RGPVNOTES.IN

Program : **B.Tech**

Subject Name: **Energy & Environmental Engineering**

Subject Code: **ES-301**

Semester: **3rd**

Module 3: Biodiversity and its conservation • Introduction – Definition: genetic, species and ecosystem diversity; Biogeographically classification of India; Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

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.

Biodiversity includes the genetic variability (for which different varieties of spices have appeared in the course of evolution) and diversity of life forms such as plants, animal microbes, etc. living in a wide range of ecosystems.

The diversity may be interspecific (within species) and interspecific (in between the species) but these are well supported by ecosystem. It is seen that the diverse living forms of the ecosystem are modulated with the global environmental changes.

Types of Biodiversity:

There are three interrelated hierarchical levels of biodiversity namely, genetic diversity, species diversity and community or ecosystem diversity.

1. Genetic diversity:

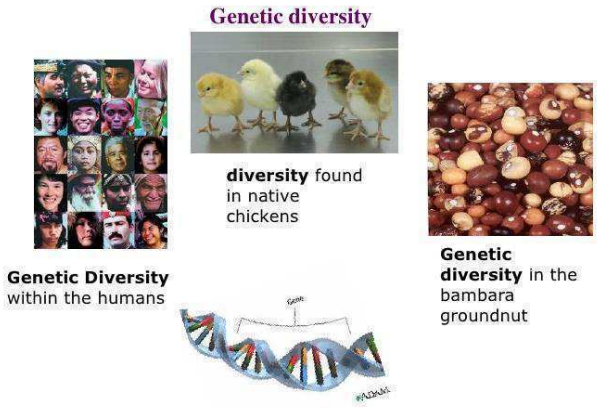
It describes the variation in the number and types of genes as well as chromosomes present in different species. The magnitude of variation in genes of a species increases with increase in size and environmental parameters of the habitat. The genetic variation arises by gene and chromosome mutation in individuals and in sexually reproducing organisms and it is spread in the population by recombination of genetic materials during cell division after sexual reproduction.

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.



2. Species diversity:

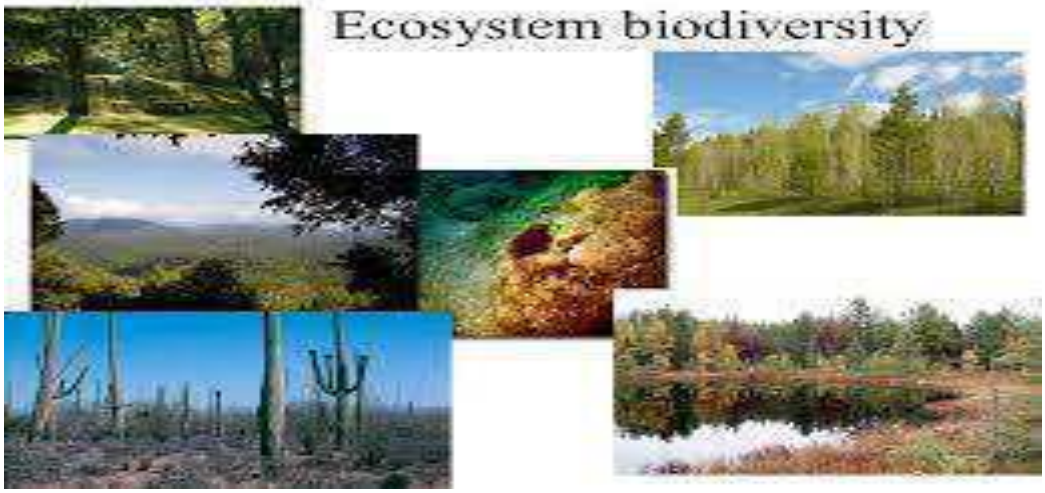
It describes the variety in the number and richness of the spices with in a region. The species richness may be defined as the number of species per unit area. The richness of a species tells about the extent of biodiversity of a site and provides a means for comparing different sites.

The species richness depends largely on climatic conditions. The number of individuals of different species with in a region represents species evenness or species equitability. The product species richness and species evenness give species diversity of a region. When a species is confined entirely to a particular area, it is termed as endemic species.

3. Ecosystem diversity:

It describes the assemblage and Interaction of spices living together and the physical environment a given area. It relates varieties of habitats, biotic communities ecological processes in biosphere. It also tells about the diversity within the ecosystem. It is referred as Land escape diversity because it includes placement and size of various ecosystems.

For example, the landscapes like grass lands, deserts, mountains etc. show ecosystem diversity. The ecosystem diversity is due to diversity of niches, trophic levels and ecological processes like nutrient cycling, food webs, energy flow, role of dominant species and various related biotic interactions. Such type of diversity can generate more productive and stable ecosystems or communities capable of tolerating various types of stresses e.g. drought, flood etc.



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.

Biogeographically classification of India

Biogeographic classification of India is the division of India according to biogeography characteristics. Biogeography is the study of the distribution of species (biology), organisms, and ecosystems in geographic space and through geological time. There are ten biogeographic zones in India.
(i) Trans Himalayas,
(ii) Gangetic plain,
(iii) Desert,
(iv) Semiarid zone;
(v) Western Ghats;
(vi) Deccan peninsula,
(vii) North eastern zone,
(viii) Coastal lands
(ix) Himalayas,
(x) Islands.

Trans Himalayas

The Himalayan ranges immediately north of the Great Himalayan range are called the Trans-Himalayas. The Trans-Himalayan region with its sparse vegetation has the richest wild sheep

and goat community in the world. The snow leopard is found here, as is the migratory black-necked crane.

Himalayas

Bio-geographical representation of himalayas.

The Himalayas consist of the youngest and loftiest mountain chains in the world. The Himalayas have attained a unique personality owing to their high altitude, steep gradient and rich temperate flora.

The forests are very dense with extensive growth of grass and evergreen tall trees. Oak, chestnut, conifer, ash, pine, deodar are abundant in Himalayas. There is no vegetation above the snowline. Several interesting animals live in the Himalayan ranges. Chief species include wild sheep, mountain goats, ibex, shrew, and tapir. Panda and snow leopard are also found here.

Semi-Arid Areas

Adjoining the desert are the semi-arid areas, a transitional zone between the desert and the denser forests of the Western Ghats. The natural vegetation is thorn forest. This region is characterized by discontinuous vegetation cover with open areas of bare soil and soil-water deficit throughout the year.

Thorny shrubs, grasses and some bamboos are present in some regions. A few species of xerophytic herbs and some ephemeral herbs are found in this semi-arid tract. Birds, jackals, leopards, eagles, snakes, fox, buffaloes are found in this region.

Western Ghats

The mountains along the west coast of peninsular India are the Western Ghats, which constitute one of the unique biological regions of the world. The Western Ghats extend from the southern tip of the peninsula (8°N) northwards about 1600 km to the mouth of the river Tapti (21°N).

The mountains rise to average altitudes between 900 and 1500 m above sea level, intercepting monsoon winds from the southwest and creating a rain shadow in the region to their East.

The varied climate and diverse topography create a wide array of habitats that support unique sets of plant and animal species. Apart from biological diversity, the region boasts of high levels of cultural diversity, as many indigenous people inhabit its forests.

The Western Ghats are amongst the 25 biodiversity hot-spots recognized globally. These hills are known for their high levels of endemism expressed at both higher and lower taxonomic levels. Most of the Western Ghat endemic plants are associated with evergreen forests.

The region also shares several plant species with Sri Lanka. The higher altitude forests were, if at all, sparsely populated with tribal people. Rice cultivation in the fertile valley proceeded gardens of early commercial crops like areca nut and pepper. The original vegetation of the ill-drained valley bottoms with sluggish streams in elevations below 100m would be often a special formation, the Myristica swamp.

Expansion of traditional agriculture and the spread of particularly rubber, tea, coffee and forest tree plantations would have wiped out large pockets of primary forests in valleys. The Western Ghats are well known for harboring 14 endemic species of caecilians (i.e., legless amphibians) out of 15 recorded from the region so far.

North-West Desert Regions

This region consists of parts of Rajasthan, Kutch, Delhi and parts of Gujarat. The climate is characterised by very hot and dry summer and cold winter. Rainfall is less than 70 cm. The plants are mostly xerophytic. Babul, Kikar, wild palm grows in areas of moderate rainfall. Indian Bustard, a highly endangered bird is found here. Camels, wild asses, foxes, and snakes are found in hot and arid parts of the desert.

Deccan Plateau

Beyond the Ghats is Deccan Plateau, a semi-arid region lying in the rain shadow of the Western Ghats. This is the largest unit of the Peninsular Plateau of India. The highlands of the plateau are covered with different types of forests, which provide a large variety of forest products.the Deccan plateau includes the region lying south of the Satpura range.it extends up to the southern tip of peninsular India.Anai mudi is the highest peak of this region.The Deccan plateau is surrounded by the western and the eastern ghats.These ghats meet each other at the Nilgiri hills. The western ghats includes the Sahyadri, Nilgiris, Anamalai, and cardamom hills.many rivers such as Mahanadi, Godavari, krishna, and kaveri originates from western ghats and flow toward the east.The eastern ghats are broken into small hill rangesby river coming from the western ghats.Most of these rivers fall into the bay of bengal.The Godavari is the longest river in the Deccan plateau .the Narmada and the Tapi flow westwards and fall into the Arabian sea.

Gangetic Plain

In the North is the Gangetic plain extending up to the Himalayan foothills. This is the largest unit of the Great Plain of India. Ganga is the main river after whose name this plain is named. The aggradational Great Plains cover about 72.4mha area with the Ganga and the Brahmaputra forming the main drainage axes in the major portion.

The thickness in the alluvial sediments varies considerably with its maximum in the Ganga plains. The physiogeographic scenery varies greatly from arid and semi-arid landscapes of the Rajasthan Plains to the humid and per-humid landscapes of the Delta and Assam valley in the east.

Topographic uniformity, except in the arid Western Rajasthan is a common feature throughout these plains. The plain supports some of the highest population densities depending upon purely agro-based economy in some of these areas. The trees belonging to these forests are teak, sal, shisham, mahua, khair etc.

North-East India

North-east India is one of the richest flora regions in the country. It has several species of orchids, bamboos, ferns and other plants. Here the wild relatives of cultivated plants such as banana, mango, citrus and pepper can be grown

Islands

The two groups of islands, i.e., the Arabian Sea islands and Bay Islands differ significantly in origin and physical characteristics. The Arabian Sea Islands (Laccadive, Minicoy, etc.) are the foundered remnants of the old land mass and subsequent coral formations. On the other hand, the Bay Islands lay only about 220 km.

Away from the nearest point on the main land mass and extend about 590 km. With a maximum width of 58 km the island forests of Lakshadweep in the Arabian Sea have some of the best-preserved evergreen forests of India. Some of the islands are fringed with coral reefs. Many of them are covered with thick forests and some are highly dissected.

Coasts

India has a coastline extending over 7,516. 4 km. The Indian coasts vary in their characteristics and structures. The west coast is narrow except around the Gulf of Cambay and the Gulf of Kutch. In the extreme south, however, it is somewhat wider along the south Sahyadri.

The backwaters are the characteristic features of this coast. The east coast plains, in contrast are broader due to depositional activities of the east-flowing rivers owing to the change in their base levels.

Extensive deltas of the , Godavari, Krishna and Kaveri are the characteristic features of this coast. Mangrove vegetation is characteristic of estuarine tracts along the coast for instance, at Ratnagiri in Maharashtra.

Larger parts of the coastal plains are covered by fertile soils on which different crops are grown. Rice is the main crop of these areas. Coconut trees grow all along the coast.

Value of biodiversity

The living organisms on earth are of great diversity, living in diverse habitats and possessing diverse qualities and are vital to human existence providing food, shelter, clothing's, medicines etc.

Value of biodiversity

1. Productive values:

Biodiversity produces a number of products harvested from nature and sold in commercial markets. Indirectly it provides economic benefits to people which include water quality soil

protection, equalization of climate, environmental monitoring, scientific research, recreation etc.

2. Consumptive value:

The consumptive value can be assigned to goods such as fuel woods, leaves, forest products etc. which may be consumed locally and do not figure in national and international market.

3. Social value:

The loss of biodiversity directly influences the social life of the country possibly through influencing ecosystem functions (energy flow and biogeochemical cycle). This be easily understood by observing detrimental effects of global warming and acid rain which cause an unfavorable alteration in logical processes.

4. Aesthetic value:

Aesthetic values such as refreshing fragrance of the flowers, taste of berries, softness of mossed, melodious songs of birds, etc. compel the human beings to preserve them. The earth's natural beauty with its colour and hues, thick forest, and graceful beasts has inspired the human beings from their date of birth to take necessary steps for its maintenance. Similarly botanical and zoological gardens are the means of biodiversity conservation and are of aesthetic values.

5. Legal values:

Since earth is homeland of all living organisms, all have equal right to coexist on the surface of earth with all benefits. Unless some legal value is attached to biodiversity, it will not be possible to protect the rapid extinction of species.

6. Ethical value:

Biodiversity must be seen in the light of holding ethical value. Since man is the most intelligent amongst the living organisms, it should be prime responsibility and moral obligation of man to preserve and conserve other organisms which will directly or indirectly favour the existence of the man.

7. Ecological value:

Biodiversity holds great ecological value because it is indispensable to maintain the ecological balance. Any disturbance in the delicately fabricated ecological balance maintained by different organisms, will lead to severe problems, which may threaten the survival of human beings.

8. Economic value:

Biodiversity has great economic value because economic development depends upon efficient and economic management of biotic resources.

In the day to day life, human beings are maintaining their lifestyle at the sacrifice of surrounding species which come from diversity of plants and animals struggling for their existence.

So, it is highly essential for the human beings to take care of their surrounding species and make optimum use of their service, for better economic development. Thus, it is rightly told, survival of the man depends upon the survival of the biosphere.

Biodiversity at Global, National and Local Levels

Global Level: **Conservative estimates of the existing biodiversity is ten million species, but if estimates for insects are correct then it could be around 30 million species, we have till now enlisted about 1.4 million species.**

It includes among others about 98% birds, 95% reptiles and amphibians, 90% fish and about 85% higher plants known to exist on this Earth.

Table 4.1 Known and Estimated diversity of life on Earth

Form of Life	Known Species	Estimated Total Species
Insects and other arthropods	874,161	30 Million species, extrapolated from surveys in forest canopy in Panama, most believed to be unique to tropical forests.
Higher plants	248,400	Estimates range from 275,000 to 400,000 at least 10.15% species believed undiscovered.
Invertebrates (excludes arthropods)	116,873	True invertebrates may number millions of species. Nematodes, eelworms, and roundworms may each comprise more than one million species
Lower plants (fungi and algae)	73,900	Not available
Micro organisms	36,600	Not available
Fish	10,056	21,000 assuming that 10% fish remain undiscovered, the Amazon and Orinoco rivers alone may account for 2,000 additional species.
Birds	9,040	Known species probably account for over 98% of all birds.
Reptiles and Amphibians	8,962	Known species probably account for over 95% of all reptiles and amphibians.
Mammals	4,000	Known species probably account for over 95% of all mammals.
Total	1,390,992	10 million species considered a conservative estimate. If insect estimates are accurate, total exceeds 30 million.

National and Local Level:

India has over 108,276 species of bacteria, fungi, plants and animals already identified and described (Table 4.2). Out of these, 84 percent species constitute fungi (21.2 percent), flowering plants (13.9 percent), and insect (49.3 percent). In terms of the number of species, the insecta alone constitute nearly half of the biodiversity in India (Fig 4.1).

These species occur on land, fresh and marine waters, or occur as symbionts in mutualistic or parasitic state with other organisms. In the world as a whole, 16, 04,000 species of Monera, Protista, Fungi, Plantae and Animalia have been described so far. However, it is estimated that at least 179, 80,000 species exist in the world, but as a working figure 122, 50,000 species are considered to be near reality.

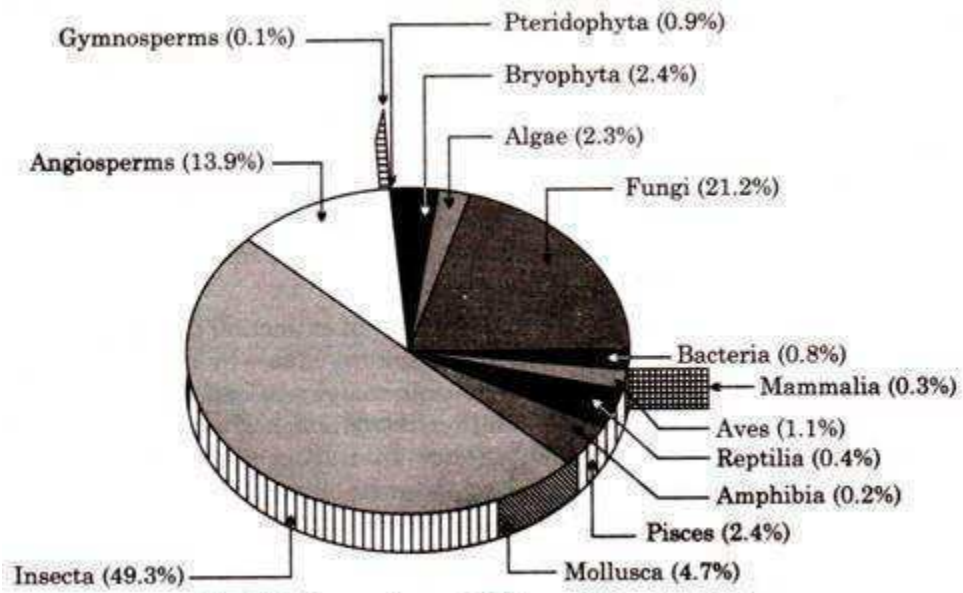


Fig. 4.1. Percentage of Different Biota in India.

Table 4.2 : Number of Species of Bacteria, Fungi, Plants and Animals

Taxon	Number of Species	Percentage
Bacteria	850	0.8
Fungi	23,000	21.2
Algae	2,500	2.3
Bryophyte	2,564	2.4
Pteridophyta	1,022	0.9
Gymnosperms	64	0.1
Angiosperms	15,000	13.9
Insecta	53,430	49.3
Mollusca	5,050	4.7
Pisces	2,546	2.4
Amphibian	204	0.2
Reptilia	446	0.4
Aves	1,228	1.1
Mammalian	372	0.3
Total	108,276	100.00

India is 10th among the plant rich countries of the world, fourth among the Asian countries, eleventh according to the number of endemic species of higher vertebrates (amphibia, birds and mammals), and tenth in the world as far as richness in mammals is concerned. Out of the 10 'Hot spots' identified in the world, India has four. These are Eastern Himalaya, North East India, Western Ghats and Andaman & Nicobar Islands.

The crops which first grew in India and spread throughout the world include rice, sugarcane, Asiatic vignas, jute, mango, citrus, and banana, several species of millets, spices, medicinal, aromatics and ornamentals. India ranks sixth among the centres of diversity and origin in terms of agro-biodiversity.

India as a mega-diversity nation

A mega-diverse country is one that harbors the majority of the Earth's species and is therefore considered extremely biodiverse. India is rich in biodiversity from north to south and from east to west. India contains many species that world's gone country have. It has 14 major basins through which drain numerous rivers. The annual rainfall varies from less than 37 cm in Rajasthan to 1500m in Cherapunji. The country experiences three different seasons – winter, summer, and monsoons. It has two global terrestrial biodiversity hot spots – the North-eastern States and the Western Ghats. The Western Ghats have moist deciduous forests and rainforests. The region shows high species diversity as well as high levels of endemism. Around 62% of reptile and 77% of amphibians are found in here. The North-eastern States depicts high altitudinal variations. This area has at least 163 globally threatened species like one-horned rhinoceros and the wild Asian water buffalo. The Relict Dragonfly, an endangered species found here. This zone houses the Himalayan Newt the only salamander species found within Indian limits.

1. The great variety of ecological conditions prevailing in India, tropical location, climate and physical features all aid in supporting an enormous diversity of wildlife, including, hot desert forms, like wild ass and the cold desert forms, like the Tibetan antelope: animals of open scrubland, like the black buck and of grassy swamps, like the rhinoceros; animals of the deciduous forests like the wild gaur and of the tropical rainforests, like the lion-tailed macaque. India's bio-geographical composition is unique as it combines living forms from three major bio-geographical realms, namely – Eurasian, Agro-Tropical, and Indo-Malayan. India lies at the confluence of Ethiopian, Palaearctic, and Indo-Malayan faunas and possesses some interesting components. The chinkara, the hyena, and the rates represent the Ethiopian element; the lynx, wolf, hangul represent the Palaearctic; the Chinese by red panda and the musk-deer; the Indo-Malayan by the hoolock gibbon, the goat-antelope, and the mouse deer. The endemic varieties include sloth bear, antelope or black buck, four-horned antelope and Boselaphus or nilgai. 15,000 species of flowering plants, 53,430 species of insects; 5050 species of mollusks, 6,500 species of other invertebrates; 2,546 species of fishes; 1228 species of birds, 446 species of reptiles, 372 species of mammals and 204 species of amphibians have been identified. India's biodiversity is estimated to be over 45,000 plant species representing about 7% of the world's flora and India stands tenth in 25 most plant-rich countries of the world. Its variety of animal life represents 6.5 per cent of world's fauna.
2. It has great marine diversity due to its 7500km long coastline. The near shore coastal waters of India are extremely rich fishing grounds. The marine environment of India supports coral reefs in the Gulf of Kutch, off the southern mainland coast, and around some islands opposite Sri Lanka. Indian coral reefs' resources are of high commercial

value. On the Gulf of Mannar and Gulf of Kutch reefs corals, coral debris and coral sands are widely exploited, and ornamental shells, sharks, and pearl oysters are the basis of an important reef industry in the south of India. Five species of marine turtle occur in Indian waters: Green turtle Chelonia mydas, Loggerhead Caretta caretta, Olive RidleyLepidochelys olive, Hawksbill Eretmochelys imbricate, and Leatherback Dermochelys coriacea. Seagrass beds are important feeding areas for the Dugong dugon, plus several species of marine turtle.

3. To preserve the rich biodiversity, nine biosphere reserves have been set up in specific biogeographic" zones: the biggest being in the Deccan Peninsula in the Nilgiris covering Tamil Nadu, Andhra Pradesh, and Karnataka. Others include the Nanda Devi in Uttarakhand in the Western Himalayas, the Nokrek in Meghalaya, Manas, and Dibru Saikhowa in Assam, the Sunderbans in the Gangetic plain in West Bengal, Similar in Orissa, the Great Nicobar and the Gulf of Mannar in Tamil Nadu. As per satellite imaging, about 19 percent of the land area of the country comprise of forests. It has 80 national parks at present, which houses the largest number of tigers and one-horned rhinos found in the world, Asiatic lions and a large percent of elephants. Six significant wetland areas 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."
4. There is a vital, but often neglected factor when we focus on biodiversity. It may be a matter of surprise to understand that the tribal people who officially constitute 7.5 percent of India's population have preserved around 90 percent of the country's biocultural diversity. To a large extent, the survival of our biodiversity depends on how best the tribal are looked after.
5. India accredited the International Convention on Biodiversity (CBD) on 18 February 1994 and became Party to the Convention in May 1994. The CBD is an international legal instrument for fostering conservation and sustainable use of biological diversity and the fair and equitable sharing of the benefits arising from commercial and other utilization of genetic resources. It is the responsibility of The Ministry of Environment and Forest in India to oversee environmental policy and procedures and the administration of the national parks of the country as well. India has worked on creating 'landscape conversion' that include wildlife reserves, communal forest, and some private lands.

India is one of the twelve mega diversity nations of the world due to the following reasons:

(i) It has 7.3% of the global fauna and 10.88% of global flora as per the data collected by Ministry of Environment and forest.

(ii) It has 350 different mammals, 1200 species of birds- 453 different reptiles, 182 amphibians and 45,000 plants spices.

(iii) It has 50,000 known species of insects which include 13,000 butterflies and moths.

(iv) It has 10 different biogeographical regions and 25 biotic provinces having varieties of lands and species.

(v) In addition to geographical distribution, geological events in the land mass provide high level of biological diversity.

(vi) Several crops arose in the country and spread throughout the world.

(vii) There is wide variety of domestic animals like cows, buffaloes, goats, sheep, pigs, horses etc.

(viii) The marine biota includes sea weeds, fishes, crustaceans, molluses, corals, reptiles etc.

(ix) There are a number of hot spots (namely Eastern Ghats, Western Ghats, North Eastern hills etc.).

Hot-spots of biodiversity

Hot spots are the areas with high density of biodiversity or mega diversity which are most threatened at present. There are 16 hot spots in world, out of which two are located in India namely North-East Himalayas and Western Ghats.

The hot spots are determined considering four factors:

(i) Degrees of endemism;

(ii) Degree of expectation

(iii) Degrees of threat to habitat due to its degradation and fragmentation and

(iv) Number of Species diversity.

The British biologist Norman Myers coined the term "biodiversity hotspot" in 1988 as a biogeographic region characterized both by exceptional levels of plant endemism and by serious levels of habitat loss. In 1990 Myers added a further eight hotspots, including four Mediterranean-type ecosystems. Conservation International (CI) adopted Myers' hotspots as its institutional blueprint in 1989, and in 1996, the organization made the decision to undertake a reassessment of the hotspots concept. Three years later an extensive global review was undertaken, which introduced quantitative thresholds for the designation of biodiversity hotspots.

According to CI, to qualify as a hotspot a region must meet two strict criteria: it must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics, and it has to have lost at least 70% of its original habitat. In 1999, CI identified 25 biodiversity hotspots in the book "Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions".

Collectively, these areas held as endemics about 44% of the world's plants and 35% of terrestrial vertebrates in an area that formerly covered only 11.8% of the planet's land surface. The habitat extent of this land area had been reduced by 87.8% of its original extent, such that this wealth of biodiversity was restricted to only 1.4% of Earth's land surface. In 2005 CI published an updated titled "Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions".

GLOBAL BIODIVERSITY HOTSPOTS: WORLD

1. **AFRICA**

A total of 8 Hotspots in African continent hold a diversity of plant and animal life, many of which are found nowhere else on Earth.

2. **ASIA-PACIFIC**

Composed of large land areas as well as islands dotting the Pacific seas, these 14 Hotspots represent important biodiversity.

3. **EUROPE AND CENTRAL ASIA**

From the Mediterranean Basin to the Mountains of Central Asia, these four Hotspots are unique in their diversity.

4. NORTH AND CENTRAL AMERICA

North and Central America play host to thousands of acres of important habitat.

5. SOUTH AMERICA

From Brazil's Cerrado to the Tropical Andes, South America has some of the richest and most diverse life on Earth.

Life on Earth faces a crisis of historical and planetary proportions. Unsustainable consumption in many northern countries and crushing poverty in the tropics are destroying wild nature. Biodiversity is besieged. Extinction is the gravest aspect of the biodiversity crisis: it is irreversible. While extinction is a natural process, human impacts have elevated the rate of extinction by at least a thousand, possibly several thousand, times the natural rate. Mass extinctions of this magnitude have only occurred five times in the history of our planet; the last brought the end of the dinosaur age. In a world where conservation budgets are insufficient given the number of species threatened with extinction, identifying conservation priorities is crucial.

The biodiversity hotspots hold especially high numbers of endemic species, yet their combined area of remaining habitat covers only 2.3% of the Earth's land surface. Each hotspot faces extreme threats and has already lost at least 70% of its original natural vegetation. Over 50% of the world's plant species and 42% of all terrestrial vertebrate species are endemic to the 35 biodiversity hotspots.

World's 35 Biodiversity Hotspots

I. Africa	III. Europe and Central Asia
Cape Floristic Region	3. Caucasus
Coastal Forests of Eastern Africa	4. Irano-Anatolian
Eastern Afromontane	5. Mediterranean Basin
Guinean Forests of West Africa	6. Mountains of Central Asia
Horn of Africa	
Madagascar and the Indian Ocean Islands	IV. North and Central America
Maputaland-Pondoland-Albany	
Succulent Karoo	7. California Floristic Province
	8. Caribbean Islands
II. Asia-Pacific	9. Madrean Pine-Oak Woodlands
	10. Mesoamerica
East Melanesian Islands	
0. Himalaya	V. South America
1. Indo-Burma	
2. Japan	1. Atlantic Forest
3. Mountains of Southwest China	2. Cerrado
4. New Caledonia	3. Chilean Winter Rainfall-Valdivian Forests
5. New Zealand	4. Tumbes-Chocó-Magdalena
6. Philippines	5. Tropical Andes
7. Polynesia-Micronesia	
8. Southwest Australia	

9. Forests of Eastern Australia (new) 10. Sundaland 11. Wallacea 12. Western Ghats and Sri Lanka	

GLOBAL BIODIVERSITY HOTSPOTS: ASIA-PACIFIC

1. East Melanesian Islands

Once largely intact, the 1,600 East Melanesian Islands are now a hotspot due, sadly, to accelerating levels of habitat loss.

2. Himalaya

The Himalaya Hotspot is home to the world's highest mountains, including Mt. Everest.

3. Indo-Burma

Encompassing more than 2 million km² of tropical Asia, Indo-Burma is still revealing its biological treasures.

4. Japan

The islands that make up the Japanese Archipelago stretch from the humid subtropics in the south to the boreal zone in the north, resulting in a wide variety of climates and ecosystems.

5. Mountains of Southwest China

With dramatic variations in climate and topography, the Mountains of Southwest China support a wide array of habitats including the most endemic-rich temperate flora in the world.

6. New Caledonia

An island the size of New Jersey in the South Pacific Ocean, New Caledonia is the home of no less than five endemic plant families.

7. New Zealand

A mountainous archipelago once dominated by temperate rainforests, New Zealand harbors extraordinary levels of endemic species.

8. Philippines

More than 7,100 islands fall within the borders of the Philippines hotspot, identified as one of the world's biologically richest countries.

9. Polynesia-Micronesia

Comprising 4,500 islands stretched across the southern Pacific Ocean, the Polynesia-Micronesia hotspot is the epicenter of the current global extinction crisis.

10. Southwest Australia

The forest, woodlands, shrublands, and heath of Southwest Australia are characterized by high endemism among plants and reptiles.

11. Forests of Eastern Australia

Forests of East Australia Hotspot consists of a discontinuous coastal stretch along the Australian states of Queensland and New South Wales, extending inland and further west, although it includes the New England Tablelands and the Great Dividing Range. This region contains more than 1500 endemic vascular plants.

12. Sundaland

The spectacular flora and fauna of the Sundaland Hotspot are succumbing to the explosive growth of industrial forestry in these islands.

13. Wallacea

The flora and fauna of Wallacea are so varied that every island in this hotspot needs secure protected areas to preserve the region's biodiversity.

14. Western Ghats and Sri Lanka

Faced with tremendous population pressure, the forests of the Western Ghats and Sri Lanka have been dramatically impacted by the demands for timber and agricultural land.

BIODIVERSITY HOTSPOTS IN INDIA

1. **Himalaya: Includes the entire Indian Himalayan region (and that falling in Pakistan, Tibet, Nepal, Bhutan, China and Myanmar)**
2. **Indo-Burma: Includes entire North-eastern India, except Assam and Andaman group of Islands (and Myanmar, Thailand, Vietnam, Laos, Cambodia and southern China)**
3. **Sundalands: Includes Nicobar group of Islands (and Indonesia, Malaysia, Singapore, Brunei, Philippines)**
4. **Western Ghats and Sri Lanka: Includes entire Western Ghats (and Sri Lanka)**

Threats to biodiversity

Biodiversity is considered as a reservoir of resources to be used for the manufacture of food, medicine, industrial products, etc. But with an increased demand of rapid population growth, biodiversity is gradually depleting. A number of plants" and animal species have already become extinct and many are endangered.

The different factors responsible for causing threat to biodiversity are as follows:

1. Habitat destruction:

The primary cause of loss of biodiversity is habitat loss or destruction which is resulted due to the large industrial and commercial activities associated with agriculture, irrigation, construction of dams, mining, fishing etc.

2. Habitat fragmentation:

With increased population, the habitats are fragmented into pieces by roads, fields, canals, power lines, towns etc. The isolated fragment of habitats restricts the potential of species for dispersal and colonization. In addition, the habitat fragmentation also brings about microclimatic changes in light, temperature, wind etc.

3. Pollution:

The most dreaded factor inducing loss of biodiversity is environmental pollution which include air pollution, Water pollution, industrial pollution, pollution due to chemical Pastes, pesticides radioactive materials etc.

4. Over exploitation:

The natural resources are over exploited to meet growing rural poverty, intensive technological growth and globalization of economy. All these factors together may be responsible for the extinction of a number of species.

5. Introduction of exotic species:

The introduction of exotic species are due to:

(i) horticulture

(ii) agriculture;

(iii) European colonisation and

(iv) accidental transport.

It is seen that some exotic species may kill or eat the native species thereby causing its extinction.

6. Diseases:

Since the animals are more vulnerable to infection, the anthropological activities may increase the incidence of diseases in wild species, leading to their extinction.

7. Shifting or Jhum cultivation:

The shifting or Jhum cultivation by poor tribal people greatly affects the forest structure which is a store house of biodiversity.

8. Poaching of wild life:

A number of wildlife species are becoming extinct due to poaching and hunting.

<u>Conservation of biodiversity</u>

Biodiversity is being depleted by the loss of habitat, fragmentation of habitat, over exploitation of resources, human sponsored ecosystems, climatic changes, pollution invasive exotic spices, diseases, shifting cultivation, poaching of wild life etc. Since the human beings are enjoying all the benefits from biodiversity, they should take proper care for the preservation of biodiversity in all its form and good health for the future generation i.e., the human being should prevent the degradation and destruction of the habitats thereby maintaining the biodiversity at its optimum level. Conservation of biodiversity is protection, uplift-ment and scientific management of biodiversity so as to maintain it at its threshold

level and derive sustainable benefits for the present and future generation. In other words, conservation of bio-diversity is the proper management of the biosphere by human beings in such a way that it gives maximum benefits for the present generation and also develops its potential so as to meet the needs of the future generations.

Mainly the conservation of biodiversity has three basic objectives:

(a) To maintain essential ecological processes and life supporting systems.

(b) To preserve the diversity of species.

(c) To make sustainable utilisation of species and ecosystems.

Strategies for Conservation of Biodiversity:

The following strategies should be undertaken in order to conserve biodiversity:

(1) All the possible varieties (old or new) of food, forage and timber plants, live stock, agriculture animals and microbes should be conserved.

(2) All the economically important organisms in protected areas should be identified and conserved.

(3) Critical habitats for each species should be identified and safeguarded.

(4) Priority should be given to preserve unique ecosystems.

(5) There should be sustainable utilisation of resources.

(6) International trade in wild life should be highly regulated.

(7) The poaching and hunting of wildlife should be prevented as far as practicable.

(8) Care should be taken for the development of reserves and protected areas.

(9) Efforts should be made to reduce the level of pollutants in the environment.

(10) Public awareness should be created regarding biodiversity and its importance for the living organisms.

(11) Priority should be given in wildlife conservation programme to endangered species over vulnerable species and to vulnerable species over rare species.

(12) The habitats of migratory birds should be protected by bilateral and multilateral agreement.

(13) The over exploitation of useful products of wild life should be prevented.

(14) The useful animals, plants and their wild relatives should be protected both in their natural habitat (in-situ) and in zoological botanical gardens (ex-situ)

(15) Efforts should be made for setting up of National parks and wild life sanctuaries to safeguard the genetic diversity and their continuing evolution.

(16) Environmental laws should be strictly followed.

<u>Conservation Methods:</u>

There are two types of conservation methods namely in-situ and ex-situ conservations. Let us discuss the different conservation methods along with their importance.

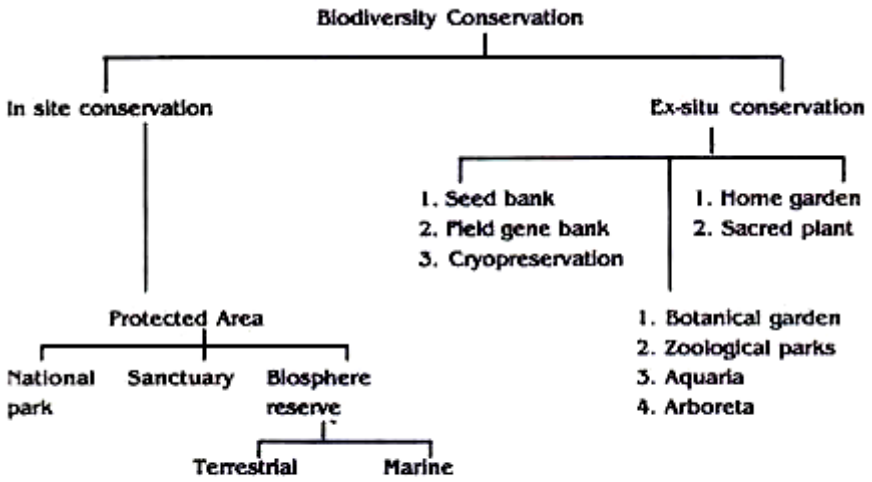


FIG. 5.1 : SCHEME SHOWING BIODIVERSITY CONSERVATION MANAGEMENT SYSTEMS.

(a) In situ conservation:

The conservation of species in their natural habitat or natural ecosystem is known as in situ conservation. In the process, the natural surrounding or ecosystem is protected and maintained so that all the constituent species (known or unknown) are conserved and benefited. The factors which are detrimental to the existence of species concerned are eliminated by suitable mechanism.

The different advantages of in situ conservation are as follows:

(a) If is a cheap and convenient way of conserving biological diversity.

(b) It offers a way to preserve a large number of organisms simultaneously, known or unknown to us.

(c) The existence in natural ecosystem provides opportunity to the living organisms to adjust to differed' environmental conditions and to evolve in to a better life form.

The only disadvantage of in situ conservation is that it requires large space of earth which is often difficult because of growing demand for space. The protection and management of biodiversity through in situ conservation involve certain specific areas known as protected areas which include national parks, Sanctuaries and Biosphere reserves.

1. Protected areas:

The protected areas are biogeographical areas where biological diversity along with natural and cultural resources are protected, maintained and managed through legal and administrative measures. The demarcation of biodiversity in each area is determined on the basis of climatic and physiological conditions.

In these areas, hunting, firewood collection, timber harvesting etc. are prohibited so that the wild plants and animals can grow and multiply freely without any hindrance. Some protected areas are: Cold desert (Ladakh and Spiti), Hot desert (Thar), Saline Swampy area (Sunderban and Rann of Kutch), Tropical moist deciduous forest (Western Ghats and north East) etc. Protected areas include national parks, sanctuaries and biosphere reserves. There are 37,000

protected areas throughout the world. As per World Conservation Monitoring Centre, India has 581 protected areas, national parks and sanctuaries.

2. National parks:

These are the small reserves meant for the protection of wild life and their natural habitats. These are maintained by government. The area of national parks ranges between 0.04 to 3162 km. The boundaries are well demarcated and circumscribed. The activities like grazing forestry, cultivation and habitat manipulation are not permitted in these areas. There are about 89 national parks in India.

Some important national Parks of India are:

(i) Biological Park, Nandankanan, Orissa,
(ii) Corbett national Park Nainital, U.P. (First national Park)
(iii) Koziranga national Park, Jorhat, Assam
(iv) Tudula national Park, Maharashtra
(v) Hazaribagh national Park, Hazaribagh, Bihar
(vi) Band havgarh national park, M.P.
(vii) Bandipur national park, Karnataka.
(viii) Kanha National Park, M.P.
(ix) Reibul Lamjao National Park, Manipur
(x) Nawgaon National Park, Maharashtra

3. Sanctuaries:

These are the areas where only wild animals (fauna) are present. The activities like harvesting of timbers, collection of forest products, cultivation of lands etc. are permitted as long as these do not interfere with the project. That is, controlled biotic interference is permitted in sanctuaries, which allows visiting of tourists for recreation. The area under a sanctuary remains in between 0.61 to 7818 km.

Some important sanctuaries of Orissa are as follows:

(i) Nandankanan Zoological Park
(ii) Chandaka Elephant reserve
(iii) Simlipal Tiger Reserve
(iv) Bhitarkanika Wild life Sanctuary
(v) Gharial project at Tikarpada
(vi) Chilika (Nalaban) Sanctuary

4. Biosphere reserves:

Biosphere reserves or natural reserves are multipurpose protected areas with boundaries circumscribed by legislation. The main aim of biosphere reserve is to preserve genetic diversity in representative ecosystems by protecting wild animals, traditional life style of inhabitant and domesticated plant/ animal genetic resources. These are scientifically managed allowing only the tourists to visit.

Some importance of biosphere reserves are as follows:

(a) These help in the restoration of degraded ecosystem.

(b) The main role of these reserves is to preserve genetic resources, species, ecosystems, and habitats without disturbing the habitants.

(c) These maintain cultural, social and ecologically sustainable economic developments.

(d) These support education and research in various ecological aspects,

Some important biosphere reserves are:

Simlipal, (Orissa), Sunderban (West Bengal), Kanha (M.P Kaziranga (Assam) etc. The biosphere reserve net work was introduced by UNESCO 1971.

TABLE 5.2 : BIOSPHERE RESERVES OF INDIA

S. No.	Date notified	Name of the site	Area in sq.km.	Location (state)
1.	0.1.08.86	Nilgiri	5,520	Parts of Wynad, Nagarhole, bandipur and Mudumalai, Nilambur, Silent Valeey, and the Siruvani Hills (Tamil Nadu, Kerala and Karnataka)
2.	18.01.88	Nanda Devi	5,860.69	Parts o the Chamoli, Pithoragarh, and Almorae dis tricts Uttaranchal)
3.	01.09.88	Nokrek	820	Part of Gora Hills (Meghalaya)
4.	14.03.89	Manas	2,837	Parts of the Kokrajhar, Bongaigaon, Parpeta, Nalbari, Kamprup, and Daarang districts (Assam)
5.	29.03.89	Sunderbans	9,630	Parts of the Brahamaputra and Ganga deltas (West Bengal)
6.	18.02.89	Gulf of Mannar	10,500	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu)
7.	06.01.89	Great Nicobar	885	Southernmost islands of the Andaman and Nicobar islands.
8.	21.06.94	Similpal	4,374	Partof Mayurbhanj district (Orissa)
9.	29.07.97	Dibru-Saikhowa	765	Parts of the Dibrugarh and Tinsukia districts (Assam)
10.	02.09.98	Dehang Debang	5,112	Parts of Siang and Debang Valley (Arunachal Pradesh).
11.	03.03.99	Pachmarhi	4,926.28	Part of the Betul, Hoshangabad, and Chindwara dis tricts (Madhya Pradesh)
12.	07.02.00	Kanchanjanga	2,619.92	Part of Kanchanjanga Hills (Sikkim)

(b) Ex-situ conservation:

Ex-situ conservation involves maintenance and breeding of endangered plants and animals under partially or wholly controlled conditions in specific areas like zoo, gardens, nurseries etc. That is, the conservation of selected plants and animals in selected areas outside their natural habitat is known as ex-situ conservation.

The stresses on living organisms due to competition for food, water, space etc. can be avoided by ex-situ conservation there by providing conditions necessary for a secure life and breeding.

Some important areas under these conservation are:

(i) Seed gene bank,

(ii) Field gene bank;

(iii) Botanical gardens;

(iv) Zoos.

The strategies for ex-situ conservations are:

(i) Identification of species to be conserved.

(ii) Adoption of Different ex-situ methods of conservation.

(i) Long-term captive breeding and propagation for the species which have lost their habitats permanently.

(ii) Short-term propagation and release of the animals in their natural habitat

(iii) Animal translocation

(iv) Animal reintroduction

(v) Advanced technology in the service of endangered species.

The different advantages of ex-situ conservation are:

(a) It gives longer life time and breeding activity to animals.

(b) Genetic techniques can be utilised in the process.

(c) Captivity breed species can again be reintroduced in the wild.

Some disadvantages of this method are:

(a) The favourable conditions may not be maintained always.

(b) Mew life forms cannot evolve.

(c) This technique involves only few species.

Endangered and Endemic species of India

1. Endangered species of India

A plant, animal or microorganism that is in immediate risk of biological extinction is called endangered species or threatened species. In India, 450 plant species have been identified as endangered species. 100 mammals and 150 birds are estimated to be endangered. India's biodiversity is threatened primarily due to:

1. **Habitat destruction**
2. **Degradation and**
3. **Over exploitation of resources**

The RED-data book contains a list of endangered species of plants and animals. It contains a list of species of that are endangered but might become extinct in the near future if not protected.

Some of the rarest animals found in India are:

1. **Asiatic cheetah**
2. **Asiatic Lion**
3. **Asiatic Wild Ass**
4. **Bengal Fox**
5. **Gaur**
6. **Indian Elephant**
7. **Indian Rhinocerous**
8. **Marbled Cat**
9. **Markhor**

Extinct species is no longer found in the world. Endangered or threatened species is one whose number has been reduced to a critical number. Unless it is protected and conserved, it is in immediate danger of extinction. Vulnerable species is one whose population is facing continuous decline due to habitat destruction or over exploitation. However, it is still abundant. Rare species is localized within a restricted area or is thinly scattered over an

extensive area. Such species are not endangered or vulnerable. A few endangered pecies in the world are listed below:

1. West Virginia Spring Salamander (U.S.A)
2. Giant Panda (China)
3. Golden Lion Tamarin (Brazil)
4. Siberian Tiger (Siberia)
5. Mountain Gorilla (Africa)
6. Pine Barrens Tree Frog (Male)
7. Arabian Oryx (Middle East)
8. African Elephant (Africa)

Other important endangered species are:

1. Tortoise, Green sea Turtle , Gharial, Python (Reptiles)
2. Peacock, Siberian White Crane, Pelican, Indian Bustard (Birds)
3. Hoolock gibbin, Lion-tailed Macaque, Capped mokey, Golden monkey (Primates)
4. Rauvol fia serpentina (medicinal plant), Sandal wood tree, etc

FACTORS AFFECTING ENDANGERED SPECIES

1. Human beings dispose wastes indiscriminately in nature thereby polluting the air, land and water. These pollutants enter the food chain and accumulate in living creatures resulting in death.
2. Over-exploitation of natural resources and poaching of wild animals also leads to their extinction.
3. Climate change brought about by accumulation of green houses gases in the atmosphere. Climate change threatens organisms and ecosystems and they cannot adjust to the changing environmental conditions leading to their death and extinction.

An international treaty to help protect endangered wildlife is, "Convention on International Trade in Endangered Species 1975" (CITES). This treaty is now signed by 160 countries.

1. CITES lists 900 species that cannot be commercially traded as live specimens or wildlife products as they are in danger of extinction.
2.
3. CITES restricts trade of 2900 other species as they are endangered.

DRAWBACKS OF CITES

1. This treaty is limited as enforcement is difficult and convicted violators get away by paying only a small fine.
2. Member countries can exempt themselves from protecting any listed species.

Endemic species of India

Species that are found only in a particular region are known as endemic species. Almost 60% the endemic species in India are found in Himalayas and the Western Ghats. Endemic species are mainly concentrated in:

1. North-East India
2. North-West Himalayas
3. Western Ghats and

4. Andaman & Nicobar Islands.

Examples of endemic Flora species are

1. Sapria Himalayana
2. Ovaria Lurida
3. Nepenthis khasiana etc

Endemic fauna of significance in the western ghats are:

1. Lion tailed macaque
2. Nilgiri langur
3. Brown palm civet and
4. Nilgiri tahr

Factors affecting endemic species:

1. Habitat loss and fragmentation due to draining and filling of inland wetlands.
2. Pollution also plays an important role.

Ex:

1. Frog eggs, tadpoles and adults are extremely sensitive to pollutants especially pesticides.
2. Over-hunting and
3. Populations can be adversely affected by introduction of non active predators and competitors. Disease producing organisms also play an important adversary in reducing populations of endemic species.

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