4 Biodiversity and Its Conservation

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INTRODUCTION

The term 'biodiversity' refers to 'the variety and variability among living organisms and the ecological complexes in which they occur'. If you observe a patch of forest, you may find a wide variety of plant and animal life. The plant life may range from a small herb to a large tree, and animal life may vary from a tiny insect to a large mammal. Apart from plants and animals, numerous microorganisms, which cannot be seen with naked eyes also occur in the soil. This shows biological diversity or biodiversity of a forest patch. Thus, biodiversity can be defined as *'the totality of genes, species and ecosystems of a region'*.

All the species do not occur at one place. The site of occurrence of a species is determined by the environmental conditions of the site and the range of tolerance of the species. Therefore, different patches of forests possess different forms of plant and animal life. Thus, biodiversity differs from place to place. Taking into consideration, the total habitats of plants and animals, one can conclude that enormous biodiversity exists on the earth.

The human population depends on biodiversity for food and other necessities. The increasing human population is depleting natural resources and causing pollution. As a result, the biologically rich and unique habitats are being destroyed, fragmented and degraded. At present, biodiversity loss is one of the world's most pressing crises. This is because of the realization that biological diversity is being lost even before its size is known. The loss of biodiversity would prevent evolutionary capability of biota to cope up with environmental changes. Today the major challenges to science is, how to check the loss of species and erosion of gene pool.

MAGNITUDE OF BIODIVERSITY

Biologists are enganged in the identification and naming of species for the last 250 years. Still, they are able to name and describe for less number of species than the actual number present. Presently, the known and described number of species of all organisms on the earth is between 1.7 and 1.8 million, which is fewer than 15% of the actual number. It is predicted that the number of total species varies from 5 to 50 million. A summary of the total number of known species from major taxonomic groups is given in *Table 4.1*. Approximately 61% of the known species are insects. About 2,70,000 species of plants and only 4650 species of mammals are known to science. Only fragmentary information is available about bacteria, viruses, protists and archaea.

Table 4.1. Approximate Numbers of Species from Major Taxonomic Groups which have been Described From All Over the World

Taxonomic Group	*Number of Species*
Higher plants	270,000
Algae	40,000
Fungi	72,000
Bacteria (including cyanobacteria)	4,000
Viruses	1,550
Mammals	4650
Birds	9700
Reptiles	7150
Fishes	26,959
Amphibians	4780
Insects	1,025,000
Crustaceans	43,000
Molluscs	70,000
Nematodes and worms	25,000
Protozoans	40,000
Others	110,000

India possesses a large plant and animal life due to diverse climatic conditions, ranging from the cold desert of Ladakh and Spiti to the hot desert of Thar, the temperate forests in the Himalayas to the tropical rain forests of low lands. There are also present large inland fresh water lakes like Wular and Manasbal in Kashmir, the Chilka in Orissa, the Kolleru lake in Andhra Pradesh and the rugged and rich coastline and coral reefs of Deccan. *Figure 4.1* shows the number of species of different taxonomic group, described from India.

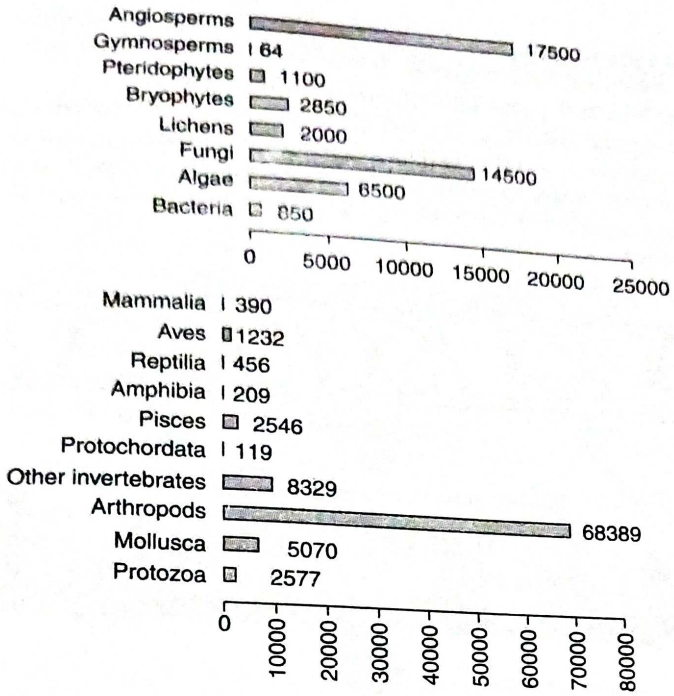


Fig. 4.1. Number of plant and animal species in different groups recorded in India.

LEVELS OF BIODIVERSITY

There exist a wide variety of organisms, complex ecological relationship among organisms, genetic diversity within species and a great variety of ecological systems in nature. One must be clear about the concept of biodiversity to develop conservation plans for the later. The biological diversity include three hierarchial levels, *viz.* (*i*) Genetic diversity, (*ii*) Species diversity, and (*iii*) Community and ecosystem diversity (*Fig. 4.2*). These levels of biodiversity are interrelated with each other yet distinct enough to be studied separately to understand their interrelations.

1. Genetic Diversity

Each species of living being store an immense amount of genetic information. The number of genes present in a species differs from those present in another species. For instance, the number of genes is about 4000 in *Escherichia coli* (colon bacteria), 13000 in *Drosophila melanogaster* (fruit fly), 32000–50000 in *Oryza sativa* (rice) and 35000 to 45000 in *Homo sapiens sapiens* (man).

The genetic variation existing within a species is called genetic diversity. The genetic variation may be in **alleles** (different variants of same genes), in **entire genes** (the traits determining particular characteristics) or in **chromosomal structures**. A population is able to adapt to its environment and respond to natural selection due to its genetic diversity. A species with more genetic diversity can adapt better to the changed environmental conditions. A species with low genetic diversity results into uniformity. For example, large monocultures

of genetically similar crop plants often leads to uniformity. The uniformity among crop plants is advantageous for achieving higher yields. However, it becomes a problem when an insect or a fungus attacks the field and poses threat to the entire crop.

The genetic diversity within a species often increases with environmental variability. The evolution of new species *i.e.* **speciation**, depends upon the amount of genetic variation. Speciation plays a key role in the maintenance of diversity at species and community levels. A community with higher number of species has greater genetic diversity than the community having only a few species.

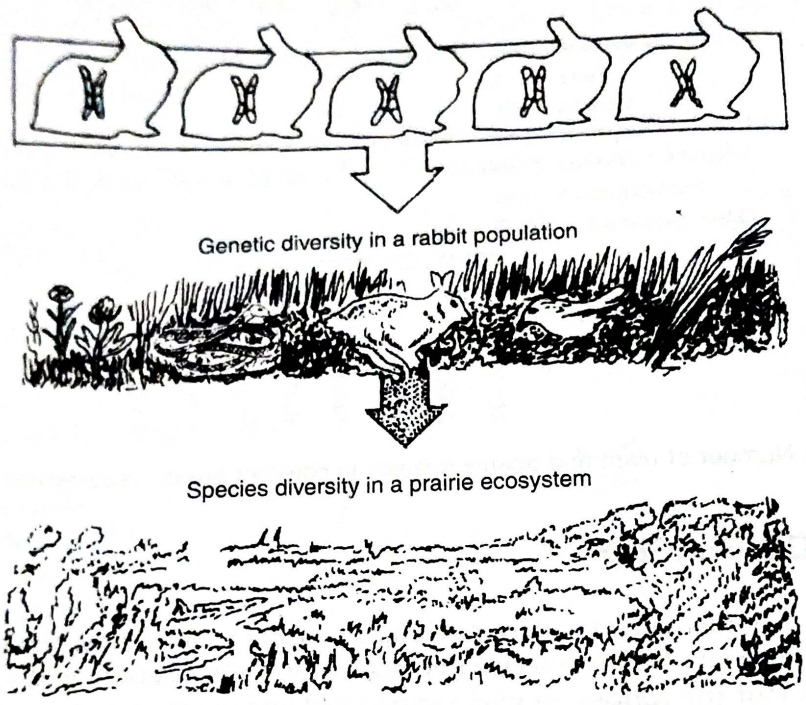


Fig. 4.2. Different levels of biodiversity.

2. Species Diversity

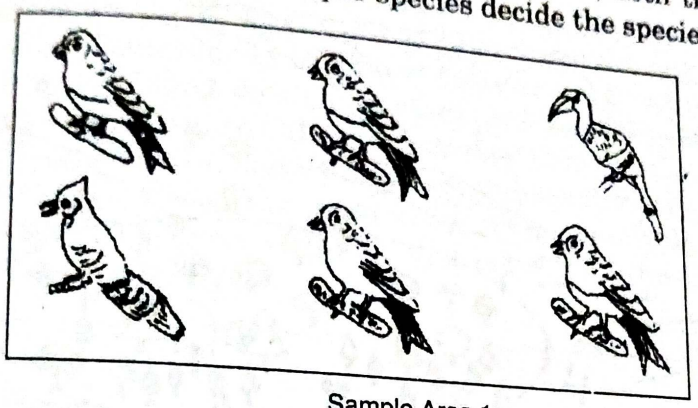
Species diversity refers to the variety of species within a region. It includes the full range of species in the region, from micro-organisms to multicellular plants and animals. Species are distinct units of diversity, each of which have specific role in an ecosystem. Therefore, loss of a species effect the ecosystem as a whole.

The species diversity of a region is measured on the basis of two parameters : species richness and equitability/evenness.

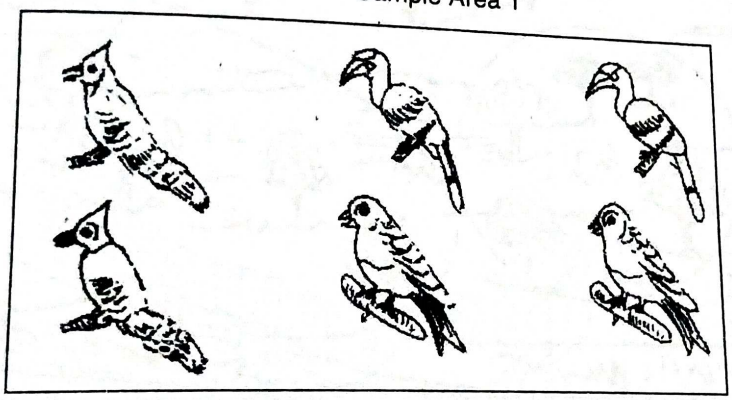
Species richness refers to the number of species per unit area. The number of species increases with the area of the site. Generally, higher species diversity represents greater species diversity.

Evenness or **equitability** indicates the evenness in the number of individuals of a species. The evenness of species represents higher species diversity in the region. Suppose, there are three sample areas. The sample area one has three species of birds. Two species are

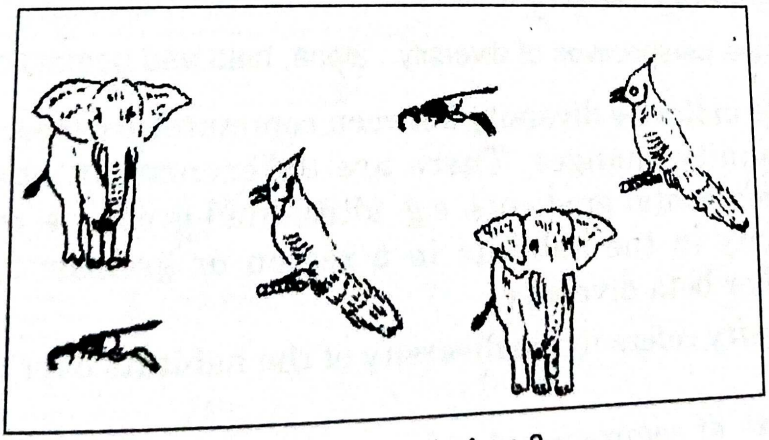
represented one individual each, while the third species has four individuals. The second sample area has the same three species, each of which is represented by two individuals. This sample area shows greater evenness, and there are equal chances for species being represented in the sample. Thus, the second sample area is considered more diverse than the first. The third sample area also has three species represented by an insect, a bird and a mammal. This sample area has taxonomically unrelated species and is therefore, considered to be the most diverse among the three (*Fig. 4.3*). In the above example, each sample area shows equal number of species but varying number of individuals per species. Thus, both the number or kind of species as well as the number of individuals per species decide the species diversity of an area.



Sample Area 1



Sample Area 2



Sample Area 3

Fig. 4.3. The different sample areas showing species richness (sample area 1), species evenness (sample area 2), wild diversity due to taxonomically unrelated species (sample area 3).

3. Community and Ecosystem Diversity

Community diversity refers to the variations in the biological communities in which species live. There are three perspectives of diversity at the level of community. These are (*i*) alpha diversity, (*ii*) beta diversity and (*iii*) gamma diversity (*Fig. 4.4*).

(*i*) ***Alpha Diversity*** indicates diversity within the community. It refers to the diversity of organisms sharing the same community or habitat. A combination of species richness and equitability/evenness is used to represent diversity within a community or habitat.

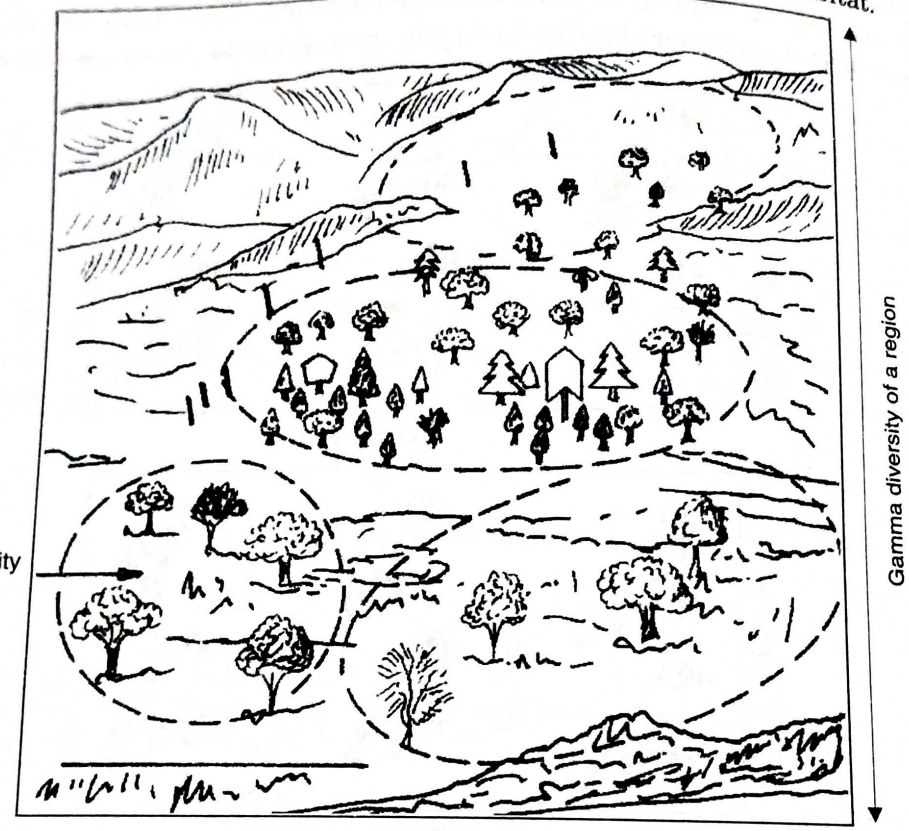


Fig. 4.4. Three perspectives of diversity : alpha, beta and gamma diversity.

(*ii*) ***Beta Diversity*** indicates diversity between communities. Species frequently change when habitat or community changes. There are differences in species composition of communities along environmental gradients, *e.g.* altitudinal gradient, moisture gradient, etc. The higher heterogenecity in the habitats in a region or greater dissimilarity between communities exhibit higher beta diversity.

(*iii*) ***Gamma Diversity*** refers to the diversity of the habitats over the total land scape or geographical area.

The higher diversity at community level provides stability and higher productivity. In temperate grasslands, it has been observed that diverse communities are functionally more productive and stable, even under environmental stresses such as prolonged dry conditions.

Ecosystem diversity refers to the variation in the structure and functions of the ecosystem. It describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food webs and the recycling of nutrients. It has focus on various biotic interactions and the role and function of **keystone species** (species determining the ability of large number

of other species to persist in the community). As we have studied in earlier chapter that grasslands, rain forests, deserts, lakes, wetlands and oceans are major ecosystems, where species live and evolve. The number of habitats or ecosystems may vary within a geographical region. It is the measure of ecosystem diversity in a region.

India is a country with rich diversity of the biogeographically distinct regions (*Fig. 4.5*) due to varying physical conditions and species groupings. About 42% of the Indian landmass is occupied by Deccan Peninsula. The most biodiversity rich zones *i.e.* the **Western Ghats** and the **North-east**, account for 4% and 5.2% of the geographical area, respectively. Several habitats, biotic communities and ecosystems are present in each biogeographical zone. These zones are inhabited by a large number of **endemic** species. *'The species which are confined to a particular country are called endemic species'*. Our country has a rich endemic flora and fauna. About 33% of the flowering plants recorded in India are endemic to our country. Out of the recorded vertebrates, 53% fresh water fishes, 60% amphibians, 36% reptiles and 10% mammalian fauna are endemic. The North-east, Western Ghats, North-west Himalaya and Andaman and Nicobar Islands are the main zones for the endemics. Several amphibian species are endemic to the **Western Ghats.** However, the biodiversity of many ecosystems still remains poorly explored in India. These include deep oceans, wetlands and lakes, and the habitats such as the tree canopy and soil of tropical rain forests.

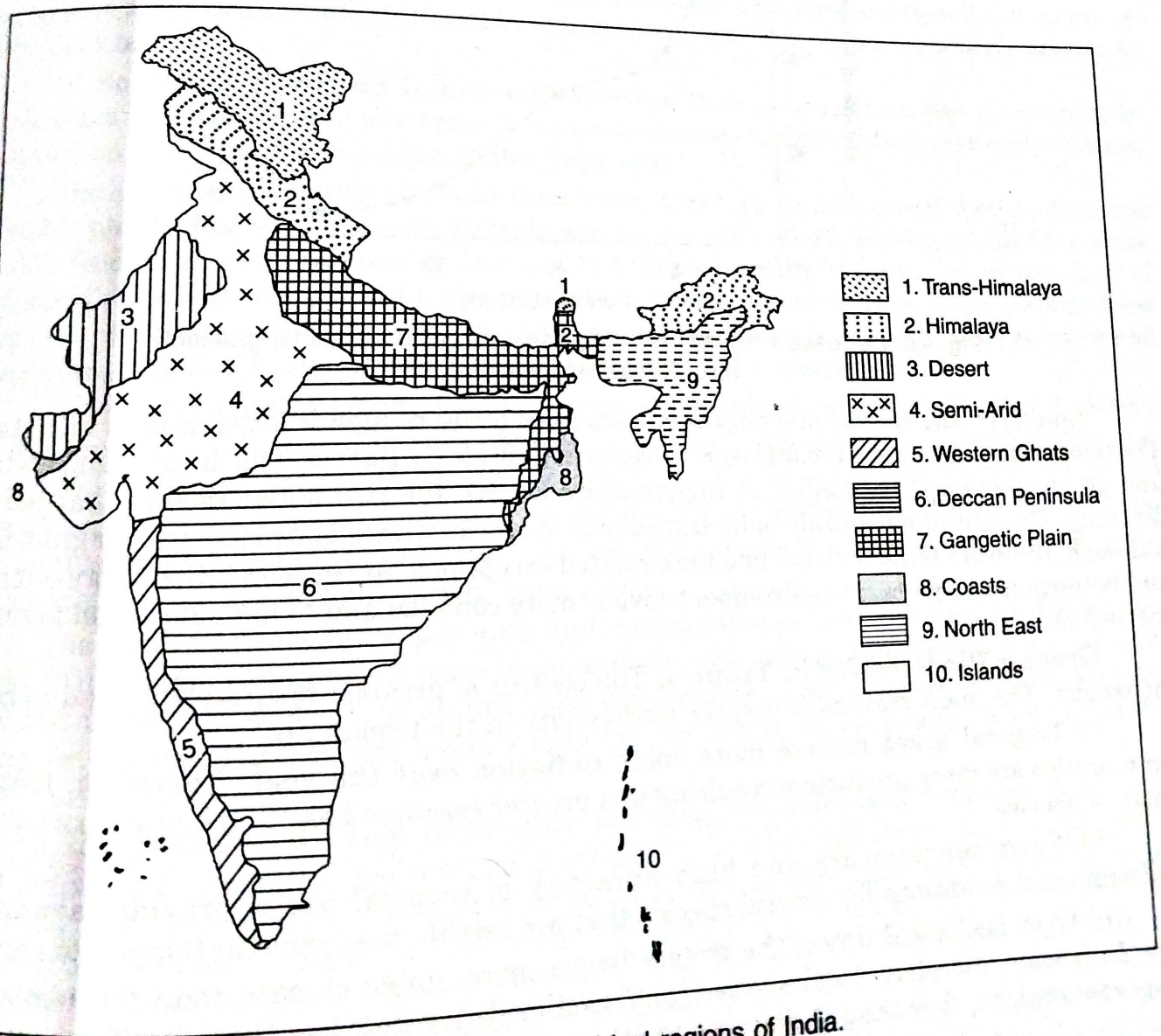


Fig. 4.5. Biogeographical regions of India.

GRADIENTS OF BIODIVERSITY

Biodiversity is not uniform on the earth. It varies with change in latitude or altitude. Biodiversity increase, when we move from high to low latitude (*i.e.* from the poles to the equator). The temperate region has severe climate with short growing period for plants. On the other hand tropical region has favourable conditions for the growth throughout the year. The favourable environmental conditions favour speciation (*i.e.* origin of new species) and make it possible for a larger number of species to occur and grow. Therefore, tropical regions are rich in biodiversity. For instance, in tropical rain forests, the mean number of vascular species per 0.1 ha sample area varies from 118–236, whereas it is only in the range of 21–28 species in the temperate regions. This type of correlation between diversity and latitude is also found for several taxonomic groups such as ants (*Fig. 4.6*), butterflies, moths and birds, etc.

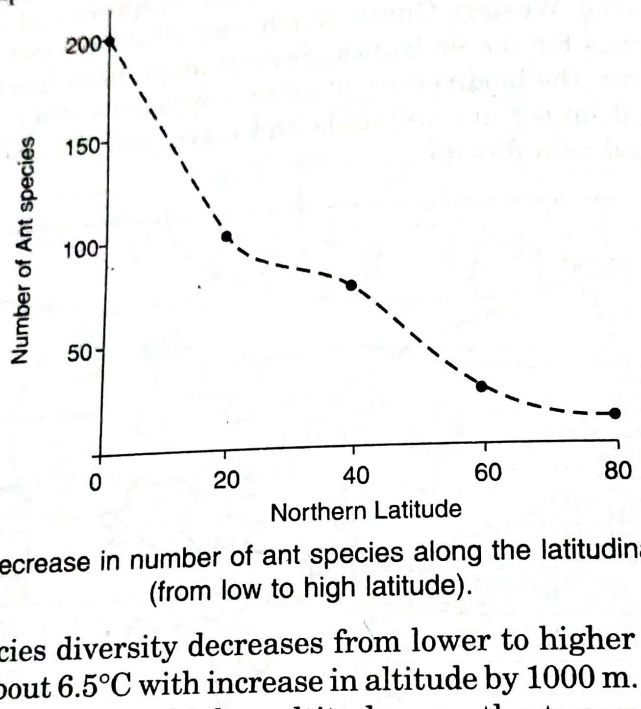


Fig. 4.6. Decrease in number of ant species along the latitudinal gradient (from low to high latitude).

Similarly, the species diversity decreases from lower to higher altitude on a mountain. The temperature drops about 6.5°C with increase in altitude by 1000 m. The drop in temperature and greater seasonal variability at higher altitudes are the two major factors that reduce diversity. The latitudinal and altitudinal gradients of species diversity are two master gradients, although, there are some regional and taxa-related exceptions. At the same time, more complex and heterogeneous physical environment favour more complex and diverse flora and fauna in the region.

Greater Biodiversity in Tropics. The centres of greatest biodiversity, tend to be in the tropics. The main reasons of greater biodiversity in the tropics are :

(*i*) Tropical areas receive more solar radiation over the year. Therefore, tropical communities are more productive resulting in a greater resource base that can support a wide range of species.

(*ii*) Warm temperature and high humidity of tropical areas provide favourable environmental conditions for several species that are unable to survive in temperate regions.

(*iii*) Over geological times, the tropics had a more stable climate than the temperate ones. In tropics, therefore, local species continued to thrive and live there itself, whereas in temperate regions, they tend to disperse to other areas.

(*iv*) There has been more time for tropical communities to evolve as they are older than temperate ones. This could have allowed tropical communities greater degree of specialization and local adaptations to occur.

(*v*) In tropics, the greater pressure from pests, parasite and diseases does not allow any single species to dominate. Thus, there is opportunity for many species to coexist. In temperate areas, on the other hand, there is reduced pressure from pests, parasites and diseases due to low temperature, which results dominance of one or few species that exclude many other species.

(*vi*) In tropics, higher rate of out crossing among organisms (especially among plants) may lead to higher levels of genetic variability.

BENEFITS OF BIODIVERSITY (USES OF BIODIVERSITY)

A rich biodiversity is essential for the health of biosphere and bioindustrial development of a country. Humans derive many direct and indirect benefits from the living world. Biodiversity is the source of food, medicines, pharmaceutical drugs, fibres, rubber and timber. Several microorganisms are used in industries to obtain valuable products. Additionally, diversity of organisms also provide many ecological services free of cost. The main uses of biodiversity are described below:

1. **Source of Food and Improved Varieties.** Modern agriculture uses biodiversity in three ways : (*i*) as a source of new crops (*ii*) as a source material for breeding improved varieties, and (*iii*) as a source of new biodegradable pesticides.

Human food is entirely obtained from living world. There are several thousand species of edible plants, but only less than 20 plant species are cultivated to produce about 85% of the world's food. The rest of the world's food (*i.e.* 15%) is produced by animals. Nearly two-third of the world's food sustaining the human population, is contributed by three major carbohydrate crops *viz.* wheat, corn and rice. To meet the requirements of increasing population, more and more new species of food and other useful plants need to be investigated.

Improved varieties of crop plants and domestic animals are the backbone of modern agriculture. In recent years, many improved varieties of crops and other useful plants have been developed through breeding programmes. Genes of wild species are used to confer new properties, such as disease resistance or improved yield in domesticated species. For example, rice cultivated in Asia is protected from the four main diseases by the genes received from a single wild rice species (*Oryza nivara*) from India.

The wild relatives of crop plants and useful animals are essential for the regular production of high yielding and disease resistance varieties of crops and animals. This is because pest and pathogens evolve new stains, soils vary, climate and demands of consumers also change with time. The average life of a crop variety is 5 to 15 years only. After which it is likely to deteriorate.

2. **Drugs and Medicines.** Biodiversity has many medicianl uses. A number of substance with therapeutic properties are obtained from plants. Several important pharmaceuticals are produced from plant based substances. Some of the plant based substances developed into valuable drugs are (*i*) **Morphine**, used as an analgesic is obtained from *Papaver somniferum*, (*ii*) **Quinine**, used for the treatment of malaria, is obtained from *Chinchona ledgeriana*, and (*iii*) **Taxol**, an anticancer drug is obtained from the bark of the yew tree (*Taxus baccata* and *T. brevifolia*). Most of the traditional drugs over the world are prepared from plants. About 25% of the pharmaceutical drugs are derived from a mere 120 species of plants (*Table 4.2*).

Several plant species are used for the manufacture of innumerable synthetic products. Such plant based synthetic products are called **botanochemicals**.

Table 4.2. Commonly Used Modern Drugs Derived from Plant Sources

Drug	*Plant Source*	*Use*
Atropine	Belladonna	Anticholinergic; reduces intestinal pain in diarrhoea
Bromelain	Pineapple	Controls tissue inflammation due to infection
Caffeine	Tea, Coffee	Stimulant of the central nervous system
Camphor	Camphor tree	Rubefacient; increases local blood supply
Cocaine	Cocoa	Analgesic and local anesthetic; reduces pain and prevents pain during surgery
Codeine	Opium poppy	Analgesic; reduces pain
Morphine	Opium poppy	Analgesic; controls pain
Colchicine	Autumn crocus	Anticancer agent
Digitoxin	Common foxglove	Cardiac stimulant used in heart diseases
Diosgenin	Wild yams	Source of female contraceptive; prevents pregnancy
L-Dopa	Velvet bean	Controls Parkinson's disaease, which leads to jerky movements of the hands
Ergotamine	Smut-of-rye or ergot	Control of hemorrhage and migraine headaches
Glaziovine	*Ocotea glaziovii*	Antidepressant
Gossypol	Cotton	Male contraceptive
Indicine N-oxide	*Heliotropium indicum*	Anticancer agent
Menthol	Mint	Rubefacient; increases local blood supply and reduces pain on local application
Monocrotaline	*Cotolaria sessiliflora*	Anticancer agent
Papain	Papaya	Dissolves excess protein and mucus, during digestion
Penicillin	*Penicillium* fungi	General antibiotic, kills bacteria and controls infection by various microorganisms
Quinine	Yellow cinchona	Antimalarial
Reserpine	Indian snakeroot	Reduces high blood pressure
Scopolamine	Thorn apple	Sedative
Taxol	Pacific yew	Anticancer (ovarian)
Vinblastine, Vincristine	Rosy periwinkle (*Vinca rosea*) (Sadaphali or Sadabahar)	Anticancer agent; controls cancer in children

3. **Aesthetic and Cultural Benefits.** Biodiversity also has great aesthetic value. It provides a good deal of fun and recreation. Ecotourism, bird watching, wildlife, pet keeping, gardening, etc. are some examples of aesthetic rewards of biodiversity.

Biodiversity is also related to our cultural and religious beliefs. Plants and animals are considered to be the symbols of national pride and cultural heritage. Many plants like *Ocimum sanctum* (Tulsi), *Ficus religiosa* (Pipal), *Prosopis cineraria* (Khejri), etc. are considered sacred and worshiped by the people in majority of Indian villages and towns. Several birds, animals and even snakes are considered sacred and worshipped.

4. **Ecosystem Services.** Biodiversity is essential to keep natural cycles going and make the ecosystem self sustaining unit. It is essential for the maintenance and sustainable utilization of goods and services from ecological systems as well as from individual species. Some of these services are : (*i*) maintenance of gaseous composition of the atmosphere, (*ii*) climate control by

forests and oceanic systems, (*iii*) natural pest control, (*iv*) formation and protection of soil, (*v*) conservation and purification of water, and (*vi*) nutrient cycling, etc. It is estimated that the value of ecosystem services is in the range of 16 to 54 trillion (10^{12}) US dollars per year.

5. **Unknown Benefits.** It is unpredictable that which species may become useful in future. If *Penicillium* and cinchona tree of Peru had become extinct before the **penicillin** (antibiotic) and **quinine** were discovered from them, man would have continued to suffer from malaria and severe infections. Similar is true for other plant and animal species.

THREATS TO BIODIVERSITY

Human activities are the major threat to biodiversity. The important factors leading to extinction of species and consequent loss of biodiversity are described below :

1. **Destruction of Habitats.** Destruction of natural habitat is the primary threat to the biodiversity. Natural habitats, which protect natural flora and fauna are being converted to human settlements (*Fig. 4.7*), harbours, dams, reservoirs, crop-lands, grazing grounds and mining sites. Deforestation deprive animal life of shelter and food. This decreases the population of many species. Deforestation declines reproductive capacity of certain wild animals due to reduction of the area of their free movement. Migratory animals are also affected by deforestation because of the disturbance in their routes. Some of the dams are blocking, spawning and migration of fishes by inundating the habitats and by changing the physical environment. Sometimes human cleanliness destroy the habitat of scavengers such as vultures, kites etc. The carcasses of livestock which form their food used to be left in the open in the past, are now burried or burnt in certain countries. The **california condor** (*Cathartes californianus*) a shy scavanger, which is the largest flying bird of today, has been severely affected by human cleanliness.

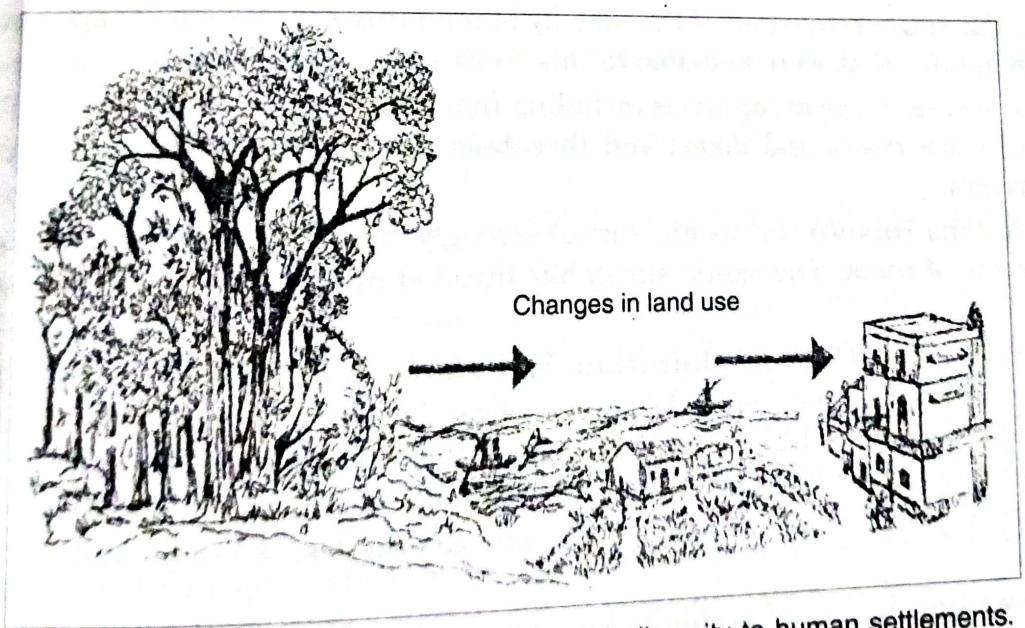


Fig. 4.7. Destruction of natural habitat of biodiversity to human settlements.

2. **Habitat Fragmentation.** Habitats that formerly occupied wide areas are now often divided up into pieces by roads, fields, towns, canals, powerlines etc. Habitat fragmentation is the process where a large, continuous area of habitat is divided into two or more fragments. It may limit the dispersal and colonisation potential of species and also reduces the foraging ability of animals.

3. **Disturbance and Pollution.** Natural as well as man-made disturbances such as fire, tree fall, defoliation by insects, etc. effect communities adversely. Man-made disturbances differ from natural disturbances in intensity, rate and spatial extent. For example, frequent fires may change species of richness of a community. Massive use of synthetic compounds, vast release of radiations and spillover of oil in sea lead to a change in habitat quality.

The most subtle form of habitat degradation is environmental pollution. Pollution may reduce and eliminate populations of sensitive species. The populations of fish eating birds and falcons have declined due to excessive use of pesticides in crop fields. Lead poisoning is another major cause of mortality of many aquatic birds like ducks, swans and cranes. These birds often swallow the spent shotgun pellets that fall into lakes and marshes. The nutrient enrichments (eutrophication) also drastically reduce biodiversity.

4. **Introduction of Exotic Species.** New species entering a geographical region are called **exotic** or **alien species.** Introduction of exotic species may cause significant loss to the biological communities. The great majority of the exotic species do not become established in the introduced new places. However, some of the species are able to establish in new areas. Such successful exotic species may kill or eat native species to the point of extinction, or may so alter the habitat that many natives are no longer able to persist. In the process, the purposely or accidentally introduced organisms (some notorious examples being *Eupatorium*, *Lantana*, *Eichhornia* or water Hyacinth, *Parthenium* or congress or carrot grass) have led to the extinction of many local species as well as adversely affected human health. Disease causing microorganisms, if introduced to new virgin areas may cause epidemics and native species are eliminated completely. The effect of exotic species is maximum on island ecosystems, which harbour much of the world's threatened biodiversity. A few examples of introduction of exotic species and their effects are given below:

(i) Introduction of **Nile perch** (an exotic predatory fish) into lake Victoria (South Africa) threatened the entire ecosystem of the lake by eliminating several native species of the small Cichlid fish species that were endemic to this fresh water ecosystem.

(ii) In several tropical countries including India, **water hyacinth** (A free floating exotic water weed) clogs rivers and lakes, and threatens the survival of many aquatic species in lakes and rivers.

(iii) Lantana camara (an exotic shrub) strongly competes with the native species and eliminate many of them. The exotic shrub has invaded many forests in different parts of our country.

5. **Hunting and Over Exploitation.** Man started hunting wild animals for food, safety and pleasure, since his appearance. Disappearance of **dodo** (*Oidus imeptus*), a unique bird of Mauritius and of Cheetah (*Acinomyx jubatus*) the fastest mammal of India is mainly due to excessive hunting (*Fig. 4.8*). Over fishing is seriously depleting the marine and fresh water living resources. Many species of fishes, molluscs, sea turtles, sea cows and whales are facing extinction.

6. **Poaching.** Killing of prohibited wild animals for illegal trading of wildlife products is called poaching. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, horns, tusks, live specimens and herbal products worth millions of rupees per year is still going on. Poachers make huge money through smuggling wildlife products to other countries mediated through mafia. Poaching is a serious threat to wildlife.

Dodo

Cheetah

Fig. 4.8. Two extinct animal species due to hunting.

7. Other Causes. The use of a wide range of animal and plant products for pharmaceuticals, perfumes, cosmetics, aphrodiasias and decoration souvenirs and specimens for museum are some other dangers for wildlife.

MAN-WILDLIFE CONFLICTS

Many times wildlife cause a lot of damage and danger to man, thus creating conflicting situations between man and animal. Reports of man-animal conflicts from different parts of our country often appear in newspapers. During the last 5 years, wild elephants killed at least 195 people in Sambalpur district, Orissa. In retaliation, the local people killed 98 elephants and badly injured 30 elephants either by electrocution or hiding explosives in their fields. Instances of man-elephant conflict have been reported recently from the adjoining areas of forests in Karnataka because of the massive damage caused by elephants to the farmer's crops. Such conflicting situations are often reported from the border regions of Corbett, Dudhwa, Palamu and Ranthambore National Parks in our country.

Causes of Man-Animal Conflicts. The main causes of man-animal conflicts are as follows :

1. Destruction of habitats of wild animals compels them to move outside the forest and attack the fields and sometimes even humans.

2. Conflicts between man and the wildlife arise when, man encroaches into the forest areas, because it is an issue of survival of both.

3. When a wild animal gets injured or becomes weak, it develops a tendency to attack man. The females of many wild animals often attack humans, when they feel that their newborns are in danger. A tiger/tigress becomes man-eater, if she tastes human flesh once. In the process of tracing and killing such animal many innocent tigers/tigresses may be killed.

4. When there is a shortage of staple food for wild animals in wildlife sanctuaries and national parks, the animals move out of the sanctuaries and national parks in search of food and cause massive damage in the crop fields of surrounding areas. The farmers gets revengeful and kill the wild animals.

5. When there is a disruption in migratory routes of wild animals due to development of human settlements, the migratory animals attack these settlements.

6. Often, the government does not pay sufficient compensation for the damage caused by the wild animals to the farmer's crop. The agonised farmers start killing the wild animals.

Measures to Curb the Conflict

1. Adequate fodder, food and water should be made available for the wild animals within the forest zones so that animals may not come out of forests in search of food or water.

2. Near the forest borders, farmers should change the cropping pattern. They should cultivate the crops which are not liked by the wild animals.

3. To prevent the wild animals from straying into fields, solar powered fencing should be provided along with electric proof trenches.

4. Wildlife corridors should be provided for the migratory animals during unfavourable periods.

5. The forest guards should be made equipped with vehicles, binoculars, radio sets, tranquillizer guns etc., to tactfully deal with any emergency situation.

6. The government should make provisions for the adequate compensation to the farmers for the crops damaged by the wild animals.

Case Studies

1. **Kailadevi Wildlife Sanctuary, Sawai Madhopur, Rajasthan.** In most Protected Areas (PAs) across the country, the conservation efforts are associated with conflicts between villagers and forest officials. The Kailadevi Wildlife Sanctuary in Rajasthan has involved local community initiatives for conservation and regeneration. The sanctuary was initiated in 1983, over 674 sq. km, forming a part of the 1334 sq. km Ranthambore Tiger Reserve. It is located within the Karauli and Sapotra blocks of the Sawai Madhopur district.

The inhabitants in the adjoining area belong to Meena and Gujjar communities whose primary occupation in pastoralism and subsistence agriculture. There was great pressure from migrant grazers, Rabaris, who came from the Mewar region of Rajasthan with large herds of sheeps. Other pressures were from exploitation of timber and fuel wood and mining. The threat poised by the migrant grazers spurred the formation of the **'Baragaon ki Panchayat'** in 1990, which in turn initiated a **'Bhed Bhagao Andolan'**. The Forest Department supported the villagers in the formation of **Forest Protection Committees** (FPCs) and **Van Suraksha Samitis** (VSSs). The benefits involving local people in protection of their resources were obvious. Illegal felling was stopped. The use of forest resources for local use was monitored. The FPCs were also successful in stopping the mining in the sanctuary. Mining is now banned in the sanctuary. The people not only protect their forests but also use their resources judiciously.

2. **Kokkare Bellure, Karnataka: Man and wildlife Co-existence.** Kokkare-Bellure is a village in Karnataka in Southern India. The pelican, which is an endangered species breeds in large numbers at Kokkare-Billure, which is one of the ten known breeding sites in India. In December every year, hundreds of spot billed pelicans, painted storks, ibis and other birds migrate to this area to establish breeding colonies on the tall tamarind trees in the centre of the village. The local people have protected birds, believing that they bring good luck with regard to rain and crops. The villagers collect a rich supply of the natural fertilizer that collects below the nests, the **guano.** The droppings of these fish eating birds are rich in nitrates.

The owners of the trees inhabited by the birds dig deep pits under the trees, into which the guano falls. Silt from nearby lakes and ponds are mixed with the guano, which is used in their fields and sold as fertilizer. They have now planted trees around their homes to encourage nesting.

Extinction of Species

The most serious aspect of the loss of biodiversity is the extinction of species. Once a species is eliminated, the unique information contained in its DNA and the special contribution of characters that it possesses are unlikely to be repeated again. Once a species goes extinct, its chances for further evolution are lost. A species is considered **extinct**, when no member of the species remains alive anywhere in the world. If individuals of a species remain alive only in captivity or other human-controlled conditions, the species is said to be **extinct in the wild**. In both of these situations, the species would be considered **globally extinct**.

A species is considered to be **ecologically extinct**, if it persists at such reduced numbers in the wild that their impact on prey population is insignificant.

Extinction is a natural process. Species have disappeared and new ones have evolved to take their place over the long geological history of the earth. Species become extinct through three types of extinction processes.

1. **Natural Extinction.** It is the extinction of species slowly from the earth due to change in environmental conditions. Some species disappear and the others which are more adapted to changed conditions, take their places. Many species have lost in the geological past by natural extinction. The extinction of species in the geological past is also called **background extinction**.

2. **Mass Extinction.** It refers to the extinction of large number of species due to catastrophe. There have been several periods in the earth's geological history, when large number of species became extinct because of catastrophes. Mass extinction occurred in millions of years.

3. **Anthropogenic Extinction.** It refers to disappearance of species from the face of earth due to human activities. The man-made mass extinction represents a very severe depletion of biodiversity, as it is occurring within a short period of time.

According to the World Conservation Monitoring Centre (WCMC), 533 animal (mostly vertebrates) and 384 plant species (mostly flowering plants) have become extinct since the year 1600. The islands have registered extinction of more species than from the mainlands and the oceans. The present rate of extinction is 1000 to 10,000 times higher than the background extinction. Some interesting observations about the current loss of species are given below :

(*i*) The ten high diversity localities in tropical forests, which covers 30,00,000 km^2 may loss about 17,000 endemic plant species and 3,50,000 endemic animal species in near future.

(*ii*) The tropical forests alone are losing roughly 14000–40000 species per year (or 2–5 species per hour).

(*iii*) If the current rate of loss continues, the earth may lose upto 50% of the species by the end of 21st century.

Susceptibility of Extinction

All species are not equally susceptible to extinction. The characteristics which make a species susceptible to extinction are listed below :

(*i*) Large body size *e.g.* Bengal tiger, lion and elephant.

(*ii*) Small population size and low reproductive rate *e.g.* Blue whale and Giant Panda.

(*iii*) Feeding at high tropic levels in the food chain *e.g.* Bengal tiger and Bald eagle.

(*iv*) Fixed migratory routes and habit. *e.g.* Blue whale and whooping crane.

(*v*) Localized and narrow range of distribution. *e.g.* Woodland caribou and Island species.

The IUCN Red List Categories

The International Union for Conservation of Nature and Natural Resources (IUCN), has published the IUCN Red List of threatened species. The IUCN Red List is a catalogue of taxa that are facing the risk of extinction. It aims to impart information about the urgency and scale of conservation problems to the public and policy makers. The main objectives of Red lists are listed below :

(*i*) Identification and documentation of endangered species.

(*ii*) Providing a global index of the decline of biodiversity.

(*iii*) Developing awareness about the importance of threatened biodiversity, and

(*iv*) Defining conservation priorities at the local level and guiding conservation action.

The World Conservation Union, formerly known as International Union for the Conservation of Nature and Natural Resources (IUCN), has recognized Light Red List categories of species according to the degree to which they face the threat of extinction. These are : Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient and Not Evaluated.

The species which are **threatened with extinction** are included in Vulnerable, Endangered or Critically Endangered Category. The species with small populations in the world that are not at present endangered or vulnerable but are at risk, are called **rare.** The rare species are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range. The various IUCN red list categories with definitions are given in *Table 4.3.*

Table 4.3. Various Categories of IUCN Red List Species

S. No.	*Red List Category*	*Definition*
1.	**Extinct**	A taxon is Extinct when there is no reasonable doubt that the last individual has died.
2.	**Extinct in the wild**	A taxon is Extinct in the wild when exhaustive surveys in known and/or expected habitats, have failed to record an individual.
3.	**Critically endangered**	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
4.	**Endangered**	A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
5.	**Vulnerable**	A taxon is Vulnerable when it is not Critically Endangered or Endangered, but is facing a high risk of extinction in the wild in the medium-term future.
6.	**Lower risk**	A taxon is Lower Risk when it has been evaluated and does not satisfy the criteria for Critically Endangered, Endangered, or Vulnerable.
7.	**Data deficient**	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.
8.	**Not evaluated**	A taxon is Not Evaluated when it has not yet been assessed.

The evaluation of the conservation status of species and sub-species was initiated by IUCN in 1963. The organization is compiling the **Red Data Books** or the **Red Lists** that provide uptodate information about the species that are threatened. The Red List also provide information to international agreements such as the Convention on Biological Diversity and the convention on International Trade in Endangered species of Wild Flora and Fauna. The **2000 IUCN Red List** is the most comprehensive inventory of the global conservation status of plants and animal species. To evaluate the extinction risk of species and sub-species, IUCN uses a set of criteria relevant to all species and all regions of the world. Presently, the 2000 Red List contains assessment of more than 18,000 species, out of which 11,000 species are threatened.

Status of Threatened Species. The 2000 Red List contains 11,046 species (5,611 plants and 5,485 animals) under threatened category (*i.e.* Critically Endangered, Endangered or Vulnerable). Out of these, 1939 species (1,014 plants and 925 animals) have been assessed as Critically Endangered. The percentage of some major groups of organisms evaluated as Critically Endangered, Endangered, Vulnerable and at Lower Risk are depicted in (*Fig. 4.8*) out of the evaluated species, 9–16 per cent species are critically endangered, 17–22 per cent are endangered and 34–51 per cent are vulnerable.

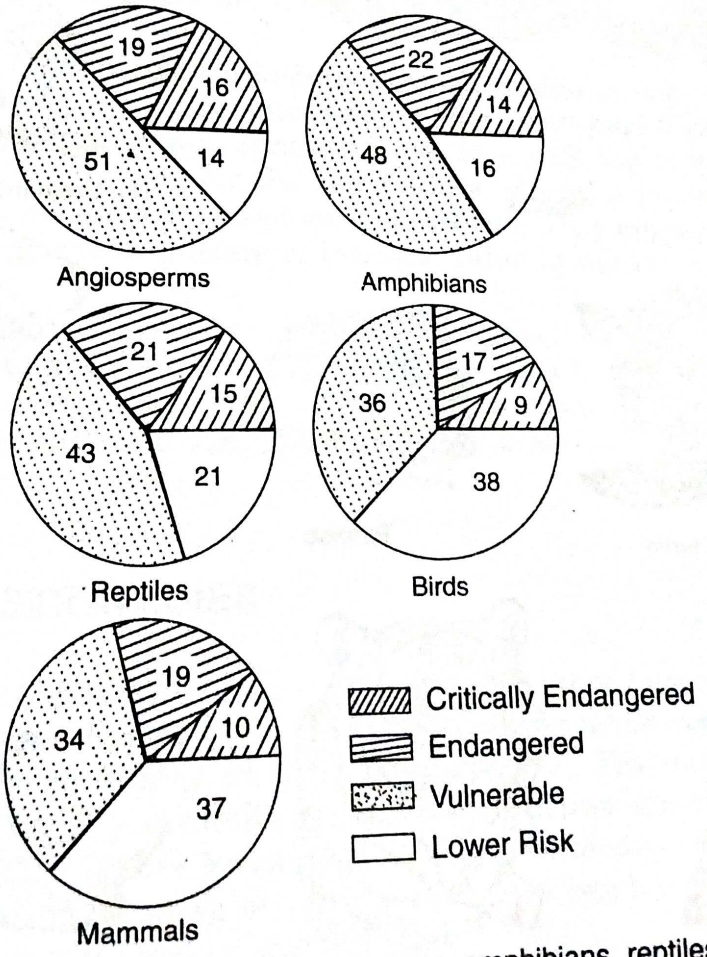


Fig. 4.9. The percentage of threatened angiosperms, amphibians, reptiles, birds and mammals categorised as Critically Endangered, Endangered. Vulnerable and at Lower Risk.

Several species of plants and animals have been evaluated under threatened category in India. These species have been included in the Red List. Amongst plants, 44 species are critically endangered, 113 endangered and 87 vulnerable. While amongst animals, 18 species are critically endangered, 54 endangered and 143 vulnerable (*Fig. 4.10*).

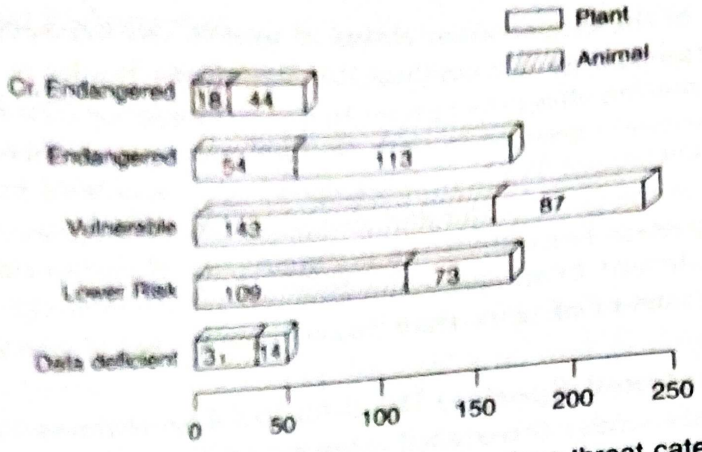


Fig. 4.10. The number of plant and animal species of various threat categories in India.

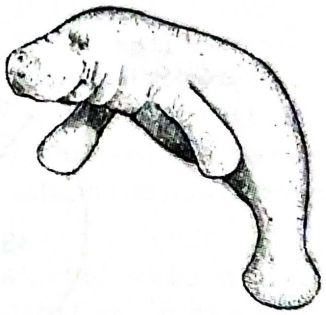
A few examples of endangered animals (*Fig. 4.11*) and plants are given in *Table* 4.4.

Peacock

The Great Indian Bustard

Green sea turtle

Tortoise



Dugong

Red panda

Tiger

Rhinoceros

Fig. 4.11. Some endangered species of animals.

Table 4.4. A few Examples of Endangered Animals and Plants

S. No.	Animal/Plant	Examples
1.	**Reptiles**	Phyton, Gharial, Tortoise, Green sea turtle.
2.	**Birds**	Great Indian bustard, Pelican, Great Indian Hornbill, Peacock, Siberian white crane, Spotted owl.
3.	**Carnivorous Mammals**	Indian wolf, Red panda, Sloth bear, Tiger, Leopard, Indian lion, Striped hyena, Red fox, Golden cat, Desert cat, Dugong.
4.	**Primates**	Hoolock gibbon, Lion tailed macaque, Nilgiri langur, Capped monkey, Golden monkey.
5.	**Other Mammals**	Black rhinoceros, Black buck (*Antilope cervicapra*)
6.	**Plants**	Many species of Orchids, Rhododendrons, Sarpagandha (*Rauwolfia serpentina*), Sandal wood tree (*Santalum album*) Sago palm (*Cycas beddomei*), Pitcher plant (*Nepenthes Khasiana*).

CONSERVATION OF BIODIVERSITY

Almost all the ecosystems are undergoing change due to pollution, invasive species, over exploitation by humans, and climate change. As a result biodiversity is being destroyed at all the levels. Besides, economic arguments put to justify the protection of biodiversity, there are also ethical arguments for the same. These ethical arguments have roots in the value systems of most religious philosophies and cultures. They appeal to, a respect for life, a reverence for the living world, a sense of intrinsic value in nature, and a concept of divine creation.

It is our moral duty to look after our planet and pass it on in a good health to our future generations. We should not deprive the future generations from the economic and aesthetic benefits that they can derive from biodiversity. The decisions we make now, as individuals and as a society, will determine the diversity of genes, species and ecosystems that remain in future.

CONSERVATION STRATEGIES

Conservation of biodiversity means '*the management of human use of the biosphere so that it may give maximum benefit to the present generation while maintaining its potential to meet the needs and aspirations of the future generations*'. The most effective and efficient mechanism for conserving biodiversity is to prevent further destruction or degradation of habitats by us. We require more knowledge to conserve biodiversity in reduced space and under increased pressure of human activities. There are two basic strategies of biodiversity conservation : *in situ* (on site) and *ex situ* (off site).

In Situ Conservation Strategies

It refers to the conservation of biological diversity in their natural habitats through protection of total ecosystem. The *in situ* approach includes protection of a group of typical ecosystems through a network of protected areas. The areas which provide protection to the biological diversity include : Protected areas, Biosphere reserves, Sacred forests and Sacred lakes.

1. **Protected Areas.** These are areas of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources. The protected areas are managed through legal or other effective means. There are several areas throughout the world which protect rare species or wilderness. **National Parks** and **Wildlife Sanctuaries** are the examples of protected areas. The World Conservation Monitoring Centre (WCMC) has recognised 37,000 protected areas around the world. As of September 2002, India has 581 protected areas (89 National Parks and 492 Wildlife Sanctuaries). These areas cover 4.7 per cent of the land surface as against 10 per cent internationally suggested norm. The protected areas provide following benefits.

(*i*) Maintain viable populations of all native species and sub-species ;

(*ii*) Maintain the number and distribution of communities and habitats, and conserve the genetic diversity of all the present species ;

(*iii*) Prevent man-made introduction of alien species ; and

(*iv*) Make it possible for species/habitats to shift in response to environmental changes.

(*a*) ***National Parks.*** A National Park is an area which is strictly reserved for the welfare of wildlife and where activities such as forestry, grazing or cultivation are not allowed. Private ownership right and habitat manipulation are not permitted in a National Park. The earliest National Parks, the **Yellowstone** in USA and the **Royal** near Sydney, Australia, were chosen because of their scenic beauty and recreational values. The **Jim Corbett National Park** near Nainital, was the first National Park established in India. At present, there are 89 National Parks in our country. Some important National Parks of India are given in *Table* 4.5 and (*Fig.* 4.12).

Table 4.5. Some Important National Parks of India

Name and Location	*Area in sq. km*	*Important Animals Found*
1. Kaziranga National Park District Sibsagar (Assam)	430	Rhinoceros, elephant, wild buffalo, bison, tiger, leopard, sloth bear, sambhar, swamp deer, barking deer, wild boar, gibbon, python and birds like pelican, stork and ring tailed fishing eagles. This is a famous national park famous for one-horned rhinoceros of India.
2. Sundarban (Tiger Reserve), 24-Pargana (West Bengal)	2,585	Tiger, wild boar, deer, gangetic dolphin, eustuarine crocodile.
3. Hazaribagh National Park, Hazaribagh (Jharkhand)	186	Tiger, leopard, hyaena, wild boar, gaur, sambhar, nilgai, chital, sloth bear, peafowl.
4. Corbett National Park District Nainital (Uttranchal)	525	Tiger, elephant, panther, sloth bear, wild boar, nilgai, sambhar, chital, crocodile, python, king cobra, peafowl, partridge. This is the first national park of India which is famous for tigers.

5. Gir National Park, District Junagarh (Gujarat)	1,412	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. Kanha National Park, Mandla and Balaghat (Madhya Pradesh)	940	Tiger, panther, chital, chinkara, barking dear, blue bull, four horned deer, langur, wild boar, black buck, nilgai, wild dog, sloth bear, sambhar, crocodile, grey horn bill, egret peafowl.
7. Tandoba National Park, Chandrapur (Maharashtra)	116	Tiger, sambhar, sloth bear, bison, chital, chinkara, barking deer, blue bull, four horned deer, langur, peafowl, crocodile.
8. Bandipur National Park District Mysore (Karnataka)	874	Elephant, tiger, leopard, sloth bear, wild dog, chital, panther, barking deer, langur, procupine, gaur, sambhar, malabar squirral, green pigeon.
9. Desert National Park Jaisalmer (Rajasthan)	3,000	Great Indian bustard, black buck, chinkara.

Fig. 4.12. Diagram showing the location of some important National Parks and sanctuaries in India.

(*b*) **Sanctuaries.** A sanctuary is an area, which is reserved for the conservation of animals only. Operations such as harvesting of timber, collection of minor forest products and private ownership rights are allowed provided they do not affect the animals adversely. At present, there are 492 wildlife sanctuaries in our country. Some important wildlife sanctuaries of India are given in *Table 4.6*.

Table 4.6. Some Important Sanctuaries of India

S. No.	Name and Location	Area in sq km	Important Animals Found
1.	Annamalai Sanctuary, Coimbatore (Tamil Nadu)	958	Elephant, tiger, panther, gaur, sambhar, spotted deer, sloth bear, wild dog, barking deer.
2.	Jaldapara Sanctuary, Madarihat (West Bengal)	1,115	Rhino, elephant, tiger, leopard, gaur, deer, sambhar, different kinds of birds.
3.	Keoladeo Ghana Bird Sanctuary, Bharatpur (Rajasthan)	29	Siberian crane, strokes, 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 birds.
4.	Sultanpur Lake Bird Sanctuary, Gurgaon (Haryana)	12	Crane, sarus, spot bill, duck, drake, green pigeon, wild boar crocodile, python.
5.	Bir Moti Bagh Wildlife Sanctuary, Patiala (Punjab)	8.3	Nilgai, wild boar, hog deer, black buck, blue, jackal, peafowl, partridge, sparrow, mynah, pigeon, dove.
6.	Shikari Devi Sanctuary, Mandi (Himachal Pradesh)	213	Black bear, snow leopard, flying fox, barking deer, musk deer, chakor partridge.
7.	Dachigam Sanctuary, Srinagar, (Jammu & Kashmir)	89	Hangul or Kashmir stag, musk deer, snow leopard, black bear, brown bear.
8.	Mudumalai Wildlife Sanctuary Nilgiri (Tamil Nadu)	520	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 Guntur Kamool and Nalgonda (Andhra Pradesh)	3,568	Tiger, panther, wild bear, chital, nilgai, sambhar, black buck, fox, jackal, wolf, crocodile.
10.	Periyar Sanctuary, (Kerala)	777	Elephants, gaur, leopard, sloth bear, sambhar, bison, black langur, hornbill, egret. It is famous for elephants.
11.	Chilka Lake Bird Sanctuary, Balagaon (Orissa)	990	Water fowls, ducks, cranes, ospreys, 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.

2 **Biosphere Reserves.** The man and Biosphere (MAB) programme of UNESCO formulated the concept of Biosphere Reserves in 1975, which deals with the conservation of ecosystems and the genetic resources contained therein. *'The Biosphere Reserves are a special category of protected areas of land/or coastal environments, wherein people are an integral component of the system'.* These are representative examples of natural biomes

and contain unique biological communities. At present, there are 13 Biosphere Reserves in India (*Fig. 4.13*).

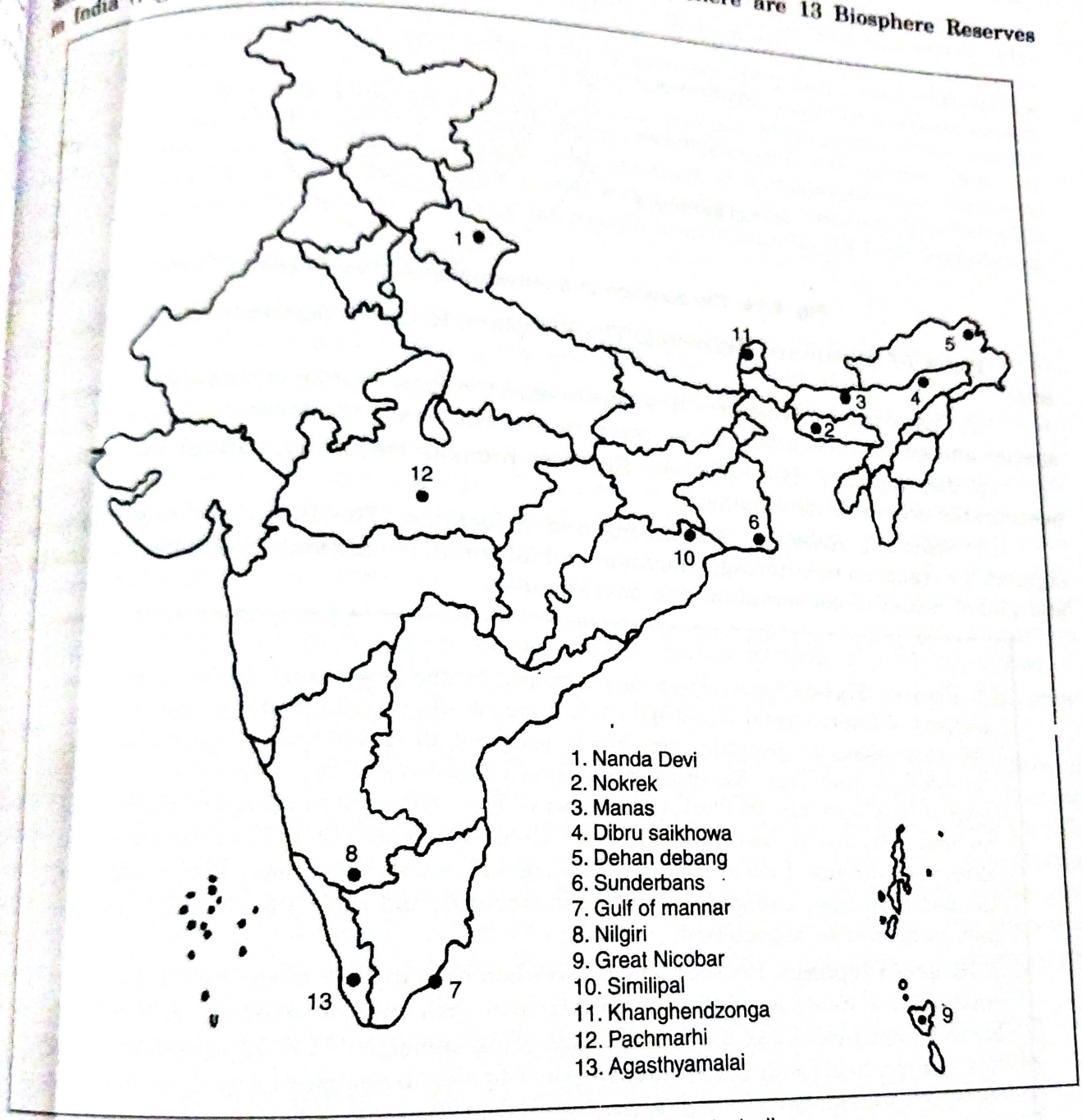


Fig. 4.13. The Biosphere Reserves in India.

A Biosphere Reserve consists of three zones—Core, buffer and transition zones (*Fig. 4.14 on next page*).

(*i*) ***Core or Natural Zone.*** It comprises an undisturbed and legally protected ecosystem.

(*ii*) ***Buffer Zone.*** It surrounds the core area, and is managed to accommodate a greater variety of resource use strategies, and research and educational activities.

(*iii*) ***Transitional Zone.*** It is the outer most part of the Biosphere Reserve. It serves as an area of active cooperation between reserve management and the local people, wherein activities like settlements, cropping, forestry and recreation and other econonic uses continue in harmony with conservation goals.

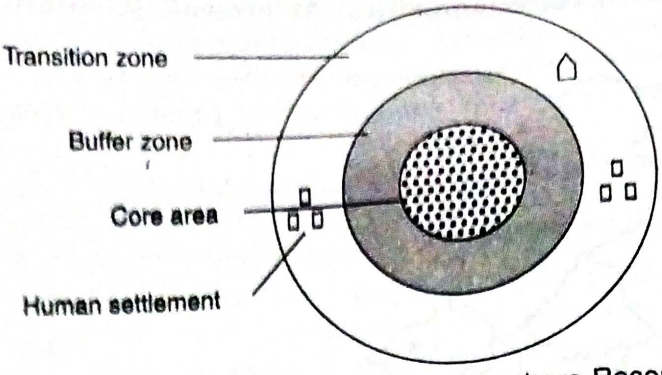


Fig. 4.14. The zonation in a terrestrial Biosphere Reserve.

Roles of Biosphere Reserves. The Biosphere Reserves perform following three main roles :

(*i*) *Conservation.* Biosphere Reserves ensure the conservation of landscapes, ecosystems species and genetic resources. These reserves also encourage the traditional resource use.

(*ii*) *Development.* The Biosphere Reserves promote culturally, socially and ecologically sustainable economic development.

(*iii*) *Scientific Research, Monitoring and Education.* The Biosphere Reserves provide support for research monitoring, education and information exchange related to local, national and global issues of conservation and development.

Case Study

1. **Project Tiger.** Project Tiger was launched by the government of India with the support of International World Wild Life Fund (WWF) in 1973, and was the first such initiative aimed at protecting this key species and all its habitats. Project Tiger was initiated in nine Tiger Reserves in different ecosystems of the country, covering an area of 16,339 sq. km. By 2001, the number of Tiger Reserves increased to 27, covering an area of 37,761 sq. km. The tiger count climbed from 268 in 1972 in the nine Tiger Reserves to around 1500 in 1977 in the 23 Tiger Reserves. The Project Tiger recognized the fact that tigers cannot be protected in isolation, and that to protect the tiger, its habitat needed to be protected.

2. **Project Elephant.** Project Elephant was launched in 1992 to ensure the long term survival of a viable population of elephants in their natural habitats in North and North-Eastern India and South India. It is being implemented in 12 States. Inspite of this, our elephant herds are at threat as their habitat is shrinking and their migration routes are disrupted by human activities.

3. **Crocodile Conservation.** Crocodiles have been threatened as their skin is used for making leather articles. This led to the near extinction of crocodiles in the wild in the 1990s in India. A Crocodile Breeding and Conservation Programme was initiated in 1975 to protect the remaining population of crocodiles in their natural habitat and by creating breeding centres. It is perhaps one of the most successful *ex situ* conservation breeding projects in the country.

Crocodiles have been extensively bred in over 30 captive breeding centres, zoos and other sites where successful breeding takes place. Thousands of crocodiles have been bred and restocked in 20 natural water-bodies.

3. **Sacred forests and scared lakes.** There has been traditional practice in India and some other Asian countries to maintain sacred forests and lakes to protect biodiversity. The sacred forests are protected by the tribal communities due to religious sanctity accorded to these forests. The sacred forests represent islands of **pristine forests** *i.e.* most undisturbed forests without any human impact. These forests have been free from all disturbances, though these are frequently surrounded by highly degraded landscapes. Many states in our country such as Karnataka, Maharashtra, Kerala, Meghalaya, etc. possess sacred forests. These are serving as protective centres for a number of rare, endangered and endemic taxa. Similarly, aquatic flora and fauna is also protected in sacred water bodies. For instance **Khecheopalri lake** in Sikkim has been declared sacred by the people to save aquatic life from degradation.

Ex Situ Conservation Strategies

It refers to the conservation of biodiversity at places away from their natural habitat. For *ex situ* conservation of biodiversity, **germ plasm banks** or **gene banks** are established. These include botanical gardens, zoos, genetic resource centres, pollen grains, seed, seedling, tissue culture and DNA banks.

Seed gene banks are the easiest way to store germplasm of wild and cultivated plants at low temperature in cold rooms. Storage of germplasm at ultra low temperature (*i.e.* at a temperature of – 196°C in liquid nitrogen) is called **cryopreservation.** The cryopreservation is particularly useful for conserving seeds, vegetatively propagated parts, tissue culture, etc. The storage of materials at ultra low temperature by very rapid cooling is used for storing seeds and by gradual cooling and simultaneously dehydration is used for vegetative propagules and tissue culture. By cryopreservation germplasm can be stored for a long period of time.

Field gene banks are other ways of preservation of genetic resources. These field gene banks preserve genetic resources under normal growing conditions.

Botanical gardens and zoos are the most common places for the conservation of biodiversity. All over the world, there are more than 1500 botanical gardens and arboreta which contains more than 80,000 species of plants. Arboreta are botanical gardens where specific tree and shrub species are cultivated. Many of these botanical gardens have seed banks, tissue culture facilities and other *ex situ* technologies. Similarly, there are more than 800 zoos around the world. These zoos are professionally managed and are harboured by about 3000 species of mammals, birds, reptiles and amphibians. Well developed captive breeding programmes are carried out in many of these zoos.

Case Study

Beej Bachao Andolan (*Save the Seeds Movement*). This movement began in the Himalayan foothills. The members have collected seeds of diverse crops in Garhwal. The movement has successfully conserved hundreds of local rice varieties, rajma (kidney beams), pulses, millets, vegetables, spices and herbs. Many different varieties are being grown as an outcome of this programme in local farmer's fields. This has also been supported by local women's groups who felt these varieties were better than those provided by the green revolution. In contrast, men who were interested in cash returns in a short time found it difficult to appreciate the benefits of growing indigenous varieties.

Significance of Conservation of Biodiversity. The main significance of conservation of biodiversity are given below :

(*i*) The conservation of wild relatives of crop plants and the off site conservation of crop varieties or cultures of microorganisms provides breeders and genetic engineers with a ready source of genetic material.

(*ii*) Plants and animals conserved in botanical gardens, arboreta, zoos and aquaria can be used to restore degraded land, reintroduce species into wild, and restock depleted populations.

HOT SPOTS OF BIODIVERSITY

The distribution of biodiversity is not uniform across the geographical regions of the earth. Certain regions of the world harbour very large number of species. These regions are called **megadiversity zone.** Twelve countries has been identified as **megadiversity countries,** which contain 60–70 percent of the world's biodiversity. India is one of the megadiversity country, which contributes approximately 8 per cent species to the global diversity, but accounts for only 2.4 per cent of the land area of the world.

To designate priority areas for *in situ* conservation, **Norman Myers** developed the **'hot spots'** concept in 1988. *'The hot spots are the richest and the most threatened reservoirs of plant and animal life on earth'.* The main criteria for determining a hot spot are :

(*i*) Number of endemic species *i.e.* the species which are found nowhere else, and

(*ii*) Degree of threat which is measured in terms of habitat loss.

Over the world 25 terrestrial hot spots have been identified for the conservation of biodiversity (*Fig. 4.15*). Out of these 15 hot spots have tropical forests, 5 occur in Mediterranian-type zones and 9 hot spots are present in tropics. The hot spots together occupy 1.4 per cent of the earth's land area. About 20 per cent of the human population lives in the hot spots.

Hot spots in India. Out of the 25 hot spots of the world, two are found in India. These are Western Ghats and Eastern Himalayas, and these extend to the neighboring countries also. These areas show high degree of endemism and are inhabited by a wide variety of flowering plants, swallow tailed butterflies, amphibians, reptiles and mammals.

(*i*) **Western Ghats.** It lies parallel to the Western Coast of Indian peninsula for almost 1600 km, spread over in Maharashtra, Karnataka, Tamil Nadu and Kerala. The evergreen forests are found at low elevation (*i.e.* 500 m above mean sea level), whereas semi-evergreen forests occur at 500–1500 m height. The two main centres of biological diversity are : (*i*) the Agastryamalai hills and Silent valley and (*ii*) the new Amambalam Reserve.

(*ii*) **Eastern Himalaya.** It extend to the north eastern India and Bhutan. Many deep and semi isolated valleys are found in this region. These valleys are exceptionally rich in endemic plant species. There occur temperate forests at altitudes of 1780 to 3500 m in this region. The eastern Himalaya is an active centre of evolution and exhibits a rich diversity of flowering plants. Numerous primitive angiosperm families (*e.g. Magnoliaceae* and *Winteraceae*) and primitive genera of plants like *Magnolia* and *Betula* are found in this region.

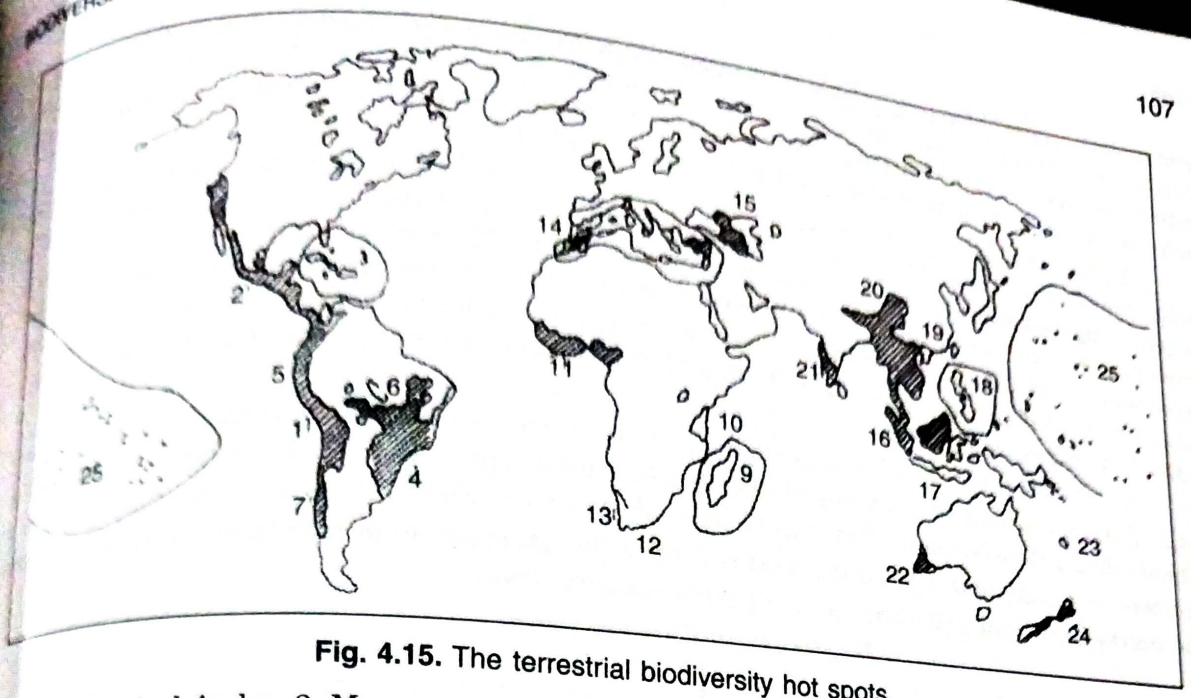


Fig. 4.15. The terrestrial biodiversity hot spots.

1. Tropical Andes, 2. Mesoamerica, 3. Caribbea, 4. Brazil's Atlantic, 5. Choco/Darien/Western Ecuador, 6. Brazil's Cerrado, 7. Central Chile, 8. California Floristic Province, 9. Madagascar, 10. Eastern Arc and Coastal Forests of Tanzania/Keyna, 11. West African Forests, 12. Cape Floristic Province. 13. Succulent Karoo, 14. Mediterranean Basin, 15. Caucasus, 16. Sundland, 17. Wallacea, 18. Phillipines, 19. Indo-Burma, 20. South-Central China, 21. Western Ghat/Sri Lanka, 22. South west Australia, 23. New Caledonia, 24. New Zealand, 25. Polynesia/Micronesia.

INTERNATIONAL EFFORTS FOR CONSERVING BIODIVERSITY

The **Earth Summit** held in June, 1992 at **Rio di Janèiro, Brazil** discussed the ways of combining increased protection of the environment with more effective economic development in less wealthy countries. The summit resulted into a convention on Biodiversity which came into force on 29 December, 1993. The convention has three key objectives :

(*i*) Conservation of biological diversity

(*ii*) Sustainable use of biodiversity

(*iii*) Fair and equitable sharing of benefits arising out of the utilization of genetic resources.

A number of projects for the conservation and appropriate development of Biosphere Reserves, are being supported by the World Conservation Union and the World Wide Fund for Nature (WWF).

BIODIVERSITY CONSERVATION OF INDIA

India is a centre of rich biological diversity and has contributed significantly to the global biodiversity. India is a homeland of 167 cultivated species and 320 wild relatives of crop plants. It is a centre of diversity of animal species (*e.g.* zebu, mithun, chicken, water buffalo, camel) ; crop plants (*e.g.* rice, sugarcane, banana, tea, millet) ; fruit plants (*e.g.* mango, jackfruit,

cucurbits) ; vegetables (*e.g.* edible *diascorea*, *alocasia*, *colocasia*) ; species and condiments (*e.g.* cardamom, black pepper, ginger, turmeric), bamboos, *brassica* and tree cotton. India also represents a secondary centre of domestication for some animals (*e.g.* horse, goat, sheep, cattle, yak and donkey) and plants (*e.g.* tobacco, potato and maize).

Different biodiversity management systems involving both *in situ* and *ex situ* conservation programmes are being carried out in India are shown in *Fig. 4.16*. The National Parks, Wildlife sanctuaries and other protected areas maintained by the Ministry of Environment and Forests provide *in situ* conservation of biodiversity. The joint forest management systems involve forest departments and local communities to enable tribal and local people to have access to non-wood forest products (such as lac, silk, honey, wax, tendu leaves, etc.) and at the same time to protect the forest resources.

A number of botanical and zoological gardens are located in different climate regions of India. They have large collections of plants and animal species to provide *ex situ* conservation of biodiversity. The National Bureau of Plants, Animal and Fish Genetic Resources is supporting a number of programmes to collect and conserve the germplasm of plants and animals in seed gene banks and field gene banks for *in vitro* conservation.

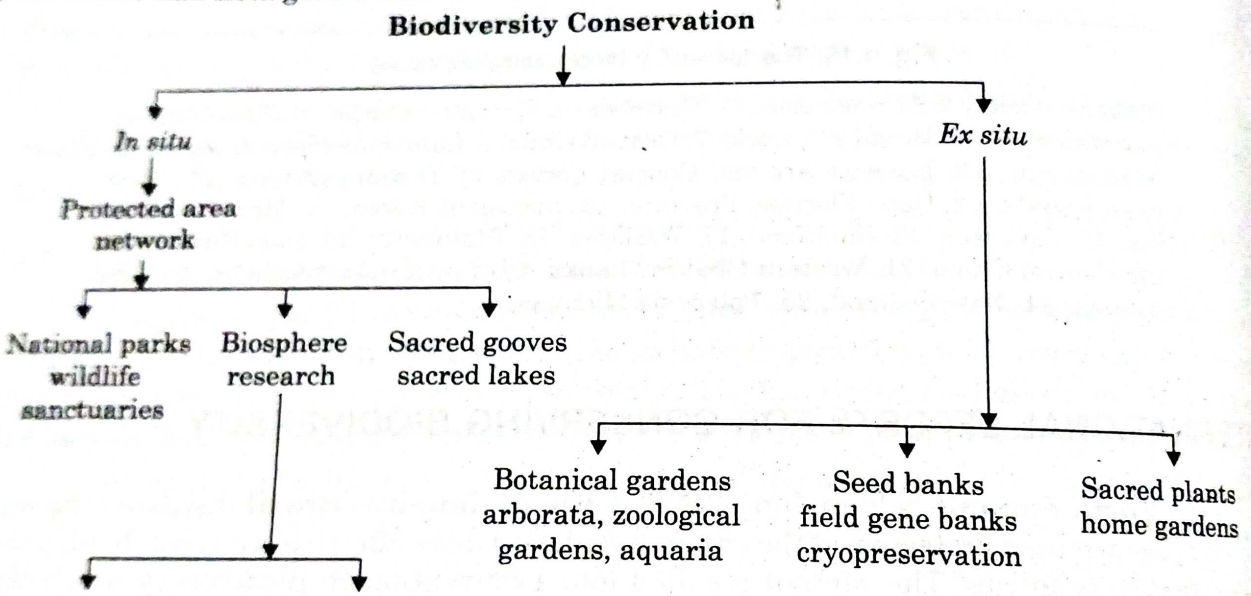


Fig. 4.16. The *in situ* and *ex situ* approaches of conserving biodiversity in India.

The tribal people working individually or with various non-governmental agencies are actively involved in conservation of land, races of diverse food and medicinal plants. The woman folk playing important role in the conservation of agrobiodiversity. The Government of India is developing a system of community registers of local informal innovations related to genetic resources as well as natural resource management in general.

IMPORTANT TERMS

1. **Alpha Diversity.** The diversity of organisms sharing the same community/habitat.
2. **Beta Diversity.** The diversity of communities along environmental gradients.
3. **Biodiversity.** The variety and variability among living organisms and ecological complexes in which they occur.

Or

The totality of genes, species and ecosystem of a region.

4. **Biosphere Reserve.** A protected area where multiple use of the land is permitted by dividing it into certain zones.

Or

A special category of protected areas of land/or coastal environments, where in people are an integral component of the system.

5. **Botanochemicals.** Derivative chemicals synthesised from plant products.
6. **Conservation.** The national management and care for the biosphere to avoid creation of imbalance resulting in the destruction of habitats and the extinction of species.
7. **Cryopreservation. Storage of living materials at ultra low temperature** (*i.e.* – 196°C in liquid nitrogen).
8. **Endemic Species. The species which are confined to a particular country.**
9. **Extinction.** The elimination of a species.
10. **Exotic Species (Alien Species).** A species introduced in a country from another country.
11. **Gamma Diversity.** The diversity of habitats over the total landscape or geographical area.
12. **Hot Spots.** The richest and the most threatened reservoirs of plant and animal life on earth.
13. **Megadiversity Zones.** The regions of the earth, which harbour a very large number of species.
14. **National Parks.** A protected area aimed at the betterment of wildlife, where human activities are not permitted.
15. **Red Data Book (Red List).** Book list containing a record of threatened species.
16. **Sanctuary.** A protected area aimed at the conservation of animals only, where certain human activities such as harvesting of timber, collection of minor forest products are permitted.
17. **Specification.** Refers to the evolution of new species.
18. **Species Richness.** The number of species per unit area.
19. **Wildlife.** The living organisms in their natural habitats other than the cultivated plants and domesticated animals.

TEST QUESTIONS

Multiple Choice Type Questions

Select the correct option to the following questions

1. If all the plants of the earth die suddenly, all the animals die due to deficiency of
   (*a*) Food (*b*) Shade
   (*c*) Oxygen (*d*) Shelter.
2. Indian bustard has become endangered species due to
   (*a*) Deforestation in Rajasthan (*b*) Spread of desert
   (*c*) Hunting (*d*) Change in climate.
3. In our country the percentage of land under forest is about
   (*a*) 20% (*b*) 19%
   (*c*) 25% (*d*) 30%.
4. The animal that has recently become extinct is
   (*a*) Dinosaur (*b*) Dodo
   (*c*) Wolly Mammonth (*d*) Archaeopteryx.
5. **The area reserved for the welfare of wildlife is called**
   (*a*) National Park (*b*) Botanical garden
   (*c*) Sanctuary (*d*) Forest.