

NEET Revision Notes

Biology

Biodiversity and Conservation

Introduction

- Broad and diversified biota communities inhabit distinct zones leading to form ecosystems.
- W.G. Rosen coined the term **biodiversity** in the year 1980.
- It is a combination of two words: "biological" and "diversity."
- The huge diversity of species and types of all life forms on Earth is often used to define biodiversity or biological diversity.
- They include microorganisms, fungi, algae, plants, and animals found on Earth in various habitats, as well as the ecological structures and niches, they inhabit.
- Whether or not a species can thrive and colonise a neighbourhood is determined by global environmental conditions as well as the species' tolerance range.

MAGNITUDE OF BIODIVERSITY

- India is considered one of the world's 12 mega diversity-bearing countries as it harbours approximately 45,000 plant species and almost double as many animal species.
- Scientists estimate that there are nearly 5.50 million species of creatures in the world.
- The most fascinating part of biodiversity is that animals contribute to more than 70% of all species, while plants constitute only 22% of the biodiversity.
- Insects account for roughly 70% of all animals, with a current approximation of 7 out of 10 animals.

BIODIVERSITY LEVELS

1. GENETIC DIVERSITY:

- It is the variety of genes and chromosomes found in different species, as well as different forms of genes and their alleles within the same species.

- A bacteriophage has 100 genes on average, *Drosophila melanogaster* has 13000 genes, and *Homo sapiens* has 30,000 – 40,000 genes.
- Variation in a species' genes rises as the species' size and environmental variables of the habitat increase.
- Adapting to changing environmental conditions requires genetic diversity.
- It aids in the evolution or speciation of new species.
- Reduced genetic diversity within a species or variety is very beneficial for yield homogeneity as well as higher yield.
- Lower genetic diversity is more vulnerable to degradation and mass-scale destruction in case of fungal or insect attacks.

2. SPECIES VARIETY:

- It is the variation and diversity of a region's species in terms of number and richness.
- The species number found per unit area is referred to as species richness.
- The number of individuals of distinct species in a given area represents species evenness or species equitability.
- Those communities are even when species are represented by approximately the same number of individuals.
- Communities with more individuals of one or more species than others exhibit dominance or unevenness.
- Species diversity is the result of species richness, evenness, or equitability.

3. ECOSYSTEM AND COMMUNITY DIVERSITY:

- **COMMUNITY DIVERSITY:** There are three types of community diversity:
 1. **Alpha diversity** appears within the context of community diversity. Species diversity is determined by species richness and evenness. There is huge competition, structural changes, and inter-relationships among participants of the same community. Variations are limited in this case.
 2. **Beta diversity** occurs among communities. It can be found along a habitat gradient within the geographic region. Changes in communities may occur as a result of differences in microhabitats,

niches, and climate changes, which may result in the replacement of species.

3. Gamma diversity is the organism's variety present in community ranges and is depicted by the variability of habitats or ecosystems across the entire geographical area.

- **ECOSYSTEM DIVERSITY:** Ecosystem diversity refers to the variety of forms found in an ecosystem as a result of the variability of trophic levels, niches, and ecological processes such as recycling of nutrients, food webs, energy flow, dominant species roles, and numerous biotic interactions.
- Diversity contributes to more productive and reliable ecosystems that can withstand a variety of environmental stresses including prolonged drought.

INDIA AS MEGA DIVERSITY REGION

- Because India has been designated as a mega diversity nation, it has achieved a unique distinction.
- The country is divided into ten biogeographical regions.
- The biogeographical regions of India include:
 - The Trans Himalaya
 - Himalaya
 - Desert
 - Western Ghats
 - Gangetic Plain
 - Semi-arid regions
 - Deccan Peninsula
 - North-East
 - Coasts
 - Islands.
- There are **89 national parks** in India, **492 wildlife refuges**, **14 biosphere reserves**, **6 waterways**, and **5 world heritage sites**. There are also **27 tiger reserves** in the country.
- The **Deccan peninsula** is the **greatest** biogeographical region, with the **Western Ghats and northeast** having the **most biodiversity**.
- Endangered species include:
 - 60% of amphibians
 - 53% of freshwater fishes
 - 36% of reptiles

- 33% of flowering plants
- 10% of mammals.
- The **richest** areas are the **Himalayas** as well as the **Western Ghats**.

BIODIVERSITY LATITUDINAL AND ALTITUDINAL GRADIENT PATTERNS

LATITUDINAL GRADIENT:

- At the poles, there was very little biodiversity.
- Temperate areas have more biodiversity, but tropical rainforests have the most.
- This is because tropical rain forests provide more favourable conditions for a wider range of organisms, with fewer or no natural disasters.
- This has resulted in environmental stability and the development of new species.
- Mostly during the cold season, harsh conditions exist in temperate areas. However, harsh conditions persist in arctic regions for the majority of the year.

ALTITUDINAL GRADIENT:

- As we move up on the high mountains, species diversity decreases due to temperature drops and increased seasonal variability.

SPECIES-AREA RELATIONSHIP

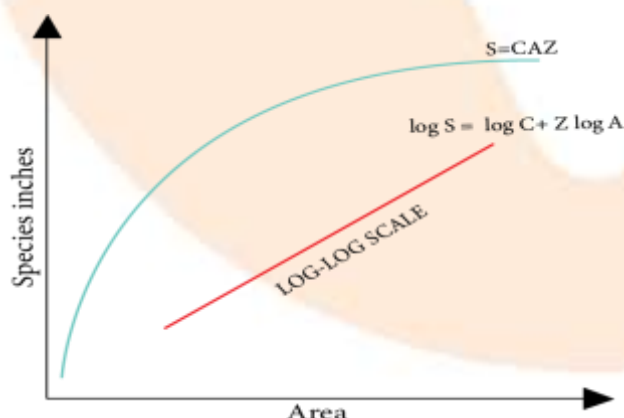


Image: Graph showing the relation between Species richness and Area

Alexander von Humboldt discovered that the richness of species within a region increases with the increasing area, but only up to a point.

- The correlation between species richness and area is a rectangular hyperbola for a wide range of taxa, whether they are birds, freshwater fishes, bats, or flowering plants.
- On a logarithmic scale, it is displayed as a straight line where S is species richness, Z is the regression coefficient (slope of the line), C represents the y-intercept, and A represents the area.
- The regression coefficient is commonly 0.1 - 0.2, irrespective of taxonomic group or region, for example, plants found in the United Kingdom, birds seen in California, or mollusks found in New York.
- When the species-area relationship is assumed for a very large area, such as the entire continent, the geographical retrogression coefficient (slope of graph) will have a Z value of 0.6 - 1.2, for example, frugivorous birds and mammals of distinct continents' tropical forests will reflect a steeper line of 1.15.

IMPORTANCE OF BIODIVERSITY

FOOD SOURCE:

- Hardly 150 of the 3000 species of food plants have been commercialised. It can be seen that less than 20 species form 85 percent of the food output.
- Only three carbohydrate-rich crops produce two-thirds of all food: wheat, maize, and rice.
- It is necessary to use an increasing number of food plants.

FAT AND OIL SOURCE:

- Soybean, mustard, peanut, coconut, sunflower, cottonseed, sesame, and oil palm are the most important oilseed plants.
- Some newly developed species of oil are being studied for high-performance lubricants. Bitter colocynth and jojoba seed are two examples.

FIBRES:

- Cotton, hemp, jute, flax, coir, agave, sun hemp, and rosella are the most common fibre sources.
- The search for new superior fibre-yielding plants is ongoing.

NEW VARIETIES:

- Domesticated agricultural species have been upgraded for a variety of traits, particularly disease resistance, by breeding with wild relatives.
- Rice has been genetically modified to be resistant to four major diseases by crossing it with its wild species like *Oryza nivara* from India.
- Potato has been engineered to be resistant to late blight (a *Solanum demissum* trait), Potato Mosaic Virus (a *Solanum stolonifera* trait), and five cyst nematode races (a *Solanum spegazzini* trait)

DRUGS AND MEDICINES:

- Several drugs are derived from plants.
- Rosy periwinkle (from *Catharanthus roseus* or *Vinca rosea*) produces alkaloids (Vincristine and vinblastine) that can be used to treat leukaemia. The same thing is now being chemically synthesised.
- Various types of drugs are obtained from the plants, like:
 - Morphine is obtained from the bark of *Papaver somniferum* for pain
 - Quinine is obtained from the bark of *Cinchona ledgeriana* for malaria
 - Taxol is obtained from the bark of *Taxus brevifolia* and *Taxus baccata* for cancer treatment
 - Reserpine is obtained from *Rauwolfia serpentina* for blood pressure and schizophrenia.
- Currently, 120 plant species are used to produce 25% of all drugs.
- Traditional medical systems all over the world use lots of local or wild plants to treat a variety of ailments.
- Plant chemicals are also known as botany chemicals, and they can be used to make a wide range of synthetic products.

AESTHETIC VALUE:

- Biodiversity is extremely valuable in terms of beauty and attracting people to a specific location.
- The aesthetic value of biodiversity is frequently misused in tourism activities, bird watching, and other activities like gardening and wildlife conservation.

CULTURAL BENEFITS:

- Throughout history, people have developed attachments to special plants and animals.
- Many Indian houses have *Ocimum sanctum* (Tulsi) varieties planted in gardens and pots.
- *Ficus religiosa*, also known as Peepal, and *Prosopis cineraria*, also known as Khejri, are sacred trees. They are also revered.
- Many birds are revered as sacred. Snakes are also revered.
- Every country and state honours a specific plant or animal as an emblem of national and state glory and cultural heritage.

ECOSYSTEM SERVICES:

- Biodiversity is required for the survival and use of various ecosystems' and individual species' products and services.
- Forest and oceanic systems regulate climate and keep the atmosphere's gaseous composition stable.
- The **Amazon rain forests** are known as the **planet's lungs** because they produce **28 percent of total oxygen**.
- Biodiversity is critical for natural pest management and the survival of various species' populations. It is critical for insect and bird pollination, nutrient cycling, water conservation and purification, soil formation and protection, and so on. The services are worth between 16 and 54 trillion dollars per year.

THREATS TO BIODIVERSITY

The world is witnessing an increase in the rate of species extinction, owing largely to human intervention. There are four leading causes, also known as the "evil quartet":

1. Habitat Loss and Fragmentation:

- Every year, overpopulation, urbanisation, and industrialization necessitate the acquisition of new land.
- It can occur as a result of the destruction or segmentation of natural habitats, such as filling wetlands, ploughing grasslands, felling trees, burning a forest, or clearing some vegetation.
- Animals that require large territories suffer greatly.
- Migrating animals would undoubtedly become lost and would have to be killed.

2. Overexploitation:

- Excessive misuse of a species, whether plant or animal, decreases the size of its population, making it vulnerable to extinction.
- Due to human overhunting, three subspecies of the Tiger, dodo, passenger pigeon, and stellar sea cow have become extinct in the last 500 years.
- Several populations of marine fish are currently declining around the world.

3. Extraterrestrial or Alien Species Invasions:

- Non-native or alien species are frequently used inadvertently for economic or other purposes.
- They frequently become invasive, impeding the survival and growth of native species.
- The most vulnerable ecosystems are those on islands. This is primarily due to their small size and low species diversity.
- The introduction of water hyacinth (*Eichhornia crassipes*) was intended to reduce pollution in Indian waters.
- In many places, it has resulted in the blocking up of water bodies, including wetlands. Several aquatic plants, as well as animal species, have died as a result of this.
- **Nile perch** is a predator fish that was launched into South Africa's Lake Victoria. It has since killed and completely erased the ecologically distinct diversity of more than 200 native small **cichlid species**.

4. Co-Extinctions:

- Specific mutualistic relationships occur in nature, such as the Yucca moth and Yucca flower.
- The extinction of one will result in the extinction of another.
- Another example is a fish on which many parasites reside. So, if the host fish becomes extinct, all parasites found only on it will also become extinct.

CONSERVATION OF WILDLIFE

Wildlife conservation is important for a variety of reasons.

Natural Balance:

- There exists a natural balance in all ecosystems. The various types of living organisms coexist in harmony.

- The food web is an interconnected system of the food chain, and the extinction of any wildlife species in an ecosystem can upset the natural balance.

Commercial value of Wildlife:

- We have a diverse range of wildlife. The government-created national parks and sanctuaries will draw a large number of international visitors. This is an important source of foreign trade.
- Huge excess of animals are sold to regional and global zoos and parks, generating foreign exchange.

Biological research:

- Naturalists, zoologists, and behavioural biologists can review the ecology, physiology, and behaviour of various types of wildlife in their natural environments. This advances our understanding of biology.

Recreation and Sports:

- Due to the constantly declining number of animals, the sport of hunting is severely restricted.
- Wildlife centres frequently provide good recreation in the form of trekking, camping, and other outdoor adventures.

CONSERVATION OF BIODIVERSITY

- The conservation of biodiversity is divided into three categories.
 1. Narrow utilitarian
 2. Broad utilitarian
 3. Ethical considerations

1. Narrow Utilitarian:

- Nature provides so many direct economic benefits to humans.
- Nature provides food, such as cereals, pulses, and fruits, as well as firewood, fibre, and building materials.
- Natural products are also used in the manufacture of industrial products including tannins, dyes, lubricants, resins, and perfumes.
- Products with medicinal value are also available.

- Bioprospecting is the process of investigating genetics as well as species-level diversity in order to obtain and develop economically significant products.

2. Broad Utilitarian:

- During photosynthesis, Amazonian forests alone generate roughly 20% of the world's oxygen.
- Pollinators include bees, birds, and bats, which pollinate the plant and allow it to produce seed.
- The aesthetic delight we derive from biodiversity conservation.

3. Ethical considerations:

- Humans rely on the existence of all other organisms that live and have lived on this planet.
- Each species and variety has inherent value.
- It is our moral obligation to protect and transfer on the biological legacy that has been bestowed upon us.

STRATEGIES FOR BIODIVERSITY CONSERVATION

- Conservation strategies are classified into two types:
 - In-situ/ On-site
 - Ex-situ/ Off-site

IN-SITU OR ON-SITE CONSERVATION

- To protect threatened species, the entire ecosystem and also its biodiversity must be conserved and protected at all levels.
- However, it is neither economically feasible nor feasible to preserve all current biological wealth and ecosystems.

Hot-spots:

- These are zones with a high concentration of biodiversity, also known as **megadiversity**.
- These are the most vulnerable zones too.
- The following four factors influence ecological hotspots:
 - A. The number of species or the diversity of species

B. Endemism level

C. The level to which a specific habitat is threatened as a result of degradation and fragmentation.

D. Amount of exploitation

- Mayers (1988) first detected 12 hot spots with 14 percent of plant species in a 0.2 percent area.
- Today, ecologists have identified 34 hotspots that cover less than 2% of the land surface and are home to approximately 20% of the human population.
- There are **three hotspots in India**:
 - Indo-Burma
 - The Himalayas and the Western Ghats
 - Sri Lanka.

Protected Areas:

- They are ecological or biogeographical areas where biodiversity, as well as natural and cultural resources, are secured, maintained, and handled through legal or other effective measures.
- They are defined and delimited by biological diversity, such as a cold desert in Thar, a wetland in Assam, a saline swampy area in the Sundarbans, and so on.
- National parks, sanctuaries, and biosphere reserves are examples of protected areas.

1. National Parks:

- They are regions under government management which are set aside for wildlife cultivation enhancement.
- Human endeavours like forestry, grazing, and habitat alteration are prohibited in national parks.
- In India, **89 national parks** cover nearly 1.1 percent of the land area.

2. Sanctuaries:

- They are huge portions of land with or without lakes where wildlife and plants can hide from hunters.
- Other human-disrupting activities such as collecting forest products, harvesting timber, personal control of property, tilling land, and so on are permitted.

3. Biosphere Reserves:

- They have secured areas that are intended to serve multiple functions.
- They are meant to preserve genetic diversity in constituent ecosystems of diverse natural biomass and biological communities.
- This is accomplished by safeguarding wild populations, tribal and cultured plant and animal natural resources.
- The creation of a biosphere reserve began in 1975 as part of UNESCO's MAB programme.
- There were a total **408 biosphere reserves** established in 94 countries as of 2002.
- In India, **17 biosphere reserves** have now been established.
- Each biosphere reserve includes:

Core or Natural zone: There is no human activity permitted. The area is a pristine, legally protected ecosystem.

Buffer zone: This zone is located around the core area. Human activities like consumption of resources, business strategy, and education are prohibited.

Transition zone: This is the outermost or external part of the biosphere reserve where reserve organisation and local people actively collaborate for activities such as settlements, forestry, cropping recreation, and other economic uses that do not disrupt the ecology. The transition zone is divided into sections such as forestry, agriculture, tourism, and restoration zones. A restoration area is a damaged area that has been chosen for restoration to its natural state.

Importance of Biosphere Reserves Includes:

- **Restoration:** Biosphere reserves contribute to the recovery of damaged ecosystems and habitats.
- **Conservation:** They help to conserve genetic resources, ecosystems, animals, and landscapes while preventing uprooting local populations.
- **Development:** They ensure long-term economic development by preserving cultural, social, and ecological dignity.
- **Monitoring:** It is essential to execute continuous inspection of development and conservation progress.

- **Education and Research:** Each biosphere reserve encourages teaching and research on the ecological features of the ecosystem. At the global and national level, there is also a sharing of data about research, regeneration, conservation, and development.

MAB (MAN AND BIOSPHERE) PROGRAM:

- The Man and Biosphere Program (MAB) is a UNESCO international biological programme that began in 1971 but was presented in India in 1986.
- MAB has investigated the effects of human intervention and pollution on biotic and abiotic factors and is developing conservation measures for the present and future.

EX-SITU CONSERVATION:

- These are methods of conserving any favoured species or variety that are located outside of their natural habitats.
- They are collected **off-site**.
- They are live collections of domesticated and wild species in **zoos, botanical gardens**, and other facilities.
- There are currently over 1500 botanical gardens with over 8000 species.
- Many of them have **seed banks, tissue culture labs**, and other in-house technologies.
- There are over 800 zoological parks in the United States.
- They require approximately 3000 species of mammals, reptiles, birds, and amphibians.
- Most of these ex-situ facilities have a well-managed captive breeding programme as well.
- Captive breeding is used when the number of surviving residents is so low that there is no genuine prospect of survival in the wild.
- Individuals are selectively discharged into the wild as the number of surviving lifeforms increases.
- Offsite selection could also be used to restock depleted populations, reintroduce endangered species, and restore degraded habitats.

Gene Bank:

- These institutes maintain seed banks, orchards having live growing plants, tissue cultures, frozen germplasm with a wide range of genetic variety, etc.

Seed banks:

- There are two kinds of seeds: orthodox and recalcitrant.
- **Orthodox seeds** are those that can withstand a 5% decrease in moisture content, anaerobic conditions, and temperatures as low as or even lower for extended periods of time, such as cereals and legumes.
- Seeds are enabled to germinate into plants at regular intervals, resulting in the development of new seeds for storage.
- **Recalcitrant seeds** like tea, cocoa, jackfruit, and coconut are those which die when moisture and temperature are reduced.
- They can be housed in rooms with normal air for a shorter period of time after being treated with fungicides.

Orchards:

- Orchards are made from plants with obstinate seeds.
- Orchards keep all feasible strains and varieties, such as litchi, rubber tree, oil palm, and so on.

Tissue culture:

- Tissue culture is used for plants that are seedless, varying seed progeny, have recalcitrant seed, or where a clone is to be maintained.
- It is performed through callus formation, development of embryoids, pollen grain culture, and shoot tip culture.
- The method is useful for maintaining a large number of genotypes in a small area, rapid species multiplication, and hybrid rescue.
- Shoot tip cultures are frequently used to keep plants virus-free.
- It is used for the world trade of germplasm in vegetatively multiplied cultures. For example, bananas and potatoes.

Cryopreservation:

- Tissue culture, gametes, animal tissues, and spermatozoa can be kept indefinitely at -196°C (using liquid nitrogen).

- When the cryopreserved material is needed, special techniques are used to bring it back to life.

BIODIVERSITY ACT (2002)

- To protect India's rich biodiversity and related knowledge from misuse by foreign individuals and organisations who do not benefit from such use, as well as to overcome biopiracy.

CONVENTION ON BIODIVERSITY

- The Biodiversity Convention "The Earth Summit" held in Rio de Janeiro in 1992 urged all nations to take reasonable steps for biodiversity conservation and the sustainable utilisation of its benefits.
- In 2002, at Johannesburg (South Africa), World Summit on Sustainable Development, 190 countries made a pledge about their genuine commitment to achieving a significant reduction in the present rate of biodiversity loss at the global, regional, and native levels by 2010.
- To protect India's rich biodiversity and allied activities from misuse by foreign individuals and organisations who do not benefit from such use, as well as to counteract biopiracy.

Key points to remember:

1. Sum total of diversity that exists at all levels of biological organisation is called biodiversity.
2. Conservation efforts are aimed at protecting diversity at all levels.
3. More than 1.5 million species have been recorded and nearly 6 million are waiting to be discovered and named.
4. More than 70 percent of named species are animals of which 70 % are insects.
5. Fungi has more species than all vertebrate species combined.
6. India with 45,000 species of plants and twice as many species of animals, is one of the 12 mega diversity countries of the world.
7. Species diversity is highest in the tropics and decreases towards the poles.
8. Tropics provide a relatively constant environment, receive more sunlight so have greater productivity and species richness.
9. Species richness is also a function of area and species-area relationship is generally a rectangular hyperbolic function.

10. Communities with high diversity tend to be less variable, more productive and resistant to biological invasions.
11. Mass extinctions have occurred in the past but present rates are 100 to 1000 times higher largely due to human activities.
12. Nearly 700 species became extinct in recent times and more than 15,500 species (of which > 650 are from India) currently face threat of extinction.
13. Habitat loss and fragmentation, over-exploitations, biological invasions and co-extinctions are the main causes of extinction.
14. Biodiversity needs to be conserved for narrowly utilitarian, broadly utilitarian and ethical reasons.
15. Direct benefits are food, fibre, firewood, pharmaceuticals etc.
16. Indirect benefits are through ecosystem services like pollination, pest control, climate moderation and flood control.
17. We have a moral responsibility to take good care of earth's biodiversity and pass it on in good order to our next generation.
18. Biodiversity conservation may be in-situ as well as ex-situ.
19. Endangered species are protected in their natural habitat in in-situ conservation.
20. Total 34 'biodiversity hotspots' have been proposed in the world for intensive conservation efforts.
21. Western Ghats and Sri Lanka, Himalaya and Indo-Burma cover India's biodiversity rich regions.
22. India's in-situ conservation efforts are reflected in its 14 biosphere reserves, 90 national parks, 448 wildlife sanctuaries and many sacred groves.