BIODIVERSITY

The term **biodiversity** was coined as a contraction of **biological diversity** by **E.O. Wilson in 1985**. Biodiversity may be defined as the variety and variability of living organisms and the ecological complexes in which they exist. In other words, biodiversity is the occurrence of different types of ecosystems, different species of organisms with the whole range of their variants and genes adapted to different climates, environments along with their interactions and processes.

Types of Biodiversity:

Biodiversity is of three types:

1. Species diversity
2. Genetic diversity
3. Ecological diversity

1. Species Diversity:

According to Biological Species Concepts (BSC), species is a basic unit of classification and is defined as a group of similar organisms that interbreed with one another and produce offspring's and share a common lineage. Species diversity refers to biodiversity at the most basic level and is the 'variety and abundance of different types of individuals of a species in a given area'. It includes all the species on Earth, ranging from plants such as bacteria, viruses, fungi, algae, bryophytes, pteridophytes, gymnosperms, angiosperms and all the species of animals including unicellular protozoans to mammals.

Certain regions support more diverse populations than others. Regions that are rich in nutrients and have well balanced climatic factors, such as moderate temperature, proper light and adequate rainfall, show high degree of diversity in their life forms. The tropical areas support more diverse plant and animal communities than the desert and polar areas, as for example, a tropical forest has higher species diversity as compared to a timber plantation. **The regions**

that are rich in species diversity are called hotspots of biodiversity.

2. Genetic Diversity:

'Genetic diversity pertains to the range of diversity in the genetic resources of the organisms'. Every individual member of a plant or animal species differs from other individuals in its genetic constitution. Each individual has specific characters, which is due to the genetic makeup or code. The genes present in the organisms can form infinite number of combinations that causes genetic variability.

Thus, we find that each human, who is representative of the same species, i.e. Homo sapiens, is distinct from another. Similarly, there are many varieties within the same species such as rice, wheat, apples, mangoes, etc. that differ from one another in shape, size, colour of flowers and taste of fruits and seeds due to the variations at the genetic level.

The term 'gene pool' has been used to indicate the genetic diversity in the different species. This also includes the diversity in the wild species, which through intermixing in nature over millions of years have given rise to newer varieties. The domesticated varieties of agricultural crops and animals have also evolved from the wild gene pool.

The genetic variability is essential for healthy breeding population, the reduction in genetic variability among breeding individuals leads to inbreeding which in turns can lead to extinction of species. In the recent decades, a new science named 'biotechnology' has emerged. It manipulates the genetic materials of different species through various genetic re-combinations to evolve better varieties of crops and domestic animals.

Genetic diversity has the following importance:

(i) It helps in speciation or evolution of new species;

(ii) It is useful in adaptation to changes in environmental conditions;

(iii) It is important for agricultural productivity and development.

3. Ecological/Ecosystem Diversity:

Each ecosystem consists of organisms from many different species, living together in a region connected by the flow of energy and nutrients. The Sun is the ultimate source of energy for all the ecosystems. The Sun's radiant energy is converted to chemical energy by plants. This energy flows through the different systems when animals eat the plants and then are eaten, in turn, by other animals. Fungi and bacteria derive energy from the decomposing dead organisms, releasing nutrients back into the soil as they do so.

An ecosystem, therefore, is a collection of living components, like microbes, plants, animals, fungi, etc. and non-living components, like climate, matter and energy that are connected by energy flow. Ecological diversity refers to the 'variability among the species of plants and animals living together and connected by flow of energy and cycling of nutrients in different ecosystems or ecological complexes'. It also includes variability within the same species and variability among the different species of plants, animals and microorganisms of an ecosystem. Thus, it pertains to the richness of flora, fauna and microorganisms with in an ecosystem or biotic community.

The richness of the biosphere in terms of varied life forms is due to the variations in the ecosystems. The earth has a number of ecosystems like grasslands, forests, semi arid deserts, marine, freshwater, wetland, swamp, marshlands etc. each one having its distinct floral, faunal and microbial assemblages. Ecological diversity represents an intricate network of different species present in local ecosystems and the dynamic interaction among them. The ecological diversity is of great significance that has developed and evolved over millions of years through interactions among the various species within an ecosystem.

Measuring Biodiversity:

There are various mathematical ways of measuring biodiversity, which calculate the number of species diversity in different regions. The measure of diversity of species is also known as species richness.

According to Whittaker (1965), the community diversities are of three types:

(i) α-Diversity:

It tells the species diversity in a given community.

It depends upon species richness and evenness.

(ii) β-Diversity:

It describes a range of communities due to replacement of species which arises due to the presence of different microhabitats, niches and environmental conditions.

(iii) γ -Diversity:

It describes diversity of habitat over a total land escape or geographical area

Alpha diversity:

This is the diversity in species, i.e. the number of species within a community. This depends on the interaction between the biotic and abiotic factors and also takes into account immigration from other locations.

Beta diversity:

This is the change in the composition of the species with reference to the changes in the environment.

Gamma diversity:

This refers to the overall diversity and is applied to larger areas in which both alpha and beta diversity are measured.

$\gamma = \alpha + \beta + Q$ where, Q = Total number of habitats or communities,

α = Average value of α diversities

β = Average value of β diversities

Biodiversity can be conserved in two main ways, in-situ conservation and ex-situ conservation.

Way # 1. In-Situ Conservation Strategies:

In-situ or on site conservation is conservation of wild animals and plants in their natural habitat. The aim of in-situ conservation is to allow the population to maintain or perpetuate itself within the community environment, to which it is adapted. In-situ conservation is the ideal method of conserving wild plant genetic resources. In-situ conservation of plant genetic resources presents a number of advantages as compared to ex-situ conservation.

Advantages of In-Situ Conservation of Plant Resources:

a. It enables the conservation of a large range of potentially interesting alleles.

b. This method is especially suitable for species, which cannot be established or regenerated outside the natural habitats.

c. This method allows natural evolution to continue because of the existence of variation.

d. It facilitates research on species in their natural habitats.

e. It assures protection of other species that are dependent on the species under consideration.

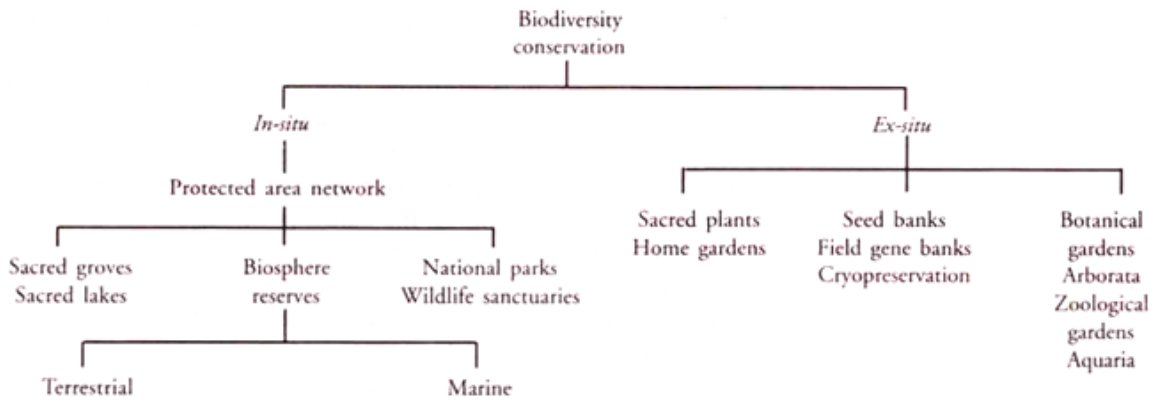


Fig. 3 The *in-situ* and *ex-situ* approaches of conserving biodiversity in India.

Methods of In-Situ Conservation:

In-situ conservation is done by providing protection to biodiversity rich areas through a network of protected areas. In India, the protected areas are of the following kinds – national parks, wildlife sanctuaries, biosphere reserves and ecologically fragile and sensitive areas. A protected area network of 85 national parks and 448 wildlife sanctuaries has been created. The results of this network have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles and elephants.

The main advantages and features of protected areas are as follows:

a. The genetic diversity of all species inhabiting an area can be conserved.

b. Species can be maintained in their natural habitat.

c. In protected areas, human intervention is minimal.

d. Pollution and poaching in the protected area can be checked.

Eco-development programmes involving local communities have been initiated recently for sustained conservation of ecosystems. The economic needs of the local communities are taken care under this programme through provision of alternative sources of income and a steady availability of forest and related products.

Programmes have also been launched for scientific management and wise use of wetlands, mangroves and coral reef ecosystems. Twenty-one wetlands and mangrove areas and four coral reef areas have been identified for intensive conservation and management purposes.

Six significant wetlands of India have been declared as 'Ramsar Sites' under the Ramsar Convention. Under the World Heritage Convention, five natural sites have been declared as 'World Heritage Sites'.

National Park:

A **national park** is a reserve of land, usually owned by a national government. It is a tract of land, which is declared public property to preserve and develop for the purpose of recreation and culture. It is protected from human development activities and pollution. National parks are protected areas of IUCN category II.

There are 10 existing national parks in India covering an area of 38,024.10 km^2, which is 1.16% of the geographical area of the country. Yellowstone National Park in California was established as the world's first protected area. The first national park in India was Hailey National Park, now known as Jim Corbett National Park, established in the year 1935.

Sanctuaries:

A sanctuary is a reserved area for the protection of wildlife. Collection of forest products, cutting trees for timber are allowed provided they do not affect the animals. There are 448 existing wildlife sanctuaries in India. Another 217 sanctuaries are proposed in the Protected Area Network report.

Biosphere Reserves:

Biosphere reserves are protected areas meant for preserving genetic diversity in the various biomes. The concept of biosphere reserves has been evolved by UNESCO's Man and Biosphere programme or MAB. In the year 1976, the Man and Biosphere programme identified about

57 biosphere reserves. The numbers of such areas have increased since then.

The biosphere reserve has concentric areas zoned for different use.

a. The core zone is the innermost zone devoted to preserve biodiversity with no human interference.

b. Around the core zone there is the buffer zone in which some settlement and resource use is allowed. In this area, variety of educational programmes and research activities are carried out, such as identification of endangered species, artificial propagation of species, and application of tissue culture techniques to enable rapid multiplication of threatened species.

c. The outermost zone is the transition zone where sustainable development activities are permitted. This is an area of interaction between the biosphere reserve management and the local people. Here activities such as forestry, recreation, cropping, etc. are permitted (Fig. 4).

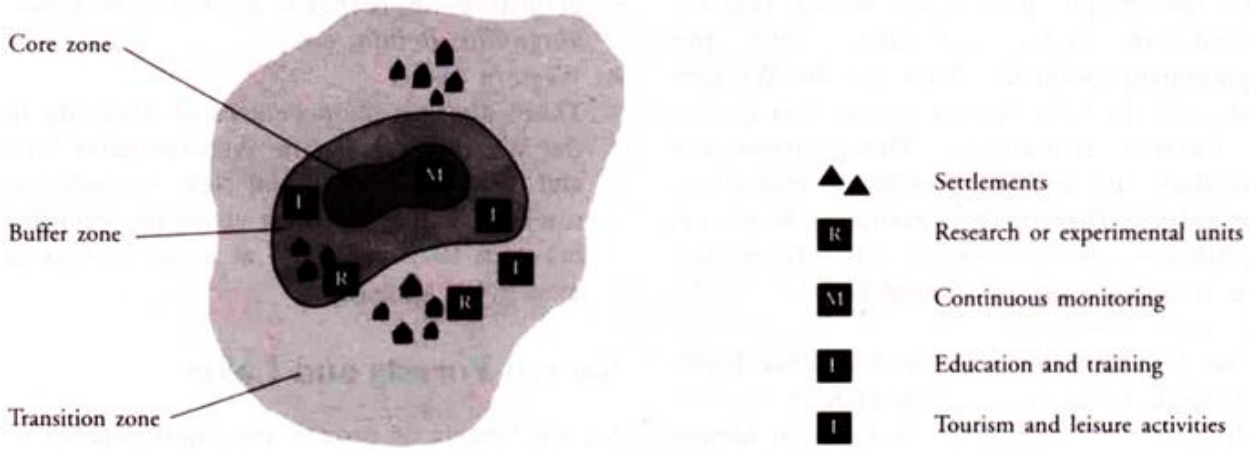


Fig. 4 Biosphere reserve.

These reserves aim at conserving the biological diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems. There are approximately 400 biosphere reserves in 94 countries. The list of biosphere reserves in India is given in Table 6.

Table 6 List of biosphere reserves in India.

S. No.	Reserve	Location
1.	Great Nicobar	Andaman and Nicobar Islands
2.	Gulf of Mannar	Tamil Nadu
3.	Kanha	Madhya Pradesh
4.	Kaziranga	Assam
5.	Manas	Assam
6.	Namdapha	Arunachal Pradesh
7.	Nanda Devi	Uttar Pradesh
8.	Niligris	Tamil Nadu, Kerala and Karnataka
9.	Nokrek Tura	Meghalaya
10.	Rann of Kutch	Gujarat
11.	Sunderbans	West Bengal
12.	Thar Desert	Rajasthan
13.	Valley of flowers	Uttar Pradesh

The Mega Diversity Regions

The World Conservation Monitoring Centre recognised 17 mega diverse countries in July 2000 including Australia, Brazil, China, Colombia, Democratic Republic of the Congo (DRC) (formerly Zaire), Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, the Philippines, South Africa, the United States of America (USA) and Venezuela. Together, these 17 countries harbour more than 70% of the earth's species. Some of the very valuable "gene pool" from these countries have been identified and they have been utilized for the built up of modern agriculture and allied business.

Hot Spots:

According to Norman Myers, hot spots are areas that are extremely rich in species, have high endemism, and are under constant threat. Biological hot spots include the Western Amazon (Colombia, Ecuador, Peru), Madagascar, North and Eastern Borneo, North Eastern Australia, West Africa, and the Brazilian Atlantic forest. All of these

areas have high biodiversity and many are threatened by human activities.

Of the 25 hot spots in the world, two are located in India extending into the neighbouring countries. They are the Western Ghats and the Indo-Burma region that covers the Eastern Himalayas. These areas are particularly rich in floral wealth and endemism, especially flowering plants. Reptiles, amphibians, swallow-tailed butterflies, and some mammals are also found here.

a. Eastern Himalayas:

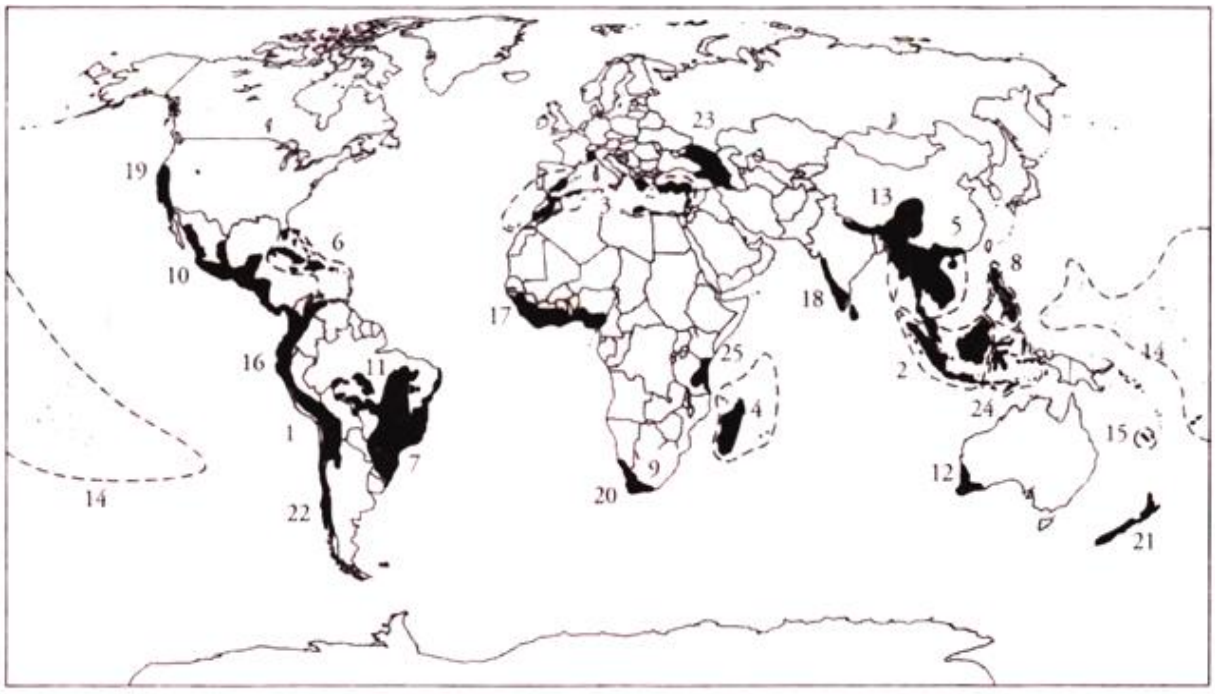
The Eastern Himalayas located in the North Eastern India is a region rich in species diversity and endemism. But due to human intervention the forest cover in the Eastern Himalayas has dwindled from 340,000 sq. km to 110,000 sq. km. Despite this loss, the North-Eastern region is home to some botanical rarities. One of these is the Sapria himalayana, a parasitic angiosperm that has been sighted only twice since 1836. The primitive angiosperm genera are Alnus, Magnolia, Betula, etc.

b. Western Ghats:

There are two main centres of diversity in the Western Ghats, the Agastyamalai hills and the Silent Valley and New Amambalam reserve basin. The forest cover has declined between 1972 and 1985 at a rate of loss of over 2.4% annually.

To qualify as a biodiversity hotspot, a region must meet two strict criteria:

- It must have at least 1,500 vascular plants as endemics — which is to say, it must have a high percentage of plant life found nowhere else on the planet. ...
- It must have 30% or less of its original natural vegetation.



1. Tropical Andes
2. Sundaland
3. Mediterranean basin
4. Madagascar
5. Indo-Burma
6. Caribbean islands
7. Atlantic Forest region, Brazil
8. Philippines
9. Succulent karoo
10. Mesoamerica
11. Brazilian Cerrado
12. South-West Australia
13. Mountains of South-Central China
14. Polynesia/Micronesia
15. New Caledonia
16. Choco-Darien Western Equador
17. West African Forest
18. Western Ghats and Srilanka
19. California Floristic province
20. Cape Floristic province
21. New Zealand
22. Central Chile
23. Caucasus
24. Wallacea
25. Guinean Forests of West Africa

Fig. 5 Map showing the 25 hot spots.

Sacred Forests and Lakes:

Sacred forests or groves are small patches of forests, which are conserved through man's spiritual belief and faith. In India, sacred groves are found in Khasi and Jaintia hills of Meghalaya, Aravalli hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh. Many plant species are found in this forest belonging to 183 genera and 84 families.

The protection of whole communities as sacred ponds and groves is a remarkable feature of the Indian subcontinent.

Some prominent examples are listed below:

a. One of the most widespread of the traditions in India is the protection given to trees of the genus Ficus, which are found in the countryside and are often the only large trees in the midst of towns and cities. They are considered by biologists as 'keystone species' serving as food source at times of need for other frugivores.

b. The pipal tree (Ficus religiosa) has had a conspicuous position in the cultural landscape of North India and human collective memory for more than 5,000 years.

c. For Hindus, the Bel tree, Aegle marmelos, is associated with Lord Shiva, tulasi with Lord Vishnu, and fig (Ficus glome rata) with Lord Dattatreya, the son of Trimurty and the kadamba tree is likened to Lord Krishna.

d. In many villages of South India, there are no temples. The Gramdevata or village goddess may be a big tree located in the village.

e. Khecheopalri Lake is considered as one of the sacred lakes both by the Buddhist and the Hindus. The lake remains hidden in the rich forest cover and the aquatic flora and fauna are naturally preserved.

But due to the fast-changing society framework and mindset of the younger generation, the belief associated with the forests has been diluted. The forest cover is subject to degradation due to clearing of forests and there is an urgent need to preserve the forest. Thus, to save the sacred forests there is a need for conservation programmes with the help of local administration and NGOs.

Way # 2. Ex-Situ Conservation Strategies:

Ex-situ conservation is the conservation of plants and animals in locations outside their natural habitats. It includes collection and conservation of species in specific locations such as botanical gardens, zoos, safari parks, aquaria, and in institutes such as gene banks.

Offsite Conservation of Species:

Many species of plant species are conserved in botanical gardens and arboreta. Arboreta are gardens with trees and shrubs. Seed banks and tissue culture facilities in the offsite areas have helped in conserving many specimens.

Captive breeding of animals in zoos have increased the number of endangered species and saved them from extinction. The ultimate aim of captive breeding programme is the re-introduction of animals into their natural wild habitat.

Gene Bank Conservation:
Gene banks are places that conserve the germplasm.

According to the nature of the germplasm, they may of the following types:
a. **Seed banks** are places where viable seeds are stored.

b. **Orchards** are places where specific plants are grown in large numbers.

c. **Tissue culture labs** are laboratories where callus, embryoids, pollen grains and shoot tip culture are carried out for plants that are seedless or that have recalcitrant seeds. Tissue culture is particularly useful in rapid multiplication of endangered species, maintaining genotypes in small areas, production of virus free shoots and growing plants such as banana that can propagate only vegetatively.

d. **Cryopreservation** is the storage in liquid nitrogen at -196°C. This technique is a useful technique for preserving vegetatively propagated crops such as potato, seeds of plants and for preserving sperms, eggs, cells and embryonic tissues of animals for the conservation of genetic diversity.

The seeds of many plant species remain viable longer when moisture is reduced and stored at low temperature. But the seeds must be germinated periodically in order to obtain fresh seeds. This method ensures protection and conservation of rare species.

Protection of Endangered Species:
Special projects have been launched to protect selected species which face the danger of extinction.

Some important examples are listed below:
a. Project tiger

b. Gir lion project