BIODIVERSITY AND CONSERVATION

- **Biodiversity** (Gk *bios* = life, *diversity* = forms) or **biological diversity** can be defined as the vast array of species of micro-organisms, algae, fungi, plants and animals occurring on the earth either in the terrestrial or aquatic habitat aud the ecological complexes of which they are a part. This includes diversity within species, between species and of the ecosystem. Although India has only 2.4 per cent of the world's land area, its share of **global species diversity** is an impressive **8.1 per cent**. India's biodiversity is one of the most important in the world. It is **one of the 12 mega-biodiversity countries** of the world. It has about 45,000 species of plants and twice as many species of animals.

MAGNITUDE OF BIODIVERSITY

- According to the IUCN (2004), the total number of plants and animal species described so far is slightly more than 1.5 million, but we have no clear idea of how many species are yet to be discovered and described. Scientists have described the range of total number of world's species between 1.7 – 1.8 million as in 2010. Total number of plants over earth are approximately 3, 21, 212; total number of vertebrates – 62, 305; total number of invertebrates – 1, 305, 250 and others (bacteria, cyanobacteria, algae) are approximately 51, 563. Thus, number of species over earth totals to 1,740, 330.

- India has **10 biogeographical regions** namely, Trans Himalaya, Himalaya, Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plain, Coasts, North-East and Islands. The country is rich in endemic flora and fauna. The **richest regions** are the Himalayas, Western Ghats, Indian Islands and North-Eastern Hills of India. Each biogeographical region has several habitats, biotic communities and ecosystems. The **largest biogeographical**

1. Trans Himalaya
2. Himalaya
3. Desert
4. Semi-Arid
5. Western Ghats
6. Deccan Peninsula
7. Gangetic Plain
8. Coats
9. North East
10. Islands

Fig.: Biogeographical regions of India

region is Deccan Peninsula and the most biodiversity rich regions are Western Ghats and North-East.

LEVELS OF BIODIVERSITY

- The term biodiversity was coined by **Walter G. Rosen** in 1982. The term was popularised by Edward Wilson to describe combined diversity at all the levels of biological organisation.

- Biodiversity is of three inter-related hierarchial levels :genetic diversity, species diversity and community/ ecosystem diversity.

- **Genetic diversity** is the diversity in the numbers and types of genes as well as chromosomes present in different species and also the variations in the genes and their alleles in the same species.

- The genetic variation of *Rauwolfia vomitoria* growing in different Himalayan ranges might be in terms of the potency and concentration of the active chemical (reserpine) that the plant produces.

- India has more than 50,000 genetically different strains of rice and 1,000 varieties of mango.

- **Species diversity** is the diversity in number and richness of the species of a region. The number of the species per unit area is called **species richness.** Number of individuals of different species represent **species evenness** or **species equitability.**

- Western Ghats have greater amphibian species diversity as compared to Eastern Ghats.

- **Community and ecosystem diversity** (ecological diversity) is related to the different types of ecosystems/ habitats *e.g.*, terrestrial (forests, grasslands, deserts etc.) and aquatic (fresh water and marine) ecosystems.

- It is of three types **alpha, beta and gamma diversity.**
    - **Alpha (a) diversity** refers to the diversity of organisms *i.e.*, number of species in given community or habitat. It is calculated by the combination of species richness and evenness or equitability.
    - **Beta diversity (between community diversity)** is diversity which develops due to change in a habitat or community along environmental gradients like altitude, latitude, moisture gradient, etc. The greater the difference or turnover of species between the habitats, the greater is the beta-diversity.
    - **Gamma diversity** is also called **regional diversity.** It represents the total richness of species in all the habitats found within a region, geographical area or landscape. When each habitat has a unique biota, gamma diversity is equal to average alpha diversity multiplied by the number of such habitats.

- **Ecosystem diversity is quite high in India** because of the occurrence of a large number of ecosystems like deserts, rain forests, deciduous forests, mangroves, coral reefs, wetlands, estuaries and alpine meadows. **It is quite low in small countries like Norway.**
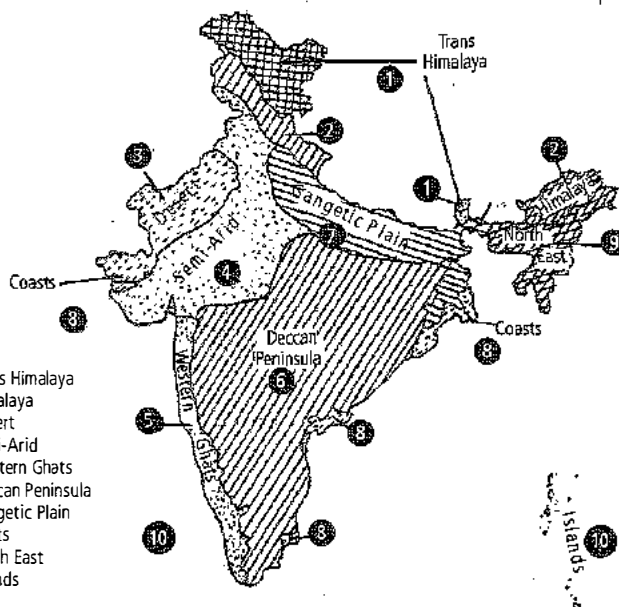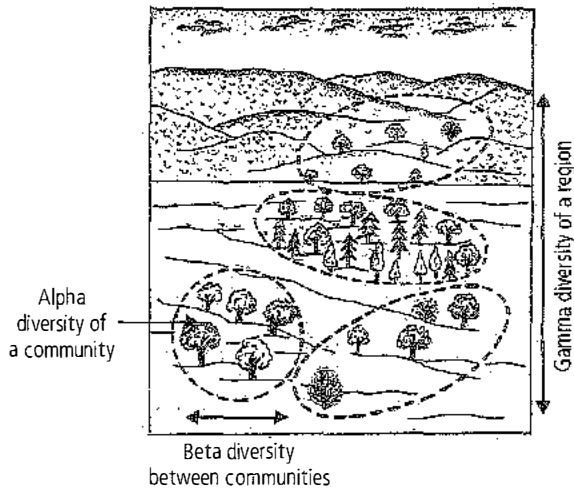
Fig.: Three types of diversity

PATTERNS OF BIODIVERSITY

Latitudinal and altitudinal gradient

- In barring arid/ semiarid and aquatic habitats, biodiversity shows latitudinal and altitudinal gradients.
- Species diversity decreases as we move away from the equator towards the poles. It increases in temperate areas but reaches the **maximum in tropical rain forests**. **Maximum diversity occurs in Amazon rain forest of South America** with 40,000 species of plants, 3000 species of fish, 1300 birds, 427 mammals, 427 amphibians, 378 reptiles and more than 1,25,000 invertebrates.
- Tropics account for greater biological diversity. Colombia located near the equator has nearly 1,400 species of birds while New York at 41°N has 105 species and Greenland at 71°N has only 56 species. India, with much of its land area in the tropical latitudes has more than 1,200 species of birds.
- There are some **reasons behind the maximum biological diversity of tropical regions.** These are:
  - **Prolong evolutionary time :** Speciation is generally a function of time. Unlike temperate regions which were subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for **species diversification.**
  - **Constant environment :** Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity.
  - **High productivity :** There is more solar energy available in the tropics, which contributes to higher productivity; this in turn, might contribute indirectly to greater diversity.

Species-area relationships

- German naturalist and geographer **Alexander von Humboldt** while exploring the wildeness of South American jungles found that within a region, the species richness increased with increasing area but upto a certain limit. The relationship between species richness and area turned out to be **rectangular hyperbola** for a wide variety of taxa whether they are birds, bats, fresh water fishes or flowering plants.

- On a logarithmic scale it is a straight line.

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

  Here, S is species richness, Z is slope of line or regression co-efficient, C is Y intercept while A is area.
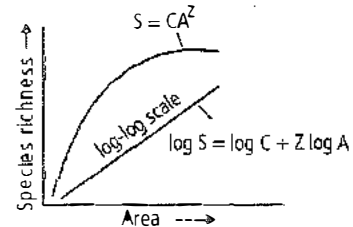

Fig.: Species-area relationship

- **Regression co-efficient** is generally 0.1–0.2 regardless of taxonomic group or region (whether it is the plants in Britain, birds in California or molluscs in New York state, the slopes of the regression line are amazingly similar). However, when the species-area relationship is considered for a very large area like a whole continent, regression coefficient or slope of the line comes to have Z value of 0.6–1.2, *e.g.*, for frugivorous birds and mammals of tropical forests of different continents, the slope is found to be 1.15

IMPORTANCE OF BIODIVERSITY

- Rich diversity is essential not only for ecosystems but also for the very survival of human race. Species diversity provides stability to the ecosystems. It is important for maintaining higher levels of productivity and ecosystem health.

Stability of ecosystem

- Biodiversity is essential for stability of an ecosystem. Communities with more species tend to be more stable than those with less species.
- It is able to resist occasional disturbance. Alien species are unable to find a foot-hold.
- Destruction of a part of ecosystem does not degrade it but the ecosystem is resistant and is able to restore itself after sometime. This has been confirmed by David Tilman's long term ecosystem experiments using outdoor plots.

Sources of food and improved varieties

- Several thousand species of edible plants and animals are known. However, **85% of the world's food production is met by cultivating less than 20 plant species.**
- Three carbohydrate-rich crops namely, **wheat, corn** (maize) and **rice** alone yield nearly **two-third of the food production.**
- To meet the demands of increasing human population, man not only is exploring new varieties of plants but also animal food.
- Biodiversity is also used as a source material for **breeding improved varieties.** To improve the desired traits, commercial/domesticated species are crossbred with

their wild relatives. In this way disease resistant and high yielding varieties of crops (*e.g.*, wheat, rice, maize, sugarcane) and fruits have been developed.

- For example, cross breeding of wild rice species (*Oryza nivara*) has helped in developing new varieties which are resistant to four main rice diseases. Similarly, potato has been made resistant to late blight disease, potato mosaic virus, etc. through cross breeding experiments.
- Also, hybrid animal varieties have been produced to increase the production of milk, meat, eggs, etc.
- This indicates the need for protecting biodiversity for breeding programmes in agriculture, horticulture, floriculture, animal husbandry, apiculture, sericulture, lac culture, piggery, poultry and fishery

Fibres

- A variety of plant species such as cotton, flax, hemp, jute, *Agave*, *Abaca* (Manila hemp) etc. are the major sources of fibres.
- More and more variety of plants are being explored for obtaining superior fibres.

Useful products

- Plant species provide a variety of useful products such as gums, resins, dyes, fragrance, perfumes, waxes, lubricants, hydrocarbons, rubber, latex, tannins, paper, tea, coffee, dry-fruits, etc.
- Similarly, animal species provide wool, fur, skin, leather, honey, lac, silk, waxes, lubricants, pearls, ivory, horns, antlers, etc. for trade.

Drugs and medicines

- Large number of substances with therapeutic properties are obtained from variety of plant species. For example, quinine is obtained from the bark of plant *Cinchona ledgeriana* to combat malaria; taxol from the bark of yew trees (*Taxus brevifolia*, *Taxus baccata*) for treating cancer, etc.
- Ayurvedic medicines available in the market for treating innumerous diseases in man are based on plant products.
- Currently, mere 120 plant species are utilized to obtain 25% of the drugs in the pharmacy.

Scientific value

- Animals are used for biological and medical research. Fruitfly, frog, rat, rabbit, guinea pig, dog and monkey are among such valuable animals.
- New medicines are tested first on animals. Similarly new surgical techniques are first tried on animals. Animals preceded humans in space. All this necessitates the safety for wild life.

Ecosystem services

- Biodiversity plays a major role in many ecosystem services such as replenishing oxygen through photosynthesis, pollination through bees, bumble bees, birds and bats etc., regulation of global climate, storage and retention of rain water in aquifers and reservoirs, control of floods and soil erosion, nutrient cycling, microbial waste treatment, biological control of pests, etc.

LOSS OF BIODIVERSITY

- The most serious aspect of the loss of biodiversity is the extinction of species. Extinction is of three types – natural extinction, mass extinction and anthropogenic extinction.
- **Natural or background extinction** is a slow process of replacement of existing species with the better adapted species due to alternate evolution, changes in environmental conditions, predators and diseases.
- Earth has experienced five **mass extinctions** due to environmental catastrophes. Mass extinctions occurred in millions of years. Extinction of marine invertebrates in permian period, extinction of dinosaurs and number of other species between cretaceous and tertiary periods are examples of mass extinctions.
- **Anthropogenic extinctions are** extinctions abetted by human activities like settlements, hunting, over-exploitation and habitat destruction. The primary cause of the loss of biodiversity is not direct human exploitation but the **habitat destruction** that inevitably results from the expansion of human populations and human activities.

Factors contributing to extinction

- The world is facing accelerated rates of species extinctions, largely due to human interference. There are four major causes– the evil quartet :
  - Habitat loss and fragmentation
  - Over exploitation
  - Alien species invasions
  - Co-extinctions.
- However, other factors also intensify extinctions like **disturbance and degradation, pollution, intensive agriculture** and **forestry.**
- **Habitat fragmentation** is the process where a large, continuous area of habitat is both, reduced in area and divided into two or more fragments. The most subtle form of **habitat degradation** is environmental **pollution** and the most common causes are pesticides, industrial chemicals and wastes, emissions from factories and automobiles, and sediment deposits from eroded hill sides. Effects of **pesticide pollution, water pollution** and **air pollution** on environment are well known. Spill-over of oil in sea causes death of several marine algae, fish and sea birds. Pollution, therefore, reduces species biodiversity.
- Increasing human population has escalated the use of natural resources. Dodo, Passenger Pigeon, three subspecies of Tiger and Steller Sea Cow have become extinct in the last 500 years due to **over-exploitation** by humans. Many marine fish populations are declining around the world because of over-harvesting. Some commercially important species are likely to become endangered.
- Non-native or **alien species** are often introduced inadvertently for their economic and other uses. They often become invasive and drive away the local species. **Water hyacinth** *(Eichhornia crassipes)* was introduced in Indian waters to reduce pollution. It has clogged water bodies including wetlands at many places resulting in death of several aquatic plants and animals. **Nile Perch** (a predator

fish) was introduced in lake Victoria of South Africa. It killed and eliminated ecologically unique assemblage of over 200 native species of small Cichild Fish.

⊛ Certain obligatory mutualistic relationships exist in nature, *e.g., Pronuba yuccaselles* and *Yucca*. Extinction of one will automatically cause extinction of the other. This is known as co-extinction. If the host fish becomes extinct, all the parasites exclusively found on it will also become extinct.

⊛ Natural disturbance and degradation are caused by spontaneous jungle fire, tree fall, pest infestation, defoliation by insects or locust attack.

⊛ Man made disturbances and degradation are more severe. They include cutting of trees, use of fire for clearing, collection of litter and over exploitation for other economically important products.

⊛ Spread of agriculture is at the cost of wetlands, grasslands and forests. Destruction of habitats results in extinction of species. Intensive agriculture is also based on a few high yielding varieties. As a result, there is reduction in the genetic diversity The Amazon rain forest (it is so huge that it is called the 'lungs of the planet'), harbouring probably millions of species, is being cut and cleared for cultivating soyabeans or for conversion to grasslands for raising beef cattle.

⊛ There is a tendency to grow economically important trees in pure strands, *e.g.*, sal, teak. It drives away or annihilates other species found in forests. The pure strands are liable to be attacked by insects and pathogens.

RED DATA BOOK AND IUCN

⊛ To highlight the legal status of rare species for the purpose of conservation, the International Union for Conservation of Nature and Natural Resources (IUCN) has established the five main conservation categories. These are extinct, endangered, vulnerable, rare and insufficiently known species.

⊛ Using the IUCN categories, the World Conservation Monitoring Centre (WCMC) has evaluated and described threats to about 60,000 plant and 2000 animal species in its series of Red Data Books.

⊛ Threatened species include those which are endangered, vulnerable, and rare in IUCN categories.

⊛ The great majority of the species on these lists of Red Data Books are plants. However, there are also species of fish (343), amphibians (50), reptiles (170), invertebrates (1355), birds (1037) and mammals (497).

⊛ Red Data Book or Red List was initiated in 1963. The 2000 Red List has made assessment of 18,000 species, out of which 11096 species (5485 animals and 5611 plants) are on the threatened list world-wide. The number of threatened species has now gone up to 15,500 (IUCN, 2004).

⊛ Red List has eight categories of species.

⊛ These are extinct, extinct in wild, critically endangered, endangered, vulnerable, lower risk, data deficient and not evaluated species.

– The taxon that has been completely eliminated or died out from earth is called extinct, e.g., Dodo.

– The taxon that is absent in any of its natural or expected habitats in the wild is known as extinct in wild.

– Critically endangered species is the taxon which is facing very high risk of extinction in the wild and can become extinct any moment in the immediate future. *e.g., Berberis nilghiriensis, Podophyllum.*

– Endangered species are facing a high risk of extinction in the wild in near future due to decrease in its habitat, excessive predation or poaching e.g., Red panda, Blue whale, Asiatic wild ass, Lion tailed macaque.

– Lower risk species are threatened species which have lower risk of extinction and, therefore, require only a small attention to become normal flourishing species.

– When the data for making direct or indirect assessment of risk of extinction is deficient, such species are called data deficient species.

– Not evaluated species are those that has not been evaluated for risk of extinction.

⊛ Out of these, four categories of species are included under threatened species– critically endangered, endangered, vulnerable and lower risk species. Two more categories are also added to them. These are rare species and indeterminate species.

– Rare species (R) are species with naturally small populations, either localised or thinly scattered, which are always at risk from pests/pathogens/predators/ exotic species. Clouded leopard (*Neo felis nebulosa*) of Himalayas is a rare species.

– Indeterminate species are in danger of extinction but the reason is not known, *e.g.*, 3-banded Armadillo of Brazil, short eared rabbit of Sumatra, Mexican prairie dog.

CONSERVATION OF BIODIVERSITY

⊛ Biodiversity conservation means protection, upliftment and scientific management of biodiversity to maintain it at its optimum level and derive sustainable benefits for the present as well as future strategies. The maintenance of a high level of biodiversity is important for the stability of ecosystems. Thus, there are three main reasons to conserve the biological diversity which can be grouped in three categories :

– Narrow utilitarian (useful human products like food, fibres, drugs and medicines etc.)

– Broadly utilitarian (ecosystem services like provision of pollinators etc. climate regulation, flood and erosion control, ecological balance through nutrient cycling, microbial waste treatment, biological pest control and it also consider aesthetic and cultural values).

- Ethical utilitarian (every living species has an intrinsic value though it may not have any direct economic value, and also, every species has a right to live).
- Conservation strategies are broadly of two types – *in situ* and *ex situ*.

In situ conservation

- *In situ* conservation means on site conservation. It is conservation and protection of the whole ecosystem and its biodiversity at all levels in **order to protect the threatened species**. However, it is not economically feasible to conserve all biological wealth and all the existing ecosystems. Two alternate methods are being used to save biodiversity. These are **hotspots** and **protected areas.**

Hotspots

- Hotspots are areas with high density of biodiversity or megadiversity which are also the most threatened ones. Ecologically hotspots are determined by four factors as:
  – Number of species/species diversity.
  – Degree of endemism.
  – Degree of threat to habitat due to its degradation and fragmentation.
  – Degree of exploitation.
- A hotspot is an area which faces serious threat from human activities and supports a unique biodiversity with representatives of evolutionary processes of speciation and extinction. It is also defined as a geographical zone or ecological niche with a large number of endemic plants.
- Myers (1988) initially identified 12 hot spots with 14% of plant species in an area of only 0.2%. Four more hotspots were added by Myers (1991). Today the number of hotspots identified by ecologists is 34 covering an area less than 2% of land surface with about `20% of human population living there. India has three hotspots – **Indo-Burma, Himalayas and Western Ghats - Sri Lanka.**

Protected areas

- They are ecological/biogeographical areas where biological diversity alongwith natural and cultural resources is protected, maintained and managed through legal or other effective measures. They are delimited on the basis of biological diversity, *e.g.,* **cold desert** (Ladakh and Spiti), **hot desert** (Thar), **wetland** (Assam), **saline swampy areas** (Sunderbans, Rann of Kutch), mangroves, temperate forests, subtropical forests, etc.
- Protected areas include **national parks, sanctuaries** and **biosphere reserves.**

National Park

- **National parks** are larger areas of scenic and national beauty maintained for scientific, educational and recreational use. They are **not usually used for commercial extraction of resources.**
- The first national park of India was **Jim Corbett National Park** (1936). Some early national parks of world are Yellowstone park (USA) and Royal Park (near Sydney, Australia).

Table: Some National Parks of India

	Name and location	Important animals found
1.	Kaziranga National Park (Assam)	One-horned Rhinoceros, elephant, wild buffalo, bison, tiger, leopard, sloth bear, sambhar, swamp deer, barking deer, wild boar, gibbon (hoolock gibbon), python and birds like pelican, and ring-tailed fishing eagles.
2.	Sundarbans (Tiger Reserve) 24-Pargana (West Bengal)	Royal Bengal tiger, wild boar, deer, gangetic dolphin, eustuarine crocodile.
3.	Hazaribagh National Park, Hazaribagh (Jharkhand)	Tiger, leopard, hyaena, wild boar, gaur, sambhar, nilgai, chital, slot.
4.	Corbett National Park, District Nainital (Uttaranchal)	Tiger, elephant, panther, sloth bear, bear, wild boar, nilgai, sambhar, chital, crocodile, python, king cobra, peafowl, partridge. **This is the first National Park of India and is famous for tigers.**
5.	Gir National Park, District Junagadh (Gujarat)	**Asiatic lion,** panther, striped hyaena, sambhar, nilgai, chital, 4-horned antelope, chinkara, wild boar, langur, python, crocodile, green pigeon, partridge. **This National Park is famous for the Asiatic lions.**
6.	Kanba National Park, Mandla and Balaghat (Madhya Pradesh)	Tiger, panther, chital, chinkara, barking deer, blue bull, four horned deer, langur, wild boar, black buck, nilgai, wild dog, sloth bear, sambhar, crocodile, grey horn bill, egret, peafowl.
7.	Tadoba National Park, Chandrapur (Maharashtra)	Tiger, sambhar, sloth bear, bison, chital, chinkara, barking deer, blue bull, four horned deer, langur, peafowl, crocodile.
8.	Bandipur National Park, District Mysore (Karnataka)	Elephant, tiger, leopard, sloth bear, wild dog, chital, panther, barking deer, langur, porcupine, gaur, sambhar, malabar squirrel, green pigeon.
9.	Desert National Park, Jaisalmer (Rajasthan)	Great Indian Bustard, black buck, chinkara, desert cat, desert fox.

Sanctuaries

- **Sanctuaries** are the tracts of land with or without lake where wild **animals/fauna can take refuge without being hunted.** Other activities like collection of forest products, harvesting of timber, private ownership of land, tilling of land, etc. are allowed. India has 500 (368 in 1988) sanctuaries occupying over 3.6% of geographical area (India 2005).

Table: Some important sanctuaries of India

	Name and location	Important animals found
1.	Annamalai Sanctuary, Coimbatore (Tamil Nadu)	Elephant, tiger, panther, gaur, sambhar, spotted deer, sloth bear, wild dog, barking deer.
2.	Jaldapara Sanctuary, Madarihat (West Bengal)	Rhino, elephant, tiger, leopard, gaur, deer, sambhar, different kinds of birds.
3.	Keoladeo Ghana Bird Sanctuary, Bharatpur (Rajasthan) (Earlier it was once the duck shooting ground of a king)	Siberian crane, storks, egrets, herons, spoon bill, etc. Drier parts of this marshy sanctuary have spotted deer, black buck, sambhar, wild boar, blue bull, python. This sanctuary is famous for aquatic birds.
4.	Sultanpur Lake Bird Sanctuary, Gurgaon (Haryana)	Crane, sarus, spotbill, duck, drake, green pigeon, wild boar, crocodile, python.
5.	Bir Moti Bagh Wildlife Sanctuary, Patiala (Punjab)	Nilgai, wild boar, hog deer, black buck, blue bull, jackal, peafowl, partridge, sparrow, myna, pigeon, dove.
6.	Shikari Devi Sanctuary, Mandi (Himachal Pradesh)	Black bear, snow leopard, flying fox, barking deer, musk deer, chakor, partridge.
7.	Dachigam Sanctuary Srinagar, (Jammu and Kashmir)	Hangul or Kashmiri stag, musk deer, snow leopard, black bear, brown bear.
8.	Mudumalai Wildlife -Sanctuary, Nilgiri (Tamil Nadu)	Elephant, gaur, sambhar, chital, barking deer, mouse deer, four horned antelope, langur, giant squirrel, flying squirrel, wild dog, wild cat, civet, sloth bear, porcupine, python, rat, snake, monitor lizard, flying lizard.
9.	Nagarjuna Sagar Sanctuary (Andhra Pradesh)	Tiger, panther, wild boar, chital, nilgai, sambhar, black buck, fox, jackal, wolf, crocodile.
10.	Periyar Sanctuary, Idukki (Kerala)	Elephants, gaur, leopard, sloth bear, sambhar, bison, black langur hornbill, egret. It is famous for elephants.
11.	Chilka Lake Bird Sanctuary, Balagaon (Orissa) (Largest brackish water lagoon in Asia)	An oasis of birds like water fowls, ducks, crane's, Golden plovers, sand pipers, flamingoes.
12.	Manas Wildlife Sanctuary, Kamrup (Assam)	Tiger, panther, rhino, gaur, wild buffalo, sambhar, swamp deer, golden langur, wild dog, wild boar.

Biosphere reserve

- **Biosphere reserves** are multi-purpose protected areas which are meant for preserving genetic diversity in representative ecosystems of various natural biomes and unique biological communities by protecting wild populations, traditional life style of tribals and domesticated plant/animal genetic resources. Creation of biosphere reserve was initiated in 1975 under MAB programme of UNESCO. Till May 2002, 408 biosphere reserves had been established in 94 countries.
- Each biosphere reserve has following zones:
    - **Core or Natural zone :** No human activity is allowed. The area is undisturbed and legally protected ecosystem.
    - **Buffer zone :** It surrounds the core area. Limited human activity is allowed like resource use strategies, research and education.
    - **Transition zone (Manipulation zone) :** It is the outermost or peripheral part of biosphere reserve where an active cooperation is present between reserve management and local people for activities like **settlements, cropping, recreation, forestry** and other **economic uses without disturbing ecology.** Transition zone has different parts like forestry, agriculture, tourism and restoration regions. **Restoration region** is degraded area which is selected for restoration to near-natural form.
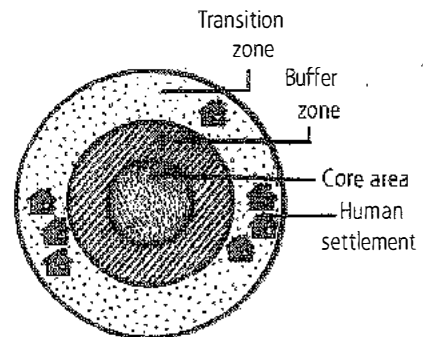

Fig. : Zonation in terrestrial biosphere.

The importance of biosphere reserve includes :

- **Restoration :** Biosphere reserves help in restoration of degraded ecosystems and habitats.
- **Conservation :** They are the means of conserving genetic resources, species, ecosystems and landscapes without uprooting the local people.
- **Development :** They ensure culturally, socially and ecologically sustainable economic development.
- **Monitoring :** There is a regular monitoring of development and conservation progress.
- **Education and research :** Each biosphere reserve supports education and information about research, restoration, conservation and developmental aspects at the national and global levels.

Table : Biosphere reserves of India

	Biosphere reserve	State
1.	Nilgiri [First biosphere reserve of India (1986)]	Karnataka
2.	Nanda Devi (1988)	Uttaranchal
3.	Agasthyamalai	Kerala

4.	Sunderbans	West Bengal
5.	Panchmarhi	M.P
6.	Manas	Assam
7.	Kanchanjunga	Sikkim
8.	Nokrek (Tura range)	Meghalaya
9.	Similipal	Odisha
10.	Dibru Saikhowa	Assam
11.	Dehang Debang	Arunachal Pradesh

Sacred forests and lakes (= sacred grooves) are forest patches around places of worship which are held in high esteem by tribal communities. They are the most undisturbed forest patches (island of pristine forests) which are often surrounded by highly degraded landscapes. They are found in several parts of India, e.g., Karnataka, Maharashtra, Rajasthan. Not a single branch is allowed to be cut from these forests. As a result many endemic species which are rare or have become extinct elsewhere can be seen to flourish here.

Ex situ conservation

- It is the conservation outside the habitats which includes **offsite collections** and **gene banks.**
- **Offsite collections** are live collections of wild and domesticated species in botanical gardens, zoological parks, wildlife safari parks, arboreta (= arboretums = arbouretums), etc. Currently, there are more than 1500 **botanical gardens** and **arboreta** (gardens with trees and shrubs) having more than 80,000 species.
- Many of them have **seed banks, tissue culture facilities** and other ex situ technologies.
- The number of zoos/zoological parks is more than 800. They have about 3000 species of mammals, birds, reptiles and amphibians.
- Most of them have well managed **captive breeding programmes.**
- As a result, many animals which have became extinct in the wild, continue to be maintained in zoological parks.
- **Gene banks** are institutes that maintain stocks of viable seeds (seed banks), live growing plants (orchards), tissue culture and frozen germplasm with the whole range of genetic variability.
- In **seed banks,** seeds are of two types; orthodox and recalcitrant.
- **Orthodox seeds** are those seeds which can tolerate reduction in moisture content (upto 5%), anaerobic conditions and low temperature of –10° to –20°C or even lower for prolonged periods, e.g., cereals, legumes. At intervals, the seeds are allowed to germinate, form plants and develop fresh seeds for storage.
- **Recalcitrant seeds** are those seeds which get killed on reduction of moisture and exposure to low temperature, e.g., tea, cocoa, jackfruit, coconut.
- They can be stored for shorter duration after treatment with fungicides in rooms having humid air and normal oxygen.

- Plants with recalcitrant seeds are grown in **orchards** where all possible strains and varieties are maintained, e.g., litchi, oil palm, rubber tree, etc.
- **Tissue culture** is carried out through callus formation, embryoids, pollen grain culture and shoot tip culture for those plants which are either seedless, have recalcitrant seeds, variable seed progeny or where clone is to be maintained. The method is useful in maintaining a large number of genotypes in small area, rapid multiplication of even endangered species and for hybrid rescue.
- Preservation at –196°C (liquid nitrogen) can maintain tissue culture, embryos, animal cells/tissues, spermatozoa indefinitely. This is called **cryopreservation.** The cryopreserved material is revived through special technique when required.

Table : Some special projects for endangered animal species

	Name of project	Characters
1.	Tiger project	There are 40 tiger reserves in 17 states to save tigers. It was launched on 1st April, 1973.
2.	Lion project (Gir Lion Project)	Asian lion is found only in Gir forest of Gujarat. It was started in 1972.
3.	Crocodile breeding project	It was started in Orissa to save crocodiles in 1975. There are three species of crocodiles in India : (i) saltwater (*Crocodylus porosus*), (ii) fresh water mugger (*Crocodylus palustris*), (iii) gharial (*Gavialis gangeticus*). Being run by UNDP and central govt.
4.	Rhino conservation project	It was started in Assam in 1987. Dudhwa National Park was selected for the rhino reintroduction project.
5.	Snow-leopard project	There are 12 snow-leopard reserves in Himalayas.
6.	Hangul project	It was started in 1970 to protect hangul or Kashmiri stag (*Cervus elaphus hanglu*).
7.	Brow-antlered deer project	It was started in Manipur since 1977 to protect brow-antlered deer (*Cervus eldi eldi*).
8.	Musk deer project	It was started by U.P. Government, IUCN and Central Government to protect musk-deer (*Moschus moschiferus*).
9.	Elephant project	It has been recently started (1991) to protect elephants.
10.	Yak Project Research Centre	It is in Arunachal Pradesh.

INTERNATIONAL EFFORTS FOR CONSERVING BIODIVERSITY

- **Earth Summit** at **Rio de Janerio** (1992), Brazil, promoted Convention on Biological Diversity (CBD) which was signed by 152 nations. Its recommendations came into effect on 29th Dec. 1993. India became a party to this Convention on Biological Diversity in May, 1994.

- **Agenda 21, a product of Earth Summit**, is a blue print for promoting sustainable development of diversity through social, economic and environmental measures in the 21st century.

- A second World Summit was held in 2002 in Johannesberg, South Africa. 190 countries attended the summit and pledged to significantly reduce the current rate of biodiversity loss at global, regional and local levels by 2010.

- Some non-governmental organizations (NGOs) like **green peace** provide international support for conservation.

- **World Conservation Union (former IUCN)** is an international, independent organisation which provides leadership, common approach and expertise in arena of conservation.

- Another similar organisation is **World Wide Fund for Nature (WWF)**.

- Convention in International Trade in Endangered Species (CITES) has helped in **restricting poaching and loss of rare species.**

- Restriction on trading in animal products is believed to have saved the elephant from extinction.

- Establishment and maintenance of biosphere reserves are helped by UNESCO under its Man and Biosphere (MAB) programme.

BIODIVERSITY CONSERVATION IN INDIA

- India is centre of origin and natural home of 167 cultivated species. It is **homeland** of some 320 wild relatives of crop plants. The latter include, rice, sugarcane, millets (crop plants), banana, mango (fruit plants), jackfruit, cucurbits, *Dioscorea, Alocasia, Colocasia* (vegetables), cardamom, black pepper, ginger, turmeric (spices and condiments), Brassicas (oil and vegetables).

- India is the centre of biodiversity for some animal species like Zebu *(Bos indicus)*, water buffalo *(Babalus arnee = B.bubalus)*, Gayal *(Bos frontalis)*, chicken *(Gallus domesticus)* and camel *(Camelus dromidarius)*

- **Bamboos and tree cotton also originated in India.**

- India is **secondary home** of some animals (*e.g.*, sheep, goat, horse, cattle, yak, donkey) and plants (*e.g.*, maize, potato, tobacco).

- Because of abundant diversity present in the country, its conservation is very important not only for the country but also for rest of the world.

- Both *in situ* and *ex situ* conservation measures are being undertaken. It is being conducted by Ministry of Environment and Forests.

- Major *ex situ* conservation of biodiversity is being managed by **National Bureau of Plant, Animal and Fish Genetic Resources.**

- There is an **International Crop Research Institute for Semi-Arid Tropics (ICRISAT)** in Hyderabad for conserving germplasm of groundnut, pigeon pea, chick pea, pearl millet and sorghum.

- A number of other centres in India are maintaining hundreds and thousands of present and past varieties of crop plants.

Points to be noted

- Country symbols based on animals/plants
  - Nepal : Rhododendron
  - New Zeeland : Kiwi
  - Russia : White Bear
  - South Africa : Spring-bok/spring-buck
  - U.S.A. : Bald eagle
  - India : Tiger
  - Australia : Kangaroo
  - China : Giant Panda
  - World Wildlife Fund : Giant Panda
  - U.A.E. : Falcon
- Wildlife Institute of India (WII) is in Dehradun.
- 21st March : World Forest Day
- 22nd March : World Water Day
- 22nd April : World Earth Day
- 5th June : World Environment Day
- 4th October : World Animal Day
- 3rd December : World Conservation Day
- 29th December : Biological Diversity Day
- Silviculture : The management of forests or woodlands for the production of timber and other wood products.
- Hailey National Park (established in 1935) was renamed Ramganga National Park (1954) and again renamed as Jim Corbett National Park (1957).
- The first Earth Day was celebrated in 1970 by a group of people of America to draw attention towards increasing environmental problems caused by humans on earth.
- The Salim Ali School of Ecology and Environmental Sciences is located in Pondicherry.

CONCEPT MAP

Biodiversity and Conservation

- Biodiversity is defined as the vast array of species of micro-organisms, algae, fungi, plants and animals occurring on the earth and the ecological complexes of which they are a part. This includes diversity within species, between species and of the ecosystem.

Types

Alpha diversity
- Diversity in the given community or habitat.

Beta diversity
- Diversity between communities.

Gamma diversity
- It is regional diversity.

Levels of biodiversity

Genetic diversity
- It is the diversity in the numbers and types of genes as well as chromosomes present in different species and the variations in genes and their alleles in the same species.

Species diversity
- It is the diversity in number and richness of the species of a region.

Community/Ecosystem diversity
- It is related to the different types of ecosystems/habitats e.g., terrestrial (forests, grasslands, deserts, etc.) and aquatic (fresh water and marine) ecosystems.

Patterns of biodiversity

Latitudinal and altitudinal gradient
- Species diversity on earth is not uniformly distributed but shows interesting patterns. It is generally the highest in the tropics and decreases towards the poles.
- Important explanations for the species richness of the tropics are: Tropics had more evolutionary time; they provide a relatively constant environment and, they receive more solar energy which contributes to the greater productivity.

Species-area relationships
- Species richness is also a function of the area of a region; the species-area relationship is generally a rectangular hyperbolic function.

Importance of biodiversity

- Stability of ecosystem
- Sources of food and improved varieties
- Source of fibres
- Provide variety of useful products such as gums, resins, dyes, perfumes, lubricants, rubber, latex, tea, dry fruits, etc.
- Provide drugs and medicines
- Scientific value
- Ecosystem services

Loss of biodiversity

- The most serious aspect of loss of biodiversity is the **extinction of species.**

Types of extinction
- Natural extinction
- Mass extinction
- Anthropogenic extinction

Habitat loss & fragmentation

Factors contributing to extinction
- Over exploitation
- Alien species invasion
- Disturbance & Degradation
- Pollution
- Co-extinctions
- Forestry
- Intensive agriculture

Red Data Book & IUCN

- IUCN is International Union of Conservation of Nature and Natural Resources which is now called World Conservation Union (WCU).
- It maintains a Red Data Book or Red List which is a catalogue of taxa facing risk of extinction.
- Red List has eight categories of species.
- These are extinct, extinct in wild, critically endangered, endangered, vulnerable, lower risk, data deficient and not evaluated species.

Ex situ
- Sacred plants, Home gardens
- Seed banks, Field gene banks, Cryopreservation
- Botanical gardens, Arboreta, Zoological parks, Aquaria

In situ
- Hot spots
- Protected areas

Conservation of Biodiversity

Reasons
- The reasons for conserving biodiversity are narrow utilitarian, broadly utilitarian and ethical.

Process

- Sacred forests/ groves, Sacred lakes
- Biosphere reserves
- National parks, Wildlife sanctuaries