

## **BLOCK 3**

### **BIODIVERSITY**

#### **CHAPTER 1**

#### **GENETIC, SPECIES AND ECOSYSTEM**

#### **INTRODUCTION:**

The variety of life on Earth, its biological diversity is commonly referred to as biodiversity. The number of species of plants, animals, and microorganisms, the enormous diversity of genes in these species, the different ecosystems on the planet, such as deserts, rainforests and coral reefs are all part of a biologically diverse Earth. Appropriate conservation and sustainable development strategies attempt to recognize this as being integral to any approach. Almost all cultures have in some way or form recognized the importance that nature, and its biological diversity has had upon them and the need to maintain it. Yet, power, greed and politics have affected the precarious balance.

The word “biodiversity” is a contracted form of the term ‘biological diversity’. The Convention on Biological Diversity defines biodiversity as: "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems."

Thus, biodiversity includes genetic variation within species, the variety of species in an area, and the variety of habitat types within a landscape. Biological diversity is of fundamental importance to the functioning of all natural and human-engineered ecosystems, and by extension to the ecosystem services that nature provides free of charge to human society. Living organisms play central roles in the cycles of major elements (carbon, nitrogen, and so on) and water in the environment, and diversity specifically is important in that these cycles require numerous interacting species.

#### **Types of Biodiversity**

- 1.Genetic diversity: variety in the genetic makeup among individuals within a species
- 2.Species diversity: variety among the species or distinct types of living organisms found in different habitats of the planet
- 3.Ecosystem or ecological diversity: variety of forests, deserts, grasslands, streams, lakes, oceans, coral reefs, wetlands and other biological communities.

## **1)Genetic biodiversity**

Genetic diversity refers to the diversity (or genetic variability) within species. Each individual species possesses genes which are the source of its own unique features: In human beings, for example, the huge variety of people's faces reflects each person's genetic individuality. The term genetic diversity also covers distinct populations of a single species, such as the thousands of breeds of different dogs or the numerous varieties of roses.

### **Significance of genetic diversity**

The huge variety of different gene sets also defines an individual or a whole population's ability to tolerate stress from any given environmental factor.

While some individuals might be able to tolerate an increased load of pollutants in their environment, others, carrying different genes, might suffer from infertility or even die under the exact same environmental conditions. Whilst the former will continue to live in the environment the latter will either have to leave it or die. This process is called natural selection and it leads to the loss of genetic diversity in certain habitats. However, the individuals that are no longer present might have carried genes for faster growth or for the ability to cope better with other stress factors.

### **How do human activities affect genetic diversity?**

Any change in the environment - natural or human induced causes a selection of events that only the fittest survive. Anthropogenic impact is particularly apparent in the coastal zone and increases the number of changes occurring to individual and populations. Such pressure is exerted by

- artificial selection (harvesting, aquaculture)
- degradation of habitats (leading to a reduction of total stocks and thus increasing the likeliness of inbreeding) and
- The release of farmed fish into the wild. These activities reduce the sum of genes available, thus leaving behind a population that is less capable of tolerating any further natural or anthropogenically caused changes in environment.

These activities reduce the sum of genes available, thus leaving behind a population that is less capable of tolerating any further natural or human disturbances in environment.

### **Why prevent the loss of genetic diversity?**

The loss of genetic diversity is difficult to see or measure. In contrast, the reduction and extinction of populations is far easier to see. Extinction is not only the loss of whole species, but is also

preceded by a loss of genetic diversity within the species.

**This loss reduces the species ability to perform its inherent role in the whole ecosystem.**

Furthermore, the loss of genetic diversity within a species can result in the loss of useful and desirable traits (e.g. resistance to parasites). Reduced diversity may eliminate options to use untapped resources for food production, industry and medicine.

## **2) Species Biodiversity**

### **What is species diversity?**

The word biodiversity is primarily associated with the diversity of living organisms, meaning the abundance of different animal, plant and microbial species.

### **What is the significance of species diversity?**

The composition of species in a given ecosystem is the result of long lasting evolution. Each species has adapted to its own niche, which is characterized by certain features (e.g. temperature range, availability of food or light) enabling the species to reproduce and thus maintain its population.

Living in an ecosystem, the species interacts with its environment (e.g. mussels take particles out of the water, reed forms root systems) and thus performs certain functions (increasing the light availability for plant growth, preventing sediment erosion). In a natural state, these interactions and consequently the system is in balance.

The loss of one species affects many other species and causes imbalance. As a result, several functions within and of the system are not carried out any more. Any species that will take over the lost specie's niche will most certainly not replace all of the functions it used to perform.

When species get extinct, their services for the global biosphere are lost for ever. It is impossible to replace it.

### **How do human activities affect species diversity?**

Over-exploitation, pollution and habitat conversion are the main threats to species diversity. They cause a gradual loss of species on local, regional and global levels. Additionally, the introduction of species into new ecosystems destroys natural balance.

The ever-growing tendencies of tourism, transport, profit-oriented food production (e.g. single-crop agriculture, selective (?) aquaculture), and industry enforce these human activities.

Global warming and population growth continually increase these pressures on biodiversity.

These issues will be discussed in more detail in the chapter "Urgencies".

## **Why prevent the loss of species diversity?**

It should have become clear that the loss of species is accompanied by a loss of functionality, some of which directly affect human life in a severe way: reduction of commercially used fish stocks, and erosion of soil and sediment are only two examples.

To date, scientists have counted and described some 1.7 million living organisms, but the planet's total number is estimated at between 5 and 30 million, with some scientists putting forward figures of 80 million or more.

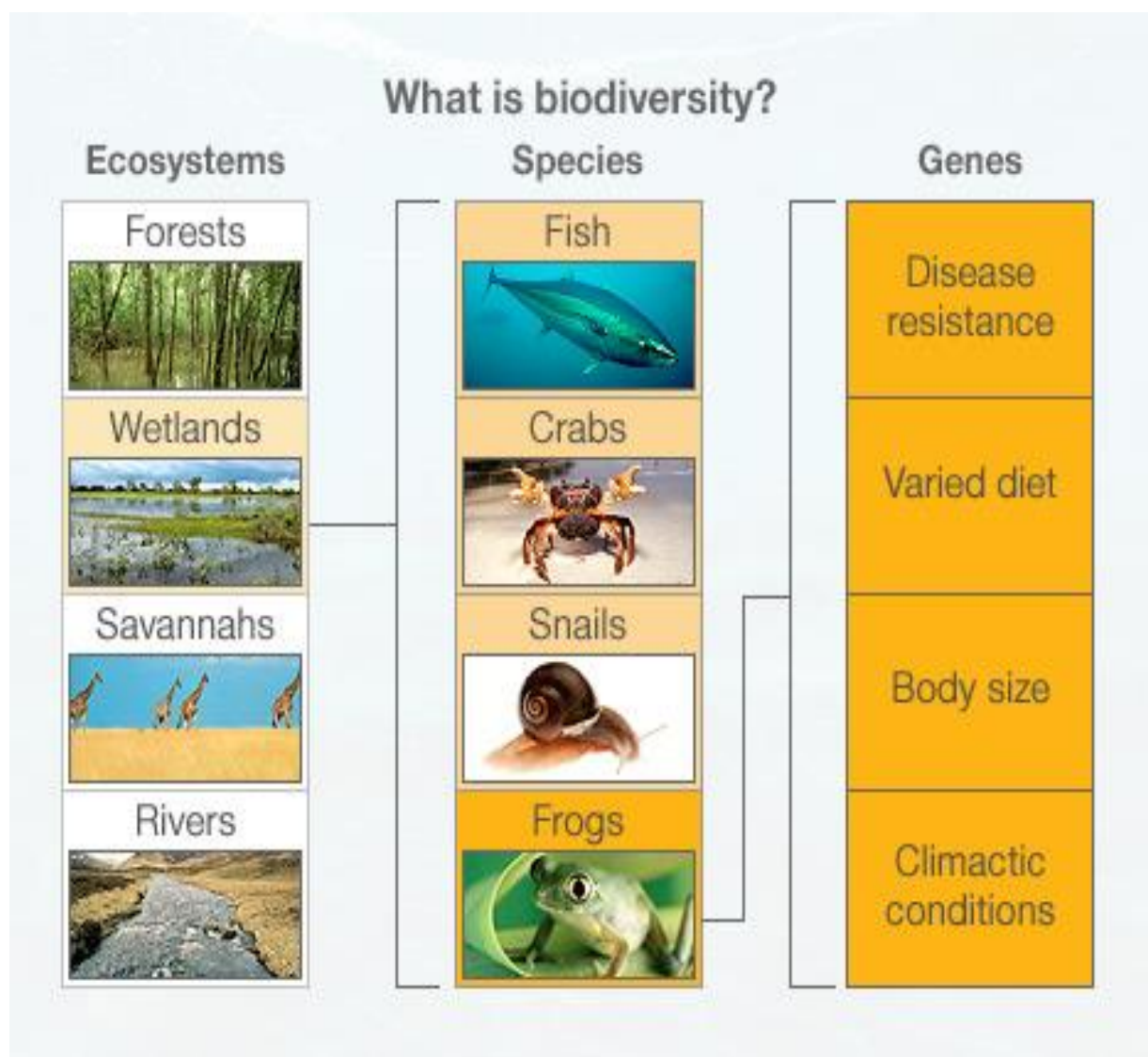
Just as not even the whole inventory of the earth's species has been made, very little is known about the role and the potential that each of them has for increasing the quality of human life. It is therefore necessary to prevent the loss of species' diversity in order to avoid the loss of opportunities to gain from it.

## **3)Ecosystem Biodiversity**

The third group of elements of biodiversity encompasses the scales of ecological differences from populations, through habitats, to ecosystems, ecoregions, provinces, and on up to biomes and biogeographic realms. This is an important dimension to biodiversity not readily captured by genetic or organismal diversity, and in many ways is that which is most immediately apparent to us, giving the structure of the natural and semi-natural world in which we live. However, ecological diversity is arguably also the least satisfactory of the groups of elements of biodiversity. There are two reasons. First, whilst these elements clearly constitute useful ways of breaking up continua of phenomena, they are difficult to distinguish without recourse to what ultimately constitute some essentially arbitrary rules. For example, whilst it is helpful to be able to label different habitat types, it is not always obvious precisely where one should end and another begins, because no such beginnings and endings really exist.

In consequence, numerous schemes have been developed for distinguishing between many elements of ecological diversity, often with wide variation in the numbers of entities recognized for a given element. Second, some of the elements of ecological diversity clearly have both abiotic and biotic components (e.g. ecosystems, ecoregions, biomes), and yet biodiversity is defined as the variety of life. Much recent interest has focused particularly on delineating ecoregions and biomes, principally for the purposes of spatial conservation planning, and there has thus been a growing sense of standardization of the schemes used. Ecoregions are large areal units containing geographically distinct species assemblages and experiencing geographically distinct environmental conditions.

Ecoregions can in turn be grouped into biomes, global-scale biogeographic regions distinguished by unique collections of species assemblages and ecosystems. There are distinguish 14 terrestrial biomes, some of which at least will be very familiar wherever in the world one resides (tropical & subtropical moist broadleaf forests; tropical & subtropical dry broadleaf forests; tropical & subtropical coniferous forests; temperate broadleaf & mixed forests; temperate coniferous forests; boreal forest/taiga; tropical & subtropical grasslands, savannas & shrub lands; temperate grasslands, savannas & shrub lands; flooded grasslands & savannas; montane grasslands & shrublands; tundra; Mediterranean forests, woodlands & scrub; deserts & xeric shrublands; mangroves). At a yet coarser spatial resolution, terrestrial and aquatic systems can be divided into biogeographic realms.



## CHAPTER 2

### BIODIVERSITY AT VARIOUS LEVELS AND HOTSPOTS

#### 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

#### National and Local Level:

India has over 108,276 species of bacteria, fungi, plants and animals already identified and described. 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 insect alone constitute nearly half of the biodiversity in India

**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.                     |

These species occur on land, fresh and marine waters, or occur as symbioses 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. Percentage of Different Biota in India

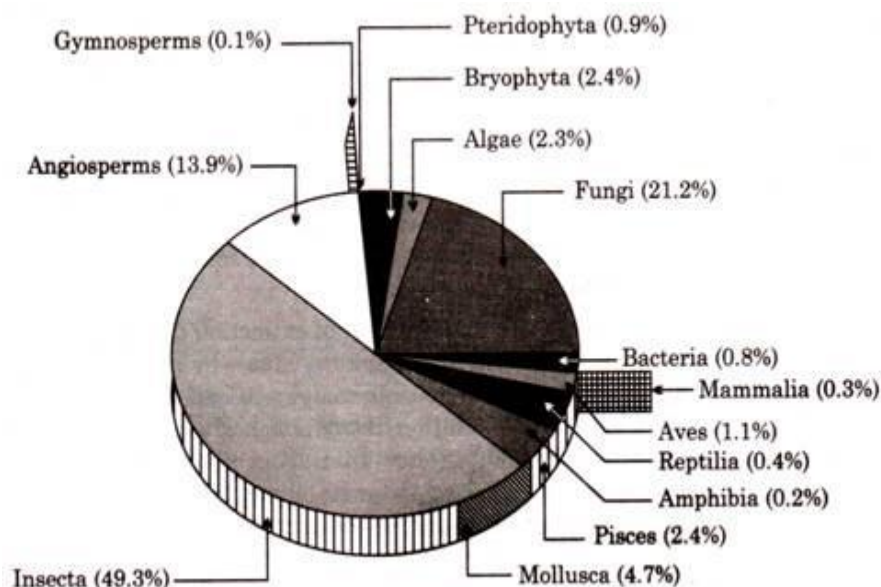


Fig. 4.1. Percentage of Different Biota in India.

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.

### **Hotspots**

Biodiversity hotspots are areas that support natural ecosystems that are largely intact and where native species and communities associated with these ecosystems are well represented. They are also areas with a high diversity of locally endemic species, which are species that are not found or are rarely found outside the hotspot.

The current, planned or potential management activities in hotspots place the natural values at risk, and it is likely this risk will increase in the future in the absence of active conservation management.

Because the natural values of hotspots are largely intact, undertaking action now to maintain these values has the potential to provide value-for-money in contributing to the efforts in biodiversity conservation.

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 percent of the world's total) as endemics, and it has to have lost at least 70 percent of its original habitat.

Accordingly, 25 biodiversity hotspots were identified.

- Collectively, these areas held as endemics no less than 44 percent of the world's plants and 35 percent of terrestrial vertebrates in an area that formerly covered only 11.8 percent of the planet's land surface.
- The habitat extent of this land area had been reduced by 87.8 percent of its original extent, such that this wealth of biodiversity was restricted to only 1.4 percent of Earth's land surface.

Later the list was expanded.

Currently, there are 34 Biodiversity Hotspots.

- Each of them holds at least 1,500 endemic plant species, and having lost at least 70 percent of its original habitat extent.
- Overall, the 34 hotspots once covered 15.7 percent of the Earth's land surface.
- In all, 86 percent of the hotspots' habitat has already been destroyed, such that the intact remnants of the hotspots now cover only 2.3 percent of the Earth's land surface.



## **List of Biodiversity Hotspots**

The Conservation International identifies the Biodiversity Hotspots as under

### **North and Central America**

- |                                  |                   |
|----------------------------------|-------------------|
| 1. California Floristic Province | Caribbean Islands |
| 2. Madrean Pine-Oak Woodlands    | Mesoamerica       |

### **South America**

- |                                              |                        |
|----------------------------------------------|------------------------|
| 1. Atlantic Forest                           | Cerrado                |
| 2. Chilean Winter Rainfall-Valdivian Forests | Tumbes-Chocó-Magdalena |
| 3. Tropical Andes.                           |                        |

### **Europe and Central Asia**

- |                        |                           |
|------------------------|---------------------------|
| 1. Caucasus            | Irano-Anatolian           |
| 2. Mediterranean Basin | Mountains of Central Asia |

### **Africa**

- |                                |                                         |
|--------------------------------|-----------------------------------------|
| 1. Cape Floristic Region       | Coastal Forests of Eastern Africa       |
| 2. Eastern Afromontane         | Guinean Forests of West Africa          |
| 3. Horn of Africa              | Madagascar and the Indian Ocean Islands |
| 4. Maputaland-Pondoland-Albany | Succulent Karoo                         |

### **Asia-Pacific**

- |                                |                        |
|--------------------------------|------------------------|
| 1. East Melanesian Islands     | 2. Himalaya            |
| 3 Indo-Burma                   | 4. Japan               |
| 5.Mountains of Southwest China | 6.New Caledonia        |
| 7.New Zealand                  | 8.Philippines          |
| 9.Polynesia-Micronesia         | 10 Southwest Australia |
| 11. Sunderland                 | 12. Western Ghats      |
| 13.Wallace                     | 14.Sri Lanka           |

### **Hotspots in India**

India has two biodiversity hot spots, namely:

- 1) Himalaya (Eastern Himalayas)    2) The Western Ghat

#### **Eastern Himalaya**

Phyto-geographically, the Eastern Himalaya forms a distinct floral region and comprises of Nepal, Bhutan, states of East and North-East India, and a contiguous sector of Yunnan province in South-Western China.

- In the whole of Eastern Himalaya, there are an estimated 9,000 plant species, out of which

3,500 (i.e. 39 per cent) are endemic.

- In the Indian portion, there occurs some 5,800 plant species, roughly 2,000 (i.e. 36 per cent) of which are endemic.
- At least 55 flowering plants endemic to this area are recognized as rare, for example, the Pitcher Plant (*Nepenthes khasiana*).
- The area has long been recognized as a rich centre of primitive flowering plants and is popularly known as the 'Cradle of Speciation'.
- Species of several families of monocotyledons, Orchidaceae, Zingiberaceae and Arecaceae are found in the area. Gymnorperms and Pteridophytes (ferns) are also well represented here.

The area is also rich in wild relatives of plants of economic significance e.g. rice, banana, citrus, ginger, chilli, jute and sugarcane.

It is also regarded as the centre of origin and diversification of five palms of commercial importance, namely coconut, arecanut, Palmyra palm, sugar palm and wild date palm.

- Tea (*Thea sinensis*) has been cultivated in this region for the last 4,000 years. Many wild and allied species of tea, the leaves of which are used as a substitute for tea, are found in the North East, in their natural habitats.
- The Taxol plant (*Taxus wallichiana*) is sparsely distributed in the region and is listed under the red data category due to its overexploitation for extraction of a drug effectively used against cancer.

As regards faunal diversity, 63 per cent of the genera of land mammals in India are found in this region. During the last four decades, two new mammals have been discovered from the region - Golden Langur from Assam-Bhutan region, and Namdapha Flying Squirrel from Arunachal Pradesh, indicating the species richness of the region. The region is also a rich centre of avian diversity - more than 60 per cent of the bird species found in India have been recorded in the North East. The region also hosts two endemic genera of lizards, and 35 endemic reptilian species, including two turtles. Of the 240 Indian amphibian species, at least 68 species are known to occur in the North East, 20 of which are endemic.

From Namdapha National Park itself, a new genus of mammal, a new subspecies of a bird, six new amphibians' species, four new species of fish, at least 15 new species of beetles and six new species of flies have been discovered.

## **Western Ghats**

The Western Ghats region, which is spread into 6 states of India, is considered to be one of the most important bio-geographic zones of India, as it is one of the richest centres of endemism.

Due to varied topography and microclimatic regimes, some areas within the region are considered to be active zones of speciation.

The region has 490 arboreal taxa, of which as many as 308 are endemic. About 1,500 endemic species of dicotyledonous plants are reported from the Western Ghats. 245 species of orchids belonging to 75 genera are found here, of which 112 species in ten genera are endemic to the region. As regards the fauna, as many as 315 species of vertebrates belonging to 22 genera are endemic, including 12 species of mammals, 13 species of birds, 89 species of reptiles, 87 species of amphibians and 104 species of fish. The extent of endemism is high amongst amphibian and reptile species. There occur 117 species of amphibians in the region, of which 89 species (76 per cent) are endemic. Of the 165 species of reptiles found in Western Ghats, 88 species are endemic. Many of the endemic and other species are listed as threatened.

Nearly 235 species of endemic flowering plants are considered endangered. Rare fauna of the region include - Lion Tailed Macaque, Nilgiri Langur, Nilgiri Tahr, Flying Squirrel, and Malabar Gray Hornbill.

### CHAPTER 3

#### INDIA-BIOGEOGRAPHIC CLASSIFICATION

#### MEGA DIVERSITY NATION -ENDANGERED AND ENDEMIC SPECIES

Three unparalleled factors give India its biological opulence. First, there is an astounding spectrum of habitats and ecosystems existing over a wide range of latitudes and longitudes. These, together with varied climatic regimes, have resulted in an impressive range of bio-physical environments. Second, India lies at the confluence of three global centres of origin of life or 'Biogeographic Realms', viz. Indo-Malayan, Eurasian and Afro-tropical. India's flora and fauna have been enriched by elements from each of these realms. Third, India has a legacy of co-existence of humans and nature and a longstanding tradition of conservation.

For the planning of conservation of biodiversity at the state and national levels, classifications of ecosystems are done based on biogeography.

The biogeographical classification uses following four levels of planning:

**(a) The Biogeography Zone:**

It is a large distinctive unit of similar ecology, biome representation, community and species, e.g., the coasts, the islands, etc.

**(b) The Biotic Province:**

It is secondary unit within a biogeographic zone, giving weight to particular community.

**(c) The Land Region:**

It is a tertiary set of units within a province. It indicates different land forms.

**(d) The Biome:**

It is an ecological unit and is found in biogeographic zones or provinces.

The 10 biogeographic zones that India has been divided into:

**Trans-Himalaya:** Constituting 5.6 percent of the country's geographical area, this zone includes high altitude cold and arid mountain areas, including cold deserts. An extension of the Tibetan Plateau, this zone has sparse alpine steppe vegetation with many endemic species. It supports some of the biggest populations of wild sheep and goats in the world as well as some rare species of fauna such as Snow Leopard (*Uncia uncia*).

**Himalaya:** Consisting of the entire Himalayan mountain range, this zone covers 6.4 percent of the total geographical area and has alpine and sub-alpine forests, grassy meadows and moist deciduous

forests. It provides diverse habitats for a range of species including endangered ones such as Hangul (*Cervus eldi eldi*) and Musk Deer (*Moschus moschiferus*).

**Desert:** This arid zone falls west of the Aravalli hill range and comprises both the salt and sand deserts of north-western India. Constituting 6.6 percent of the country's geographical area, this zone also has large expanses of grasslands that support several endangered species such as the Great Indian Bustard (*Ardeotis nigriceps*).

**Semi-Arid:** This zone covers 16.6 percent of the country. Although overall semi-arid, this zone also has several lakes and marshlands. The grasses and palatable shrub layer of this zone support the highest wildlife biomass. The endangered Asiatic Lion (*Panthera leo persica*) is also found in this zone (in the Gir forests of Gujarat).

**Western Ghats:** Western Ghats is a mountain range running along the western coast of peninsular India, from Tapti River in the north to Kanyakumari in the south. Constituting 4 percent of the country's geographical area, this zone supports tropical evergreen forests that are home to approximately 15,000 species of higher plants, of which around 4,000 (c. 27 percent) are endemic. There are several endemic faunal species as well, such as the Nilgiri Langur (*Presbytis johnii*) and the Lion-tailed Macaque (*Macaca silenus*).

**Deccan Peninsula:** This is the largest zone covering as much as 42 percent of the country. It supports some of the finest forests in India with abundant populations of deer and antelope species such as Chital (*Axis axis*), Sambar (*Cervus unicolor*) and Four-horned Antelope (*Tetracerus quadricornis*). There are small populations of Asian Elephants (*Elephas maximus*) and Wild Water Buffaloes (*Bubalus arnee*) as well.

**Gangetic Plain:** Flanking the Ganga River and its tributaries, the Gangetic Plain zone extends up to the Himalayan foothills in the north. This flat alluvial zone is topographically fairly homogenous and constitutes 10.8 percent of the country's geographical area. This zone supports many large and charismatic mammals such as One-horned Rhinoceros (*Rhinoceros unicornis*), Asian Elephant and Wild Water Buffalo. Other characteristic fauna includes Swamp Deer (*Cervus duvauceli*), Hog Deer (*Axis porcinus*) and Hispid Hare (*Caprolagus hispidus*).

**Coasts:** The coastal zone constitutes 2.5 percent of the geographical area and covers beaches, mangroves, mud flats, coral reefs and marine angiosperm pastures. Sundarbans – shared with Bangladesh – is the largest contiguous mangrove area in the world. The Lakshadweep Islands – having a biodiversity-rich reef lagoon system – are also included in this zone.

**North-East:** Characterised by diverse habitats and long-term geological stability, the North-East zone covers 5.2 percent of India's geographical area. Due to its location at the junction of the

Indian, Indo-Malayan and Indo-Chinese bio-geographical regions, it is considered a 'gateway' for much of India's flora and fauna. There are significant levels of endemism in all floral and faunal groups.

**Islands:** Although this zone covers only 0.3 percent of the country's geographical area, it is nonetheless important from the biodiversity perspective. The Andaman and Nicobar Islands have some of India's finest tropical evergreen moist forests and show high degree of endemism in flora and fauna.

### **India- A mega diversity nation**

India is one of the 12 mega diverse countries in the world, commanding 7%-8% of the world's biodiversity and supporting 16% of the major forest types, varying from alpine pastures in the Himalayas to temperate, sub-tropical, tropical forests and mangroves in the coastal areas. However, the country is facing several challenges with regard to maintaining its mega diverse status.

With only 2.4% of land area, India accounts for 7%-8% of the recorded species of the world. After surveying almost 70% of the country's land area, about 45000 species of plants and 89000 species of animals have been described till date. It has been estimated that another 400 000 species may still exist in India, which so far remain undescribed. The rich domesticated fauna, with about 60 livestock breeds, 20 goat breeds, and 163155 accessions in the national gene bank of domesticated plants are an integral part of Indian culture;

Out of 34 biodiversity hotspots identified so far, which hold high numbers of endemic species, but cover only 2.3% of their combined area of remaining habitat in the world, India has two hotspots- the Himalayas and the Western Ghats.

The efforts of in-situ conservation in India are mainly concentrated in 617 protected areas, as of 2010. Also India has 14 biosphere reserves, spread across various bio-geographic zones of the country. The Sunderbans, Gulf of Mannar, and the Nilgiri are now included in the international network of biosphere reserves recognised by UNESCO. Also, India has six World Heritage Sites listed by UNESCO. Till date, 25 wastelands have been designated as Ramsar sites. From the cultural perspective, India has about 40000-50000 endogamous groups of people, suggesting a very high level of diversity of languages, culture, knowledge of ecosystems, and so on. More than 400000 practitioners of traditional medicinal systems in the country use 80% of the plant-based raw material for making drugs.

With the wide variety of terrain and climatic conditions, which range from permanent snowfields to tropical coastlands; from areas of virtual desert in the northwest to fertile, intensively

cultivated rice fields in the North East, India has been classified 10 biogeographic regions. The unique geo-physical and hydro-climatic conditions represented by these zones are instrumental in the evolution of the rich biodiversity of this country. The wild and domesticated biodiversity is distributed along the global biodiversity hotspots, centres of domestication of domesticated species of plants and animals, protected areas, community conserved areas, and so on. Considering the overlapping priorities of biodiversity conservation in India, various efforts have been undertaken using processes such as the hotspot science. One of the major foci of the hotspot science is the uniqueness of the region in terms of species diversity restricted to specific areas (endemism) and special ecosystems. Interestingly, as recent as 2009, a large number of species were discovered in India's biodiversity hotspots. While 20 new faunal species were discovered from the Western Ghats, 37 were found in the Himalayas. Similarly, 41 new species of plants have been reported in recent times from different parts of the country.

## **Endangered and Endemic species**

### **Endangered species**

An endangered species is a native species that faces a significant risk of extinction in the near future throughout all or a significant portion of its range. Such species may be declining in number due to threats such as habitat destruction, climate change, or pressure from invasive species.

The term *endangered species* can be used either in general or legal context. When used in a general sense, the term describes a species that faces a risk of extinction but does not necessarily indicate that the species is protected under any law. When used in a legal context, the term refers specifically to a species that is listed on the Endangered Species List and is defined legally as an animal or plant species in danger of extinction throughout all or a significant portion of its range.

### **Endangered animals in India**

Critically Endangered species in India According to the Red Data Book of International Union for Conservation of Nature (IUCN), there are 47 critically endangered species in India. The 10 most endangered animals are discussed below:

#### **1. Snow Leopard**

It is one of the most secretive cats and not many people in the world have had the privilege to see them in the wild in India. The wild cat loves to roam in the rocky mountain ranges of high altitude and it is estimated that in India there are about 200-600 snow Leopards found in Hemis National Park, in east Ladakh, Nanda Devi National Park and Valley of Flowers National Park, in the state of Uttarakhand a UNESCO Natural World Heritage Site, and Dibang Wildlife Sanctuary, near Anini.



## **(2) Tigers**

Tigers were once found all over Asia, and from Turkey to Russia but over the last 100 years 93 percent of their range has been lost and half of the world population of tigers now reside in India. According to the last estimate there are 1706 tigers in India and if you wish to come face to face with the regal animal, here are the best places to find them – Madhya Pradesh, in the heart of Central India, has well known Tiger parks of Pench, Kanha and Bandavgarh and have high densities of Tigers. Corbett National Park, in Northern India, in the foothills of the Himalayas, is another beautiful lush park that harbours both tigers and wild elephants, which you have a good chance of seeing, besides a host of other species and some of the best birdlife in India. You want to try and get into the Dhikala range to ensure you get away from most ‘corporate tourism’ that is now booming here. Ranthambhore National Park, the closest park to Delhi in the desert state of Rajasthan, is probably India’s most famous park.



## **(3) Asiatic Lion**

The only place in the world where you can see an Asiatic Lion is in the Sasan Gir National Park and sanctuary in Gujarat. The semi deciduous forest makes quite a comfortable home for the Lion and the population is steadily increasing with 400 lions approximately residing here. Far less eloquent than their cousins, the African lions in appearance, the Asiatic lions though are no less aristocratic and just a glance of the king in his jungle abode is enough to make a lasting impression for life.





#### (4) Ganga River Dolphin

The Ganges River Dolphin is primarily found in the Ganga and Brahmaputra Rivers and their tributaries in Bangladesh, India and Nepal. The dolphin has been recognized by the Government of India as its National Aquatic Animal. Highest densities of these dolphins have been observed in the Ganges mainstream between Maniharighat and Buxar and within this segment particularly in the Vikrانشila Gangetic Dolphin Sanctuary and just downstream between Kahalgaon and Manihari Ghat (near Katihar).



#### (5) Lion Tailed Macaque

Listed as Endangered as the total number of mature individuals is less than 2,500 there are estimates of a continued decline of over 20% of the populations in the next approximately 25 years, due to hunting and continued loss of habitat. This species is endemic to the Western Ghats hill ranges in southwestern India from the Kalakkadu Hills north to Anshi Ghat in the states of Karnataka, Kerala and Tamil Nadu. The forests of Kerala host up to 1,216 adult lion-tailed macaques, according to a large study using estimates from forest sightings. In Tamil Nadu, the Anaimalai Hills support about 500 individuals, though only with two subpopulations. Also found in the Sirsi-Honnavaara rainforests of the northern Western Ghats in Karnataka.



#### **(6) Indian Rhinoceros**

Although the overall population of this species is increasing, it is still a vulnerable animal highly threatened by poaching for its horns. Also known as the greater one horned rhinoceros the animal is confined to less than ten sites with over 70% of the population in Kaziranga National Park in Assam. Also found in Orang, Pobitara, Jaldapara and Dudhwa.



#### **(7) The Nilgiri Tahr**

Known locally as the Nilgiri Ibex or simply Ibex, it is endemic to the Nilgiri\_Hills and the southern portion of the Western Ghats in the states of Tamil Nadu and Kerala. It is the state animal of Tamil Nadu. These tahrs inhabit the open montane grassland habitat of the South Western Ghats montane rain forests ecoregion. Their range extends over 400 kilometres from north to south, and Eravikulam National Park is home to the largest population. The other significant concentration is in the Nilgiri Hills, with smaller populations in the Anamalai Hills, Periyar National Park, Palni Hills and other pockets in the Western Ghats south of Eravikulam, almost to India's southern tip.



#### **(8) Asian Elephant**

The elephant has been named as the national heritage animal of India. Once widespread in the country, the species is now restricted to four general areas: north-eastern India, central India, north-

western India, and southern India. In north-eastern India, the elephant range extends from the eastern border of Nepal in northern West Bengal through western Assam along the Himalaya foothills as far as the Mishmi Hills. From here it extends into eastern Arunachal Pradesh, the plains of upper Assam, and the foothills of Nagaland. Further west, it extends to the Garo Hills of Meghalaya through the Khasi Hills, to parts of the lower Brahmaputra plains and Karbi Plateau. Elsewhere in the south in Tripura, Mizoram, Manipur, and the Barak valley districts of Assam, isolated herds occur. In north-western India, the species occurs in six fragmented populations at the foot of the Himalayas in Uttaranchal and Uttar Pradesh, ranging from Katarniaghat Wildlife Sanctuary in Bahraich Forest Division in the east, to the Yamuna River in the west. In southern India, elephants occur in the hilly terrain of the Western Ghats and in parts of the Eastern Ghats in the states of Karnataka, Kerala, Tamil Nadu and, relatively recently, Andhra Pradesh. There are eight main populations in southern India, each fragmented from the others: northern Karnataka; the crestline of Karnataka–Western Ghats; Bhadra–Malnad; Brahmagiri–Nilgiris–Eastern Ghats; Nilambur–Silent Valley–Coimbatore; Anamalais–Parambikulam; Periyar–Srivilliputhur; and Agasthyamalais.



### **(9) Indian Bison (Gaur)**

In India, three major (Western Ghats, Central India and North-East) and two minor (Bihar and West Bengal) Gaur conservation areas have been identified although the Western Ghats and their outflanking hills in south India constitute one of the most extensive extant strongholds of Gaur, with good numbers in Wynaad – Nagarahole – Mudumalai – Bandipur complex.

The larger body structure and the ferocious nature of the Gaur, makes it a must see animal in the wild. Note the contrasting characters from the tamed, domestic cattle.



### **(10) Kashmir Red Stag (Hangul)**

Last but not the least, the Hangul adds a touch of extraordinary beauty to the already enchanting Kashmir valley. It is the state animal of Jammu & Kashmir. It's found in Dachigam National Park at an elevation of 3,035 meters and also in Himachal Pradesh in northern Chamba. Threatened by habitat destruction this red deer's population has thankfully increased in the past few years to about 300 in the wild.



### **Endangered Plants**

The flora (the plants) of India is one of the richest of the world due to the wide range of climate, topology, and environments in the country. There are over 15000 species of flowering plants in India which account for 6% of total plant species in the world. With the prevalent removal of plant and trees many plant species are being destroyed. According to Encyclopedia of earth over 8000 plant species are officially threatened or endangered at every hour.. Between one-fourth of all plants are at some risk. The combination of global warming and habitat destruction is the sole reason for the disappearance of many plants from earth's face. Though there are thousands of interesting, and unusual plants are there here are some common plants which we have seen thirty years back have become rare and endangered species. This is a list of plants which have become rare and threatened in India.

#### **1. Polygala irregularis**

Gujarat (rare) commonly known as Milkwort is an annual or perennial herb. Blooms during July and August. The plants are found at an altitude of 1000 meters. The flowers are found in blue, near white, pink and white in color. The plants are destroyed due to human habitation and land for agriculture.



### **2. *Amentotaxus assamica***

Arunachal Pradesh (threatened) otherwise called Assam catkin yew. They are shrubs or small trees found in moist deciduous forest of Assam. It belongs to a species of coniferous trees found only in India. They are found in three regions of Arunachal Pradesh that is in Turoo hills, Delei Valley, and in Dafla hills.



### **3. *Psilotum nudum***

Karnataka (rare) known as Moa, skeleton, fork fern, whisk fern, is a rootless, leafless, forming a low growing clumps. The plant produces abundant spores which are collected and used for making powder. In Greek the 'Psilo' means bare. The scientific name reflects the plant's appearance where many of the organs which will be normally present in a plant or absent in this plant like leaf, flower, roots. The whisk fern is used as small broom by tying a handful of its branches together.



### **4. *Actinodaphne lawsonii***

Kerala(threatened)it belongs to lauraceae family .It is endemic and it is threatened by habitat loss.It is canopy or sub canopy trees found in high elevation evergreen forest between 1200 to 2400 meters. The leaves are aromatic and has medicinal use.



### **5.Diospyros celebica**

Karnataka(threatened)Ebony tree -It is a flowering tree and considered highly by woodworkers as they are widely used for making high quality furniture.The trees can grow up to 20 metres height under favourable conditions..But in the past two centuries it has become a very scarce and hardly found in India.



### **6.Abutilon indicum**

Tamilnadu(rare) commonly known as indian mallow is a small shrub in Malvaceae family.it is used as medicinal plant and they occur in number of tropical and subtropical zones.The plant was much used in sidda medicine.The root,bark,flowers and leaves are all used for medicinal purposes.It is called thuthi in tamil athibalaa in Sanskrit.





## 7. *Chlorophytum tuberosum*

Tamilnadu it is a endangered plant is also called musli. It is a flowering plant native to Africa and India. It has historical uses in Ayurveda commonly used for strength and vigour. The plant belongs to Liliaceae family.



## 8. *Nymphaea tetragona*

Jammu and Kashmir (endangered and threatened) is a pygmy water lily, the tropical representative of diminutive water lilies. The original distribution was confined to Jammu, Kashmir and Meghalaya. It is a very small herb and very susceptible to pests and disease. These plants are found in Indian subcontinents where Buddhist monks used these flowers to offer to God and conserved it as a ritual plant in temple gardens.



## 9. *Belosynapsis vivipara*

Madhya Pradesh (rare and endangered) In India it is represented by three species, namely *B. epiphytica*, *B. kewensis*, *B. vivipara*. Commonly called Spiderwort, they are distributed in India, South Asia, to New Guinea. The plants usually grow at a high elevation, on densely moss-covered tree trunks and branches of trees in shady, semi-evergreen riparian forests. This species is on the verge of extinction and is equally important to biodiversity in the local ecosystem.



### 10. *Ceropegia odorata*

(Endangered) can be found only in four places in India, pavagah in Gujarat, Tarubanda in Melghat tiger, and Salsette Island as well as at Mount Abu in Rajasthan where it may now be extinct. It is found only in high altitude at about 3000mts where it is unreachable by human beings. It is a only species of the genus whose flowers have very strong fragrance hence the name odorata. They bloom for few days and they are called Jeemikanda in Gujarat. These plants have medicinal values and are chewed to cure stomach pain and juice from the tubers is used in treating eye medicine.



### Endangered Birds

Due to the loss of habitat, prey and heavy hunting for meats, some of the Indian birds are on the verge of extinction. Poaching and massive hunting took these beautiful species birds into the category of critically endangered birds of India. Great Indian bustard, Indian Vulture, Himalayan Quail and Siberian Crane are few species of birds who are facing critical problem of extinction.

**1. Great Indian Bustard:** The Great Indian Bustard is a most endangered species of bird found only in India and adjoining region. Bustard is one of the largest flying species of bird with weight up to 15 kg and about 1 m tall from the ground. The largest land bird habitat in the scrub, tall grass, semi-arid grasslands and semi desert regions of Rajasthan. Due to heavily hunting and habitat loss, the

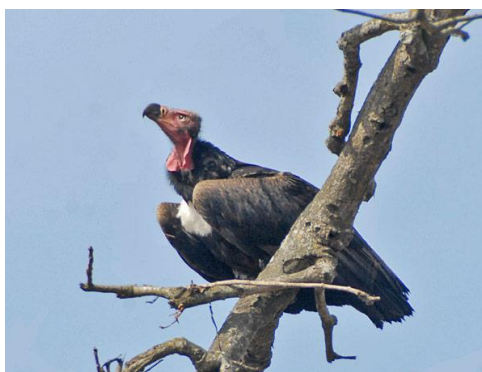


bird is disappearing from the many regions of India, Its state bird of Rajasthan. There is a wildlife sanctuary called Great Indian Bustard Sanctuary at Solapur, Maharashtra.



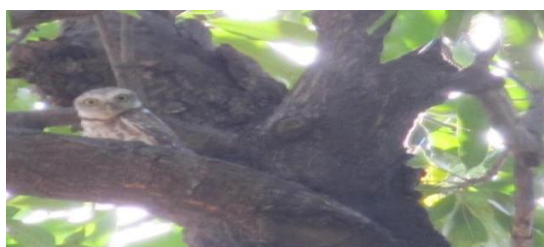
## **2.Red Headed Vulture**

The Red-headed Vulture is also known as Indian Black Vulture or King Vulture is one of the species of Old World vultures found in the Indian Subcontinent. Due to the Diclofenac in veterinary medicine population of this species become extremely less in recent years. Indian Vulture, Slender-billed Vulture and White rumped Vulture are the few more species of vultures found in India and falls in the category of critically endangered species of birds.



## **3.Forest Owlet**

Forest Owlet is the highly endangered species of the typical owls family and endemic to forests of central India. Small Forest Owlet was considered extinct but later rediscovered and small number population make this species critically endangered in India. Melghat Tiger Reserve, Taloda Forest Range and forest area of Madhya Pradesh and Chhattisgarh are best place to located these small jungle owl. Forest Owlet is the state bird of Maharashtra now.



#### 4.Spoon Billed Sandpiper

Spoon Billed Sandpiper is the world's most threatened bird species and fall in the category of critically endangered in India too. Extremely small population, habitat loss and loss of breeding grounds takes spoon-billed sandpiper chicks on the verge of extinction. Main wintering grounds in India are delta of Sundervan and neighbouring countries.



#### 5.Jerdon's Courser

The nocturnal bird,Jerdon's Courser is most threatened and enigmatic birds of India, Specially endemic to southern Andhra Pradesh. Jerdon's Courser is listed as critically endangered bird, it was thought to be extinct but again appear but remains critically endangered due to habitat loss. Mostly found in Godaveri river valley,Sri Lankamalleshwara Sanctuary and in the Eastern Ghats forest range.



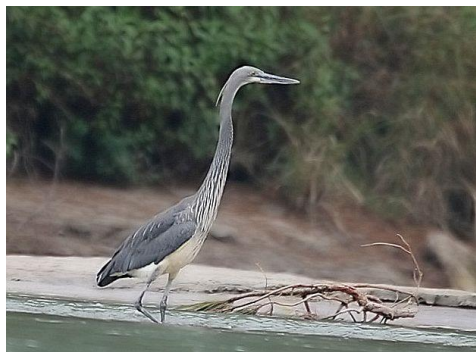
#### 6.Bengal Florican:

The Bengal Florican is the rare species of bustard family and native to Indian Subcontinent only. Bengal Florican is one of the most threatened species and almost extinct at other place of world, less than 1,000 only young Bengal Floricans are disturbed in the Indian Subcontinent. Its the world's rarest bustard but Poaching and land conversion for agriculture took its habitat and flag it as endangered species.



### **7.White Bellied Heron**

The Great White-bellied Heron also known as Imperial Heron is a large heron found in the foothills of Great Himalaya to the eastern Himalayas ranges. The tall dark and grey heron is large species with longest neck and no black stripes on the neck. Disappearance of wetlands, poaching and habitat destruction are the major concern for heron.



### **8.Himalayan Quail:**

The amazing and beautiful Himalayan quail is a belongs to pheasant family and found only at western Himalayas of Uttarakhand and north-west region of India. Himalayan Quail is one of very critically endangered species of Indian birds, habitat destruction makes it on the verge of extinction. Quail is medium-sized and only flying to the close area.



### **9.Sociable Lapwing**

Sociable Lapwing is a migratory bird from open grassland of Kazakhstan and found only in the north-west region of India. The medium sized lapwing is very attractive with longish black legs, dark belly and a short black bill. Habitat destruction is the main reason of for this species to get listed in the endangered birds.



### 10.Siberian Crane

The stunning Siberian White Crane are migratory birds and visit India during the winters season. Majestic Siberian Cranes are among one of the most endangered species of birds in the world. In the last few years population of the migratory Siberian cranes are slightly decreased and fall under the threat of extinction.



### Endemic Species

A species which is only found in a given region or location and nowhere else in the world.

This definition requires that the region that the species is endemic to, be defined, such as a “site endemic” (e.g. just found only in Gujarat), a “national endemic” (e.g. found only in India), a “geographical range endemic” (e.g. found in the Himalayan region, which however covers several Himalayan countries and therefore is not a national endemic), or a political region endemic (e.g. found in countries of Asia). Taken to an extreme, a cosmopolite species is still endemic to Earth!

Listed below are few animal species endemic to India:

- |                      |                           |                       |
|----------------------|---------------------------|-----------------------|
| 1)Indian Elephant    | 2)Asiatic Lion            | 3)Lion Tailed Macaque |
| 4)Royal Bengal Tiger | 5)Great Indian Rhinoceros | 6)Neelgai             |



7)Indian Flying Fox

8)Chinkara

9)Wild Assam

10)Leopard

11)Pangolin

12)Nilgiri Tahr

The list below is the plant species endemic to India:

1)Teak Tree(*Tectona Grandis*)



2) Neem Tree (*Azadirachta indica*)



3)Arjuna Tree(*Terminalia Arjuna*)



4)Indian Mahagony(*Swietenia mahagoni*)



5)Tulsi Plant (*Ocimum Sanctum*)



6)Turmeric Plant (*Curcuma Longa*)



7)Eucalyptus tree(*Eucalyptus globulus*)

8)Peepal tree (*Ficus religiosa*)



9)Amla(*Phyllanthus emblica*)



10)Brahmi (*Bacopa monnieri*)



## CHAPTER 4      THREATS AND CONSERVATION OF BIODIVERSITY

### THREATS TO BIODIVERSITY

Extinction is a natural event and, from a geological perspective, routine. We now know that most species that have ever lived have gone extinct. The average rate over the past 200 million

years is 1-2 species per year, and 3-4 families per my. The average duration of a species is 2-10 million years (based on last 200 million years). There have also been occasional episodes of mass extinction, when many taxa representing a wide array of life forms have gone extinct in the same blink of geological time.

In the modern era, due to human actions, species and ecosystems are threatened with destruction to an extent rarely seen in earth history. Probably only during the handful of mass extinction events have so many species been threatened, in so short a time. What are these human actions? There are many ways to conceive of these - let's consider two.

First, we can attribute the loss of species and ecosystems to the accelerating transformation of the earth by a growing human population. As the human population passes the six billion mark, we have transformed, degraded or destroyed roughly half of the world's forests. We appropriate roughly half of the world's net primary productivity for human use. We appropriate most available fresh water, and we harvest virtually all of the available productivity of the oceans. It is little wonder that species are disappearing and ecosystems are being destroyed.

Second, we can examine six specific types of human actions that threaten species and ecosystems - the "sinister sextet"

**(1) Over-hunting** has been a significant cause of the extinction of hundreds of species and the endangerment of many more, such as whales and many African large mammals. Most extinction over past several hundred years is mainly due to over-harvesting for food, fashion, and profit commercial hunting, both legal and illegal (poaching), is the principal threat. Snowy egret, passenger pigeon, heath hen are USA examples. At \$16,000 per pound, and \$40,000 to \$100,000 per horn, it is little wonder that some rhino species are down to only a few thousand individuals, with only a slim hope of survival in the wild. The pet and decorative plant trade falls within this commercial hunting category, and includes a mix of legal and illegal activities. The annual trade is estimated to be at least \$5 billion, with perhaps 1/4 to 1/3 of it illegal.

Sport or recreational hunting causes no endangerment of species where it is well regulated, and may help to bring back a species from the edge of extinction. Many wildlife managers view sport hunting as the principal basis for protection of wildlife.

While over-hunting, particularly illegal poaching remains a serious threat to certain species, for the future, it is less important than other factors mentioned next.

**(2) Habitat loss/degradation/fragmentation** is an important cause of known extinctions. As deforestation proceeds in tropical forests, this promises to become the cause of mass extinctions

caused by human activity.

All species have specific food and habitat needs. The more specific these needs and localized the habitat, the greater the vulnerability of species to loss of habitat to agricultural land, livestock, roads and cities. In the future, the only species that survive are likely to be those whose habitats are highly protected, or whose habitat corresponds to the degraded state associated with human activity (human commensals).

Habitat damage, especially the conversion of forested land to agriculture (and, often, subsequent abandonment as marginal land), has a long human history. It began in China about 4,000 years ago, was largely completed in Europe by about 400 years ago, and swept across USA over the past 200 years or so. Viewed in this historical context, we are now mopping up the last forests of Pacific Northwest.

In the new world tropics, lowland, seasonal, deciduous forest began to disappear after 1500 with Spanish and Portuguese colonization of the New World. These were the forested regions most easily converted to agriculture, and with a more welcoming climate. The more forbidding, tropical humid forests came under attack mainly in 20th C, under the combined influences of population growth, inequitable land and income distribution, and development policies that targeted rain forests as the new frontier to colonize.

Tropical forests are so important because they harbor at least 50%, and perhaps more, of world's biodiversity. Direct observations, reinforced by satellite data, documents that these forests are declining. The original extent of tropical rain forests was 15 million km<sup>2</sup>. Now there remains about 7.5-8 million km<sup>2</sup>, so half is gone. The current rate of loss is estimated at near 2% annually (100,000 km<sup>2</sup> destroyed, another 100,000 km<sup>2</sup> degraded). While there is uncertainty regarding the rate of loss, and what it will be in future, the likelihood is that tropical forests will be reduced to 10-25% of their original extent by late 21<sup>st</sup> C. Habitat fragmentation is a further aspect of habitat loss that often goes unrecognized. The forest, meadow, or other habitat that remains generally is in small, isolated bits rather than in large, intact units. Each is a tiny island that can at best maintain a very small population. Environmental fluctuations, disease, and other chance factors make such small isolates highly vulnerable to extinction. Any species that requires a large home range, such as a grizzly bear, will not survive if the area is too small. Finally, we know that small land units are strongly affected by their surroundings, in terms of climate, dispersing species, etc. As a consequence, the ecology of a small isolate may differ from that of a similar ecosystem on a larger scale.



For the future, habitat loss, degradation, and fragmentation combined is the single most important factor in the projected extinction crisis.

**(3) Invasion of non-native species** is an important and often-overlooked cause of extinctions. The African Great Lakes - Victoria, Malawi and Tanganyika - are famous for their great diversity of endemic species, termed "species flocks", of cichlid fishes. In Lake Victoria, a single, exotic species, the Nile Perch, has become established and may cause the extinction of most of the native species, by simply eating them all. It was a purposeful introduction for subsistence and sports fishing, and a great disaster.

Of all documented extinctions since 1600, introduced species appear to have played a role in at least half. The clue is the disproportionate number of species lost from islands: some 93% of 30 documented extinctions of species and sub-species of amphibians and reptiles, 93% of 176 species and sub-species of land and freshwater birds, but only 27% of 114 species and subspecies of mammals. Why are island species so vulnerable, and why is this evidence of the role of non-indigenous species?

Islands are laboratories for evolution ( occur when the removal of one species (an extinction event) or the addition of one species (an invasion event) affects the entire biological system. Domino effects are especially likely when two or more species are highly inter-dependent, or when the affected species is a "keystone" species, meaning that it has strong connections to many other species .

The seeds of the tree *Calvaria major*, now found exclusively on the island of Mauritius, must pass through the abrasive gut of a large animal in order to germinate. Their tough seed coats are protection against digestion, but also a kind of living coffin, for the seed can not germinate unless abraded. None of the animals currently on Mauritius have that ability. The dodo (a 25 kg pigeon), hunted to extinction in the late 17th century, probably was the key to recruitment in this species. Some seeds, abraded, roughened, and excreted by dodos, germinated and grew. Today, no seeds germinate, and only a few very old trees now survive. The blackfooted ferret was once very abundant in the western prairies. It preyed upon prairie dogs and used their burrows to nest in. Poisoning of prairie dogs has greatly reduced their abundance, and the black footed ferret is now the rarest mammal in North America

**(4)Pollution** from chemical contaminants certainly poses a further threat to species and ecosystems. While not commonly a cause of extinction, it likely can be for species whose range is extremely small, and threatened by contamination. Several species of desert pupfish, occurring in small isolated pools in the US southwest, are examples.

**(5)Climate change:** A changing global climate threatens species and ecosystems. The distribution

of species (biogeography) is largely determined by climate, as is the distribution of ecosystems and plant vegetation zones (biomes). Climate change may simply shift these distributions but, for a number of reasons, plants and animals may not be able to adjust.

The pace of climate change almost certainly will be more rapid than most plants are able to migrate. The presence of roads, cities, and other barriers associated with human presence may provide no opportunity for distributional shifts. Parks and nature reserves are fixed locations. The climate that characterizes present-day Yellowstone Park will shift several hundred miles northward. The park itself is a fixed location. For these reasons, some species and ecosystems are likely to be eliminated by climate change. Agricultural production likely will show regional variation in gains and losses, depending upon crop and climate.

As a consequence of these multiple forces, many scientists fear that by end of next century, perhaps 25% of existing species will be lost.

Estimates of current and future extinction rates are based on well-documented relationships between the number of species in a region and habitat area, and on reasonably well-known rates of habitat loss. We must also employ some ratio to approximate the total number of species (described and undescribed), from the number of described species.

The relationship between species (S) and area (A) is described by the equation:

$$S = c A^z$$

where z is the slope of the log-linear relationship, and c is a constant which described the height of the line. Based on censuses of species on islands, the number of species found on an island increases log-linearly with island area. Conversely, as island (or habitat area) is reduced, so is the number of species that will be found there. The slope (z) usually varies between 0.15 to 0.35. When combined with current rates of loss of tropical forest (this calculation uses 1.8% per year), these values of the slope translate into species extinction rates of roughly 0.5% annually. Extrapolated to the year 2020, roughly 20% of remaining species will disappear. Simply using the most conservative values of the slope, and assuming the true biodiversity of tropical forests is roughly 10 million species, the projected rate of loss of species is 27,000 per year, and three during this hour.

- Biodiversity refers to the number and variety of species, of ecosystems, and of the genetic variation contained within species.
- Roughly 1.4 million species are known to science, but because many species are undescribed, an estimated 10-30 million species likely exists at present.

- Biodiversity is threatened by the sum of all human activities. It is useful to group threats into the categories of over-hunting, habitat destruction, invasion of non-native species, domino effects, pollution, and climate change.
- Habitat loss presents the single greatest threat to world biodiversity, and the magnitude of this threat can be approximated from species-area curves and rates of habitat loss. The spread of non-native species threatens many local species with extinction, and pushes the world's biota toward a more homogeneous and widely distributed sub-set of survivors. Climate change threatens to force species and ecosystems to migrate toward higher latitudes, with no guarantee of suitable habitat or access routes. These three factors thus are of special concern.

### **Conservation of Biodiversity**

From a selfish point of view, humans should be concerned about saving biodiversity because of the benefits it provides us—biological resources and ecosystem services. However, nature provides social and spiritual benefits as well.

#### **Need for conservation:**

Biological resources are those products that we harvest from nature. These resources fall into several categories: food, medicine, fibers, wood products, and more. For example, over 7,000 species of plants are used for food, although we rely heavily on only 12 major food crops. Most of the human population depends on plants for medicines. In the developed world, many of our medicines are chemicals produced by pharmaceutical companies, but the original formulas were often derived from plants. For example, opiate pain relievers are derived from poppies, aspirin is derived from willows, quinine for treating malaria comes from the *Chinchona* tree. The rosy periwinkle (*Vinca rosea*) and Pacific yew (*Taxa brevifolia*) both provide substances used in chemotherapy to inhibit the cell division of cancerous cells. Fibers for clothing, ropes, sacking, webbing, netting, and other materials are provided by a large number of plants, including cotton plants, flax plants (linen), hemp (cordage and sail canvas), *Agave* plants (sisal), *Corchorus* plants (jute), bamboo and palms. Trees provide the wood products used in making homes, furniture, and paper.

Ecosystem services are processes provided by nature that support human life. These services include the decomposition of waste, pollination, water purification, moderation of floods, and renewal of soil fertility. Ecosystem processes are often overlooked, and are not generally valued as part of the economy until they cease to function. When economic value is assigned to these

services, it is often startlingly high. For example, insect pollinators help produce many commercially important fruits such as almonds, melons, blueberries, and apples. The global economic value of pollination services performed by insects has been valued at \$217 billion per year.

Human construction and development disrupt natural environments, but most habitats have an extraordinary ability to recover when given the chance. This is because dormant seeds in the soil can germinate, stabilize the soil, and initiate successional events that restore vegetation which provides food and structure for other colonizing organisms. Native plants like fireweed can help revegetate an area after fire.

Different cultures developed in different landscapes that influenced activities, occupations, diet, language, and architecture. Cultures adapted to local environmental challenges by growing local domestic crops, developing irrigation and terracing systems, hunting, fishing, and gathering. Biodiversity provides a sense of place. Countries and states have flagship animals and plants that are a source of pride and highlight the uniqueness of each habitat (Figure 6). Travel, which provides great pleasure to many people, is motivated by the desire to see this combination of cultural, landscape and biological diversity.

Ecotourism is travel with the desire to view, sustain, and support natural ecosystems and local cultures. Support from ecotourism can reduce habitat destruction, preserve species that suffer from poaching and illegal trade in the pet market, plus provide jobs for the local economy. For example, the Wasini Island Project in Kenya has been a major ecotourism success story. Coral reefs and mangrove forests were suffering degradation from development, agriculture, and from exploitation of reef species. Support from the Biodiversity Conservation Programme made it possible for the local community to build boardwalks and other features that facilitate viewing wildlife. Local people were trained as guides and in administration, and they now run a profitable ecotourism operation. Money from tourism helps the local economy, provides incentive to maintain the habitat, provides funds for the local health clinic, and scholarships for local students.

In modern times, with increasing urbanization, people seek out local parks, open space and trails, and travel to national parks and wild places where they can enjoy nature. Birding, hiking, fishing, hunting, gardening, and other forms of recreation in nature are popular activities, and are economically important.

### **Conservation strategies**

There are several strategies which are adapted for conservation of Biodiversity. Some of these are:

## 1. Legislation

Formal policies and programmes for conservation and sustainable utilisation of biodiversity resources dates back to several decades. The concept of environmental protection is enshrined in the Indian constitution in articles 48a and 51a(g). Major central acts relevant to biodiversity include:

- Environment Protection Act, 1986
- Fisheries Act, 1897
- Forest Act, 1927
- Forest (Conservation) Act, 1980
- Wildlife (Protection) Act 1972 and Wildlife (Protection) Amendment Act 1991.

The various central Acts are supported by a number of state laws and statutes concerning forests and other natural resources. The policies and strategies directly relevant to biodiversity include National Forest Policy amended in 1988, National Conservation Strategy and Policy Statement for Environment and Sustainable Development, National Agricultural Policy, National Land Use Policy, National Fisheries Policy, National Policy and Action Strategy on Biodiversity, National Wildlife Action Plan and Environmental Action Plan.

## 2. In-situ Conservation

Conserving the animals and plants in their natural habitats is known as in situ conservation. The established natural habitats are:

- National parks and sanctuaries
- Biosphere reserves
- Nature reserves
- Reserved and protected forests
- Preservation plots
- Reserved forests

The first such initiative was the establishment of the Corbett National Park in 1936. National Parks are highly protected by law. No human habitation, private land holding or traditional human activity such as firewood collection or grazing is allowed within the park. Sanctuaries are also protected but certain types of activities are permitted within these areas. Biosphere Reserves are another category of protected areas. Under this, a large area is declared as a Biosphere Reserve where wildlife is protected, but local communities are allowed to continue to live and pursue traditional activities within the Reserve. The Government of India has set up seven biosphere reserves: Nokrek(Meghalaya), Nilgiri (Kamataka, Kerala, Tamil Nadu), Namdapha (Arunachal Pradesh), Nanda Devi (Uttar Pradesh), Sundarbans (West Bengal), Great Nicobar(Andaman & Nicobar Islands), Gulf of Mannar(Tamil Nadu).

Several special projects have also been launched to save certain animal species which have been identified as needing concerted protection effort. These projects are designed to protect the

species in situ, by protecting and conserving their natural habitat. Project Tiger, Project Elephant, Save the Barasingha campaign are examples of this initiative. Other strategies include offloading pressure from reserve forests by alternative measures of fuel wood and fodder need satisfaction by afforestation of degraded areas and wastelands. A programme "Eco-development" for in-situ conservation of biological diversity involving local communities was initiated. It integrates the ecological and economic parameters for sustained conservation of ecosystems by involving local communities with maintenance of earmarked regions surrounding protected areas.

Approximately, 4.2 % of the total geographical area of the country has been earmarked for extensive in-situ conservation of habitats and ecosystems. A protected area network of 85 national parks and 448 wildlife sanctuaries has been created. The results of this network have been significant in restoring viable population of large mammals such as tiger, lion, rhinoceros, crocodiles and elephants.

### **3. Ex-situ Conservation**

Ex-situ conservation of plants and animals preserve/ or protect them away from their natural habitat. This could be in zoological parks and botanical gardens or through the forestry institutions and agricultural research centres. A lot of effort is under way to collect and preserve the genetic material of crops, animal, bird and fish species. This work is being done by institutions such as the National Bureau of Plant Genetic Resources, New Delhi, the National Bureau of Animal Genetic Resources, etc. Reintroduction of an animal or plant into the habitat from where it has become extinct is another form of ex situ conservation. For example, the Gangetic gharial has been reintroduced in the rivers Uttar Pradesh, Madhya Pradesh and Rajasthan where it had become extinct. Seed banks, botanical, horticultural and recreational gardens are important centres for ex situ conservation. Ex-situ conservation measures complement in-situ conservation

### **4. Recording Indigenous Knowledge**

The lives of local communities are closely interwoven with their environment, and are dependent upon their immediate resources for meeting their needs. These communities have a vast knowledge about local flora and fauna which is very important for biodiversity conservation. Much of this knowledge is orally passed on from generation to generation. Such indigenous knowledge needs to be recorded and preserved before it is lost. Several organizations have recognized this and are working to record the knowledge and preserve it for posterity.

It is being recognized that no legal provisions can be effective unless local communities are involved in planning, management and monitoring conservation programmes. There are several initiatives to do this, both by government as well as non-governmental organizations. For example, the Joint Forest Management philosophy stresses involvement of village communities in regenerating and protecting degraded forest land in the vicinity of villages. Successful conservation strategies will have to have the confidence and participation of the local communities.

### **International Conservation Strategies**

Conserving biodiversity is not an issue confined to any one country or community. It is a crucial global concern. Several international treaties and agreements are in place in the attempt to strengthen international participation and commitment towards conserving biodiversity. Some of these are:

- The Convention on Biological Diversity: This was signed during the Earth Summit in 1992. It focuses not only on conserving biodiversity but also on sustainable use of biological resources and equitable sharing of benefits arising from its use.
- The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES): This is an international treaty which is designed to protect wild plants and animals affected by international trade. The treaty, in force since 1975, controls the export, import and re-export of endangered and threatened wildlife.
- The Convention on Wetlands of International Importance: This Convention, also known as the Ramsar Convention, was signed in Ramsar (Iran) in 1971 and came into force in December 1975. It provides a framework for international cooperation for the conservation of wetland habitats which have been designated to the 'List of Wetlands of International Importance'.

## **CHAPTER-5 CASE STUDY**

### **PROJECT TIGER**

The tiger, India's national animal, is a symbol that is an intrinsic part of our culture. One of the earliest portrayals of the tiger in India is found in the Harappan seals from the Indus valley culture, dating back to 2500 BC, which depict an intricate association between people and tigers. Human welfare and economic development in Asia depends on the same clean water, clean air, natural flood controls and other forest resources that tigers need. Tigers are an umbrella species, if we can maintain healthy tiger populations in India, we can ensure that there are healthy habitats and

prey populations present to support them. India is one of the thirteen tiger range countries and has the largest number of source sites with wild tigers. The Indian government has always made Tiger protection a priority and Project Tiger, launched in the early seventies, has put the endangered tiger on a definite path to recovery. As far as the scale of implementation and the diverse habitats under its coverage are concerned, the project has no parallel in the contemporary world.

'The tiger cannot be preserved in isolation. It is at the apex of a large and complex biotope. Its habitat, threatened by human intrusion, commercial forestry, and cattle grazing must first be made inviolate.'--Mrs.Indira Gandhi.

Project Tiger, was launched in 1973-74 by the Government of India, under the leadership of the then Prime Minister Mrs.India Gandhi.



### **What is the current state of Project Tiger?**

The Indian strategy of Project Tiger since 1972 to focus on tiger source areas in the form of 'core areas' thus stands vindicated. This vision and ongoing initiatives led India to have the maximum tiger source sites in the world today. Efforts are underway to mainstream the concerns of tiger in the landscape surrounding such source sites through restorative actions, while providing livelihood options to local people to reduce their dependency on forests. Objectives of NTCA are to provide statutory authority to Project Tiger so that compliance of its directives becomes legal. In the



face of pressing challenges of surging human population and pressure on forest land, the Project's biggest success has been to secure several source populations of tigers. In its new avatar as NTCA, the Project strives to streamline scientific modules of conservation and co-opt communities as responsible stakeholders.

### **Tiger Reserves in India (State wise)**

|                                    |                                     |
|------------------------------------|-------------------------------------|
| 1 Manas (Assam)                    | 2 Kaziranga (Assam)                 |
| 3 Nameri (Assam)                   | 4 Nagarjunasagar (Andhra Pradesh)   |
| 5 Namdapha (Arunachal Pradesh)     | 6 Pakke (Arunachal Pradesh)         |
| 7 Valmiki (Bihar)                  | 8 Indravati (Chhattisgarh)          |
| 9 Undanti-Sitandadi (Chhattisgarh) | 10 Achanakmar (Chhattisgarh)        |
| 11 Palamau (Jharkhand)             | 12 Periyar (Kerala)                 |
| 13 Parambikulam (Kerala)           | 14 Bandipur (Karnataka)             |
| 15 Bhadra (Karnataka)              | 16 Dandeli-Anshi (Karnataka)        |
| 17 Nagarhole (Karnataka)           | 18 Tadoba-Andhari (Maharashtra)     |
| 19 Pench (Maharashtra)             | 20 Melghat (Maharashtra)            |
| 21 Bandhavgarh(Madhya Pradesh)     | 22 Kanha (Madhya Pradesh)           |
| 23 Satpura (Madhya Pradesh)        | 24 Panna(Madhya Pradesh)            |
| 25 Sanjay-Dubri (Madhya Pradesh)   | 26 Pench (Madhya Pradesh)           |
| 27 Dampa(Mizoram)                  | 28 Satkosia(Orissa)                 |
| 29 Simlipal(Orissa)                | 30 Rathambhore(Rajasthan)           |
| 31 Sariska (Rajasthan)             | 31 Kalakad-mundanthurai(Tamil Nadu) |
| 33 Mudumalai(Tamil Nadu)           | 34 Anamalai(Tamil Nadu)             |
| 35 Corbett (Uttarakhand)           | 35 Dudhwa(Uttar Pradesh)            |
| 36 Buxa(West Bengal)               | 38 Sunderbans(West Bengal)          |
| 39 Sahyadri(Maharashtra)           |                                     |

### **Project Tiger: A success story**

1970: Mrs. Indira Gandhi appointed The Tiger Task Force under the chairmanship of Dr Karan Singh and this task force submitted its report in 1972. So emerged the blueprint for India's tiger conservation programme: Project Tiger in 1973. The report revealed the existence of only 1827 tigers in India. Given the biotic pressure, many had predicted the tiger would be extinct by the turn of the 20th century. Since its inception, Project Tiger has proved doomsayers wrong. While wild tiger numbers dwindled across its natural habitats in the neighbouring countries, the Project ensured that most of the source populations in India were intact.

## KEY MILESTONES OF PROJECT TIGER

- From nine tiger reserves in 1973, it expanded to 39 tiger reserves in 2010.
- In the early eighties, it undertook path breaking radio-telemetry study.
- The recent All India Tiger Estimation, using a peer reviewed internationally recognized scientific methodology, highlights the achievement of Project Tiger by showing that viable tiger population exists only in Project Tiger areas, while outside populations are highly depleted.
- Over the years, the Project envisioned a core-buffer-corridor strategy. While the core area of a tiger reserve is managed for wildlife conservation, the buffer is treated as a multiple use zone.

### Major achievements

- Project Tiger has saved the endangered tiger from extinction, and has put the species on an assured path to recovery by improving the protection and status of its habitat.
- The core buffer strategy of Project Tiger has provided scope for eliciting local public support through site specific Eco development in the buffer/fringe areas.
- The Project has contributed towards several intangible environmental benefits to society, such as absorption of carbon dioxide, improvement of micro climate, rainfall and river flow.
- The Project has generated considerable wages for the benefit of fringe dwelling communities, who are deployed as local work force for protection.
- While conserving the flagship species, the Project has saved several other species of plants and animals from extinction.
- The local communities are benefiting from eco-tourism apart from eco developmental inputs in fringe areas.
- The Project has served as a role model for wildlife management planning, habitat restoration, protection and Eco development. States have been provided funding support for enhancing protection through deployment of local work force, ex-army personnel. The field staff have been provided allowance as an incentive for working in difficult conditions.
- Independent monitoring of tiger reserves has been undertaken by a panel of experts, based on the framework of the World Commission of Protected Areas of the International Union for Conservation of Nature and Natural Resources(IUCN).
- The All India Estimation of tiger, co-predators and prey animals has been refined by Project Tiger in collaboration with the Wildlife Institute of India, with a peer review mechanism

comprising independent experts, both national and international(IUCN).

## **RECENT INITIATIVES**

1. Strengthening of anti-poaching activities, including special strategy for monsoon patrolling, by providing funding support to tiger reserve states, as proposed by them, for deployment of anti-poaching squads involving ex-army personnel/home guards, apart from workforce comprising local people, in addition to strengthening of communication/ wireless facilities.
2. Declaration of nine new tiger reserves and in-principle approval accorded for creation of four new reserves - Biligiri in Karnataka, Pilibhit in Uttar Pradesh, Ratapani in Madhya Pradesh and Sunabeda in Orissa.
3. The revised Project Tiger guidelines have been issued to states for strengthening tiger conservation, which apart from ongoing activities, include funding support to states for enhanced village rehabilitation package for people living in core or critical tiger habitats (from 1 lakh to 10 lakh per family), rehabilitation of communities involved in traditional hunting, mainstreaming livelihood and wildlife concerns in forests outside tiger reserves and fostering corridor conservation through restorative strategy to arrest habitat fragmentation.
4. Financial and technical help is provided to States under various centrally sponsored schemes, viz. Project Tiger, Project Elephant and Integrated Development of Wildlife Habitats for enhancing the capacity and infrastructure of the states for providing effective protection to wild animals.
5. A Global Tiger Forum of Tiger Range Countries has been created for addressing international issues related to tiger conservation.
6. As part of active management to rebuild Sariska and Panna tiger reserves where tigers have become locally extinct, reintroduction of tigers have been done.
7. Special advisories issued for in-situ build-up of prey base and tiger population through active management in tiger reserves having low population status of tiger and its prey.

## **Major Achievements**

- Project Tiger has saved the endangered tiger from extinction, and has put the species on an assured path to recovery by improving the protection and status of its habitat.
- The core buffer strategy of Project Tiger has provided scope for eliciting local public support through site specific Eco development in the buffer/fringe areas.
- The Project has contributed towards several intangible environmental benefits to society, such as absorption of carbon dioxide, improvement of micro climate, rainfall and river flow.
- The Project has generated considerable wages for the benefit of fringe dwelling communities, who are deployed as local work force for protection.
- While conserving the flagship species, the Project has saved several other species of plants and animals from extinction.
- The local communities are benefiting from eco-tourism apart from eco developmental inputs in fringe areas.
- The Project has served as a role model for wildlife management planning, habitat restoration, protection and Eco development. States have been provided funding support for enhancing protection through deployment of local work force, ex-army personnel. The field staff has been provided allowance as an incentive for working in difficult conditions.
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- The All India Estimation of tiger, co-predators and prey animals has been refined by Project Tiger in collaboration with the Wildlife Institute of India with a peer review mechanism comprising independent experts, both national and international.

### **International Cooperation**

India has a Memorandum of Understanding with Nepal on controlling trans-boundary illegal trade in wildlife and conservation, apart from a protocol on tiger conservation with China. The process is on for bilateral protocol with Bangladesh, Bhutan & Myanmar. A Global Tiger Forum of Tiger Range Countries has been created for addressing international issues related to tiger conservation.