.

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