

BIODIVERSITY AND CONSERVATION

Biodiversity:

- The number of plants and animals present in a particular area at a certain time is called biodiversity.
- The term 'Biodiversity' was popularized by sociobiologist **Edward Wilson**.
- He described the **combined diversity** at all the levels of biological organization ranging from **macro-molecules** within the cell to **biome**.
- Biome is the largest area of the community.

Magnitude of Biodiversity:

- The measure of a range of biodiversity is called the magnitude of biodiversity. The known and described number of species of all organisms on the earth is about 1.7 to 1.8 million.
- The total number of species that can be predicted ranges from 20 to 50 million.
- Several species have not been described yet in the tropics.
- Robert May gave a conservative estimation of 7 million varieties of species globally.
- There are about 1.5 million plant and animal species according to IUCN (2004).



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- ➔ About 70% of animal species have been recorded. Among them, insects are the largest group.

Levels of Biodiversity:

Biodiversity levels can be studied at three levels. These are Genetic diversity, Species diversity, and Ecological diversity.

Genetic diversity:

- ➔ It shows diversity in the number of genes and their types along with chromosomes present in different species.
- ➔ It also describes the different variety of genes and their alleles in the same species. It shows about high diversity of a single species at the genetic level.
- ➔ **Example:** *Rauwolfia vomitoria* is a medicinal plant in terms of potency and concentration of chemical reserpine. Reserpine is used in treating blood pressure.
- ➔ India has more than 50,000 genetically different varieties of rice strains, 1000 varieties of mangoes.
- ➔ Genetic diversity is helpful in adaptation to changes in environmental conditions and advantageous for the survival of organisms.
- ➔ It also helps in the speciation or evolution of new species.



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Species diversity:

- Measures the species richness – number of species per unit area and evenness.
- It represents the relative abundance of each species in an area.
- **Example:** Western Ghats – greater species diversity of amphibians than Eastern Ghats.

Ecological diversity:

- It is also called as Community diversity.
- India has greater biodiversity than Scandinavian countries. Because of the reason that India has deserts, rain forests, mangroves, coral reefs, wetlands, etc.
- The ecosystem has three types of diversity. They are Alpha, Beta, and Gamma diversities.
 - **Alpha diversity:** It represents species diversity in a habitat depending on species richness and evenness.
 - **Beta diversity:** It appears in a range of communities due to the replacement of species – Change in the community due to different microhabitats, niches, and environmental conditions.
 - **Gamma diversity:** It is present in ranges of communities as represented by diversity of habitats or ecosystems over a geographical area.



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Species Extinction:

- ➔ The elimination or disappearance of the total species from the earth is called extinction.
- ➔ It is of three types called as natural, mass, and anthropogenic extinction.
- ➔ **Natural extinction:** The slow process of replacement of existing species due to better adaptative evolution, changes in environmental conditions, predators and diseases.
- ➔ **Mass extinction:** Catastrophes struck the earth several times in the past and leads to mass extinction. A mass extinction took place about 225 million years ago in the Permian period. About 90% of shallow marine invertebrates disappeared.
- ➔ Cretaceous and Tertiary mass extinction took place over 60 million years ago on the earth. The five episodes of mass extinction occurred.
- ➔ The sixth extinction is in progress. Human activities lead to the extinction of species at a rate of 100 to 1000 times faster than at present.
- ➔ **Anthropogenic extinction:** It is caused by human activities like settlements, hunting, over-exploitation, and habitat loss.



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- Since 1600 A.D, about 538 animal species, 384 plant species have been lost. 75% of these extinctions are due to human interference.

In-Situ Conservation:

The conservation of plants and animals within the protected area of the network is called *in-situ* conservation.

- **Protected areas:** The ecological areas in which biological diversity along with natural and cultural resources are protected.
- The protected areas include National Parks, Sanctuaries, and Biosphere Reserves, etc.

National parks and wildlife sanctuaries:

- National parks are strictly preserved for the protection of natural life.
- Private ownership, cultivation, grazing, etc. are prohibited in national parks.
- Endangered fauna species are well protected in wildlife sanctuaries permit co-tourism.
- India has about 106 national parks and 565 wildlife sanctuaries.
- **Example:** Eravikulam National Park in Kerala.



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Biosphere reserves:

- It is a multipurpose protected area to preserve genetic diversity. It is a representative ecosystem of several natural biomes and a unique biological community.
- The genetic diversity of ecosystem is preserved by protecting the wild populations, traditional lifestyle of tribals and plants and animals genetic resources.
- There is about 738 biosphere reserve in the world. India has 18 biosphere reserves.

Each biosphere has:

- **Core or natural zone:** No human activity is allowed. The areas are undisturbed and a legally protected ecosystem.
- **Buffer zone:** It surrounds the core area. Limited human activity is allowed like resource use, strategies, research, and education.
- **Transition zone:** The outermost part of the biosphere reserve. Here, the active cooperation is present between the reserve management and local people for settlements, cropping, recreation, forestry, and other economic uses without disturbing the ecology.

Sacred forests and lakes:

- A small group of forest that some rural communities protect as abodes of deities.



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- ➔ A grove of special religious importance to a particular culture is called a Sacred grove.
- ➔ The religious importance of all the trees of wildlife is respected.
- ➔ The following are the sacred groves in India.

Name	State
Khasi and Jaintia Hills	Meghalaya
Aravalli Hills	Rajasthan
Western Ghat region	Karnataka and Maharashtra
Surguja, Bastar and Chanda	Chhattisgarh
Khecheopalri (sacred lake)	Sikkim

Ex-Situ Conservation:

- ➔ The threatened animals taken out of their natural habitat and given special care in artificially protected areas is called *ex-situ* conservation. **Example:** Zoological parks, botanical gardens, gene banks, etc.
- ➔ Advancement in *ex-situ* preservation techniques such as cryopreservation helps to protect endangered species.
- ➔ In cryopreservation technique, gametes of threatened species are stored at -196°C in liquid nitrogen. *In vitro* culture, tissue culture, gene banks, seed banks, etc., are mostly used for plants.



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- Seeds of different genetic strains of commercially important plants are stored for a long time in seed banks.

Biodiversity hotspots:

- The areas with a high density of biodiversity and the most threatened areas.
- There are about 36 biodiversity hotspots in the world. India has 4 hotspots.
- They are North-East Himalayas, Western Ghats, Sri Lanka, and Indo Burma and the Sundaland (Includes Nicobar group of Islands).
- India is a country of megadiversity with only 2.4% of world's land area and having 8.1% of global species diversity.
- India is one of the 12 megadiversity countries of the world.
- The ecological hotspots are determined by four factors.
 - The number of species/species diversity.
 - Degree of endemism.
 - Degree of threat to habitat due to its degradation and fragmentation.
 - Degree of exploitation.





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Unit - X: Ecology and Environment

Patterns of biodiversity:

Biodiversity is not uniform across the world. It varies from place to place with latitude and altitude.

The favorable conditions favor speciation and extensive biodiversity.

Latitudinal and altitudinal gradients:

- Biodiversity shows latitudinal and altitudinal gradients except for arid/semi-arid areas.
- Biodiversity increases in temperate areas and maximum in tropical rain forests.
- Favorable conditions favor species diversity.
- Species diversity decreases as you go from lower to the higher altitude on a mountain.
- **Tropical Vs Temperate regions:**
 - The temperate regions were subjected to glaciation in the past, while tropical latitudes remain undisturbed for millions of years.
 - Tropical regions are less seasonal, more stable, and predictable. Temperate regions cannot be predictable.
 - In the tropics, more availability of solar radiations for high productivity contributes to more biodiversity.



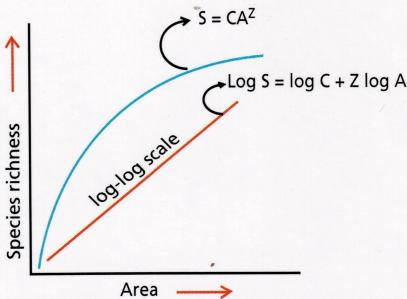


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Species-area relationship:

- According to Alexander Von Humboldt, species richness gets increased when the explored area is increased, but only up to a limit.



Graph showing Species-Area relationship

- The relationship between species richness and area for several taxa is found to be a rectangular hyperbola. Ex. Angiosperms, freshwater fishes, and birds.
- On a log scale, the relationship is a straight line. It can be explained by $\text{log } S = \text{log } C + Z \text{ log } A$.





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- In very large areas like continents, the Z value ranges between 0.6 and 1.2.

Importance of Species Diversity to Ecosystem:

- As per ecologists, the community tend to become more stable with more species than those with fewer species.
- The stable community does not show many variations in the year-to-year productivity.
- It must be either resistant or resilient to seasonal disturbances.
- It must be resistant to alien species.

Loss of Biodiversity:

- Colonization of tropical Pacific Islands by humans lead to the extinction of 2000 native birds.
- Extinction of Dodo (Mauritius), Quagga, Thylacine, Stellar's Sea Cow, and three sub-species of tigers like Bali, Javan, and Caspian are some examples.
- All around the world, 15,500 species are facing the threat.
- About 31% gymnosperms, 32% amphibians, 12% bird species, and 23% of mammals are facing the threat.





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- There are four major causes of biodiversity losses which are known as Evil Quartet. They are:

Habitat loss and fragmentation:

- Once tropical rain forest covers more than 14 percent of the earth's land surface. But now only 6%.
- The Amazon rain forest (lungs of the planet) cut and cleared for cultivating *soya beans* - for conversion to grasslands for raising beef cattle.
- Besides the degradation of many habitats, pollution also threatens the survival of many species.
- Fragmentation – the process of formation of discontinuation in the natural habitats – due to geological and human activities.
- Geological process – speciation whereas human activities – extinction of many species.

Over-exploitation:

- Humans depend on nature for food and shelter.
- When need turns to 'greed', leads to over-exploitation of natural resources.
- Steller's sea cow, passenger pigeon (North America) – many species have become extinct in last 500 years.





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- Commercially important marine fishes – endangered due to their harvesting.

Invasion of alien species:

- Introduce a new species into a habitat – adversely threatens indigenous species.
- Nile perch into Lake Victoria (East Africa) – lead extinction of 200 species of cichlid fish in the lake.
- Introduction of African catfish (exotic = non-native) – for aquaculture – a threat to indigenous fishes.
- Carrot grass, the Spanish flag plant (*Lantana*), water hyacinth (*Eichhornia*) damaged the environment and threatened native species.

Co-extinction:

- Obligate association between the plant and animal – when plant extinct – animal become extinct.
- Host and parasite association – When the host is lost – the parasite becomes extinct.
- Plant – pollinator mutualism (Ex. Fig tree and its partner wasp) female wasp – uses fruit for oviposition and nourishment to larva.





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Endangered Organisms:

- The organisms which are in danger and near to becoming extinct are called endangered organisms.
- The International Union for Conservation of Nature and Natural Resources identified rare species of plants and animals based on given below:
 - **Extinct:** A taxon when there is no reasonable doubt that the last individual has died.
 - **Extinct in wild:** A taxon extinct in the wild when exhaustive surveys, in known and expected habitats have failed to record an individual.
 - **Critically endangered:** When a taxon faces an extremely high risk of extinction in the wild in immediate future.
 - **Endangered:** A taxon facing a very high risk of extinction in the wild in near future.
 - **Vulnerable:** A taxon is not critically endangered, but faces a high risk of extinction in the medium-term future.
 - **Lower risk:** A taxon that does not satisfy the criteria for critically endangered or vulnerable.
 - **Data deficiency:** A taxon that has insufficient information for the assessment of its risk of extinction.





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- Examples of threatened species in India.

Category	Plants	Animals
Critically endangered	<i>Berberis nilghiriensis</i>	<i>Sus salvanius</i> (Pygmy hog)
Endangered	<i>Bentinckia nicobarica</i>	<i>Ailurus fulgens</i> (Red panda)
Vulnerable	<i>Cupressus cashmeriana</i>	<i>Antilope cervicapra</i> (Black buck)

Red Data Book:

International Union for Conservation of Nature and Natural Resources has published the Red data book. It includes animals and plants facing the risk of extinction.

- In the year 2004, red list has made an assessment of 18,000 species out of which 11096 species are threatened across the world.
- About 784 species become extinct in the last 500 years. (338 vertebrates, 359 invertebrates, 87 plants).
- About 27 species have become extinct in the last 20 years. Mostly, amphibians are more vulnerable to extinction.





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Ramsar Sites:

- The Biodiversity convention on Wetlands is called as Ramsar Convention (named after the city of Ramsar in Iran).
- This international treaty was established in 1971 by UNESCO and came into force in 1975.
- It provides a framework for the conservation of wetlands on both national and international basis.
- In May 2018, 2,331 Ramsar sites were included on the list of wetlands of international significance. The Ramsar Convention works closely with six other organizations which are called as International Organization Partners. These are:
 - International Union for Conservation of Nature and Natural Resources (IUCN)
 - International Water Management Institute (IWMI)
 - Birdlife International
 - World Wildlife Fund for Nature (WWF) International
 - Wildfowl and Wetlands Trust (WWT)
 - Wetlands International.





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Biodiversity Conservation:

Preservation of biodiversity in the form of genetic, species, community, and ecosystem diversity and also in a good healthy environment for the future generation is called as conservation of biodiversity.

At present, the rate of extinction is 100 to 1000 times faster. If this trend continues, half of the species in the next 100 years wiped out.

Loss of biodiversity in the region leads to a reduction in plant production, low resistance to environmental perturbation, and increases the viability in plant productivity, water use, and pest cycle.

Three reasons to conserve biodiversity:

- **Narrowly utilitarian:** Human beings obtain a large number of economic benefits like food, fiber, firewood, medicinal products, etc. from nature.
- **Broadly utilitarian:** Biodiversity plays a priceless important role: It helps in the production of oxygen, pollination of flowers, and aesthetic values like bird watching in the forest, listening to the sweet voice of bulbul, etc.
- **Ethical reason:** It is our moral duty to provide protection to this beautiful world and pass on the biological legacy to our future generations.

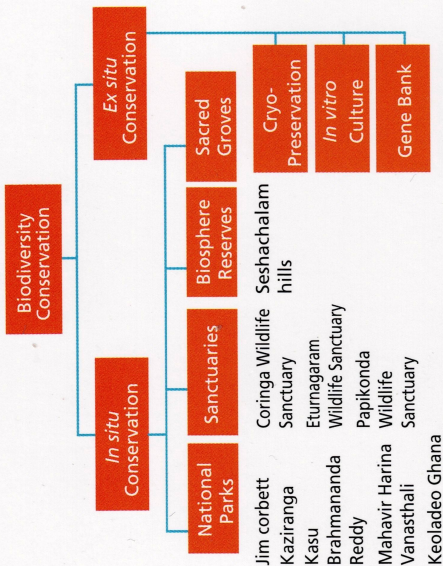




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Methods of Biodiversity Conservation:



TEST

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Unit - X: Ecology and Environment

1. Alexander Von Humboldt described for the first time:
 - (a) Ecological Biodiversity
 - (b) Laws of limiting factor
 - (c) Species area relationships
 - (d) Population Growth equation.
2. Red list contains data or information on:
 - (a) Threatened species
 - (b) Marine vertebrates only
 - (c) All economically important plants
 - (d) Plants whose products are in international trade.
3. The biodiversity of a geographic region represents:
 - (a) Genetic diversity present in the dominant species of the region.
 - (b) Species endemic to the region.
 - (c) Endangered species found in the region.
 - (d) Diversity in the organisms living in the region.



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Solutions:

1. Option (c) is correct.

Alexander Von Humboldt described the first time about species area relationships. The species richness gets increase when the explored area is increased, but only up to a limit. The relationship between species richness and area for several taxa is found to be a rectangular hyperbola. Ex. Angiosperms, freshwater fishes, and birds. On a log scale, the relationship is a straight line. It can be explained by $\log S = \log C + Z \log A$.

2. Option (a) is correct.

International Union for Conservation of Nature and Natural Resources has published the Red data book. It includes animals and plants facing the risk of extinction; mostly threatened species. In the year 2004, red list has made an assessment of 18,000 species out of which 11096 species are threatened across the world. About 784 species become extinct in the last 500 years.

3. Option (d) is correct.

Edward Wilson, a sociobiologist, popularised the word "biodiversity" to refer to the diversity present at all levels of biological organisation. The geographical region's biodiversity is a representation of the variety of creatures that live there. It contains the genetic variety, indigenous species, and threatened species of that area. Africa, for instance, is home to barren deserts, alpine mountains, and tropical rainforests.

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4. Which one has the highest number of species?
 - (a) Birds
 - (b) Angiosperms
 - (b) Fungi
 - (d) Insects
5. All of the following are included in '*ex-situ*' conservation except:
 - (a) Botanical gardens
 - (b) Sacred groves
 - (c) Wildlife safari parks
 - (d) Seedbanks
6. An area is declared as a 'hot spot' when:
 - (a) It has 1500 or more endemic species and 75% of its original habitat is lost.
 - (b) It has 1500 or more vertebral species and 75% of its original habitat is lost.
 - (c) It has more than 2000 species of plants.
 - (d) Most of the species inhabiting the area are facing the risk of extinction.



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Solutions:

4. Option (d) is correct.

The measure of a range of biodiversity is called the magnitude of biodiversity. The total number of species can be predicted from 20 to 50 million. Robert May gave a conservative estimation of 7 million varieties of species globally. About 70% of animal species have been recorded. Among them, insects are the highest number of species.

5. Option (b) is correct.

Botanical gardens, wildlife sanctuaries, and seed banks are examples of non-natural habitat conservation methods. They are included in *ex-situ* conservation method. On the other hand, Sacred groves are a type of *in-situ* biodiversity conservation in which some plants with cultural values are protected and preserved.

6. Option (a) is correct.

The areas with a high density of biodiversity and the most threatened areas are considered as biodiversity hotspots. There are about 36 biodiversity hotspots in the world. India has 4 hotspots. They are North-East Himalayas, Western Ghats, Sri Lanka, and Indo Burma and the Sundaland (Includes Nicobar group of Islands). The area with 1500 or more endemic species and 75% of its original habitat is lost is declared as a 'hot spot'.



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7. Which is not used for *ex-situ* plant conservation?
- (a) Botanical gardens
 - (b) Field gene banks
 - (c) Seed banks
 - (d) Shifting cultivation
8. Which of the following National Park is home to the famous deer Hangul?
- (a) Dachigam National Park, J & K
 - (b) Keibul Lamjao National Park, Manipur
 - (c) Bandhavgarh National Park, Madhya Pradesh
 - (d) Eaglenest Wildlife Sanctuary, Arunachal Pradesh.



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Solutions:

7. Option (d) is correct.

The threatened animals taken out of their natural habitat and given special care in artificially protected areas is called *ex-situ* conservation. Ex. Zoological parks, botanical gardens, gene banks, etc. Advancement in *ex-situ* preservation techniques such as cryopreservation helps to protect endangered species. In this technique, gametes of threatened species are stored at -196°C in liquid nitrogen. *In-vitro* culture, tissue culture, gene banks, seed banks, etc., are mostly used for plants.

8. Option (a) is correct.

National parks are strictly preserved for the protection of natural life. Private ownership, cultivation, grazing, etc., are prohibited. India has about 106 national parks and 565 wildlife sanctuaries. Dachigam National Park is in J & K which is located 22 kilometers from Srinagar. It is famous for hangul commonly called Kashmir stag.

