



Biodiversity Scenario, Threats and its Conservation in India

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Introduction

“Bio” mean life and “diversity” means variety, so biodiversity (or biological diversity) is the incredible variety of living things in nature and how they interact with each other. It is one of the most precious treasures. Every human being, plant and animal contribute to the diversity, beauty and functioning of the earth. Biodiversity is very complex and is often explained as the variety and variability of genes, species and ecosystems.

For much of the time man lived in a hunter-gather society and thus depended entirely on biodiversity for sustenance. But, with the increased dependence on agriculture and industrialization, the emphasis on biodiversity has decreased. Indeed, the biodiversity, in wild and domesticated forms, is the source for most of humanity, food, medicine, clothing and housing, much of the cultural diversity and most of the intellectual and spiritual inspiration. It is, without doubt, the very basis

of life. Further that, a quarter of the earth’s total biological diversity amounting to 1.7 million species, which might be useful to mankind in one way or other, would be in serious risk of existence over the next 2-3 decades. On realization that the erosion of biodiversity may threaten the very existence of life has awakened man to take steps to conserve it. It might be too late to save some species from extinction, but it’s not too late to take actions to save others. Together we can make big difference, and getting informed and motivated is a great way to start. In the present chapter the different aspects about threats and conservation measures are discussed in details especially on Indian prospective.

India: A Megadiversity Country

The variety of animals and plants on Earth is truly wondrous. It is estimated that about 5-50 million species of living forms exists on the earth. However, only 1.7 million have been identified so far. These include 4,27,205 species of green plants, fungi, bacteria and viruses; 61,917 species of vertebrates and protochordata; and 12,32,490 species of invertebrates including protista.

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India is one of the 17 mega diverse countries of the world. The country has two major realms called Palearctic and the Indo-Malayan, and three biomes namely the tropical humid forests, the tropical dry/deciduous forests and the warm desert/semi deserts. India is divided into 10 biogeographic regions, Trans-Himalayan, Himalayan, Indian Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic plains, North-East India, Coasts and Islands, and this diversity creates rich biodiversity in the country. The wide variety in physical features and climatic conditions have resulted in a diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems, which harbor and sustain the immense biodiversity. With only 2.45% of the world's land area, 16.7% of the world's human population and 18% livestock, it contributes about 8.10% of the known global biodiversity. Currently available data place India in the tenth position in the world and fourth in Asia in plant diversity. In terms of number of mammalian species, India ranks tenth in the world, in terms of endemic species of higher vertebrates, it ranks eleventh. It stands seventh in the world for the number of species contributed to agriculture and animal husbandry. The Himalaya and the Western Ghats are the two Indian mountain biodiversity global hotspots. These both show rich and unique biodiversity in terms of rich species endemism. In addition, India is one of the very important Vavilovian center of diversity and origin of over 167 important cultivated plant

species, 320 species of wild crop relatives, and several species of domesticated animals.

In flora, the country can boast of 45,944 species, which accounts for 10.75% of the known world plants. Of the 18,000 species of flowering plants (angiosperms) 36% are endemic and located in 26 endemic centers. Our country is very rich in faunal wealth too. The country has nearly 89,317 animal species, about 75 percent of which are insects, 4,952 vertebrates including protochordata and about 84,365 are invertebrates, including protista. In animals, the rate of endemism in reptiles is 33%, in amphibians 41%, in mammals 9%, and birds 4%. The comparative accounts of recorded plant and animal species in India and the world are given in Table 1 and 2.

The Threatened Biodiversity

The diverse ecosystems on earth such as forests, mountains, rivers, oceans, deserts, marshlands and grassy plains are specifically suited to the creatures and plants that live there. But changes to an ecosystem's environment can spell doom for its native plants and animals, and unfortunately this is happening all too fast today. Many species are at risk of disappearing entirely. While extinction has always happened as a natural part of a gradual evolutionary process, the current rate of extinction of animals and plants is thought to be hundreds, perhaps even thousands of times faster than that brought about by natural evolutionary processes. The current rate of biodiversity loss has led many to suggest that the Earth is currently experiencing a sixth major extinction event, one greater than that which resulted in the

extinction of the dinosaurs. However, unlike past extinction events, which were caused by natural disasters and planetary changes, this one is being driven by human actions.

According to IUCN (2012) report, the status of different categories of species of the world was shown as follows:

In India status of biodiversity loss is also threatening. Tropical forests of the country have been disappearing very fast, at a rate of about 0.6% per year. If this will continuously unchecked, all closed tropical forests would disappear in 175 years. This forests are home of many endemic species, which will also be destroyed along with the forest. According to Botanical Survey of India, about 6000 plant species belonging to over 41 genera of 47 families of angiosperms are endemic (Table-4).

The Indian animal groups show diverse range of endemism across different groups. Some of the lower groups such as Mesozoa (100%), Acanthocephala (88.6%), Oligochaeta (77.8%), Platyhelminthes (71.9%) and Kinorhyncha (70%) show high degree of endemism. Among higher groups, Amphibia (61.2%) and Reptilia (47%) deserve special mention (ZSI, 2008).

The Red List of threatened species of plants prepared by IUCN (2011) listed 75 species of plants as critically endangered and 141 as endangered ones from India. Botanical Survey of India (BSII is the monitoring agency for assessment of status of plant species of India. According to report of BSI, 2012, plant species listed in critically endangered (CR), endangered (EN) and vulnerable (VU) are 45, 113 and 89 respectively.

As per IUCN (2012) report, status of animal species of different categories of threatened species in India has been shown as follows:

The major reasons for extinction of biodiversity have been explored as follow:

Destruction of habitat

The natural habitat may be destroyed by man for his settlement, grazing grounds, agriculture, mining, industries, highway construction, drainage, dam building, etc. as a consequence of this; the species must adapt to the changes, move elsewhere or may succumb to predation, starvation or disease and eventually die. This is the most pervasive threat to birds, mammals and plants affecting 89% of all threatened birds, 83% of the threatened animals assessed. In our country, several rare butterfly species are facing extinction with the uncannily swift habitat destruction of the Western Ghats. Of the 370 butterfly species available in the Ghats, up to 70 are at the brink of extinction.

Hunting

From time immemorial, man has hunted for food. Commercially, wild animals are hunted for their products such as hide and skin, tusk, antlers, fur meat, pharmaceuticals, perfumes, cosmetics and decoration purposes. For example, in India, rhino is hunted for its horns, tigers for bones and skin, musk deer for musk (have medicinal value), elephant for ivory, gharial and crocodile for their skin, and jackal for thriving fur trade in Kashmir. One of the most publicized commercial hunts in that of whale. The whalebone or 'baleen' is used to make combs and other products.

Poaching of the Indian tiger has been risen because of the increasing demand from pharmaceutical industries, which consume the bones of 100 tigers per year. Such huge demand has been met by poachers from India. Even the Project tiger Programme failed to check poaching and resultantly the tigers have been almost disappeared from Ranthambore and Keoladeo national parks. Smuggling of tiger bones and skins is a lucrative business. Hunting for sport is also a factor for loss of wild animals.

Over exploitation

This is one of the main cause of the loss of not only economic species but also biological curiosities like the insectivorous and primitive species and other taxa needed for teaching or laboratory (like *Nepenthes*, *Gnetum*, *Psilotum*, etc.). commercial exploitation of wild plants has invariably causes their overuse and eventual destruction. This has been true in case of Indian wild mango trees, which were turned into plywood as of the whales that were hunted for tallow. Plants of medicinal value like *Podophyllumhexandrum*, *Coptisteeta*, *Aconitum*, *Disocoreadeltaoidea*, *Rauwolfia serpentine*, *Paphiopedilumdruryi*, etc., and horticultural plants like orchids and rhododendrons come under the over-exploited category. Faunal losses have been mainly because of over-exploitation. For instance, excessive harvesting of marine organisms such as fish, mollusks, sea cows and sea turtles has resulted in extinction of these animals.

Collection for zoo and research

Animals and plants are collected throughout the world for zoo and biological laboratories

for study and research in science and medicine. For example, primates such as monkey and chimpanzees are sacrificed for research as they have anatomical, genetic and physiological similarities to human being.

Introduction of exotic species

Native species are subjected to competition for food and space due to competition for food and space due to introduction of exotic species. For example, introduction of goats and rabbits in the Pacific and Indian regions has resulted in destruction of habitats of several plants, birds and reptiles.

Control of pest and predators

Predator and pest control measures, generally kill predators that are a component of balanced ecosystem and may also indiscriminately poison non-target species.

Pollution

Pollution alters the natural habitat. Water pollution is especially injurious to the biotic components of estuary and coastal ecosystem. Toxic wastes entering the water bodies disturb the food chain, and so to the aquatic ecosystems. Insecticides, pesticides, sulphur dioxide, nitrogen oxides, acid rain, ozone depletion and global warming too, affect adversely the plant and animal species.

The impact of coastal pollution is also very important, it is seen that coral reefs are being threatened by pollution from industrialization along the coast, oil transport and offshore mining. Noise pollution is also the cause of wildlife extinction. According to a study Arctic whales are seen on the verge of extinction as a

result of increasing noise of ships, particularly ice breakers and tankers.

8. Deforestation: One of the main causes for the loss of wildlife is population explosion and the resultant deforestation. Deforestation mainly results from population settlement, shifting cultivation, development projects, demand for fuel wood, demand of wood as a raw material for many industries such as paper and pulp, match, veneer and plywood, furniture etc.

In the Country, the current rate of deforestation is 13,000 sq. km annually. If this rate of deforestation continues, one can imagine the ultimate fate of our forest and biological richness. It is presumed that in coming years, the global loss of biodiversity from deforestation alone would be 100 species every day.

Other factors

Other ecological factors that may also contribute to the extinction of wildlife are as follows:

- i. Distribution range – The smaller the range of distribution, the greater the threat of extinction.
- ii. Degree of specialization – The more specialized an organism is, the more vulnerable it is to extinction.
- iii. Position of the organism in the food chain – The higher the position of the organism is in food chain, the more susceptibility it becomes.
- iv. Reproductive rate – Large organisms tend to produce fewer offspring at widely spaced intervals.

- v. Outbreaks of diseases – it is also one of the major causes for the decline in wildlife species.
- vi. Loss of gene flow – The individuals of plant and animal life may decline to the significant levels as a result of loss of gene flow.
- vii. Substitution – During the process of evolution an existing species may be replaced by ecologically another one.

Biodiversity Conservation Strategies

Since the biodiversity affects every living being on this planet and to a great extent is influenced by the human activities, the responsibility to protect it must be a shared goal of all the nations and communities. In this context the Convention on Biological Diversity (CBD (signed in 1992) was inspired by the world community's growing commitment to sustainable development. It represents a dramatic step forward in the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources. India was one of the early signatories to the UN CBD. Prior to CBD, the following were the legal provisions to conserve the biodiversity.

- Indian Forest Act, 1927
- Wildlife (Protection) Act 1972
- Forest (Conservation) Act 1980

Subsequent to becoming a party to CBD, India has taken the following steps towards biodiversity conservation:

- India passed the Biological Diversity Act in the year 2002. The act mainly addresses to

genetic resources and associated knowledge by foreign individuals, institutions or companies, to ensure equitable sharing of benefits arising out of the use of these resources and knowledge to the country and the local communities. A National Biodiversity Authority was set up at Chennai on 1st October, 2003 as per the provision of the Biological Diversity Act, 2002.

- Biodiversity Action Plan was approved in November 2008 to enhance natural resource base and its sustainable utilization.
- India has recently ratified the Nagoya Protocol. The Nagoya Protocol would contribute to fair and equitable sharing of benefits accruing from utilization of genetic resources and would act as incentive to biodiversity-rich countries and their local communities to conserve and sustainable use their biodiversity.
- India hosted the 11th Conference of Parties (CoP-11) to the Convention on Biological Diversity. This is also the first such conference since the launch of the United Nations Decade of Biodiversity in 2011. At the CoP-11, India has launched the Hyderabad Pledge and announced that our Government will earmark a sum of US\$ 50 million to strengthen the institutional mechanism for biodiversity conservation in India. India will use these funds to enhance the technical and human capabilities of our national and state-level mechanism to attain the CBD objectives.

During the last twenty years, plans for biodiversity conservation have been developed by the WRI and the IUCN with support from World Bank and other institution. Basically, the conservation plan should have a holistic approach and encompasses whole spectrum of biota and activities ranging from ecosystems at the macro level to DNA libraries at the molecular level. There are two approaches of biodiversity conservation namely *in situ* (on site) conservation which tries to protect the specie where they are, i.e., in their natural habitat and *ex situ* (off site) conservation which attempts to protect and preserve a species in place away from its natural habitat.

***In situ* Conservation**

In situ conservation means the conservation of ecosystem and natural habitat and maintenance and recovery of viable population of species in the natural surrounding where they have developed their distinctive characteristics.

In situ conservation methods pertain to conserving animals and plants in their natural habitats. It emphasizes the preservation and protection of total ecosystems at their original or natural environment. Human societies have always taken interest in preserving wildlife areas. The main objective is to recognize a particular biodiversity rich area and to preserve it so that the biodiversity can continue to flourish and evolve. This involves establishment of protected areas, national parks, sanctuaries, biosphere reserves, reserve forests etc. over past few decades there has been an increase in the number of such areas. Protection of the ecosystem by simply eliminating factors detrimental to the existence

of species concerned has given good results in conservation of constituent species, known or unknown.

In situ conservation of biodiversity is advantageous in that it is a cheap and convenient method that requires people's our supportive role. It maintains all organisms at different trophic levels from producers to top consumers such as carnivores. In natural environment, organisms not only live and multiply but also evolve and continue to maintain their ability to resist various environmental tresses such as drought storm, snow, temperature fluctuations, excessive rains, flood, fires, pathogens etc. *In situ* conservation requires only elimination of factors detrimental to the existence of the species and allows the larger number of species to grow simultaneously and flourish in their natural environment in which they were growing since a long time. The only disadvantage of *in situ* conservation is that it requires larger areas and minimizes the space for inhibiting human population which is increasing tremendously. The following areas may be set aside for *in situ* conservation:

National Parks and Wildlife Sanctuaries

These are legally constituted protected areas for conserving both flora and fauna of a region. In India, the Wildlife Protection act of 1972 empowers the State Governments to declare an area as a Sanctuary or National Park. This is done for protecting, propagating and developing wildlife and its environment. Section 18 to 34 and 38 of the Act, deal with the declaration of sanctuaries, Section 35 and 38 with National Parks and Section 37 with

closed areas. There are 102 national parks and 515 wildlife Sanctuaries, 47 Conservation Reserves and 4 Community Reserves in the country, covering an area of 1,61,221.57 km² (4.90% of total geographic area).

National parks (NP): A National Park is an area of land set aside to conserve the scenery (or environment) and natural objects and the wildlife therein. Under sec. 35 of the wildlife Protection Act (1972), whenever it appears to the State Government that an area, whether within a sanctuary or not, is by reason of its ecological, faunal, floral, geomorphological or zoological importance, needed to be constituted as a National park for the purpose of propagating or developing wildlife therein or its environment, it may, by notification, declare its intention to constitute such as a National Park.

All kinds of destruction, exploitation and removal of wildlife and damage to the habitat of any animal are strictly prohibited inside a National park. Grazing of domestic animals is also prohibited. However, the Chief Wildlife Warden may, after prior approval of the state government, permit destruction, exploitation and removal of wildlife from the NP if necessary for the improvement and better management of wildlife therein.

Wildlife Sanctuaries (WLS)

Similar to the National park, a wildlife sanctuary is dedicated to protect wildlife, but it considers the conservation of species only and also the boundary of it is not limited by state legislation. Under Section 26-A (b) of the Wildlife (Protection) Act of 1972, the state government may declare any area comprised

within any reserve forest or any part of territorial waters which is considered to be of adequate ecological, faunal, floral, geomorphological, natural or zoological significance for the purpose of protecting, propagating or developing wildlife or its environment to be included in a sanctuary. As per provision of the Wildlife (Protection) Act of 1972 no person shall destroy, exploit or remove any wildlife from a sanctuary, or destroy or damage the habitat of any wild animal or deprive any wild animal from its habitat, except the permission granted by Chief Wildlife Warden, after prior approval of the state government. Also, no person allowed moving freely inside the sanctuary except with the permission of the authorities. The permanent residents of the area are bound to perform certain duties such as helping in controlling fire damage, to report about dead animals and render all kinds of help in resisting the offenders.

Conservation Reserves can be declared by the State Governments in any area owned by the Government, particularly the areas adjacent to National Parks and Sanctuaries and those areas which link one Protected Area with another. Such declaration should be made after having consultations with the local communities. Conservation Reserves are declared for the purpose of protecting landscapes, seascapes, flora and fauna and their habitat. The rights of people living inside a Conservation Reserve are not affected.

Community Reserves can be declared by the State Government in any private or community land, not comprised within a National Park,

Sanctuary or a Conservation Reserve, where an individual or a community has volunteered to conserve wildlife and its habitat. Community Reserves are declared for the purpose of protecting fauna, flora and traditional or cultural conservation values and practices. As in the case of a Conservation Reserve, the rights of people living inside a Community Reserve are not affected.

Biosphere Reserve

Biosphere reserves have been described as undisturbed natural areas for scientific study as well as areas in which conditions of disturbance are under control. They have been set aside for ecological research and habitat preservation. Biosphere Reserves are areas of terrestrial and coastal ecosystems which are internationally recognized within the framework of UNESCO's Man and Biosphere (MAB) Programme launched in 1971. These reserves are required to meet a minimal set of criteria and adhere to a minimal set of conditions before being admitted to the World Network of Biosphere Reserves designated by UNESCO for inclusion in the World Network of Biosphere Reserves. The world's major ecosystem types and landscapes are represented in this Network, which is devoted to conserving biological diversity, promoting research and monitoring as well as seeking to provide models of sustainable development in the service of mankind. The objectives of the programme are:

- Conserve biotic diversity for ecological evidence.
- Safeguard genetic diversity for the process of evolution to act upon.

- Provide natural areas for basic and applied research in ecology and environmental biology.
- Provide opportunity for environmental education and training.
- Promote international co-operation.
- Promote appropriate sustainable management of the available biotic resources.
- Disseminate the experience so as to promote sustainable development elsewhere.

These reserves are rich in biological and cultural diversity and encompass unique features of exceptionally pristine nature. The goal is to facilitate conservation of representative landscapes and their immense biological diversity and cultural heritage, foster economic and human development which is culturally and ecologically sustainable and to provide support for research, monitoring, education and information exchange. The Scheme is a pioneering effort at pursuing the increasingly difficult yet urgent task of conserving ecological diversity under mounting pressures. The main features of biosphere reserve are:

- They are representative areas of specific terrestrial and coastal environment of country, continent or the entire earth planet that must be conserved for posterity;
- They are representative example of the natural or minimally disturbed ecosystem;
- The extent and size of such areas is large enough to function as a unit of conservation; and

- Biosphere Reserves remain and function as an open system; changes in land use are not usually allowed.

As of May 2008, under UNESCO-MAB Programme, 531 biosphere reserves have been established in 105 countries. This list includes four biosphere reserves from India, namely Sunderbans (West Bengal), Gulf of Mannar (Tamil Nadu), Nilgiri (Tamil Nadu, Kerala and Karnataka) and Nanda Devi (Uttaranchal) biosphere reserves in its Network of Biosphere reserves. Efforts are on for getting remaining Biosphere Reserves included in the World Network of Biosphere Reserve.

The country's first biosphere reserve came into being on 1st August 1986 in Nilgiri, covering 5520 km² in Tamil Nadu, Kerala and Karnataka. Including this one, in all 18 Biosphere Reserves covering an area of 86,626.59km² (Table- 7), have been set up in the country till 2012 (MoEF Annual Report, 2012). In addition, a number of potential sites are under consideration to be designed as biosphere reserves.

The eighteen Biosphere Reserves set up in the country so far not only aim to protect representative ecosystems, but also serve as laboratories for evolving alternative models of development. The Ministry of Environment and Forestry (MoEF) provided financial assistance to the respective State Governments for conservation and management of these Biosphere Reserves. Research and development projects were also supported. Biosphere Reserves of the country qualify the essential criteria i.e. they:

- represent an ecological protectorate,
- occur in a definite biogeographic region,
- contains abundant genetic diversity (India harbor nearly 49,219 plant and 81, 251 animal species),
- have complete structure and size sufficient to ensure efficient conservation,
- have ample opportunities for research in ecology/environment, population, genetics, evolutionary biology, plant-animal interaction, eco-development, etc., and
- receive adequate long-term legal protection.

Basically the Biosphere Reserve is consisting of two zones (Fig. 3):

- (i) **Core zone** forming the *sanctum sanctorum*, and
- (ii) **Buffer zone** that concentrically surrounds the core zone.

The Biosphere Reserves are constituted on a ‘core-buffer strategy’. The core area is kept free of biotic disturbances and forestry operations, where collection of minor forest produce, grazing, human disturbances are not allowed within. However, the buffer zone is managed as a ‘multiple use area’ with twin objectives of providing habitat supplement to the spillover population of wild animals from the core conservation unit, and to provide site specific eco-developmental inputs to surrounding villages for relieving the impact on the core. No relocation is visualized in the buffer area, and forestry operations, Non-Timber Forest Produce (NTFP) collection and other rights and concessions to the indigenous communities are permitted in a regulated

manner to complement the initiatives in the core unit.

Wetlands, Mangroves and Coral Reefs

Wetlands

Several wetlands, mangroves and coral reefs have been identified for conservation and management of specific biodiversity. National Wetland Committee was constituted in 1989. The committee in the same year identified 16 wetlands, which need conservation measures. Recognizing the fundamental ecological function of wetlands and their economic cultural, scientific and recreational value, an international convention (Ramsar Convention) was held of Ramsar, Iran on February 2, 1971 and came into force on December 21, 1975. As of January, 157 nations signed the treaty. The Ramsar convention identified 1708 sites covering around 15,30,000 km². This includes 25 wetlands in the country which needs protection. Recently in September 2012, Nalsarovar in Gujrat added into this list as 26th Ramsar site.

Mangroves and Coral Reefs

The National Environmental Policy, 2006 recognizes that mangroves and coral reefs are important coastal environmental resources. They provide habits for marine species, protection from extreme weather events, and a resource base sustainable tourism.

The mangrove cover in the country occupies an area of 4,500 km² (0.15% of the geographical area) along the coastal states/UTs (MoEF, 2007-08) an about five percent of the World’s mangrove vegetation. To protect and conserve this most fragile ecosystem, Mangrove

Conservation Programme was launched in 1987. It has so far identified 38 mangrove areas for intensive conservation and management. West Bengal has maximum of mangrove cover in the country followed by Gujarat and Andaman & Nicobar Island. MoEF has established a National Mangrove Genetic Resources Centre in Orissa.

The Indian coral reef area is estimated to be 2,375 km². India has four coral reef areas in the Gulf of Mannar, Gulf of Kutchh, Lakshadweep Island and Andaman & Nicobar Island. Their conservation and management is being implemented since 1987. There is a National Coral Reef Research Centre at Port Blair.

Taxa	Species		Percentage of India to the world
	India	World	
Bacteria	850	8,050	10.56
Algae	6,500	40,000	16-25
Viruses	Unknown	4,000	-
Fungi	14,500	72,000	20.14
Lichens	2,021	35,000	14.97
Bryophyta	2,825	17,000	16.62
Pteridophyta	1,200	13,025*	9.21
Gymnosperms	48	980*	4.90
Angiosperms	18,000+	2,58,650*	6.96
Total	45,944	4,27,205	10.75

Source: ENVIS, BSI, 2006; IUCN Red List 2007*

Table 1: Comparative account of recorded number of plant species in India and the world

Taxa	Species		Percentage of India to the world
	India	World	
Protista	2,577	31,290	8.24
Mollusca	5,070	81,000*	6.26
Arthropoda	68,389	9,90,000*	6.91
Other invertebrates	8,329	1,30,200*	6.40
Protochordata	119	2,106	5.65
Pisces	2,546	30,000*	8.49
Amphibia	209	6,199*	3.37
Reptilia	456	8,240*	5.53
Aves	1,232	9,956*	12.37
Mammalia	390	5,416*	7.20
Total	89,317	12,94,407	6.90

Source: MoEF 1999; IUCN Red List 2007*

Table 2: Comparative account of recorded number of animal species in India and the world

Species Globally assessed	63,837
Extinct	81
Extinct in the wild	63
Critically endangered	3,947
Endangered	5,766
Vulnerable	10,104
Near threatened	4,467

Source: IUCN Red List 2012

Table 3: IUCN Red List of threatened species 2012

Group	Total no. of species in India	No. of endemic species	Percentage
Marine algae	624	63	1
Fungi	14,500	3,500	24
Lichens	2,021	466	23
Liverworts	850	260	30
Mosses	2,000	678	34
Pteridophytes	1,200	193	16
Gymnosperms	48	7	2
Angiosperms	17,500	6,200	36

Source: BSI, 2009

Table 4: Endemism in different groups of plants of India

Critically Endangered (CR)	57 (including 15 Birds)
Endangered (EN)	310
Birds	14
Mammals	38
Fish	69
Amphibians	32
Vulnerable (VU)	51

Source: IUCN Red List 2012

Table 5: Threatened animal species in India

S. No.	Name of State/UT	No. of National Parks	No. of Wildlife Sanctuaries	No. of Conservation Reserves	No. of Community Reserves
1	Andhra Pradesh	6	21	0	0
2	Arunachal Pradesh	2	11	0	0
3	Assam	5	18	0	0
4	Bihar	1	12	0	0
5	Chhattisgarh	3	11	0	0
6	Goa	1	6	0	0
7	Gujarat	4	23	1	0
8	Haryana	2	8	2	0
9	Himachal Pradesh	5	32	0	0
10	Jammu & Kashmir	4	15	34	0
11	Jharkhand	1	11	0	0
12	Karnataka	5	22	2	1
13	Kerala	6	16	0	1
14	Madhya Pradesh	9	25	0	0
15	Maharashtra	6	35	1	0
16	Manipur	1	1	0	0
17	Meghalaya	2	3	0	0
18	Mizoram	2	8	0	0
19	Nagaland	1	3	0	0
20	Orissa	2	18	0	0
21	Punjab	0	12	1	2
22	Rajasthan	5	25	3	0
23	Sikkim	1	7	0	0
24	Tamil Nadu	5	21	1	0
25	Tripura	2	4	0	0
26	Uttar Pradesh	1	23	0	0
27	Uttarakhand	6	6	2	0
28	West Bengal	5	15	0	0
29	Andaman & Nicobar	9	96	0	0
30	Chandigarh	0	2	0	0
31	Dadar & Nagar Haweli	0	1	0	0
32	Lakshadweep	0	1	0	0
33	Daman & Diu	0	1	0	0
34	Delhi	0	1	0	0
35	Pondicherry	0	1	0	0
	TOTAL	102	515	47	4

Source: MoEF report of protected area network, 2009

Table 6: State-wise details of the Protected Area Network of the country

S. No.	Name	State	Date of establishment	Area (km ²)
1	*Nilgiri	Tamilnadu, Kerla, & Karnataka	01.09.1986	5520.00
2	*Nanda devi	Uttarakhand	18.01.1988	5860.69
3	*Nokrek	Meghalaya	01.09.1988	82.00
4	Manas	Assam	14.03.1989	2837.00
5	*Sundarbans	West Bengal	29.03.1989	9630.00
6	*Gulf of Mannar	Tamil Nadu	18.02.1989	10500.00
7	Great Nicobar	Andaman & Nicobar Island	06.01.1989	885.00
8	*Simplipal	Orissa	21.06.1994	4374.00
9	Dibru-Saikhowa	Assam	28.07.1997	765.00
10	Dehang-Debang	Andhra Pradesh	02.09.1998	5111.50
11	*Panchmarhi	Madhya Pradesh	03.03.1999	4926.00
12	Khangchendzonga	Sikkim	07.02.2000	2619.92
13	Agasthiyamalai	Tamil Nadu & Kerala	12.11.2001	1701.00
14	Achanakamar- Amarkantak	Madhya Pradesh & Chhattisgarh	30.03.2005	3835.51
15	Kachchh	Gujarat	29.01.2008	12454.00
16	Cold Desert	Himachal Pradesh	28.08.2009	7770.00
17	Seshachalam	Andhra Pradesh	29.09.2010	4755.99
18	Panna	Madhya Pradesh	25.08.2011	2998.98
				86626.59

Note: *Sites which have been included in the World Network of Biosphere Reserves of UNESCO.
 Source: MoEF Annual Report 2012.

Table 7: Biosphere Reserves of India

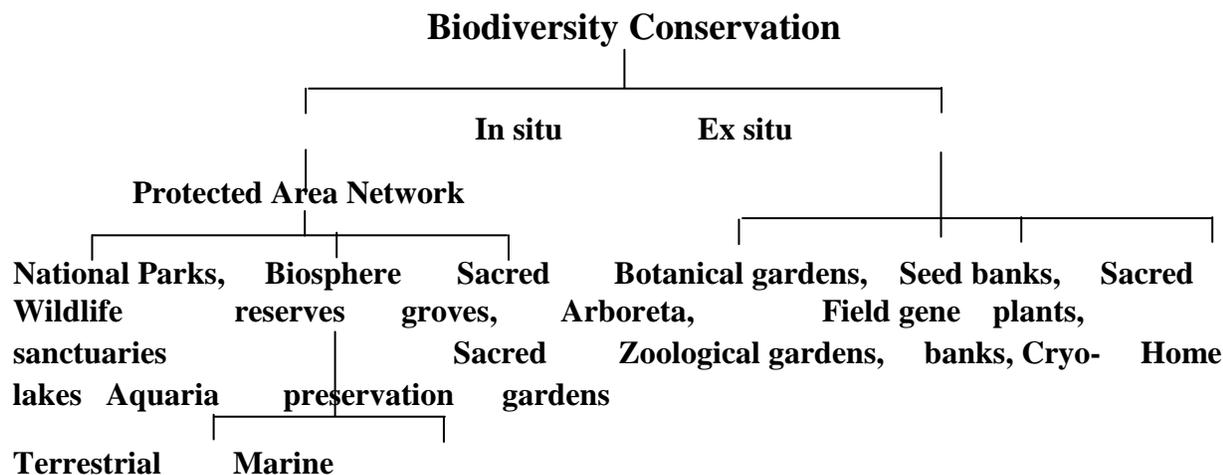


Fig. 1: The *in-situ* and *ex-situ* approaches of conserving biodiversity in India

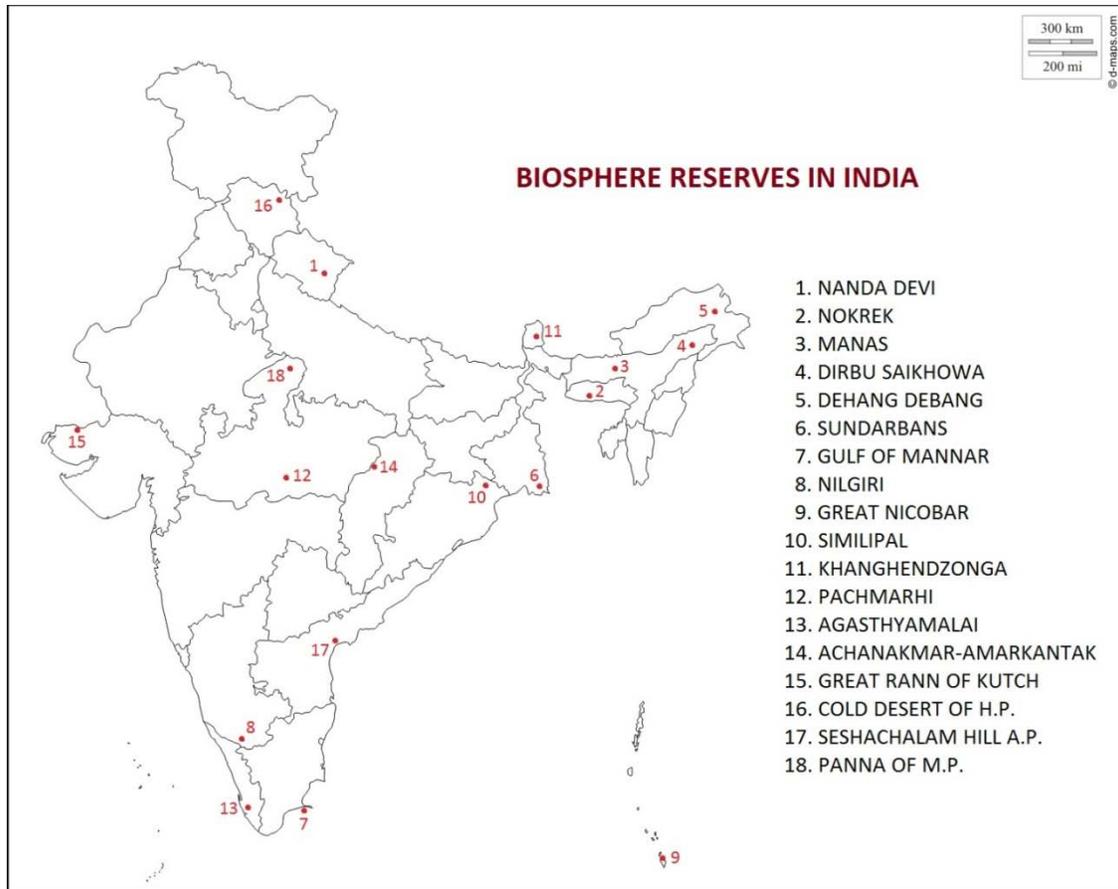


Fig. 2: Map showing the sites of 18 Biosphere Reserves setup in India

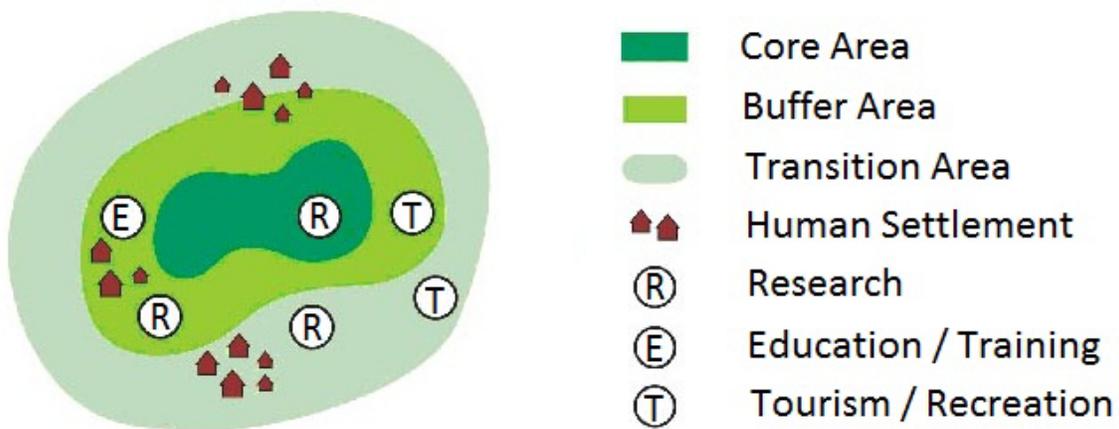


Fig. 3: Structure of a model biosphere reserve

Name	Objectives	Features	Zone
National Parks	Conservation of species of a habitat with minimal or very low intensity of human activity.	No human resides in the Park, other than a public servant on duty and permitted persons by the Chief Wild Life Warden.	Core
Sanctuaries	Conservation of species and habitats by manipulative management.	No human resides in the Sanctuary, other than a public servant on duty and permitted persons by the Chief Wild Life Warden.	Core, Buffer and Restoration
Biosphere Reserves	Conservation of the natural resources and for the improvement of the relationship between man and the environment therein.	Both natural and human-influenced ecosystems; substantial human settlements (rural).	Core, Buffer, Restoration and Cultural

Table 8: Difference between the protected area categories

Name	State	Date of Notification	Area (km ²)
Ashtamudi Wetland	Kerala	19/08/02	614
Bhitarkanika Mangroves	Orissa	19/08/02	650
Bhoj Wetland	Madhya Pradesh	19/08/02	32
Chandra Taal	Himachal Pradesh	08/11/05	.49
Chilika Lake	Orissa	01/10/81	1165
DeeporBeel	Assam	19/08/02	40
East Calcutta Wetlands	West Bengal	19/08/02	125
Harike Wetland	Punjab	23/03/90	41
Hokersar Wetland	Jammu and Kashmir	08/11/05	13.75
Kanjli Wetland	Punjab	22/01/02	1.83
Keoladeo National Park	Rajasthan	01/10/81	28.73
Kolleru Lake	Andhra Pradesh	19/08/02	901
Loktak Lake	Manipur	23/03/90	266
Nalsarovar Bird Sanctuary	Gujarat	24/09/12	123
Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu	19/08/02	385
Pong Dam Lake	Himachal Pradesh	19/08/02	156.62
Renuka Wetland	Himachal Pradesh	08/11/05	.2
Ropar	Punjab	22/01/02	13.65
Rudrasagar Lake	Tripura	08/11/05	2.4
Sambhar Lake	Rajasthan	23/03/90	240
Sasthamkotta Lake	Kerala	19/08/02	3.73
Surinsar-Mansar Lakes	Jammu and Kashmir	08/11/05	3.5
ThrissurKole Wetlands	Kerala	08/11/05	546.25
Tsomoriri	Jammu and Kashmir	19/08/02	120
Upper Ganga River (Brijghat to Narora Stretch)	Uttar Pradesh	08/11/05	265.9
Vembanad-Kol Wetland	Kerala	19/08/02	1512.5
Wular Lake	Jammu and Kashmir	23/03/90	189

Source: http://en.wikipedia.org/wiki/List_of_Ramsar_Sites_in_India

Table 9: The list of Ramsar Sites in India (as of September 24, 2012)

West Coast			East Coast		
01	Gulf of Khambat	Gujarat	17	Sunderbans	West Bengal
02	Gulf of Kutchh	Gujarat	18	Bhitarkanika	Orissa
03	Malvan	Maharashtra	19	Mahanadi	Orissa
04	Vasasi-Manori	Maharashtra	20	Subernarekha	Orissa
05	Vaitarna	Maharashtra	21	Devi	Orissa
06	Shrivardhan	Maharashtra	22	Dhamra	Orissa
07	Vikroli	Maharashtra	23	Bhitarkanika	Orissa
08	Mumbra-Diva	Maharashtra	24	Chilka	Orissa
09	Kundalika-Ravdana	Maharashtra	25	Coringa	Andhra Pradesh
10	Veldur	Maharashtra	26	East Godavari	Andhra Pradesh
11	Devgarh-Vijay Dur	Maharashtra	27	Krishna	Andhra Pradesh
12	Achra-Ratnagiri	Maharashtra	28	Pichavaram	Tamil Nadu
13	Karwar	Karnataka	29	Muthupet	Tamil Nadu
14	Dakshin Kannada /Honnavar	Karnataka	30	Ramnad	Tamil Nadu
15	Coondapur	Karnataka	31	Pulicat	Tamil Nadu
16	Vembanad	Kerala	32	Kazhuveli	Tamil Nadu
			33	North Andamans	Andaman & Nicobar Islands
			34	Nicobar	Andaman & Nicobar Islands

Source: http://en.wikipedia.org/wiki/Mangroves_in_India

Table 10: Mangrove areas in India

S. No.	Natural Heritage site	State	Year of Notification
01	Kaziranga national Park	Assam	1985
02	Keoladeo National Park	Rajasthan	1985
03	Manas National Park	Assam	1985
04	Sunderbans National park	West Bengal	1987
05	Nanda Devi National Park	Uttaranchal	1988
06	Western Ghats cluster	Maharashtra, Karnataka, Kerala, Tamilnadu	2012
07	Great Himalayan National Park	Himanchal Pradesh	2014

Source: https://en.wikipedia.org/wiki/List_of_World_Heritage_Sites_in_India

Table 11: World Natural Heritage sites in India

State	No. of Sacred groves	Local Names
Andhra Pradesh	691	<i>Pavitraskhetralu</i>
Arunachal Pradesh	65	<i>Gumpa Forest</i> (since attached to monasteries)
Assam	40	<i>Than, Madaico</i>
Chhattishgarh	600*	<i>Sarna, Devlas, Mandar, Budhadev</i>
Goa	NA*	-
Gujarat	29*	-
Haryana	248	<i>Beed or Bid, Bani, Bann, Janglat, Shamlat</i>
Himachal Pradesh	5000	<i>Deobhumi</i>
Jharkhand	21*	<i>Sarna</i> more than 500 "Jaherthan" in Godda of Jharkhand
Karnataka	1424	<i>Devarakadu, Devkad</i>
Kerala	2000	<i>Kavu, SarpaKavu</i>
Maharashtra	1600	<i>Deorai / Devrai</i>
Manipur	365	<i>Gamkhap, Mauhak</i> (sacred bamboo reserves)
Meghalaya	79	<i>Law kyntang, Law Lyngdoh</i>
Orissa	322*	<i>Jahera, Thakuramma</i>
Puducherry	108	<i>KovilKadu</i>
Rajasthan	9*	<i>Oran, Kenkri, Vani, Shamlatdeh, Devbani, Jogmaya</i>
Sikkim	56	<i>Gumpa forests</i> (since attached to monasteries)
Tamil Nadu	503	<i>KovilKadu</i>
Telangana	65	-
Uttarakhand	18*	<i>Devbhumi, Bugyal</i> (sacred alpine meadows)
West Bengal	670*	<i>Garamthan, Harithan, Jahera, Sabitrithan, Santalburithan</i>

Source: Database at the CPR Environmental Education Centre.

* Started numbers are likely to increase

Table 12: State wise list of number of sacred groves in India

Name	Location	Name	Location
Aizawl Zoo	Aizawl, Mizoram	Marble Palace zoo	Kolkata, West Bengal
Alipore Zoological Gardens	Kolkata, West Bengal	Madras Crocodile Bank Trust	Chennai, Tamil Nadu
Allen Forest Zoo	Kanpur, Uttar Pradesh	MaitriBagh	Bhilainagar, Chhattisgarh
Amirthi Zoological Park	Vellore, Tamil Nadu	Mysore Zoo	Mysore, Karnataka
Arignar Anna Zoological Park (Vandalur Zoo)	Chennai, Tamil Nadu	Nandankanan Zoo	Bhubaneswar, Orissa
Assam State Zoo-cum-Botanical Garden	Guwahati, Assam	National Zoological Park	Delhi
Bannerghatta National Park	Bengaluru	Nehru Zoological Park	Hyderabad, Andhra Pradesh
Bhiwani Zoo	Haryana	Padmaja Naidu Himalayan Zoological Park	Darjeeling, West Bengal
Birsa Deer Park	Ranchi	Parassinikkadavu Snake Park	Kannur, Kerala
ChattBir Zoo	Zirakpur, Punjab	Peacock and Chinkara Breeding Centre	Rewari, Haryana
Chennai Snake Park Trust	Chennai, Tamil Nadu	Pt. G.B. Pant High Altitude Zoo	Nainital, Uttarakhand
Chinkara Breeding Centre	Kairu, Bhiwani, Haryana	Rajiv Gandhi Zoological Park	Pune, Maharashtra
Crocodile Breeding Centre	Kurukshetra, Haryana	Ranchi Zoo (BhagwanBirsamunda Biological Park)	Ranchi, Jharkhand
Gopalpur Zoo	Udaipur, Rajasthan	Sakkarbaug Zoological Garden	Junagadh, Gujarat
GulabBagh and Zoo	Udaipur, Rajasthan	Sanjay Gandhi JaivikUdyan	Patna, Bihar
Hisar Deer Park	Haryana	Sarhana Zoo	Surat, Gujarat
Indira Gandhi Zoological Park	Visakhapatnam, Andhra Pradesh	SayajiBaug Zoo	Vadodara, Gujarat
Indore Zoo	Indore, Madhya Pradesh	Sipahijola Wildlife Sanctuary	Tripura
Jaipur Zoo	Jaipur, Rajasthan	Sri Venkateswara Zoological Park	Tirupati, Andhra Pradesh
Jawaharlal Nehru Biological Park	Bokaro Steel City	Tata Steel Zoological Park	Jamshedpur, Jharkhand
Jhargram Zoo	Jhargram, West Bengal	Thiruvananthapuram Zoo	Trivandrum, Kerala
JijamataUdyaan	Mumbai, Maharashtra	Thrissur Zoo	Thrissur, Kerala
KananPendari Zoo	Bilaspur, Chhattisgarh	Tilyar Zoo	Rohtak, Haryana
Kankaria Zoo	Ahmedabad, Gujarat	Vulture Conservation and Breeding Centre	Pinjore, Haryana
Kanpur Zoo	Kanpur, Uttar Pradesh		
Lucknow Zoo	Lucknow, Uttar Pradesh		

Source: Central Zoo Authority (CZA). www.cza.nic.in**Table 13:** Important Zoos in India

Name	Location
Bagh-e-Bahu Aquarium	Jammu, Jammu and Kashmir
Bangalore Aquarium	Bangalore, Karnataka
Calcutta Aquarium	Kolkata, West Bengal
Central Institute of Freshwater Aquaculture (CIFA) Aquarium	Bhubaneswar, Orissa
Dr. A.M. Michael Aquarium	Kochi, Kerala
District Tourism Promotion Council (DTPC) Aquarium	Kozhikode, Kerala
ICAR-NBFGR Ganga Aquarium	Lucknow, Uttar Pradesh
Jagdishchandra Bose Aquarium	Surat, Gujarat
Jawahar Aquarium	Missoorie, Uttarakhand
Kankaria Aquarium	Ahmedabad, Gujarat
Kollam Aquarium	Kollam, Kerala
LalBagh aquarium	Bangalore, Karnataka
MachhliGhar	Bhopal, Madhya Pradesh
Marine Biological Research Station	Ratnagiri, Maharashtra
Marine Life Aquarium	Chennai, Tamil Nadu
Matsyadarsini Aquarium	Visakhapatnam, Andhra Pradesh
Nandankanan Zoo Aquarium	Bhubaneswar, Orissa
Sanjay Gandhi jaivikudhan	Patna, Bihar
Star aquarium	Karunagappally, Kerala
Taraporewala Aquarium	Mumbai, Maharashtra
Travancore Royal Aquarium	Trivandrum, Kerala
Varkala Aquarium	Trivandrum, Kerala

Source: http://en.wikipedia.org/wiki/List_of_aquaria_in_India**Table 14:** Important aquaria in India

Name	Location
Acharya Jagadish Chandra Bose Indian Botanic Garden	Shibpur, Kolkata
Agri Horticultural Society of India	Alipore, Kolkata
Auroville Botanical Garden	Auroville, Tamil Nadu
Assam State Zoo-cum-Botanical Garden,	Guwahati, Assam
Botanical Garden, Near Sarangpur	Chandigarh
Botanical Garden of Forest Research Institute	Dehradun, Uttarakhand
Curzon Park	Mysore, Karnataka
Empress Garden	Pune, Maharashtra
The Garça Branca Ayurvedic Botanical Garden	Loutolim, Goa
Garden of Medicinal Plants, North Bengal University	West Bengal
Government Botanical Gardens, Ootacamund	Nilgiris district, Tamil Nadu
IFGTB Botanical Garden – The Institute of Forest Genetics and Tree Breeding (IFGTB)	Coimbatore, Tamil Nadu
Jawaharlal Nehru Tropical Botanic Garden and Research Institute (TBGRI)	Trivandrum, Kerala
Jammu and Kashmir Medicinal Plants Introduction Centre	Sonamarag, Kashmir
Jhansi Botanical Garden	Jhansi, Uttar Pradesh
Lalbagh	Bangalore, Karnataka
Lloyd's Botanical Garden	Darjeeling, West Bengal
Malampuzha Garden	Palakkad, Kerala
Narendra Narayan Park	Cooch Bihar, West Bengal
Odisha State Botanical Garden Nandankannan	Bhubaneswar, Odisha
Pilikula Arboretum (Pilikula Botanical Garden)	Mangalore, Karnataka
R. B. Botanical Garden and Amusement Park	Ahmedabad, Gujarat
Regional Museum of Natural History	Mysore, Karnataka
Saharanpur Botanical Garden	Saharanpur, Uttar Pradesh
Semmozhi Poonga	Chennai, Tamil Nadu
University of Mysore Botanical Garden	Mysore, Karnataka
Vellayani Agricultural College	Trivandrum, Kerala

Source: http://en.wikipedia.org/wiki/Botanical_Gardns_in_India**Table 15:** Important Botanical Gardens in India

S. No.	Name of the Institution	Category of Biological Resources	Web Link
1.	Botanical Survey of India, Kolkata	Flora (Angiosperms, Gymnosperms, Pteridophytes, Bryophytes, Lichens, Macrofungi, Macroalgae)	http://164.100.52.111/
2.	National Bureau of Plant Genetic Resources, New Delhi	Plant Genetic Resource	http://www.nbgr.ernet.in/
3.	National Botanical Research Institute, Lucknow	Flora (Angiosperms, Gymnosperms, Pteridophytes, Bryophytes, Lichens, Macrofungi, Macroalgae)	http://www.nbri.res.in/#
4.	Indian Council of forestry Research and Education, Dehradun (Forest Research Institute, Dehradun; Institute of Forest Genetics and Tree Breeding, Coimbatore; and Tropical Forest Research Institute, Jabalpur)	Flora (Angiosperms, Gymnosperms, Pteridophytes, Bryophytes, Lichens, Macrofungi, Macroalgae) For TFRI only – Fauna (termites, butterflies, moths)	http://www.icfre.org/ http://ifgtb.icfre.gov.in/ http://tfri.icfre.gov.in/
5.	Zoological Survey of India, Kolkata	Fauna	http://zsi.gov.in/
6.	National Bureau of Animal Genetic Resources, Karnal, Haryana	Genetic resources of domestic animals	http://www.nbagr.res.in/
7.	National Bureau of Fish Genetic Resources, Lucknow	Fish genetic resources	http://www.nbfr.res.in/
8.	National Institute of Oceanography, Goa	Marine flora and fauna	http://www.nio.org/
9.	Wildlife Institute of India, Dehradun	Faunal resources in protected Areas	www.wii.gov.in
10.	National Bureau of Agriculturally Important Micro-organisms, Mau Nathan Bhanjan, U.P.	Agriculturally important micro-organisms	http://www.nbaim.org.in/
11.	Institute of Microbial Technology, Chandigarh	Microorganisms	http://www.imtech.res.in/
12.	National Institute of virology, Pune	Viruses	http://www.niv.co.in/
13.	Indian Agricultural Research Institute, Delhi	Microbes/Fungi	http://www.iari.res.in/
14.	National Bureau of Agriculturally important insects, Bangalore	Insects	http://www.nbaii.res.in/

Table 16: Indian Repositories

Special Projects for Endangered Wildlife

These special projects have been designated for species specific management of endangered species and their habitats.

Project Tiger

In India Project Tiger was launched in 1973 with an objective “to ensure maintenance of a viable population of tigers in India for scientific, economic, aesthetic, cultural and ecological values and to preserve for all times areas of biological importance as a national heritage for benefit and enjoyment of the people”. The Project has been successfully implemented and under this project, 44 Tiger Reserves have been set up in the country till June 2011, covering an area of over 52,653 km² of tiger habitat distributed in 21 states and few more have been proposed..

However, due to intense poaching, there is decline in tiger reserves as well as in wild. For strengthening tiger conservation measures and ensuring anti-poaching activities, National Tiger Conservation Authority and Crime Control Bureau were constituted w.e.f. 04.09.2006 and 06.06.2007, respectively. According to an estimate the number of tigers which was about 4026 in 1989 went down to about 1233 in 2000.

Surprisingly no tiger in Sariska is seen since 2004. A survey of numbers of tigers in 2011 revealed that there are about 1706 tigers in India.

The Project Tiger is undisputedly the custodian of major gene pool of the country and a repository of some of the most valuable ecosystems and habitats for wildlife.

Project Elephant

This was launched in 1992 with the aim at ensuring long term survival of identified viable populations of elephant population. There have been drawn lines to restore the lost and degraded habitats of elephant including creation of corridors for their migration, mitigation of man-elephant conflict and establishment of data base on the migration and population dynamics of elephants. It also aims at improving quality of life of people living around elephant habitats through sustainable development. The project is being implemented in 13 states and 30 Elephant reserves have been established.

Gir Lion Project

The Gir forest in Saurashtra peninsula of Gujarat is unique as the only surviving habitat of the Asian lion *Pantheraleonpersica*. At present in whole of the Asia, this lion is found only in Gir forest of Gujarat. Clearing of forest for agriculture, excessive cattle grazing and other factors led to decline in the lion population.

A five year plan scheme was thus prepared in 1972 by the Govt. of Gujarat for this project. The total area of Gir sanctuary is now 1412,12 km². The central core of about 140.40 km² was constituted as a National Park in 1975. In 1978 an additional area of 118.13 km² was declared as National Park increasing the area to 258.71 km². Ultimately the entire sanctuary was declared as National Park. As a result of this there has been increase in the lion population. In 1968, there were 177 lions in the Gir. This number increases to 180 in 1974.

Crocodile Breeding Project

The project arose from proposal for development of a crocodile farming industry in India and was initiated on 1.4.1974. There are three species of crocodiles in India (i) saltwater or estuarine crocodile (*Crocodylus porosus*) (ii) freshwater, swamp crocodile i.e. mugger (*C. palustris*), and (iii) gharial (*Gavialis gangeticus*).

Crocodile population decline worldwide in poster period. Crocodile hunting is legally banned in India. Work on project was begun on 01.04.1975 in Orissa. Gharial eggs were hatched for the first time in captivity anywhere in the world at Tikerpada, Distt. Dhenkanal, Orissa in June 1975. A small batch was also hatched at Kurkrail, near Lucknow same year. Crocodile husbandry work was undertaken with a view to sanctuary development. A total of 16 crocodile rearing centers have been developed in the country in eight states (1975-78). Eleven sanctuaries have been declared under the project.

Gharial rehabilitation began in 1977 with the release of 26 animals in Mahanadi River, Orissa. By 1980, 107 animals had been released in the river where wild population had declined to five.

Rhinos Conservation

The great Indian rhinoceros (*Rhinoceros unicornis*) is listed as vulnerable on the IUCN Red List as populations are fragmented and restricted to less than 20,000 km². Moreover, the extent and quality of the rhino's most important habitat, alluvial grassland and riverine forest, is considered to be in decline

due to human and livestock encroachment. The centrally sponsored scheme "Conservation of Rhinos in Assam" was introduced in 1987 and is continued for effective and intensive management of rhino habitats. In 2015, a total of 3,555 Indian rhinoceros are estimated to live in the wild.

Turtle Conservation

Every year at few sites on Orissa coast, hundreds of thousands of Olive Ridley turtles congregate on the beach, between December to April, for mass nesting. There are several threats to these nesting sites. Shrinking nesting sites, construction of roads, and buildings close to these rookeries; and other infrastructure development projects hamper nesting. Marine biologists believe that only one out of every 1000 eggs actually matures into an adult.

After its discovery in 1974, the beach was notified as a sanctuary (the Bhitarkanika Sanctuary) and was closed for hunting. Recognizing the threats to turtles from fishing by large trawlers, the Orissa Marine Fisheries Regulation Act was passed in 1982. This Act prohibited trawling within 10 km of the coastline throughout the state and makes it mandatory for all the state and makes mandatory for all trawlers to use Turtle Excluder Devices (TEDs). In 2001, the state Government of Orissa declared that a five month period between January to May should constituted a no-fishing season for a distance of 20 km from the coastline.

Apart from these initiatives, "Operation Kachhapa" is being coordinated by the Wildlife Protection Society of India, Delhi and Wildlife Society of Orissa with many local

NGOs as partners. The Orissa Forest Department, WII, Dehradun and the Coast Guard are also involved in the project.

Project Snow-Leopard

The Project Snow Leopard was launched in 2009 to safeguard and conserve India's unique natural heritage of high altitude wildlife populations and their habitats by promoting conservation through participatory policies and actions. This is being taken to create 12 snow-leopard reserves throughout the Himalayas, covering Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh and Sikkim. It aims at promoting a knowledge-based and adaptive conservation framework that fully involves the local communities, who share the snow leopard's range, in conservation efforts.

Preservation plots

Preservation plots are also important for conservation of biological diversity. Preservation plots are areas where chief types of forests are identified for preservation and conservation of biological diversity contained in them. This process was started in India in 1905. At present there are over 309 preservation plots all over the country, 287 in natural forest and 22 in plantation forest.

World Natural Heritage Sites

India ratified the World Heritage Convention in 1977, and since then seven natural sites have been taken over as areas of outstanding universal value in terms of biodiversity. These sites are listed in the Table-11, as below:

Sacred Forest and Sacred Lakes

There has been a tradition strategy for the preservation of biodiversity in the form of sacred forest in India and many other Asian countries. Sacred forests are the forest in India and many other Asian countries. Sacred forests are the forest patches of varying dimensions protected by the tribal communities on account of their religious sanctity accorded to them. These represent islands of pristine forest i.e. most undisturbed forests with no human impact, and have been free from all disturbances despite they are frequently surrounded by highly degraded lands. Many states in our country, such as Maharashtra, Karnataka, Meghalaya and Kerala, have sacred forests which are serving as arefugia for many endemic, rare and endangered taxa. Similarly, some fresh water lakes are also serving the purpose of protection of aquatic flora water lakes are also serving the purpose of protection of aquatic flora and fauna. For example Khecheopalrilake in Sikkim has been declared sacred by the people to save aquatic life from being degraded.

The introduction of the protected area category community reserves under the Wildlife (Protection) Amendment Act 2002 has introduced legislation for providing government protection to community held lands, which could include sacred groves. The record of sacred groves in India has been maintained by C.P.R. Environmental Education Center of the Government of India. The state wise list of sacred groves is listed in the Table-12.

Ex situ Conservation

Ex situ conservation means the conservation of biological diversity components outside their natural habitat. It involves cultivation of rare plants/rearing of threatened animals outside of their natural habitats and also holding of plants and animal species in botanical and zoological gardens, and in arboretums or store them in the form of seeds in seed bank (gene banks) or some other suitable forms by means of tissue cultures techniques. There are a number of tissue cultures techniques. There are a number of plant and animal species, which have become more or less extinct in the wild, but they are being conserved in gardens or zoos, e.g. cheetah (*Acinonyx jubatus*).

Reintroduction of an animal or plant in the habitat from where it has become extinct is another form of ex situ conservation. The great Indian rhinoceros (*Rhinoceros unicornis*) has been reintroduced in the Dudhwa National Park, in an area where it has become extinct. The Gangetic gharial (*Gavialis gangeticus*) is being reintroduced in the rivers of Madhya Pradesh, Uttar Pradesh, and Rajasthan where it has become extinct.

However, because of the prohibitive cost captive breeding should only be restored to when populations are in imminent danger of extinction in the wild. Therefore, priorities in selecting species for captive breeding efforts in zoos need to be carefully established. Some of the steps involved in ex situ conservation of animals species include:

- establishing minimum target population goals to provide for maintenance of captive

genetic diversity at least for the next 100 years,

- compiling animal husbandry programmes for circulation to all breeding facilities, and
- implement an overall plan that contributes to the objectives of maintaining viable captive populations across the globe.

Reintroduction of the threatened plant species is done in the same way, in the areas from where they have become extinct: rare, endangered and even plants, which are extinct in their natural habitats, are cultivated in gardens.

Apart from zoological gardens and captive breeding programmes, the new scientific advances in the case of genetic mapping and manipulation, artificial insemination, embryo transfer, cloning and germplasm preservation and gene bank can contribute to survival of the rare animals. Some of these ex situ conservation methods are as follow:

Zoological Parks

There are roughly 5,00,000 mammals, birds, reptiles and amphibians in captivity in zoos throughout the world. Zoos contribute in many ways to the conservation of biodiversity:

- They propagate and reintroduce endangered species;
- They serve as centers for research to improve management of captive and wild populations; and
- They raise public awareness for biotic improvement.
- They enlighten the public that animals are equally important and are essential for the life support system.

The contributions that zoos have already made to the conservation of biodiversity are dramatic. Zoo populations are now the only representatives of several species including the California condor (*Gymnogypus californianus*) and possibly the Black-footed ferret (*Mustela nigripes*) and at least 18 species have been reintroduced into the wild after captive propagation.

In India first Zoo was set up in Madras in the year 1855, which was soon followed by Trivendrum (1857), Bombay (1863), Calcutta (1875), Jaipur (1876), and Udaipur (1878). After independence a number of zoos were set up. The important ones are Municipal Hill Garden Zoo (Ahmedabad), Delhi Zoological Park (Delhi), Himalayan Zoological Park (Darjeeling), Nehru Zoological Park (Hyderabad), Assam State Zoo (Guwahati), Van Vihar (Bhopal), Nandankanan (Bhubaneswar), Sakkarbang zoo (Junagarh) etc.

In the country, central Zoo authority (CZA) has been created through an amendment of the Wildlife (Protection) Act in 1979. Main functions of the CZA are:

- Specify minimum standards for housing, upkeep and care of the animals in the zoos,
- Recognition of zoos on the basis of evaluation of their functioning,
- Identify endangered species of wild animals for the purpose of captive breeding and assigning responsibilities in this regards to zoos,
- Co-ordinate the acquisition, exchange and loading of animals for breeding, and
- Provide technical and other assistance to zoos for management and development on scientific lines.

Rescue Centres

Ministry of Environment and Forests has assigned the responsibility to Central Zoo Authority for creation of rescue centres, for rehabilitation of circus animals, consequent upon ban on performance of wild animals in Circuses. Five rescue centers were identified for creation at Chennai, Visakhapatnam, Tirupati, Bannerghatta (Bangalore) and Nahargarh (Jaipur). All the five rescue centers have already been established and are functional. A total of 179 lions, 33 tigers, 18 bears, 8 panthers, and 11 monkeys have been rescued from circuses and are now being housed in these centres. The Central Zoo Authority has released Rs. 186.10 lakhs towards establishment of rescue centres and feeding and health care for these animals.

Aquaria

The role of aquaria in the captive propagation of threatened freshwater species is significant. Accordingly, the captive Breeding Specialist Group of the World Conservation Union (IUCN) is mounting a major effort to develop captive breeding programmes for endangered fish species, starting from the lake Victoria, the desert fishes of North America, and Appalachian stream fishes. The programme shall also include the restoration of natural habitats, provides protection against loss of wild restoration of natural habitats, provides protection against loss of wild species and help educate the public on threats to fishes.

Botanical Gardens

There are more than 2000 botanical gardens in over 150 countries; together they maintain 6 million accessions in their living collections and 142 million herbaria specimens. The Royal Botanical Gardens of England (Kew Gardens) alone contain an estimated 25,000 species of plants (10 percent of the world's flora); and IUCN considers some 2,700 of these species rare, threatened, or endangered. For specific taxa, the coverage afforded by the botanical gardens is even higher. About 300 to 400 of the world's botanical gardens harbor major conservation collections and 250 of these maintain seed banks. By these means, it is possible to save viable population of up to 20,000 plants species from extinction.

The contribution of botanical gardens to the conservation of species extends beyond the preservation of species threatened in wild. Botanical gardens supply plants for research and horticulture, thereby reducing pressure on wild population. Also, they are important education resources. The IUCN Botanical Garden Conservation Secretariat is now developing a computer data base of species occurrences in botanic gardens to help gardens collect species that are absent or underrepresented in captivity. The efforts of botanic gardens in germplasm conservation are being co-ordinating with the IUCN Botanical Garden Conservation Strategy. In association with the International Board for Plant Genetic Resources (IBPGR), IUCN is also putting together guidelines for collecting germplasm of wild species.

Gene Banks

A gene bank is a facility/institution where valuable plant materials likely to become irretrievably lost in the wild or in cultivation can be preserved in viable condition. Gene banks conserve stocks of both seeds and vegetative plant parts. The seeds of many species can be stored in dry, low temperature, vacuum containers. Storage at extremely low temperature, below -196 °C may extend the life of some of these species to more than a century (cryopreservation). The stored germplasm not only safeguards the species threatened but is also utilized actively by the plant scientists and breeders to develop novel varieties as desired. The technique is efficient, reproducible, and feasible for short, medium and long-term storage.

In a generalized way - a gene bank is temperature-controlled storage unit – essentially a giant ice box – which is meant to preserve biodiversity in the form of seeds, sperms, ovule, tissue culture, pollen and even DNA.

Pollen/Semen Conservation

Preservation of pollen and spores is of significant value for conservation of biodiversity of important flowering and spore bearing plants. The procedure for institution of pollen and spore banks is almost similar to that of gene banks. Cryogenic technique is useful in preserving pollen from flowering or cone bearing plants, and spores from non-flowering plants, such as ferns and mosses. Pollens preservation is thus advantageous over seeds preservation, as it gives opportunity to preserve

the full range of variation within the population in a very simple manner

Pollen grains can be stored under appropriate condition allowing subsequent use for crossing with living plants materials. Stored semen can also be used for artificial insemination in animals. A pollen bank can be an extremely powerful tool in plant breeding since it frees breeders from the tyranny of time. Also, it is useful in selfsterilised plant species.

Tissue Culture Technique

Tissue culture technique becomes necessary under the following conditions:

- If a specific genetic type (clone) is to be conserved and maintained;
- If the seeds progeny are highly variable;
- If plants have recalcitrant seeds; or
- If the seeds are altogether lacking, such as those of sugarcane, banana, arvi etc.

Shoot tips are preferred materials for conservation as they are more stable, easier to regenerate into whole plants, and produce virus free clonal plants. Shoot tips are also convenient materials for international exchange of germplasm.

Tissue culture technique for preserving germplasm has another advantage in that a large number of genotypes can be stored in a relatively small area in culture vessels and generally at a fraction of cost of growing and maintaining large living collections in the field. More importantly, tissue culture provides a means of multiplying “endangered species” with possibility of reintroducing them into their original habitats where they are becoming rare.

Through tissue culture technique it is now also possible to preserve animal cells, spermatozoa, ovarian and embryonic tissues as well as whole animals embryos under extremely low temperature in liquid nitrogen at -196 °C (cryopreservation). These cultures can be used for livestock breeding programmes.

Recombinant DNA Technology

Use of molecular markers for identification of protected species offers a greater promise in the field of conservation biology. The information on genetic diversity of wildlife is necessary to ascertain the genetic deteriorated populations so that better management plans can be established for their conservation. Accurate classification of these threatened species allows understanding of the species biology and identification of distinct populations that should be managed with utmost care. Molecular markers are versatile tools for identification of populations with genetic crisis by comparing genetic diversities that in turn helps to resolve taxonomic uncertainties and to establish management units within species. The genetic markers analysis also provides sensitive and useful tools for prevention of illegal hunting and poaching for more effective implementation of the laws for protection of the endangered species.

Conclusions

It is imperative that the phenomenon of biodiversity is very vast, complex and interdependent and there is no single overarching effect of diversity on either productivity or stability. The realized effects will depend heavily on environmental context

and the time scale over which the effects are studied. However, it has become obvious that biodiversity is indeed important for both managed and natural ecosystems, though the relative contributions of diversity and composition remain unclear. It is therefore necessary for legislators to understand the basic science in order to maintain diversity at its current levels. If current human growth and resource management patterns do not change, it is likely that we will lose many important species, and the ecosystems of the world may never recover. In present paper the various conservation strategies by government, voluntary organizations, public participation as well as the individual efforts have been discussed, that how they commutatively plays a major role for the conservation of the biodiversity.

Human is only one more of natural creatures and should not be alien to the other life-forms. We have no moral right to destroy nature and other beings that dwell on earth. We should treat all animals and plants with compassion. Every individual can make a small and yet significant effort in the race to save our planet and conserve biodiversity.

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