UNIT - V

12

CHAPTER

Biodiversity and its Conservation

Nilgiri tahr is an endangered species in the IUCN Red List of Threatened Species due to hunting and poaching

Chapter outline

Learning objectives

> *Acquire knowledge about concept, level and patterns of biodiversity.*
> *Appreciate the magnitude of India's biodiversity.*
> *Understand biogeographical regions and resources of India.*
> *Gain insight into the threats to biodiversity.*
> *Understand the reasons/ causes and effects of extinction.*
> *Create awareness to restore degraded habitats and environment.*
> *To be aware of the Biodiversity Act and its provisions.*

A wide variety of living organisms including plants, animals and micro-organisms with whom we share this planet earth makes the world a beautiful place to live in. Living organisms exist almost everywhere from mountain peaks to the ocean depths; from deserts to the rainforests. They vary in their habit and behaviour, shape, size and colour. The remarkable diversity of living organisms forms an inseparable and significant part of our planet, however, the ever increasing human population is posing serious threats to bio-diversity. In this chapter, we shall discuss biodiversity – concepts, levels, magnitude and patterns, importance of biodiversity, biogeographical regions of India, threats to biodiversity, causes of biodiversity loss, extinction, and biodiversity conservation.

12.1 Biodiversity

The 1992 UN Earth Summit defined **Biodiversity** as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes diversity within species, between species and ecosystems of a region. It reflects the number of different organisms and their relative frequencies in an ecological system and constitutes the most important functional component of a natural ecosystem.

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It helps to maintain ecological processes, create soil, recycle nutrients, influence climate, degrade waste and control diseases. It provides an index of health of an ecosystem. The survival of human race depends on the existence and wellbeing of all life forms (plants and animals) in the biosphere.

12.1.1 Concept of biodiversity

The term biodiversity was introduced by Walter Rosen (1986). Biodiversity is the assemblage of different life forms. Each species is adapted to live in its specific environments.

The changes in climatic conditions are reflected in the distribution and pattern of biodiversity on our planet. The number of species per unit area declines as we move from tropics towards the poles. The Tundra and Taiga of northern Canada, Alaska, northern Europe and Russia possess less than 12 species of trees. The temperate forests of the United states have 20-35 species of trees, while the tropical forests of Panama have over 110 species of trees in a relatively small area.

12.1.2 Levels of biodiversity

Edward Wilson popularized the term 'Biodiversity' to describe diversity at all levels of biological organization from populations to biomes. There are three levels of biodiversity – Genetic diversity, Species diversity and Community/Ecosystem diversity (**Fig. 12.1**).

Genetic diversity refers to the differences in genetic make-up (number and types of genes) between distinct species and to the genetic variation within a single species; also covers genetic variation between distinct populations of the same species. Genetic diversity can be measured using a variety of molecular techniques. India has more than 50,000 genetic variants of Paddy and 1000 variants of Mango. Variation of genes of a species increases with diversity in size and habitat. It results in the
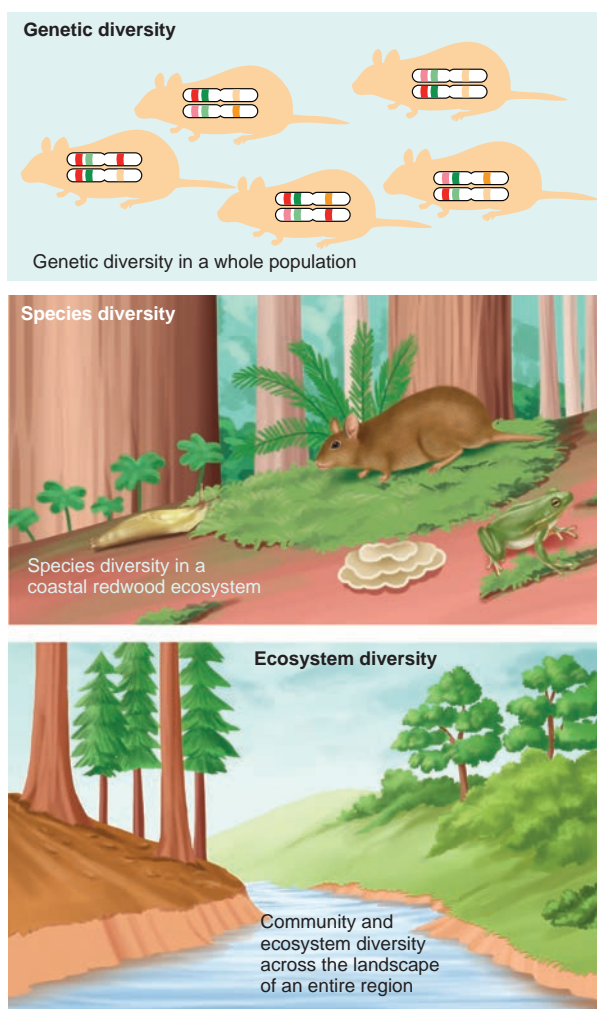

Fig. 12.1 Three levels of biodiversity

formation of different races, varieties and subspecies. *Rouwolfia vomitaria*, a medicinal plant growing in different ranges of the Himalayas shows differences in the potency and concentration of the active ingredient reserpine due to genetic diversity. Genetic diversity helps in developing adaptations to changing environmental conditions.

Species diversity refers to the variety in number and richness of the species in any habitat. The number of species per unit area at a specific time is called species richness, which denotes the measure of species diversity. The Western Ghats have greater amphibian species diversity than the Eastern Ghats. The more the number of species in an area the more is the species richness **(Fig. 12.1a)**. The three indices of diversity are - Alpha, Beta and Gamma diversity.

i. Alpha diversity: It is measured by counting the number of taxa (usually species) within a particular area, community or ecosystem.

ii. Beta diversity: It is species diversity between two adjacent ecosystems and is obtaining by comparing the number of species unique to each of the ecosystem.

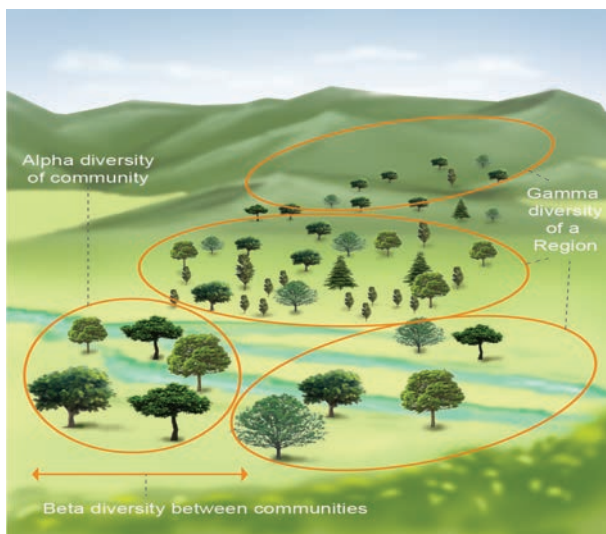iii. Gamma diversity refers to the diversity of the habitats over the total landscape or geographical area.

Fig. 12.1a Species biodiversity

Community/Ecosystem diversity is the variety of habitats, biotic communities, and ecological processes in the biosphere. It is the diversity at ecosystem level due to diversity of niches, trophic levels and ecological processes like nutrient cycles, food webs, energy flow and several biotic interactions. India with its alpine meadows, rain forests, mangroves, coral reefs, grass lands and deserts has one of the greatest ecosystem diversity on earth.

12.1.3 Magnitude of biodiversity

Biodiversity is often quantified as the number of species in a region at a given time. The current estimate of different species on earth is around 8-9 million. However, we really don't know the exact magnitude of our natural wealth. This is called the 'The Taxonomic impediment'. So far about 1.5 million species of microorganisms, animals and plants have been described. Each year about 10-15 thousand new species are identified and published worldwide, of which 75% are invertebrates. The number of undescribed species is undoubtedly much higher.

India is very rich in terms of biological diversity due to its unique bio-geographical location, diversified climatic conditions and enormous eco-diversity and geo-diversity. According to world biogeographic classification, India represents two of the major realms (The Palearctic and Indo-Malayan) and three biomes (Tropical humid forests, Tropical Dry/ Deciduous forests and Warm Deserts/Semi deserts). With only about 2.4% of the world's total land surface, India is known to have over 8 % of the species of animals that the world holds and this percentage accounts for about 92,000 known species.

India is the seventh largest country in the world in terms of area. India has a variety of ecosystems, biomes with its varied habitats like, hills, valleys, plateaus, sea shores, mangroves, estuaries, glaciers, grasslands and river basins. It also reflects different kinds of climates, precipitation, temperature distribution, river flow and soil. India is one of the 17 mega biodiversity countries of the world and has ten biogeographic zones with characteristic habitat and biota.

"The world is currently undergoing a very rapid loss of biodiversity comparable with the great mass extinction events that have previously occurred only five or six times in the earth's history."
- World Wildlife Fund

12.1.4 Patterns of biodiversity distribution

The distribution of plants and animals is not uniform around the world. Organisms require different sets of conditions for their

optimum metabolism and growth. Within this optimal range (habitat) a large number and type of organisms are likely to occur, grow and multiply. The habitat conditions are determined by their latitudes and altitudes.

Latitudinal and altitudinal gradients:

Temperature, precipitation, distance from the equator (latitudinal gradient), altitude from sea level (altitudinal gradient) are some of the factors that determine biodiversity distribution patterns. The most important pattern of biodiversity is latitudinal gradient in diversity. This means that there is an increasing diversity from the poles to equator. Diversity increases as one moves towards the temperate zones and reaches the maximum at the tropics. Thus, tropics harbour more biodiversity than temperate or polar regions, especially between the latitudes of 23.5^0N and 23.5^0S (Tropic of Cancer to the Tropic of Capricorn). Harsh conditions exist in temperate areas during the cold seasons while very harsh conditions prevail for most of the year in polar regions.

Columbia located near the equator (0^0) has nearly 1400 species of birds while New York at 41^0N has 105 species and Greenland at 71^0N has 56 species. India, with much of its land area in the tropical latitudes, is home for more than 1200 species of birds. Thus it is evident that the latitude increases the species diversity.

Decrease in species diversity occurs as one ascends a high mountain due to drop in temperature (temperature decreases @ 6.5^0C per Km above mean sea level)

The reasons for the richness of biodiversity in the Tropics are:

- Warm tropical regions between the tropic of Cancer and Capricorn on either side of equator possess congenial habitats for living organisms.
- Environmental conditions of the tropics are favourable not only for speciation

Mean Sea Level (MSL) is an average level of the surface of one or more of Earth's oceans (or seas) from which heights such as elevations may be measured.

As we travel by train we notice names of stations on big yellow signboards on which is usually written how much elevated that place is compared to MSL. For example, Erode junction is about 171 meters above MSL.

but also for supporting both variety and number of organisms.

- The temperatures vary between 25^0C to 35^0C, a range in which most metabolic activities of living organisms occur with ease and efficiency.
- The average rainfall is often more than 200 mm per year.
- Climate, seasons, temperature, humidity, photoperiods are more or less stable and encourage both variety and numbers.
- Rich resource and nutrient availability.

Species - Area relationships

German Naturalist and Geographer **Alexander von Humboldt** explored the wilderness of south American jungles and found that within a region the species richness increased with increasing area but upto a

certain limit. The relationship between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turned out to be the rectangular hyperbola. On a logarithmic scale, the relationship is a straight line described by the equation.

$$\log S = \log C + Z \log A$$

where

S = Species richness
A = Area
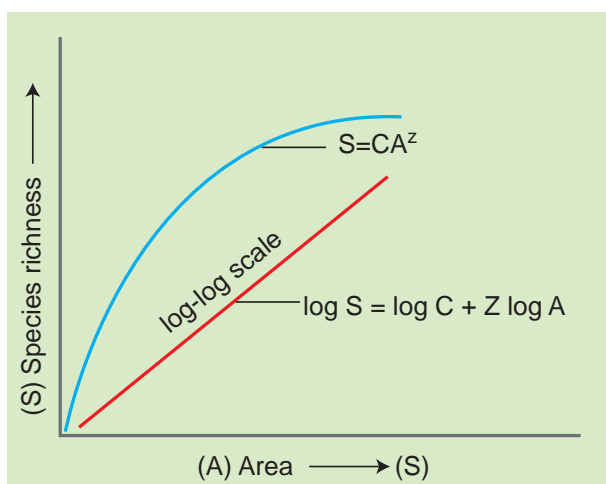Z = Slope of the line
(regression coefficient)
C = Y-intercept

Fig. 12.2 Species - Area relationship on log scale

Regression coefficient Z generally has a value of 0.1-0.2 regardless of taxonomic group or region. However, in case of the species – area relationship in very large areas like entire continents, the slope of the line appears to be much steeper (Z-value in the range of 0.6-1.2). For example, in case of the fruit eating (frugivorous) birds and mammals in the tropical forests of different continents, the slope is found to be a steeper line of 1.15 **(Fig. 12.2).**

12.2 Importance of biodiversity – Global and India

Biodiversity is the variety of life on earth. That is, it is the number of different species of flora and fauna including microorganisms. These organisms can inhabit different ecosystems with varying conditions like the Rainforests, Coral reefs, Grasslands, Deserts, Tundra and the Polar ice caps. This variety (Biodiversity) is essential for the wellbeing of our planet and sustenance of life as a whole.

Ecologist Paul Ehrlich proposed the 'Rivet Popper Hypothesis' for better understanding the loss of each species in the ecosystem. He compared each species of an ecosystem with rivets in the body of an aeroplane. Thousands of rivets (species) join all the parts of an aeroplane (ecosystem). If every passenger travelling in the aeroplane starts taking rivets home(loss of species), initially it may not affect flight safety (proper functioning of the ecosystem). However, the plane becomes dangerously weak over a period of time, when more and more rivets are removed. Moreover, which rivet is removed is also important. When the key rivets (removal of key stone species) on the wings of the aeroplane are removed, undoubtedly it poses a serious threat to the flight safety. Thus we understand the role of every species for the harmonial function of an ecosystem.

The importance of biodiversity can be viewed and measured as

a) Ecosystem services

b) Biological resources

c) Social benefits of biodiversity

The organization and functioning of ecosystems world over is effected and dependent on biodiversity and its richness. The major functional attributes are:

- continuity of nutrient cycles or biogeochemical cycles (N_2, C, H_2O, P, S cycles)

- soil formation, conditioning or maintenance of soil health (fertility) by soil microbial diversity along with the different trophic members

- increases ecosystem productivity and provide food resources

- act as water traps, filters, water flow regulators and water purifiers (forest cover and vegetation)

- climate stability (forests are essential for rainfall, temperature regulation, CO_2 absorption, which in turn regulate the density and type of vegetation)

- forest resource management and sustainable development

- maintaining balance between biotic components

- cleaning up of pollutants – microbes are the biggest degraders of molecules including many anthropogenic ones which are present in effluents, sewage, garbage and agro-chemicals

- ecological stability – the varieties and richness of species contribute to ecological stability and survival of species. Biodiverse regions are reservoirs of biological resources like food resources, gene pool, genetic resource, medicinal resources, bio-prospecting

- to provide unique aesthetic value and hot spots for Ecotourism. Along with forest resources and wildlife it has commercial significance

- an indicator of the health of the ecosystem. Endemism is a crucial indicator of richness.

12.3 Biogeographical regions of India

As per the international 'biome' type of classification based upon climate, fauna and flora and the soil conditions, India can be divided into ten different biogeographic zones, **(Fig. 12.3 and table 12.1)** namely:

Table 12.1. Biogeographical Zones Of India

S. No.	Biogeographical Zones	Biotic Provinces	Area %	Biota
1.	Trans Himalaya	Comprises mountain areas of Ladakh (J&K), North Sikkim and Lahaul and Spiti of H.P	5.7%	Alpine steppe vegetation, richest wild sheep and goat community in the world (renowned for its quality wool), Chiru, black rocked crane, etc.,
2.	Himalayas	The entire mountain chain running from western to north eastern India	7.2%	Alpine forest, orchids, rhodotendrons, wild sheep, mountain goats, shrew, snow leopard, panda etc.,
3.	Indian Desert	The extremely arid area west of the Aravalli hill range comprising of the sand desert of Rajasthan (Thar) and the salt desert of Gujarat (Kutch)	6.9%	Thorn forests, deciduous forest, wild ass (endemic), Indian bustard, camel, foxes,snakes tc.,

4.	Semi-arid zones	The zones in between the desert and the Deccan plateau including the Aravalli hill range	15.6%	Thorn and deciduous forest, mangroves, Nilghai, black buck, four horned antelopes, sambar, chital, spotted deer, Asiatic lion, tiger, leopard, jackal etc.,
5.	Western Ghats	Mountain ranges from Sat Pena in South Gujarat to the southern most tip of Kerala	4%	Evergreen to dry deciduous forests, Nilgiri langur, Indian elephant. Nilgiri tahr (state animal of Tamilnadu), the grizzled squirrel and lion tailed macaque (endemic)
6.	Deccan Peninsula	A large area comprising of raised land bound by the Sathpura range on the north, Western Ghats on the west and Eastern Ghats on the east	43%	Deciduous forest, thorn forests and pockets of semi ever green forests, chital, sambar, sloth bear, barking deer, Nilghai, elephant , black buck etc.,
7.	Gangetic plains	One of most fertile region of India which extends from eastern Rajasthan through Uttar Pradesh, Bihar and West Bengal	11%	Mangrove forest, dry deciduous forest, rhinoceros, elephant, buffalo, tiger, crocodile, swamp deer, hog deer etc.,
8.	North – East India	The plains and non Himalayan hill ranges of north eastern India. This region represents the transition zone between the Indian, Indo – Malayan and Indo – Chinese bio geographical regions. It is the meeting point of the Himalayan mountains and peninsular India	5.2%	Biogeographical Gateway for much of India's fauna and flora and also biodiversity hot spot. Semi ever green forest, monsoon forests, swamps and grassland, Indian rhinoceros, golden langur, leopard etc.,
9.	Coastal Region	The coastline from Gujarat to Sunderbans with sandy beaches, mud flats, coral reefs, and mangroves	2.5%	Mangroves, sponges, corals, crabs, turtles, tunas, ornamental fishes etc.,
10.	Andaman and Nicobar Islands	Andaman and Nicobar Islands in the Bay of Bengal	0.3%	Evergreen forest, a wide diversity of corals, Narcondam hornbills, giant robber crab, turtle, wild boar, water monitor, south Andaman krait etc.,

Fig. 12.3 Biogeographical regions of India

Legend:
- Trans-Himalaya
- Himalaya
- Semi arid Zones
- Gangetic Plains
- Indian Desert
- North East India
- Deccan Peninsula
- Coastal Region
- Western Ghats
- Andaman & Nicobar Islands

12.4 Threats to biodiversity

Even though India is one of the 17 identified mega diverse countries of the world, it faces lots of threats to its biodiversity.

Apart from natural causes, human activities, both directly and indirectly are today's main reason for habitat loss and biodiversity loss. Fragmentation and degradation due to agricultural practices, extraction (mining, fishing, logging, harvesting) and development (settlements, industrial and associated infrastructures) leads to habitat loss and fragmentation leads to formation of isolated, small and scattered populations and as endangered species.

Some of the other threats include specialised diet, specialized habitat requirement, large size, small population size, limited geographic distribution and high economic or commercial value. Large mammals by virtue of their size require larger areas to obtain the necessities of life - food, cover, mates than do smaller mammals. Individual home range of Lion

can be about 100 square Km. Mammals have specialized dietary needs such as carnivores, frugivores and the need to forage over much larger areas than general dietary herbivores and omnivores. Mammals also have low reproductive output other than small rodents.

> **DO YOU KNOW?** The interrelationship and interdependence of all living components in a system can be seen from the example of the fruit bats of Guam (South East Asia). The fruit bats are a delicacy here, and hence their population has dwindled which is not surprising. What is surprising is that local fruit production has got affected as it was identified that the bats served as pollinators. Hence there is a need for conservation of diversity as that could avert such situations.

12.5 Causes of biodiversity loss

The major causes for biodiversity decline are:

- Habitat loss, fragmentation and destruction (affects about 73% of all species)

- Pollution and pollutants (smog, pesticides, herbicides, oil slicks, GHGs)

- Climate change

- Introduction of alien/exotic species

- Over exploitation of resources (poaching, indiscriminate cutting of trees, over fishing, hunting, mining)

- Intensive agriculture and aquacultural practices

- Hybridization between native and non-native species and loss of native species

- Natural disasters (Tsunami, forest fire, earth quake, volcanoes)

- Industrialization, Urbanization, infrastructure development, Transport – Road and Shipping activity, communication towers, dam construction, unregulated tourism and monoculture are common area of specific threats

- Co-extinction

Habitat Loss

Development of human society is inevitable. Natural habitats are destroyed for the purpose of settlement, agriculture, mining, industries and construction of highways. As a result species are forced to adapt to the changes in the environment or move to other places. If not, they become victim to predation, starvation, disease and eventually die or results in human animal conflict.

Over population, urbanization, industrialization and agricultural advancements require additional land, water and raw materials every year. This is made possible only through fragmentation or destruction of natural habitats by filling wetlands, ploughing grasslands, cutting down trees, forest, desilting rivers, constructing transport ways, caving mountains, extracting, ores, changing the course of rivers and filling of seashore.

The most dramatic example of habitat loss comes from the tropical rainforests 14% of the earth's land surface once covered by these tropical forests, is not more than 6% now. The Amazon rainforest, a vast area, harbouring millions of species, also called "Lungs of the planet"is destroyed and being replaced for agriculture and human settlements. 90% of New Zealand's wetlands have been destroyed and cleared for cultivating soya beans and raising grass for beef cattle. Kodaikanal and Nilgiri hills of Tamil Nadu have been

destroyed rapidly for human occupancy. Loss of habitat results in annihilation of plants, microorganisms and forcing out animals from their habitats.

Where are the Sparrows?

Common Sparrows are going extinct because of mindless urbanization. They are losing not just their natural habitats but also the essential human touch they need and thrive upon. The population of sparrows is dwindling due to the use of packed food, insecticides in farming and changing lifestyles, and match box-styled architecture resulting in an inadequate availability of food and shelter for the birds. Unlike pigeons that can make nests on ledges, sparrows need cavities to build their nests.

Habitat fragmentation

Habitat fragmentation is the process where a large, continuous area of habitat is both, reduced in area and divided into two or more fragments. Fragmentation of habitats like forest land into crop lands, orchard lands, plantations, urban areas, industrial estates, transport and transit systems has resulted in the destruction of complex interactions amongst species, (food chain and webs) destruction of species in the cleared regions, annihilation of species restricted to these habitats (endemic) and decreased biodiversity in the habitat fragments. Animals requiring large territories such as mammals and birds are severely affected. The elephant corridors and migratory routes are highly vulnerable. The dwindling of many well-known birds (sparrows) and animals can be attributed to this.

Over exploitation:

We depend on nature for our basic needs such as food and shelter. However, when the need becomes greed, it leads to over exploitation of natural resources. Excessive exploitation of a species, reduces the size of its population to such a level that it becomes vulnerable to extinction. Dodo, passenger pigeon and Steller's sea cow have become extinct in the last 200-300 years due to over exploitation by humans. Overfishing due to population pressure leads to many marine fish (populations) declining around the world.

Exotic species invasion:

Exotic species (non-native; alien) are organisms often introduced unintentionally or deliberately for commercial purpose, as biological control agents and other uses. They often become invasive and drive away the local species and is considered as the second major cause for extinction of species. Exotic species have proved harmful to both aquatic and terrestrial ecosystems.

Tilapia fish (Jilabi kendai) (*Oreochromis mosambicus*) introduced from east coast of South Africa in 1952 for its high productivity into Kerala's inland waters, became invasive, due to which the native species such as *Puntius dubius* and *Labeo kontius* face local extinction.

The introduction of the Nile Perch, a predatory fish into Lake Victoria in East Africa led to the extinction of an ecologically unique assemblage of more than 200 nature species of cichlid fish in the lake.

Papaya Mealy Bug (*Paracoccus marginatus*) is native of Mexico and Central America, is believed to have destroyed huge crops of papaya in Assam, West Bengal and TamilNadu.

Global Climate changes

Industrialization is a major contributor to climate change and a major threat to biodiversity. Energy drives our industries, which is provided by burning of fossil fuels.

This increases the emission of CO_2, a GHG, leading to climate change. Due to large scale deforestation, the emitted CO_2 cannot be absorbed fully, and its concentration in the air increases. Climate change increases land and ocean temperature, changes precipitation patterns and raises the sea level. This inturn results in melting of glaciers, water inundation, less predictability of weather patterns, extreme weather conditions, outbreak of squalor diseases, migration of animals and loss of trees in forest. Thus, climate change is an imminent danger to the existing biodiversity **(Fig. 12.4)**.
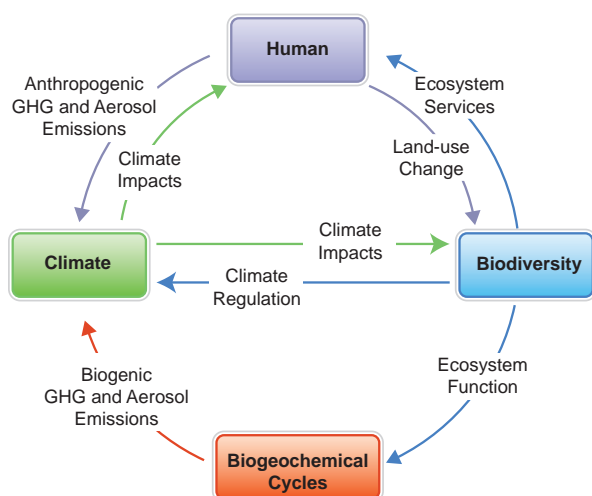

Fig. 12.4 Links between biodiversity, climate change and human well - being

Shifting or Jhum cultivation (Slash-and-burn agriculture)

In shifting cultivation, plots of natural tree vegetation are burnt away and the cleared patches are farmed for 2-3 seasons, after which their fertility reduces to a point where crop production is no longer profitable. The farmer then abandons this patch and cuts down a new patch of forest trees elsewhere for crop production. This system is practiced in north-eastern regions of India. When vast areas are cleared and burnt, it results in loss of forest cover, pollution and discharge of CO_2 which in turn attributes to loss of habitat and climate change which has an impact on the faunal diversity of that regions.

Coextinctions

Coextinction of a species is the loss of a species as a consequence of the extinction of another. (Eg., orchid bees and forest trees by cross pollination). Extinction of one will automatically cause extinction of the other. Another example for co-extinction is the connection between Calvaria tree and the extinct bird of Mauritius Island, the Dodo. The Calvaria tree is dependent on the Dodo bird for completion of its life cycle. The mutualistic association is that the tough horny endocarp of the seeds of Calvaria tree are made permeable by the actions of the large stones in bird's gizzard and digestive juices thereby facilitating easier germination. The extinction of the Dodo bird led to the imminent danger of the Calvaria tree coextinction.

Intensive agriculture

Spread of agriculture is sometimes at the cost of wetlands, grasslands and forests. Intensive agriculture is based on a few high yielding varieties. As a result, there is reduction in the genetic diversity. It also increases vulnerability of the crop plants to sudden attack by pathogens and pests. There are only few varieties of traditional paddy strains today due to use to hybrid varieties in Tamil Nadu.

12.5.1 Loss of Biodiversity

Species have been evolving and dying out (extinction) ever since the origin of life. However, species are now becoming extinct at a faster rate. This is destabilizing the ecological stability and the distribution of biological diversity on earth. Human activities greatly contribute to the loss of biodiversity. Natural resources such as land, water and organisms are indiscriminately exploited by human beings.

According to the Convention of Biological Diversity, direct and indirect human activities have a detrimental effect

on biodiversity. Direct human activities like change in local land use, species introduction or removal, harvesting, pollution and climate change contribute a greater pressure on loss of biodiversity. Indirect human drivers include demographic, economic, technological, cultural and religious factors.

Even though new species are being discovered, there is little hope for adding new species through speciation into the biodiversity treasure. Monsoon failure, global warming, depletion in ozone layer, landslides in hilly states, pollution are a few indirect effects of human activities which results in the loss biodiversity. IUCN Red List (2004) documents the extinction of 784 species in the 500 years.

It is estimated that the current rate of biodiversity loss is 100 to 1000 times higher than the naturally occurring extinction rate and is still expected to grow in the future. This loss of biodiversity has a immense impact on plant animal and human life. The negative effects include dramatic influence on the food web. Even reduction in one species can adversely affect the entire food chain which further leads to an overall reduction in biodiversity. Reduced biodiversity leads to immediate danger for food security by reducing ecosystem services.

12.5.2 Hotspots

Hotspots are areas characterized with high concentration of endemic species (the organisms which are exclusively restricted to a given area) experiencing unusual rapid rate of habitat modification loss. Norman Myers defined hot spots as "regions that harbour a great diversity of endemic species and at the same time, have been significantly impacted and altered by human activities."

A hotspot is a region that supports at least 1500 endemic vascular plant species (0.5% of the global total) has lost more than 70% of its original vegetation. There are 35 biodiversity hotspots in the world. India is home to four biodiversity hotspots (as per ENVIS). They are

a. Himalaya (the entire Indian Himalayan region)
b. Western Ghats
c. Indo-Burma: includes entire North-eastern India, except Assam and Andaman group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and Southern China)
d. Sundalands: includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines)

12.5.3 Endangered organisms

A species that has been categorized as very likely to become extinct is an Endangered species. Endangered (EN), as categorized by the International Union for Conservation of Nature (IUCN) Red List, is the second most severe conservation status for wild populations in the IUCN's scheme after Critically Endangered (CR).

In 1998 there were1102 animal and 1197 plant species in the IUCN Red List. In 2012, the list features 3079 animal and 2655 plant species as endangered (EN) worldwide.

One more species goes extinct...

George the tree snail (*Achatinella apexfulva*) died on January 1, 2019, at the age of 14. He was the last snail of his species, and is emblematic of the loss of native Hawaiian molluscs.

12.5.4 Extinction

Species is considered extinct when none of its members are alive anywhere in the world. If individuals of a species remain alive only in captivity or other human controlled conditions, the species is said to be extinct in

the wild. In both of these situations, the species would be considered globally extinct. A species in considered to be locally extinct when it is no longer found in an area it once inhabited but is still found elsewhere in the wild.

In the 450 million years of life on Earth, there had been 5 mass extinctions, which had eliminated at least 50% of the species of flora and fauna on the globe.

The extinction of species is mainly due to drastic environmental changes and population characteristics.

There are three types of Extinctions

i. **Natural extinction:** It is a slow process of replacement of existing species with better adapted species due to changes in environmental conditions, evolutionary

> **Project Tiger:** The Government of India launched the 'Project Tiger' in 1973 to protect our national animal. From 9 tiger reserves since its inception, the Project Tiger coverage has increased to 50 at present. Project Tiger is an ongoing Centrally Sponsored Scheme of the Ministry of Environment and Forests, providing central assistance to the states for tiger conservation in designated tiger reserves. Project Tiger was launched in the Jim Corbett National Park, Uttarakhand in1973. The project ensures a viable population of Bengal tigers in their natural habitats, protecting them from extinction and preserving areas of biological importance as a natural heritage.
>
> The National Tiger Conservation Authority (NTCA) is a statutory body of the Ministry, created under the Wildlife (Protection) Act, 1972. India holds over half the world's tiger population. According to the latest tiger census report released on 20th January 2015 by NTCA, the current tiger population is estimated at 2,212.

changes, predators and diseases. A small population can get extinct sooner than the large population due to inbreeding depression (less adaptivity and variation).

ii. **Mass extinction:** The earth has experienced quite a few mass extinctions due to environmental catastrophes. A mass extinction occurred about 225 million years ago during the Permian, where 90% of shallow water marine invertebrates disappeared.

iii. **Anthropogenic extinction:** These are abetted by human activities like hunting, habitat destruction, over exploitation, urbanization and industrialization. Some examples of extinctions are Dodo of Mauritius and Steller's sea cow of Russia. Amphibians seem to be at higher risk of extinction because of habitat destruction.

The most serious aspect of the loss of biodiversity is the extinction of species. The unique information contained in its genetic material (DNA) and the niche it possesses are lost forever.

12.6 IUCN

The International Union for Conservation of Nature (IUCN) is an organization working in the field of nature conservation and sustainable use of natural resources. It was established in 1948 and located at Gland VD, Switzerland. It is involved in data gathering and analysis research, field projects and education on conservation, sustainable development and biodiversity. IUCN's mission is to influence, encourage and assist societies throughout the world to conserve nature and to ensure that any use of natural resources is equitable and ecologically sustainable. It influences governments and industries through partnerships by providing information and advice. The organization collects, compiles and publishes the IUCN red list of threatened species and their conservation status in the world. It plays a vital role in the

implementation of several international conventions on nature conservation and biodiversity.

Red Data Book

Red Data book or Red list is a catalogue of taxa facing risk of extinction. IUCN – International Union of Conservation of Nature and Natural Resources, which is renamed as WCU – World Conservation Union (Morges Switzerland) maintains the Red Data book. The concept of Red list was mooted in 1963. The purpose of preparation of Red List are:

- To create awareness on the degree of threat to biodiversity
- Identification and documentation of species at high risk of extinction
- Provide global index on declining biodiversity
- Preparing conservation priorities and help in conservation of action
- Information on international agreements on conservation of biological diversity

Red list has eight categories of species i) Extinct ii) Extinct in wild iii) Critically Endangered iv) Endangered v) Vulnerable vi) Lower risk vii) Data deficiency viii) Not evaluated.

12.7 Biodiversity and its conservation

The natural resources of the Earth, including air, water, land, flora and fauna of natural ecosystems must be safeguarded for the benefit of the present and future generations through careful planning and management, as appropriate – Principle of the Stockholm Declaration, 1972.

The large-scale loss of biodiversity and its global impact makes conservation the need of the hour.

Conservation of biodiversity is protection and scientific management of biodiversity so as to maintain it at its optimum level and derive sustainable benefits for the present as well as future generations. It aims to protect species from extinction and their habitats and ecosystems from degradation.

General strategies in conservation

- identify and protect all threatened species
- identify and conserve in protected areas the wild relatives of all the economically important organisms
- identify and protect critical habitats for feeding, breeding, nursing, resting of each species
- air, water and soil should be conserved on priority basis
- wildlife Protection Act should be implemented

There are two aspects of conservation strategies **(Table 12.4).**

i) *In-situ* conservation
ii) *Ex-situ* conservation

12.7.1 *In-situ* Conservation *(Conservation in the natural habitat)*

This is the conservation of genetic resources through their protection within a natural or manmade ecosystem in which they occur. It is conservation and protection of the whole ecosystem and its biodiversity at all levels in order to protect the threatened species.

Maximum protection of biodiversity hotspots regions with very high levels of species richness. Although all the biodiversity hotspots together cover less than 2 percent of the earth land area, the number of species they harbour is

extremely high and protection of these hotspots could reduce the ongoing mass biodiversity loss.

Protected Areas

These are biogeographical areas where biological diversity along with natural and cultural resources is protected, maintained and managed through legal measures. protected areas include national parks, wild life sanctuaries, community reserves and biosphere reserves. World Conservation monitoring centre has recognized 37,000 protected areas world-wide. India has about 771 protected areas covering 162099 km^2 comprising of National Parks (104), Wild Life Sanctuaries (544), biosphere reserves (18) and several sacred groves.

National Parks (NP)

It is a natural habitat that is notified by the state government to be constituted as a National Park due to its ecological, faunal, floral, geomorphological, or zoological association of importance. No human activity is permitted inside the national park except the activities permitted by the Chief Wildlife Warden of the state under the conditions given in CHAPTER IV, of the Wildlife Protection Act (WPA) 1972 (**Table 12.2).**

Table 12.2 National Parks in Tamil Nadu

National Parks in Tamil Nadu	Year of establishment	District(s)
Guindy NP	1977	Chennai
Gulf of Mannar Marine NP	1986	Ramanathpuram and Tuticorin
Indira Gandhi (Annamalai) NP	1976	Coimbatore
Mudumalai NP	1940	Nilgiris
Mukurthi NP	2001	Nilgiris

There are 104 existing national parks in India covering an area of 40,501 km^2, which is 1.23% of the geographical area of the country (National Wildlife Database, Aug. 2018). National Park is an area which is strictly reserved for the betterment of wildlife and biodiversity and where activities like development, forestry, poaching, hunting, grazing and cultivation are not permitted. They are large areas of scenic and national beauty maintained for scientific educational and recreational use. They are not used for commercial extraction of resources. Kaziranga National park is a protected area for the one Horned Rhinoceros in Assam.

Wild Life Sanctuaries (WLS)

Any area other than the area comprised with any reserve forest or the territorial waters can be notified by the State Government to constitute as a sanctuary if such area is of adequate ecological, faunal, floral, geomorphological, natural or zoological significance. This is for the purpose of protecting, endangered factual species. Some restricted human activities are allowed inside the Sanctuary area details of which are given in CHAPTER IV, of the Wildlife Protection Act (WPA) 1972. Ecotourism is permitted, as long as animal life is undisturbed.

There are 544 existing wildlife sanctuaries in India covering an area of 118,918 km^2, which is 3.62 % of the geographical area of the country (National Wildlife Database, 2017).

Sanctuaries are tracts of land where wild animals and fauna can take refuge without being hunted or poached. Other activities like collection of forest products, regulated harvesting of timber, private ownership of land are permitted. Periyar wild life sanctuary in Kerala is famous for the Indian Tiger and Asiatic Elephant **(Table 12.3).**

Table 12.3 Wild Life Sanctuaries in Tamil Nadu

Prominent WLS in Tamil Nadu	Year of establishment	Districts
Vedanthangal Lake Birds WLS	1936	Chengalpet
Mudumalai WLS	1942	Nilgiris
Point Calimere WLS	1967	Nagapattinam
Indira Gandhi (Annamalai) WLS	1976	Coimbatore
Mundanthurai WLS	1988	Tirunelveli

THE MADRAS CROCODILE BANK TRUST

The Madras Crocodile Bank Trust and Centre for Herpetology was the brain child of the legendary Romulus Whitaker and a handful of like-minded conservation visionaries, who began work on the facility in 1976. It aimed to save India's dwindling crocodilian population. The mission is to promote the conservation of reptiles and amphibians and their habitats through education, scientific research and capture breeding. The crocodile bank remains a world leader in the field of frontline conservation and the preservation of natural landscapes. The Crocodile Bank currently consists of a large reptile park near Chennai and several field projects located throughout the subcontinent reaching as far as the Nicobar Islands. About half a million people visit the bank every year, making it one of the most popular tourist attractions along the East Coast Road.

Biosphere Reserve (BR)

Biosphere Reserve (BR) is an international designation by UNESCO for representative parts of natural and cultural landscapes extending over large area of terrestrial or coastal/ marine ecosystems or a combination thereof. BRs are designated to deal with the conservation of biodiversity, economic and social development and maintenance of associated cultural values. Biosphere Reserves are thus special environments for both people and nature and are living examples of how human beings and nature can co-exist while respecting each other's needs. The Biosphere Reserve Programme is guided by UNESCO's Man and Biosphere (MAB) programme, as India is a signatory to the landscape approach supported by MAB programme. The scheme called Biosphere Reserve was implemented by the Government of India in 1986. There are 18 Biosphere Reserves in the country.

Arignar Anna Zoological Park, Vandalur

Arignar Anna Zoological Park is spread over an area of 602 hectares. of Reserve Forest at Vandalur, Chennai. It is one of the largest zoo in South East Asia in terms of area. The Zoological Park exhibits different classes of animals – it has around 2500 wild animals of nearly 180 species which includes Mammals, Birds and Reptiles. 34 years since its establishment, the Zoological Park has emerged as a successful ex-situ conservation centre and a captive breeding centre for many endangered species like Royal Bengal Tiger, Lion Tailed Macaque, Nilgiri Langur, Gray Wolf, etc.,

The Zoo has many attractive features like Butterfly Park, Childrens Park, Walk Through Aviary, Lion & Deer Safari, Forest Museum, Interpretation centre, etc., which attracts more than 21 lakh visitors every year. The Zoo has strengthened its protection by means of installing CCTV Cameras for both visitors and animal management under the name of Zoo e-Eye. 24 x 7 Animal Live Streaming was introduced for the benefit of the visitors for the first time in the world. Vandalur Zoo Mobile Application was introduced to provide services to the visitors like facility to book tickets, Zoo navigation, Animal information in text and audio format. Digital payments at ticket counters are also available.

The Zoo school has been involved in education and outreach programmes. One such successful programme is 'Zoo Ambassador' which is been conducted for school children. In the year 2018, more than 400 students were trained and titled as Zoo Ambassadors. The Zoo also has a Rescue Centre which accommodates rescued wild animals and treats them to come out of stress.

Source: Director, Arignar Anna Zoological Park, Vandalur, Chennai

Agasthyamalai (Karnataka - Tamil Nadu - Kerala), Nilgiri (Tamil Nadu - Kerala), Gulf of Mannar (Tamil Nadu) are the BRs notified in Tamil Nadu

Sacred Groves

A sacred grove or sacred woods are any grove of trees that are of special religious importance to a particular culture. Sacred groves feature in various cultures throughout the world.

12.7.2 *Ex-Situ* Conservation

It is conservation of selected rare plants/animals in places outside their natural homes. It includes offsite collections and gene banks.

Offsite Collections

They are live collections of wild and domesticated species in Botanical gardens, Zoological parks, Wildlife safari parks, Arborata (gardens with trees and shrubs). The organisms are well maintained for captive breeding programmes. As a result, many animals which have become extinct in the world continue to be maintained in Zoological Parks. As the number increases in captive breeding, the individuals are selectively released in the wild. In this way the Indian crocodile and gangetic dolphin have been saved from extinction.

Gene Banks

Gene banks are a type of biorepository which preserve genetic materials. Seeds of different genetic strains of commercially important plants can be stored in long periods in seed banks, gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques.

However, it is not economically feasible to conserve all biological wealth and all the ecosystems. The number of species required to be saved from extinction far exceeds the conservation efforts.

Table 12.4 Difference between *Insitu* and *Exsitu* Conservation

Insitu Conservation	*Exsitu* Conservation
It is the on-site conservation or the conservation of genetic resources in natural populations of plant or animal species.	This is a conservation strategy which involves placing of threatened animals and plants in special care locations for their protection.
It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or restoring the habitat itself, or by defending the species from predators.	It helps in recovering populations or preventing their extinction under simulated conditions that closely resemble their natural habitats.
National Parks, Biosphere Reserve, Wild Life Sanctuaries form *insitu* conservation strategies.	Zoological parks and Botanical gardens are common *exsitu* conservation programs.

12.7.3 Role of WWF and CITES

World Wild Fund for Nature (WWF) is an international non-governmental charitable trust founded in 1961, with headquarters at Gland, Vaud, Switzerland. It aims at wildness preservation and the reduction of human impact on the environment. It was formerly named the World Wildlife Fund. The living planet report is being published every two years by WWF since 1998.

The vision of WWF is to conserve nature and reduce the most pressing threats to the diversity of life on Earth by conserving the world's most ecologically important regions, protect and restore species and their habitats, strengthen local communities' ability to conserve the natural resources they depend upon and to ensure that the value of nature is reflected in decision made by individuals, communities, governments and businesses.

CITES

The Convention on International Trade in Endangered Species (CITES) of wild fauna and flora, also known as the Washington Convention, is a multilateral treaty to protect endangered plants and animals. It was drafted from a resolution adopted from a meeting of members of the IUCN in 1963 and opened for signature in 1973. It came into force during July 1975.

ZOOLOGICAL SURVEY OF INDIA

The Zoological Survey of India (ZSI) was established in 1916 to promote survey, exploration and research leading to the advancement in our knowledge of various aspects of biodiversity of our country.

The objectives of ZSI are:

- Exploration, Survey, Inventorying and Monitoring of faunal diversity in various states, ecosystems and protected areas of India.
- Periodic review of the status of threatened and endemic species.
- Preparation of Red Data Book and Fauna of India.
- Biological studies on selected important species.
- Maintenance and Development of National Zoological Collections.

It aims to ensure that international trade in specimens of wild animals and plants should not be a threat to the survival of the species in the wild. It accords varying degrees of protection to more than 35,0000 species of animals and plants.

12.8 Restoration of Degraded Habitats

Biodiversity conservation through eco development – an Indian case study

The Forestry Research Education and Extension Project FREEP (A World Bank Initiative) in India is employing a strategy called 'ecodevelopment' which enlists local communities in the preservation of biodiversity. The strategy involves developing alternate resources and sources of income for those who depend on the protected natural habitat (forest) for their livelihood.

FREEP is conducting pilot ecodevelopment programmes in the Kalakad-Mundanthurai Tiger Reserve (KMTR) in Tamil Nadu. The reserve contains a unique and varied array of flora ranging from thorn and dry teak to tropical evergreen, and supports a rich variety of birds and mammals, including tigers, leopards and elephants. The last tiger refuge in Tamil Nadu, the KMTR is one of 50 sites covered under the Indian Government's Project Tiger, a programme receiving international assistance to enhance tiger habitat.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The United Nations convention on Biological Diversity, known as CBD in short, was signed by India and 172 other nations on December 29, 1993. The CBD was an attempt to establish an international program for conserving and using the world's biological resources. This historical treaty recognizes the "sovereign right of nation over their genetic resources" and considers "appropriate access to genetic resources." The treaty also takes into account the "fair and equitable sharing" of benefits arising from the use of genetic resources.

Over 100 villages are now participating in the KMTR project. Communities and individual farmers have planted fuelwood and fodder plantations. Some villagers have installed cow dung-based gas plants for home fuel needs and are using fuel-saving pressure cookers and more efficient wood-burning stoves (smokeless chulas). Loans for a wide array of alternative income-generating activities such as dairy and poultry farming, tailoring, coconut leaf weaving, and setting up tea and dry goods shops are made

available. Thus, the eco-development programme at the KMTR is rapidly coming to be seen as a model for conserving biodiversity through local participation.

12.9 Bio Diversity Act (BDA)

The Convention on Biological Diversity (CBD) is a United Nations initiative to protect Biodiversity and encourage the sustainable use of natural resources. The convention was held in 1992 at the 'Earth Summit' in Brazil. India is a signatory of the CBD. The Biological Diversity Act, 2002 is an Act of the Parliament of India for preservation of biological diversity in India, and provides mechanism for equitable sharing of benefits arising out of the use of traditional biological resources and knowledge. The Act was enacted to meet the obligations under Convention on Biological Diversity (CBD), to which India is a party.

The National Biodiversity Authority (NBA) was established by the Central Government in 2003 to implement India's Biological Diversity Act (2002). The NBA is a Statutory Body and it performs facilitative, regulatory and advisory functions for the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources. The Headquarters of the NBA is situated in Chennai.

Fresh water, wildlife, food and climate are things which are not just 'Nice to have' …. they are 'Need to have'. These are things indispensable for the survival of mankind….. together, we can protect LIFE on our planet – including our own.

Summary

Biodiversity is the variety of all life on Earth, encompassing genetic, species and ecosystem diversity. Today's biodiversity is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans. To date, about two million species have been identified on Earth.

Biodiversity supplies a large number of goods and services that sustain human life, including the provision of food, fuel and building materials; purification of air and water; stabilization and moderation of the earth's climate; moderation of floods, droughts, temperature extremes and wind forces; generation and renewal of soil health; maintenance of genetic resources as inputs to crop varieties and livestock breeds, medicines, and other products; and cultural, recreational and aesthetic benefits.

Over the past few hundred years, biodiversity has faced major challenges, including a growing demand for biological resources caused by population growth and increased consumption. This increased exploitation of biological resources has resulted in the loss of species at levels currently estimated to be 100 times faster than the natural rate of loss prior to significant human intervention. Though many species were lost and new ones formed, it is likely we will lose all this natural wealth in less than two centuries, if the present rate of biodiversity losses persist.

The biodiversity and its conservation is the important global issue of international concern. Recognition of this problem has made scientists and policy makers to work and develop mechanisms to document, conserve and sustainably use biodiversity.

The younger generation should be made to realize the critical state of biodiversity today and volunteer to protect and conserve it, so as to enable the future generations get to enjoy the benefits of Nature.

Evaluation

1. Which of the following regio n has maximum biodiversity
   a) Taiga
   b) Tropical forest
   c) Temperate rain forest
   d) Mangroves

2. Conservation of biodiversity within their natural habitat is
   ***a) Insitu* conservation**
   b) Exsitu conservation
   c) In vivo conservation
   d) In vitro conservation

3. Which one of the following is not coming under insitu conservation
   a) Sanctuaries   b) Natural parks
   c) **Zoological park**   d) Biosphere reserve

4. Which of the following is considered a hotspots of biodiversity in India
   a) Western ghats   b) Indo-gangetic plain
   c) Eastern Himalayas   **d) A and C**

5. The organization which published the red list of species is
   a) WWF   **b) IUCN**   c) ZSI   d) UNEP

6. Who introduced the term biodiversity?
   a) Edward Wilson   **b) Walter Rosen**
   c) Norman Myers   d) Alice Norman

7. Which of the following forests is known as the lungs of the planet earth?
   a) Tundra forest
   a) Rain forest of north east India
   b) Taiga forest
   c) Amazon rain forest

8. Which one of the following are at high risk extinction due to habitat destruction
   a) Mammals   b) Birds
   c) Amphibians   d) Echinoderms

9. **Assertion:** The Environmental conditions of the tropics are favourable for speciation and diversity of organisms.
   Reason: The climate seasons, temperature, humidity and photoperiod are more or less stable and congenial.

a) Both Assertion and Reason are true and Reason explains Assertion correctly.
b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c) Assertion is true , but Reason is false.
d) Both Assertion and Reason are false.

10. Define endemism.
11. How many hotspots are there in India? Name them.
12. What are the three levels of biodiversity?
13. Name the active chemical found in the medicinal plant *Rauwolfia vomitoria*. What type of diversity it belongs to?
14. "Amazon forest is considered to be the lungs of the planet"-Justify this statement.
15. 'Red data book'-What do you know about it?
16. Compare and Contrast the insitu and exsitu conservation.
17. What are called endangered species? Explain with examples.
18. Why do we find a decrease in biodiversity distribution, if we move from the tropics towards the poles?
19. What are the factors that drive habitat loss?
20. Alien species invasion is a threat to endemic species – substantiate this statement.
21. Mention the major threats to biodiversity caused by human activities. Explain.
22. What is mass extinction? Will you encounter one such extinction in the near future. Enumerate the steps to be taken to prevent it.
23. In north eastern states, the jhum cultivation is a major threat to biodiversity – substantiate the statement.
24. List out the various causes for biodiversity losses.
25. How can we contribute to promote biodiversity conservation?
26. Write a note on i) Protected areas, ii) Wild life sanctuaries, iii) WWF

Concept Map

Importance of biodiversity

Threats to biodiversity

Patterns of biodiversity

Causes of biodiversity loss

Magnitude of biodiversity

Biodiversity

Hotspots

Loss of biodiversity

Level of biodiversity

Endangered organisms

Concepts of biodiversity

Extinction

National parks

Protected areas

Red data book

Offsite conservation

Gene banks

INSITU conservation

IUCN

CITES

EXSITU conservation

Wild life Sanctuaries

Biosphere reserves

Govt

WWF

Organisations in conservation

Biodiversity conservation