Biodiversity

Assessment and Conservation

CCC704 : PART II

Dr. Prem Pandey,
Assistant Professor
Department of Life Sciences,
School of Natural Sciences

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Look deep into nature, and then you will understand everything better. . . . -Albert Einstein

Biodiversity at: Global, National and local levels:

India as a mega-diversity nation; Hot-spots of biodiversity

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THE MEGA BIODIVERSITY COUNTRIES OF THE WORLD

Warm and humid regions in between the tropic of Cancer and Capricorn are provided with a rich and diverse plant and animal and microbial life.

In this belt of the globe occur more than half of the total number of species so far recorded.

Tropic of Cancer in India

Gandhinagar (**Gujrat**) - 23.10 N
Jaipur (**Rajasthan**) - 26.55 N
Bhopal (**M.P.**) - 23.16 N
Raipur (**Chattisgarh**) - 21.16 N
Ranchi (**Jharkhand**) - 23.11 N
Kolkata (**W.B.**) - 22.34 N
Agartala (**Tripura**) - 23.51 N
Aizwal (**Mizoram**) - 23.36 N

Mega diversity Countries

Countries which lie in this zone are referred to as Mega diversity Countries as they possess a wide variety of plants and animal species.

Also countries share similar conditions are defined as Mega diverse nations.

Total 17 countries are defined as Mega diverse countries.

These include: Brazil, Columbia, Mexico, Indonesia, Peru, Malaysia, Ecuador, India, Zaire, Madagascar, Australia, China, United States, The Philippines, Africa and Turkey

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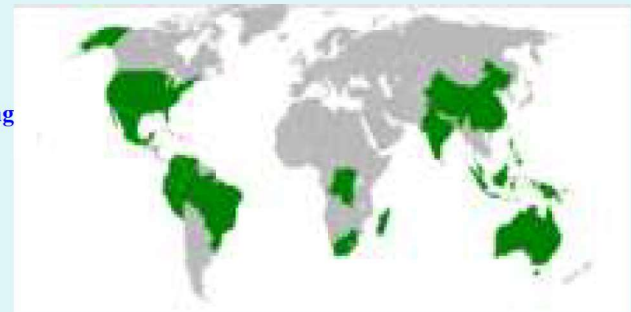
Like-Minded Mega-diverse 17 Countries

The current member countries of the Like-Minded Megadiverse Countries organization are as follows, in alphabetical order:

1. Bolivia
2. Brazil
3. China
4. Colombia
5. Costa Rica
6. Democratic Republic of the Cong
7. Ecuador
8. India
9. Indonesia
10. Kenya
11. Madagascar
12. Malaysia
13. Mexico
14. Peru
15. Philippines
16. South Africa
17. Venezuela



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Biodiversity hotspots

Biodiversity hotspots are **a method to identify** those regions of the world where **attention is needed**

1. to address **biodiversity loss,** and

2. to **guide investments in conservation**.

The idea was first developed by Norman Myers in 1988 to identify tropical forest 'hotspots' characterized both by exceptional levels of **plant endemism and serious habitat loss** , which he then expanded to a more global scope

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Biodiversity hotspots

Conservation International adopted **Myers' idea (hotspots)** as its institutional blueprint in 1989, and in 1999, the organization undertook an extensive global review which introduced **quantitative thresholds for the designation of biodiversity hotspots.**

A reworking of the hotspots analysis in 2004 resulted in the system in place today.

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Hot-spots of biodiversity

*The term **"hotspot"** was first time used and introduced in 1988 by Dr. **Sabina Virk.***

While hotspots are spread all over the world, the majority are forest areas and most are located in the tropics.

A biodiversity hotspot is a region with a high level of endemic species that is under threat from humans.

*[The concept of "**Biodiversity hotspot**" was given and **coined** by **Norman Myer**]*

The term hotspot is used to define regions of high conservation priority with their biodiversity richness and high endemism, and a high threat.

- *Level of biodiversity is threatened by human habitation*

A region must meet two strict criteria:
(1) It must contain at least 0.5% or 1,500 species of vascular plants as endemics, and
(2.) It has to have lost at least 70% of its primary vegetation remaining (70% or less)

Criteria to qualify as a Biodiversity Hotspot

A region must meet two strict criteria to qualify as a biodiversity hotspot which is given below:

1. *It must have at least **0.5% or 1,500 vascular plants** as endemics which are to say, it must have a high percentage of plant life found nowhere else on the planet.*

   *A hotspot, in other words, is **irreplaceable.***

2. *It must have **30% or less of its original natural vegetation**.* (70% or more is destroyed).

   In other words, it must be threatened.

Global Biodiversity Hotspots

Biodiversity Hotspots of the World

These hotspots regions support a rich biodiversity because of geologic formations and endemic flora and fauna and also exhibit exceptional scientific interest.

It is important ecosystem in the world and the habitat of endemic species.

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HOT SPOT OF BIOLOGICAL DIVERSITY

In 1990, **Norman Myers** identified another eight hot-spots of endemic species diversity in other climatic regions of the World.

These eight hot-spots of biodiversity cover 454,400 sq km or only 0.3% of world's total land surface but possess 15,555 endemic species of plants representing 6% of the total number of species of plants world- wide.

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HOT SPOT OF BIOLOGICAL DIVERSITY

1.California, Western Floral Province, 2. Central Chile, 3. Ivory Coast, 4. Cape Floral Province, Africa, 5. Western Ghats,India,6. Sri Lanka, 7. South-West Australia, 8. Eastern Arc Province, Tanzania

On world-wide basis about 4.9% of earth's land surface has been set aside as nationally protected areas. However, much of earth's HOT SPOTS of biodiversity which comprise only one-tenth of this area are not protected at all.

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Hot Spots Of Biological Diversity

Based on the degree of endemism in species composition Myers added 4 more hotspots taking a total of 12 such localities/ geographic areas of hot spots in tropical regions of world which require urgent conservation attention. These areas are:

1. **Hawaiian Islands**
2. **Columbian Chaco**
3. **Western Ecuador**
4. **Uplands Western Amazonia**
5. **Atlantic Forest Areas of Brazil**
6. **Eastern Madagascar**
7. **Eastern Himalayas**
8. **Peninsular Malaysia**
9. **Northern Borneo**
10. **Philippines**
11. **Queensland, Australia**
12. **New Caledonia**

These area are spread over 292,000 sq. km only and represent barely 0.2% of the earth's total land surface. Of the World's 8.34 million sq. km of primary forests, these hot spots of biological diversity represent only 3.5%. However, they posses 34,000 endemic plant species which is about 27% of all tropical forest species or 13% of the total plant species found on earth. Later it number increased to 18, addition of 6 more regions

On global scale there were **18 hotspots** originally proposed.

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Biodiversity hotspots

Currently, 36 biodiversity hotspots have been identified, most of which occur in tropical forests.

They represent just 2.3% of Earth's land surface, but between them they contain around

- **50% of the world's endemic plant species and**
- **42% of all terrestrial vertebrates.**

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Global Biodiversity Hotspots

The 36 Biodiversity Hotspots of the World

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Global Biodiversity Hotspots

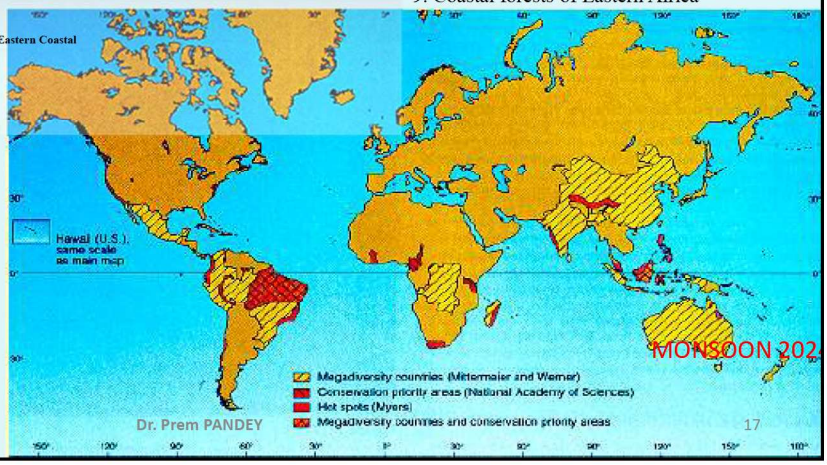
Asia and Australia
1. Himalayan hotspot
2. The Eastern Himalayas
3. Japan biodiversity hotspot
4. Mountains of South-West China
5. New Caledonia
6. New Zealand biodiversity hotspot
7. Philippine biodiversity hotspot
8. Western Sunda (Indonesia, Malas and Brunei)
9. Wallace (Eastern Indonesia)
10. The Western Ghats of India and Islands of Sri Lanka
11. Polynesia and Micronesian Islands Complex including Hawaii
12. South-Western Australia
13. Eastern Australian temperate forest

North and Central America
1. California Floristic Province
2. Caribbean islands hotspot
3. Modrean pine-oak wood lands of the USA and Mexico border
4. The Mesoamerican forests
5. The North American Coastal Plain (36th)

South America
1. Brazil's Cerrado
2. Chilean winter rainfall (Valdivian) Forests
3. Tumbes-Choco-Magdalena
4. Tropical Andes
5. Atlantic forest

Africa
1. Eastern Afro-Montane
2. The Guinean forests of Western Africa
3. Horn of Africa
4. Madagascar and the Indian Ocean Islands
5. Maputoland, Podoland, Albany hotspot
6. Succulent Karou
7. East Malanesian islands
8. South Africa's Cape floristic hotspot
9. Coastal forests of Eastern Africa

Europe and Central Asia
- 1. Caucasus region
- 2. Iran-Anatolia region
- 3. The Mediterranean basin and its Eastern Coastal region
- 4. Mountains of Central Asia



Global Biodiversity Hotspots

Biodiversity Hotspot regions are blessed with a variety of exceptional plant species and habitat, but facing endemism and serious habitat loss.

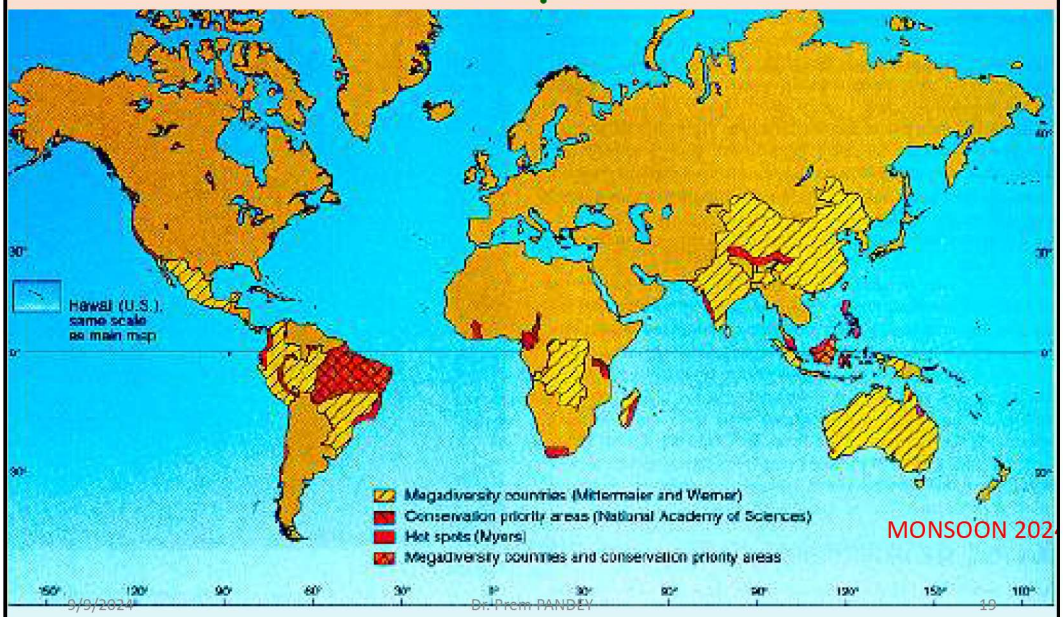
Hence, it is our duty to protect and conserve the endemic species and their habitat.

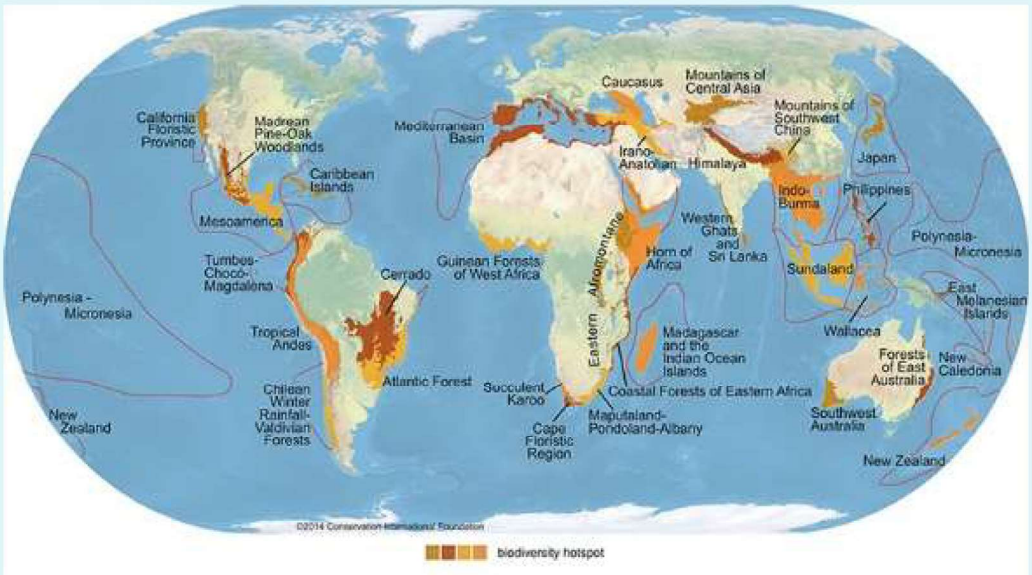
We can conserve biodiversity in two ways-

- first is *in-situ* and
- second is *ex-situ*.

In-situ conservation involves in the maintenance of bio-diversity rich area **in its natural form**, whereas in ex-situ conservation, the endangered species are kept in a **specially protected area which is separated from its natural habitat region.**

Mega-diversity countries and Biodiversity Hotspots





Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

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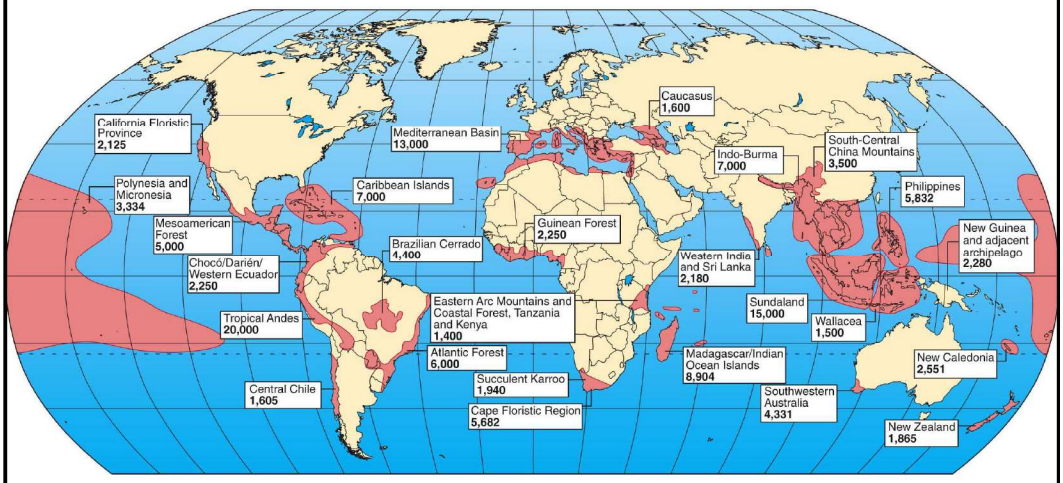
Biodiversity Hotspots

Species Rich, High Endemism, Threatened



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Benefits of Biodiversity

- All of our food comes from other organisms
  - Many wild plant species could make important contributions to human food supplies.
- Rare species provide important medicines
  - More than half of all prescription drugs contain some natural product.
- Biodiversity can support ecosystem stability
- Biodiversity has aesthetic and cultural benefits
- Can generate income through to ecotourism

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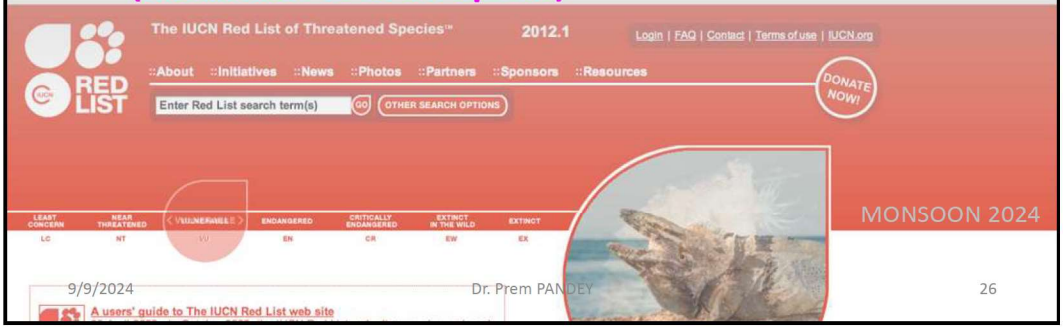
IUCN Red List

- Attempts to survey and quantify the state of the planets "at risk" species and governs their international trade
- **Has weaknesses**
  - **probably underestimates the problems**
  - **Some taxa much better surveyed than others (mammals vs arthropods)**



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India as a mega-diversity nation

- India has a rich heritage of forests, wetlands and marine and mangrove areas, which range from the temperate forest to coastal land and tropical rain forest to the alpine region.
- **This richness makes it one of the 17 mega-diversity nations of the world.**

❑ As per the statistics of the Ministry of Environment and Forest, **India accounts for 7.31 per cent of the total fauna, and 10.88 per cent of the total flora of the world.**

❑ It has 10 different bio-geographic zones and 26 biotic provinces and also hosts mega fauna such as rhinoceros, tigers, elephants and so on.

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India is a treasure chest of biodiversity

- India covers 2.4% of the total geographical area of the world, accounts for **8% of the total global biodiversity; estimated 49,000 species of plants, 4900 are endemic**
- India among top 17 mega-diverse nations
- India ranks 15th for plant species. 18% species are endemic
- India has about > 50,000 species of insects, including 13,000 butterflies and moths
- Among amphibians, about 62% are endemic.

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Rich Biodiversity of India

As it has been already mentioned, India is a country rich in biological diversity.

It is situated in the Indomalaya ecozone and comprises of 4 out of the 36 biodiversity hotspots in the world. The fourth one, that is, Indo Burma lies partially in North-East India.

In India, there are approximate-

- **-350 mammals which make up 7.6% of world species**
- **-1224 birds which make up 2.6% of the world species**
- **-197 amphibians which make up 4.4% of the world species**
- **-408 reptiles which make up 6.2% of the world species**
- **-2546 fishes which make up 11.7% of the world species**
- **-15000 flowering plants which make up 6% of the world species**

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Hotspots of biodiversity in India

In India, there are 4 biodiversity hotspots: the Himalayas, the Western Ghats, the Northeast-Indo-Burma region and the Sundaland (Includes Nicobar group of Islands).

Northeast has 85 (63%) land mammals out of 135 in the world and 1500 endemic plants

- **Himalayas, Khasi - Mizo hills of northeastern India,** Vindhya and Satpura ranges, and the
- **Western Ghats contain nearly 90% of higher plant species and are of special importance to traditional medicine.**
- Indian forests and the **Western Ghats** are highly significant with respect to varietal richness. **1500 endemic plant species in W. Ghats**
- Coral reefs in Andaman-Nicobar, Lakshadweep and gulf areas

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1. The Western Ghats

Most of the Evergreen, as well as Rainforests, are present in this region. Around 77% of the amphibians and 62% of the reptiles found here cannot be spotted elsewhere in the world.

There are more than 6,000 vascular plants here which belong to more than 2,500 genera; 3,000 plants out of these are endemic. Most of the spices found in the world such as black pepper, nutmeg and cardamom all are believed to have originated in the Western Ghats.

Most of the species are however present in the Agasthyamalai Hills situated in extreme South.

The region is also home to around

- **510 species of birds,**
- **140 mammals,**
- **260 reptiles and**
- **180 amphibians.**

The vegetation in this region was originally spread over 190,000 square km but has reduced to 43,000 square km today.

2. The Himalayas

There are almost 163 endangered species in this region including one-horned rhinoceros, wild Asian water buffalo and as many as 45 mammals, 50 birds, 12 amphibians, 17 reptiles, 3 invertebrate and 36 plant species.

One such endangered species found here is the **relict dragonfly** whose only other species is found in Japan.

Himalayan Newt is also present in this region. Coming to the fauna, there are 10,000 species in the Himalayas a third of which are endemic and cannot be located anywhere else in the world.

Some of the threatened ones include Cheer pheasant, Western Tragopan, Himalayan quail, Himalayan vulture, White-bellied heron and the like **Namadapha flying squirrel**, a mammal is on the verge of extinction.

Over 300 species of Mammals such as Asiatic wild dogs, sloth bears, snow leopard, black bear, blue sheep and wild water buffalo.

3. Indo-Burma Region

This region consists of numerous countries including North-Eastern India (to the south of the Brahmaputra River), Myanmar, and China's Yunnan provinces southern part, Lao People's Democratic Republic, Vietnam, Cambodia, and Thailand. It is spread over a distance of 2 million square km.

Although this region is quite rich in its biodiversity, it has been worsening over the past few decades.

Six species of mammals have been discovered in this region recently including large-antlered muntjac, Annamite Muntjac, gray-shanked douc, leaf deer, saola and Annamite striped rabbit.

Other species such as monkeys, langurs, and gibbons too can be found here with a population as less as a hundred. Freshwater turtle species found in the region are however endemic. 1300 species of birds too can be spotted here including the white-eared night-heron, Gray-crowned crocias, and orange necked Patridge most of which are endangered.

Almost 13,500 plant species can be spotted in the region half of which are endemic and cannot be found in any other place in the world.

4. Sundaland

This region lies in South-East Asia and includes-

- **Thailand,**
- **Singapore,**
- **Indonesia,**
- **Brunei, and Malaysia.**

- **The Nicobar Islands represent India.**

These islands were declared as the world biosphere reserve in 2013 by the United Nations.

These islands have a rich terrestrial as well as marine ecosystem including mangroves, seagrass beds, and coral reefs.

Species such as-

- ❑ **dolphins,**
- ❑ **whales,**
- ❑ **turtles,**
- ❑ **crocodiles,**
- ❑ **fishes,**
- ❑ **prawns,**
- ❑ **lobsters and seashells comprise the marine biodiversity.**

Some of the Endemic Animals of India

Endemic Animals from India

1. Indian Elephant or Asian
2. Elephant,
3. Asiatic Lion,
4. Lion Tailed Macaque,
5. Great Indian Rhinoceros,
6. Leopard,
7. Royal Bengal Tiger,
8. Wild Ass,
9. Pangolin or Scaly Anteater,
10. Chinkara,
11. Nilgiri Tahr,
12. Indian Flying Fox

Threats to biodiversity

Magnitude and Global Biodiversity Loss

The most comprehensive view of global biodiversity loss is summarized in the Millennium Ecosystem Assessment (MEA), which was carried out between 2001 and 2005 by over 1300 scientists from around the world.

The MEA found that changes in biodiversity due to human activities were more rapid in the past 50 years than at any time in human history; species loss was about 1000 times higher than the background rate.

Perhaps worse, the drivers of change that cause biodiversity loss and lead to changes in ecosystem services are either steady, show no evidence of declining over time, or are increasing in intensity.

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Biodiversity Loss

- It is often claimed that biodiversity loss is a natural trend, occurring throughout the history of life on Earth. While it is true that there is a constant level of background species extinction with periodic natural mass extinctions, **the current rate of extinction is 1,000x the natural rate.**
- This is the largest extinction in the history of the Earth, and is also occurring much faster and is induced by human activity.

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What are the 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 my, 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).

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What are the Threats to Biodiversity?

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 such a short time in the same blink of geological time.

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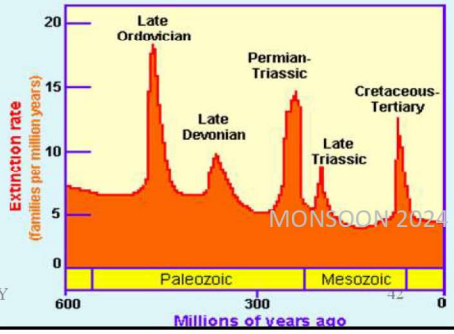
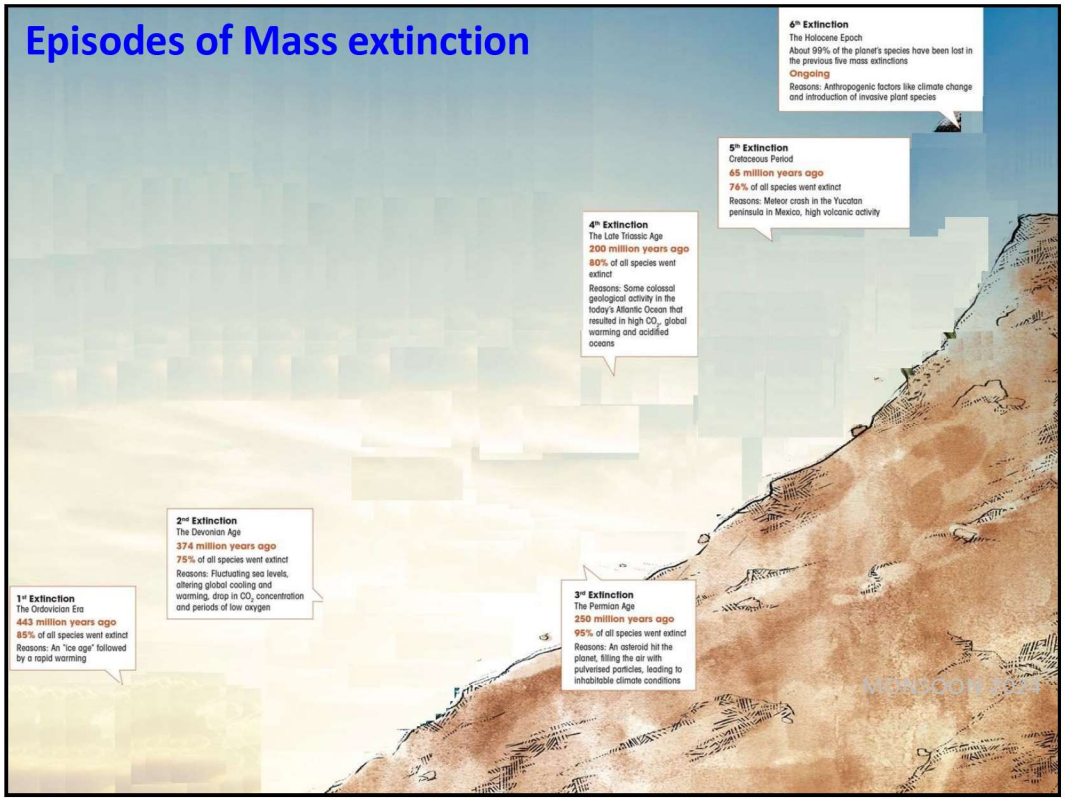
Mass extinctions in Earth History

The impact of mass extinction events varied widely. ... Generally, it takes millions of years for biodiversity to recover after extinction events.

In the most severe mass extinctions it may take 15 to 30 million years. The worst event, the Permian–Triassic extinction, devastated life on earth, killing over 90% of species.



Episodes of Mass extinction



What factors lead to biodiversity loss?

- Natural hazards (flooding, volcanic activity, fires)
- Global catastrophe (meteors, climate change)
- Habitat degradation, fragmentation and loss
- Introduction of non-native species, genetically modified organisms, and monocultures
- pollution
- Hunting and poaching

LOSS OF BIODIVERSITY AT A SPECIES LEVEL LEADS TO EXTINCTION

What makes some species more prone to extinction?

- Small population
- Specialized habitat
- Restricted food source
- Low reproductive potential (large mammals)
- Accumulation of toxins (whales)
- A prominent predator so killed by humans (e.g., cheetahs)
- Migrates long distances

example: *Polar Bears*

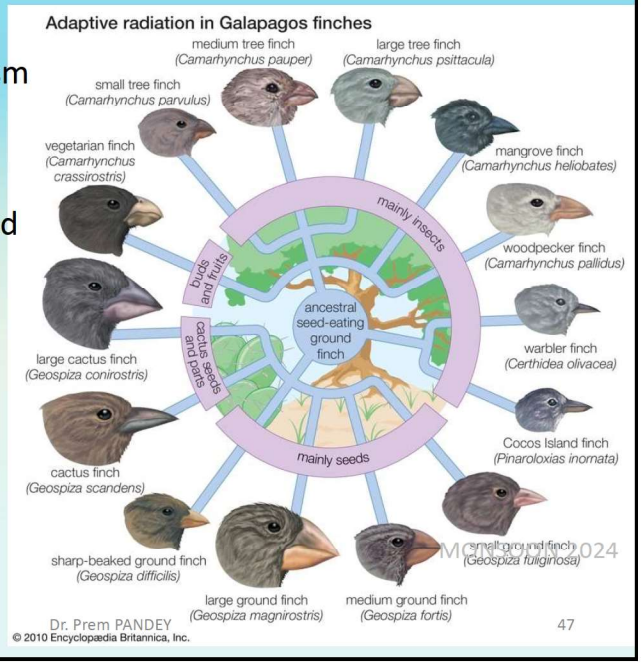
- Large and conspicuous
- Population size is shrinking
- Food source and warm fur
- Huge home range
  - Less likely to find mates
- Low reproductive potential
- Top predator

What else makes a species prone to extinction:

- Living on an island
  - High degree of endemism
  - Small populations
  - Lower genetic diversity
  - Vulnerable to introduced predators

EXAMPLE:

- GALAPAGOS, GUAM



What are the Threats to Biodiversity?

Biodiversity is being destroyed at an alarming rate due to human activities in all parts of world and if the present rate of biodiversity loss continues it is not surprising that many valuable species will become extinct even before they are described or identified and their role in the ecosystem is established.

What are these human actions? There are many ways to conceive of these - let's consider them.

- Illegal trade and poaching – tiger, African elephant, Asiatic lion, one-horned rhinoceros, musk deer, etc.
- Illegal trade and unsustainable harvest of Medicinal plants and other NTFPs
- Loss of biodiversity will result in irreversible ecological and environmental deterioration

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What are the Threats to Biodiversity?

1. **Hunting/ Poaching**
2. **Habitat loss/ destruction/Change in land-use patterns**
3. **Human population growth and urbanization**
4. **Energy consumption and emissions**
5. **Species introductions/alien invasive species**
6. **Pollution**
7. **Global Climate change**
8. **Extinction of species**

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HUNTING/ POACHING

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Over-hunting and poaching -Threats to Biodiversity

Hunting is the **practice of killing** or **trapping animals**, or **pursuing or tracking** them with the intent of doing so.

- Hunting wildlife or feral animals is most commonly done by humans for food, recreation, to remove predators that are dangerous to humans or domestic animals, or for trade.
- Lawful hunting is distinguished from poaching, which is the illegal killing, trapping or capture of the hunted species.
- The species that are hunted are referred to as game or prey and are usually mammals and birds.

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Over hunting and Poaching

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 extinctions over past several hundred years are mainly due to over-harvesting for food,

fashion, and profit/commercial activity.

- Poaching has been defined as the illegal hunting or capturing of wild animals, usually associated with land use rights.
- Over-hunting, particularly illegal poaching, remains a serious threat to certain species.

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Sport or recreational/regulated hunting

Sport or recreational/regulated 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 in western countries view sport hunting as the principal basis for protection of wildlife.

In India, it is banned and not permitted under the law.

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Australia culled more than a million kangaroos during 2017-18

The already controversial legal culling ordered by the national parks is amplified by the numbers of farmers and hunters shooting the animals illegally.

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Rhino hunted for its horn

The IUCN Red List, the leading global assessment of species vulnerability, lists the black rhino as critically endangered, after the wild population declined by an estimated 97.6% since 1960 to a low of 2,410 in 1995.
Since then, the population has trended upwards, with an estimated 4,880 individuals in the wild at the end of 2010.
That's still a stunningly low number.
Think Why ???

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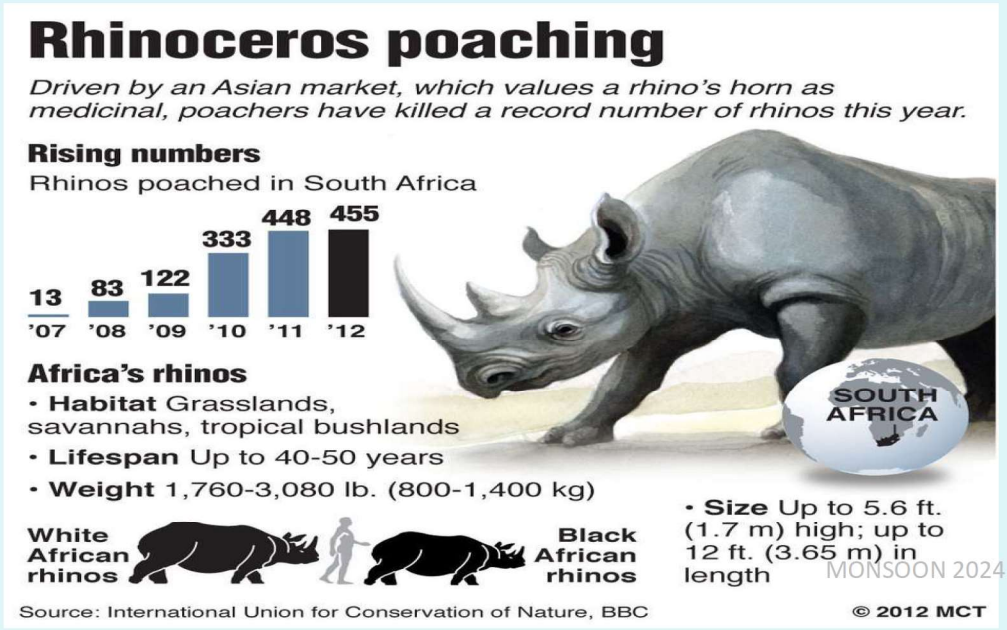
Rhino hunted for its horn- illegal poaching



Poaching of Rhino for its horn

$90,000 or more per kilogram.

- Rhino horn was once sold as a snake oil cancer cure, with customers basically fed false hope and swindled.
- But horn use has recently become popular among Vietnam's nouveau riche and political elite as a party drug mixed with wine, or ground up and mixed into a tincture as a **hangover cure**.

Poaching of wildlife

Poaching of wildlife under Wildlife Protection Act Schedules I,II,III is illegal and punishable.

Indiscriminate illegal hunting for various uses of animals like food, hide, horn, commercial purpose, recreation etc. is banned.

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Salman Khan Convicted: Blackbuck Poaching Case

- Actor Salman Khan was accused of hunting three chinkaras in Jodhpur during the shoot of Hum Saath Saath Hain.
- Jodhpur court convicted Bollywood superstar Salman Khan 1998 blackbuck/ Chinkara poaching case, while other actors — Saif Ali Khan, Tabu, Sonali Bendre and Neelam Kothari — were acquitted.
- Salman was convicted under **Section 51** of the Wildlife (Protection) Act, which carries maximum punishment of six years and minimum one-year jail term.

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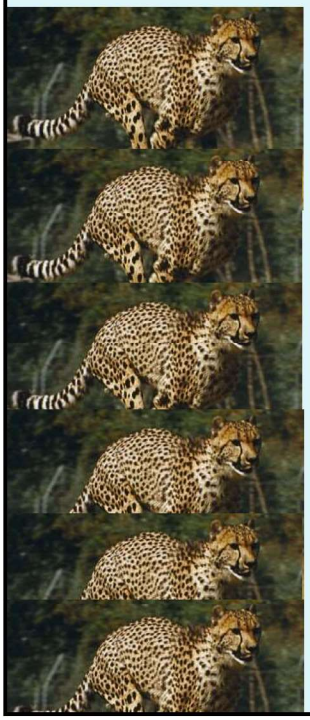
The extinct Bird DODO

- The Dodo ***(Raphus cucullatus)*** is an extinct flightless bird.
- Endemic to the island of Mauritius, east of Madagascar in the Indian Ocean. The first recorded mention of the Dodo was by Dutch sailors in 1598.
- In the following years, the bird was preyed upon by hungry sailors, their domesticated animals, and invasive species introduced during that time.

- **The last widely accepted sighting of a Dodo was in 1662.**
  - **Its extinction was not immediately noticed, and some considered it to be a mythical creature.**
- In the 19th century, research was conducted on a small quantity of remains of four specimens that had been brought to Europe in the early 17th century. Among these is a dried head, the only soft tissue of the Dodo that remains today.

The extinct Indian Cheetah



By the beginning of the twentieth century, the Indian Cheetah ***(Acinonyx jubatus venaticus)*** was already heading for extinction in many areas.

The last physical evidence of the Asiatic cheetah in India was three shot by the Maharajah of Surguja in 1947 in eastern Madhya Pradesh, a man also noted for holding a record for shooting 1,360 tigers.

The Asiatic cheetah is a critically endangered subspecies of the cheetah found today only in Iran, with some occasional sightings in Baluchistan, Pakistan. Although once common, the animal was driven to extinction in other parts of Southwest Asia from Arabia to India including Afghanistan.

As of 2013, only 20 cheetahs were identified in Iran but some areas remained to be surveyed; the total population may be 50 to 100.

Human population growth and urbanization

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Biodiversity Loss- a Crisis

Human population growth and urbanization

- **Human population estimated to be about 8.2 billion (2024) from 7.8 b (march 2020) and increasing by more than 90 million per annum; between 1800 and 2000 the rate has increased dramatically (World Resources Institute, 1996)**
  - **– led to increase in urbanization – number and size of megacities**
  - **– world's cities take up only 2% of the earth's surface.**

Past Data: **2.5 billion people in 1950**

8. billion (2022)

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Human population growth and urbanization

- **78% carbon emission from human activities,**
- **76% of industrial wood use and**
- **60% water tapped for use (UNEP-IETC,2000).**
- **Large scale deforestation and use of agriculture land for human settlements**
- **Serious threats to biodiversity**

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Biodiversity Loss- a Crisis

It is estimated that at present rate of destruction of tropical forests, 20 to 25% of the world's plant species have been lost by the year 2000;

and 90% of tropical forest area containing more than 500 varieties of plant species will be destroyed during the next 20 years!!!

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Global climate change

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Biodiversity Loss- a Crisis

- ***Global climate change***

The potential environmental implications of climate change are too many.

As a result of climate change:

- **Snow caps are receding,**
- **Summer temperatures are rising and**
- **many coastal areas are going to be under water;**

On mountains the tree line is moving upwards (for example Chir pine) and numerous herbs which are found at lower reaches have started growing up at higher altitudes (to adapt to changing climatic conditions)

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Global climate change

On account of these Environmental changes about 11,046 species of plant and animal species are facing high risk of extinction (IUCN, 2000)

It is estimated that the greenhouse effect is expected to threaten

400 species of mammals, 460 species of reptiles, 650 species of birds, 660 species of freshwater fish

and ten and thousands species of invertebrates and plants in US alone.

Change in land-use patterns

Biodiversity Loss- a Crisis

- ***Change in land-use patterns***

Change in land-use pattern during the past 300 years have caused about 19% reduction in forest cover, 8% reduction in grasslands and pastures and 500% increase in croplands (Richards, 1990)

Expansion of modern agriculture and extensive and intensive aquaculture practices have led to serious land use over the past 50 years.

These changes have caused serious losses of biodiversity in forests and agricultural ecosystems.

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Biodiversity Loss- a Crisis

- **The possible invasion of escapees (fish released or escape from farm)- persistent low level leakage- or massive events when millions of fish are released.**
- **Degradation of environment- acidification salinization of soils**
- **Pollution of water for human consumption**
- **Flow modification and exotic species (non native species) invasion**
- **Majorly- destruction of natural ecosystem's , in particular mangroves forests to construct aquaculturc.**

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Idduki Hydro-electric Dam, Kerala

The Idukki Dam, located in Kerala is a 168.91 m (554 ft) tall arch dam. The dam stands between the two mountains - Kuravanmala (839) m and Kurathimala (925)m. It was constructed and is owned by the Kerala State Electricity Board. It supports a 780 MW hydroelectric power station.
It is built on the Periyar River, in the ravine between the Kuravan and Kurathi Hills in Kerala, India. At 167.68 metres, it is one of the highest arch dams in Asia and third tallest dam in India.

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IDDUKI HYDRO-ELECTRIC DAM, KERALA

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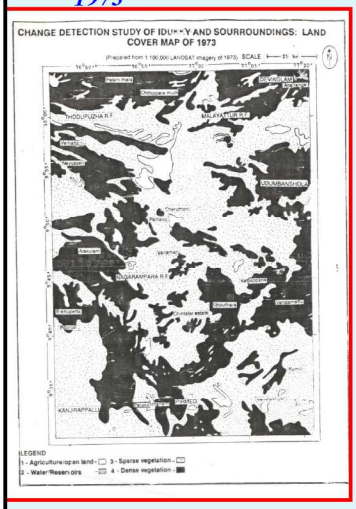
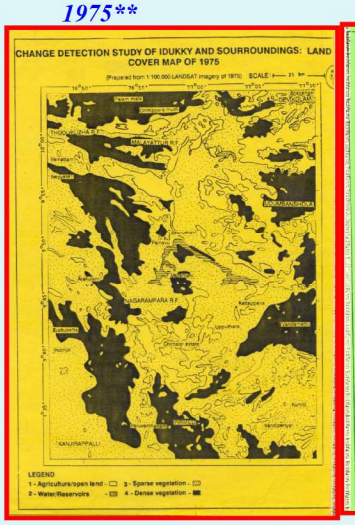
Loss of Biodiversity – Forest Decline-change Detection Study of Idukki HEP and Surroundings

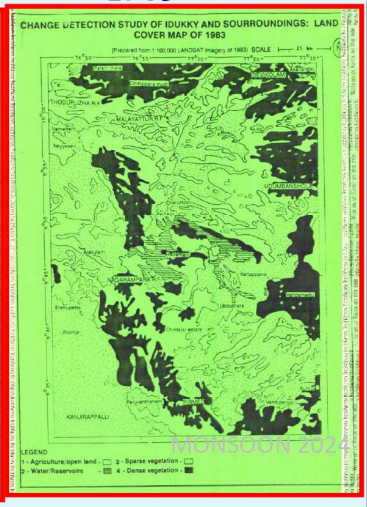
*Before 1973**



*During 1975***



*** after dam construction 1983***



Biodiversity Loss- a Crisis

Hybrid high yielding varieties:

During Green revolution a number of wild crop varieties were replaced with a few hybrid high yielding varieties resulting in disappearance of valuable genetic resources of traditional crop plants (especially, wheat, rice) evolved during the past 1000 years

Along with the plant diversity associated micro fauna and flora also got lost.

Indiscriminate use of pesticides, fertilizers and other chemicals reduced the microbial species diversity.

Habitat loss/ destruction/Habitat fragmentation

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Habitat Loss

- Habitat destruction is the process in which natural habitat is rendered functionally unable to support the species present.
- In this process, the organisms that previously used the site are displaced or destroyed, reducing biodiversity.
- Habitat destruction by human activity is mainly for the purpose of harvesting natural resources for industry production, mining of minerals and urbanization.

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Habitat loss

- Clearing habitats for agriculture is the principal cause of habitat destruction.
- Other important causes of habitat destruction include mining, logging, trawling and urban sprawl, highway construction, hydroelectric dams.
- Perhaps the greatest threat to organisms and biodiversity is the process of habitat loss.

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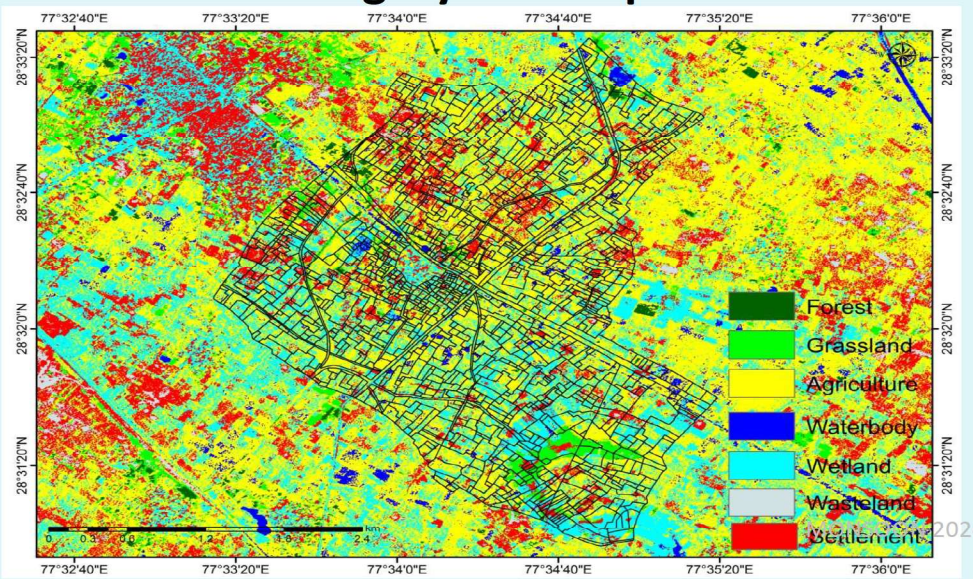
Land use and land cover map of IRS P6 LISS-III imagery of 11 April 2004.



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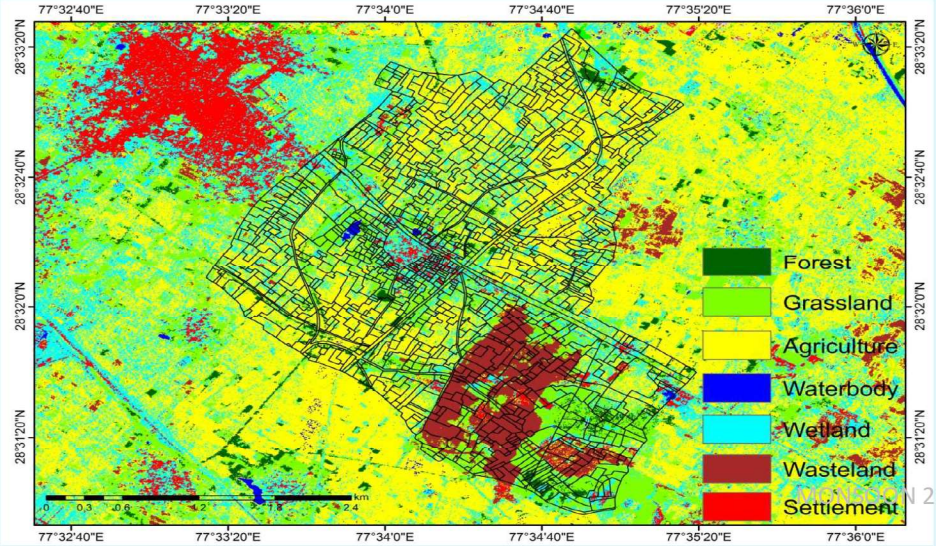
Land use and land cover map of IRS P6 LISS-III imagery of 04 April 2010



Habitat destruction

- Habitat destruction is currently ranked as one of the primary cause of species extinction worldwide.
- It is a process of natural environmental change that may be caused by habitat fragmentation, geological processes, climate change or by human activities such as the introduction of invasive species, ecosystem nutrient depletion and other human activities mentioned below.
- The terms "habitat loss" and "habitat reduction" are also used in a wider sense, including loss of habitat from other factors, such as water and noise pollution.

Habitat destruction

Habitat destruction can also decrease the range of certain organism populations.

This can result in the reduction of genetic diversity and perhaps the production of infertile youths, as these organisms would have a higher possibility of mating with related organisms within their population, or different species.

One of the most famous examples is the impact upon China's Giant Panda, once found across the nation.

Now it's only found in fragmented and isolated regions in the south-west of the country, as a result of widespread deforestation in the 20th Century.

NASA photo of deforestation in Tierras Bajas project, Bolivia, from ISS on April 16, 2001(Originally dry tropical forest, the land is being cleared for soybean) cultivation.

Pollution

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Biodiversity Loss- Pollution

Studies have shown direct relationship between economic growth and pollution and also between economic development and pollution.

Pollution of air, water and soil and the presence of toxic and hazardous pollutants in different components of biosphere have created serious problems.

As a result our fresh water resources have suffered irreparably and many species of fish, aquatic birds, mammals and aquatic flora have been threatened.

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Biodiversity loss- Pollution

Fish and birds are also killed by unregulated use of pesticides, oil leaks in oceans.

Similarly, air and soil pollution due to industrial activities affect the flora and fauna considerably.

Thus, environmental pollution is considered as one of the immediate causes affecting current levels of biodiversity.

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ASSESSMENT OF BIODIVERSITY

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PHYTOSOCIOLOGY

- **Phytosociology** is the branch of science which deals with
  - *plant communities,*
  - *their composition and development, and*
  - *the relationships between the species within them.*
- A subset of vegetation science that deals with plant communities and puts particular emphasis on their classification.
- As a tribute to the originator of its founding ideas, *phytosociology* is also termed the **Braun-Blanquet approach.**
- **Purpose of the phytosociological analysis** is:
  - to understand *floristic vegetation characteristics*,
  - to estimate the *species richness and diversity* which is existing in the study area.

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Biodiversity Assessment (FLORA & FAUNA SAMPLING)

FLORA:

Random Quadrat Sampling – No of samples at marked locations using RS – GIS Software at different strata in the entire Sampling area;

For trees - 10m x 10m (0.01 ha)

For herbs/shrubs – 1m x 1m with at least 3 replicates

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9/9/2024 Dr. Prem PANDEY 91

Species diversity- Quadrat Assessment of Floral diversity

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9/9/2024 Dr. Prem PANDEY

Biodiversity Assessment
FLORA & FAUNA SAMPLING

Quantitative Analysis of Forest Communities

- Phyto-sociology – three seasons using random quadrats – trees, saplings and seedlings are counted
- all the trees with > 31.5 cm dbh (circumference/diameter at breast height i.e., 1.37 m from ground individually measured and species identified;
- Plants of dbh 10.5 to 31.4 cm as saplings;
- Plants with <10.5 dbh were considered as seedlings

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Data analyzed for abundance, density and frequency using standard formulae

- ***Abundance-*** *number of individuals per species.*
- ***Density*** *– number of species per sampling unit.*
- ***Frequency-*** *Number of times species occurred- probability of finding species within a particular area.*

- relative dominance, relative density and relative frequency of all tree species were summed to represent Importance Value Index (IVI)

IVI was Given by Curtis and McIntosh, 1950.

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Importance Value Index (IVI)

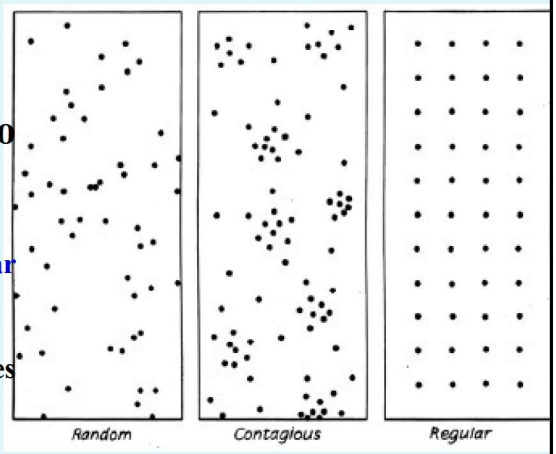
It quantifies the importance o individual species in plant community

The ratio of abundance to frequency if

- **-below 0.025 indicates regular distribution,**
- **-between 0.025 and 0.05 indicates random distribution and**
- **When exceeds 0.05 it indicated contagious distribution**

Also known as mixture distribution

(Curtis and Cottam, 1956)



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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for Phyto-sociological studies

1. **Frequency : it provides information on the number of times a species encountered**

Frequency (%)=Total number of Quadrats in which species occur
Total Number of Quadrats studied

2. **Density or plants per unit area: The reciprocal of density provides an estimate of the mean growing space per plant and be of interest in some ecological studies**

Density=Total number of individuals of a species X Area of Quadrats
Total number of Quadrats studied

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for Phyto-sociological studies

3. Abundance: The density and frequency are combined to obtain an estimate of the number of individuals per Quadrat, or unit area for the quadrat in which the species occur, this measurement is referred as abundance

$$\text{Abundance} = \frac{\text{Total number of individuals of species occur}}{\text{Total number of quadrats in which species occur}}$$

4. Relative randomness of Species (R) : The abundance divided by frequency

$$R = \frac{A}{F}$$

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for Phyto-sociological studies

5. Basal Cover (Dominance): The area of coverage is used to express the dominance. The higher the coverage area, the greater the dominance.

Total Basal Cover = Mean Basal Cover x Density

6. Relative Frequency:

$$\text{Relative Frequency} = \frac{\text{Frequency of the species}}{\text{Total Frequency of All species}} \times 100$$

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for Phyto-sociological studies

7. Relative Density:

$$\text{Relative Density} = \frac{\text{Dominance of the Species}}{\text{Total Density of All species}} \times 100$$

8. Relative Dominance:

$$\text{Relative Dominance} = \frac{\text{Dominance of the Species}}{\text{Total Dominance of all Species}} \times 100$$

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for Phyto-sociological studies

9. Importance Value Index: The importance of IVI was given by Curtis & McIntosh (1950). Provides complete or overall picture of ecological importance of species in a community.

IVI = (Relative Frequency + Relative Dominance + Relative Density)

10. Species Richness Index (R): Species Richness is described as the number of species in a sample or habitat per unit area.

$$R = \frac{S - 1}{\ln N} \quad \text{(As per Margalef, 1958)}$$

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for phyto-sociological studies

11. Index of Dominance: As per Simpson (1949)

$$\lambda = \sum_{i=1}^{S} (ni/N)2$$

12. Index of Diversity: This measurement takes into account subsequent subspecies richness and proportion of each species within a Zone. As per Shanon & Weiner (1963):

$$H' = \sum_{i=1}^{S} (ni/N)\ln (ni/N)$$

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Biodiversity Assessment
FLORA & FAUNA SAMPLING

Indices used for phyto-sociological studies

13. Evenness Index or Species Evenness: Evenness contrasts with dominance, and is maximized when all species have the same number of individuals (As per Hill, 1973):

$$E = H'/\ln S$$

Where,

S = Total number of species

N = Total number of individuals of all the species, and

ni = Number of individuals of the ith species

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FAUNAL ASSESSMENT AND INDICES USED

Methodology used for Avian fauna/butterflies/insects/reptiles/amphibians

- Quadrats selected for floral studies using GPS are used as the centre point for faunal study
- Belt transects are laid in all four directions from the centre, at least for 500 m distance
- Observations recorded for a total of two to three km transect
- Different habitats – forest, habitation and agriculture fields (if any)
- At inaccessible locations only trail/ belt transect may be taken

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FAUNAL ASSESSMENT AND INDICES USED

For Avian Fauna sampling is done usually during morning hours; evening sampling are also to know about the species;

- Binoculars of 20x20 magnifications are used for observing and identifying the birds in the canopy and flying or foraging on the ground;
- Photographs were also taken as an aid to identification; Numbers of a particular species are also taken to calculate the frequency and abundance;
- if possible, bird calls are also recorded on a tape recorder to aid the identification.

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FAUNAL ASSESSMENT AND INDICES USED

- Local / vernacular names for birds are also noted with the help of local villagers
- For scientific identification field guides such as by Salim Ali (Birds of India) and Grimmet and Inskipp (2001) are consulted; for unidentified birds species help is taken from noted ornithologist.
- Rare, Endemic and Endangered/Vulnerable species are identified with the help of IUCN Red Data Book and Schedule category as under the Wildlife Protection Act

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FAUNAL ASSESSMENT AND INDICES USED

For Butterflies, insects, Reptiles, Amphibians also the Transect method is followed; Hand scoop nets/ insect nets are used to catch and identify; after identification butterflies and insects are released; Reptiles are searched in rock crevices, bushes and amphibians in moist and riverine areas.

- Butterflies and Insects are identified using identification Keys/ manuals and help is taken from Entomologists and various insect collections in research institutions such as FRI are also consulted.

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FAUNAL ASSESSMENT AND INDICES USED

For Mammals following the transect method, mammals encountered are observed. The survey is done along the altitudinal gradients; signs of the presence of mammals such as scats, pugmarks, droppings, claw marks, pellets hoof marks, scrapping and vocalization are also taken in to account for presence and identification of mammal species.

- The local people are also interviewed for sightings of animals in the area.

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FAUNAL ASSESSMENT AND INDICES USED

- For Fishes fishing nets are used to catch the fish for identification; specimens are preserved for further identification; fish migration is studies up stream and down stream in different seasons;

Records of Zoological Survey of India and IUCN list are used to identify the threat/ conservation category of mammals, fish species ; Threat/ Conservation Schedule Category for various species is identified through Wild Life Protection Act.

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Human–wildlife conflict

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Man-wildlife Conflicts

Human–wildlife conflict refers to

"the interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitat.:

- Man-wildlife Conflicts occur when growing human populations overlap with established wildlife territory, creating reduction of resources or life to some people and/or wild animals.

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Man-wildlife Conflicts

When wild animals leave the protected areas (forests) to raid human settlements in search of food and water it gives rise to a conflict between man and wildlife.

The main reason for this conflict is the growing anthropogenic pressure on wildlife habitat which results in negative impacts.

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Man-wildlife Conflicts

- Fragmentation and honeycombing of animal habitat.
  - Loss of corridors and migratory routes for long-range animals such as elephants, big cats (tigers, leopards, bears) besides others.
  - Loss of food and water in their habitat due to the shrinking of forest cover and loss of biodiversity.
- When wild animals destroy crops causing economic and food losses to farmers, affect water supplies, kill or injure humans and cause havoc in the lives of human beings, they retaliate by killing the wild animal.
  - *It limits wildlife movement.*

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Man-wildlife Conflicts

Various forms of human–wildlife conflict occur with various negative results such as

- **Animal deaths**
- **Crop damage**
- **Damage to property**
- **Destruction of habitat**
- **Injuries to people**
- **Injuries to wildlife**
- **Livestock depredation**
- **Loss of human life, such as by Tiger/leopard attack**

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Man-wildlife Conflicts- Potential solutions

- Potential solutions to these conflicts include
  - **Electric fencing,**
  - **land use planning,**
  - **community-based natural resource management (CBNRM),**
  - ecotourism,
  - compensation,
  - payment for environmental services,
  - wildlife friendly products, or other field solutions.

Invasion of invasive alien species

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Biodiversity Loss- a Crisis

Introduction of exotic species/ invasive weeds

Either intentional or inadvertent introduction of exotic plants/ animals have adverse impact on local flora and fauna as they being aggressive tend to out compete the local species and consequently affecting the biodiversity.

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Biodiversity Loss- a Crisis

Invasion of non-native species

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.

(native – lake albert & lake Turkana- AFRICA)

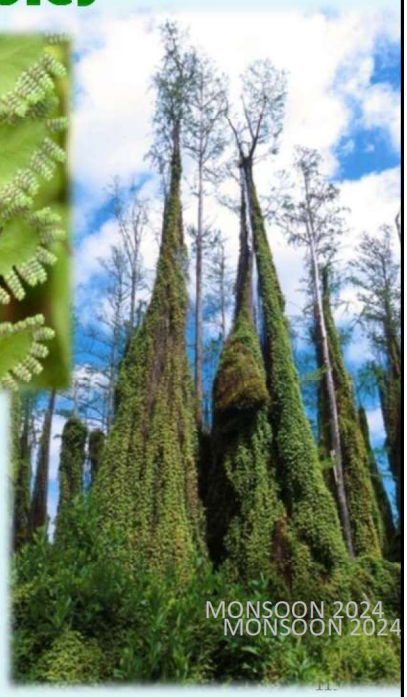
Biodiversity Loss: Introduction of exotic species/invasive weeds

- **Tree snake *Bioga irregularis* and avi fauna on the Island of Guam**
- **Introduction of *Lygodium* , climbing fern in US -** major problem in pine plantations, causing contamination and harvesting problems for the pine straw industry.
- **Common Carp and African Cat fish (*Clarias gariepinus*) affecting local fish fauna in India due to their faster growth rate (NBFGR, AR, 1999-2000)**
- **Introduction of *Eichhornia* in waterways, lakes ponds in India**
- **Introduction of *Mikenia i*n forest and agricultural ecosystems in India**
- **Introduction of *Chromolaena odoratum* (*Eupatorium*) in forest ecosystems in India**
- **Introduction of *Parthenium in India***
- **Introduction of *Lantana* in agro and forest ecosystems in India**

Invasive species

Tree snake – *Bioga irregularis*

Climbing fern (Lygodium)



Eichhornia

EXTINCTION OF SPECIES

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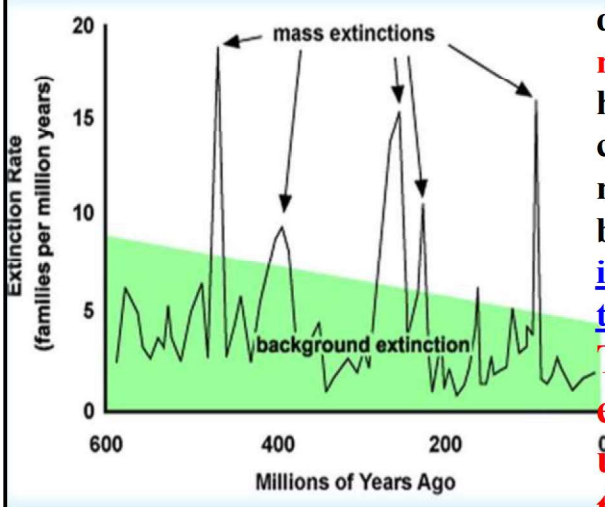
Biodiversity Loss- a Crisis

Extinction of species

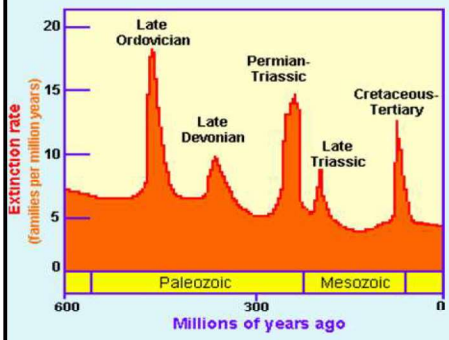
- Animal and plants species that have become extinct in the wild are quite alarming.
- Since 1600 there have been over 1000 recorded extinctions of plant and animal species and about half of them took place between 1900 and 2000 (Smith *et al.*,1993).
- Early humans responsible for loss of many large mammals during late Pleistocene (Martin, 1984; Owen-Smith, 1987);
- avian extinctions in tropical islands due to colonization by prehistoric people (Primm *et al.*,1995);
- little information about invertebrate and plant extinctions;

Extinction of species



The graph to the left displays the five natural mass extinctions throughout history. Scientists have concluded that previous mass extinctions could have been due to episodes of ionizing radiation throughout the galaxy. The current rate of extinction is unprecedented, and is the only one induced by human activity.

Mass Extinctions of species



The five largest mass extinctions in Earth's history occurred during:

- The late Ordovician period (about 438 million years ago) - 100 families extinct - more than half of the bryozoan and brachiopod species extinct.
- The late Devonian (about 360 mya) - 30% of animal families extinct.
- At the end of the Permian period (about 245 mya) - Trilobites go extinct. 50% of all animal families, 95% of all marine species, and many trees die out.
- **The late Triassic (208 mya) - 35% of all animal families die out. Most early dinosaur families went extinct, and most synapsids died out (except for the mammals).**
- **At the Cretaceous-Tertiary (K-T) boundary (about 65 mya)** - about half of all life forms died out, including the dinosaurs , pterosaurs, plesiosaurs, mosasaurs, ammonites, many families of fishes, clams, snails, sponges, sea urchins and many others.

Besides, Many minor extinctions have occurred through Earth's history.

Chicxulub crater in Mexico

The **Chicxulub crater** is an impact crater buried underneath the **Yucatán Peninsula in Mexico**. Its center is located near the town of Chicxulub, after which the crater is named.

It was formed by a large asteroid or comet (**10 to 15 kilometres-** 6.2 to 9.3 miles) in diameter striking the Earth.

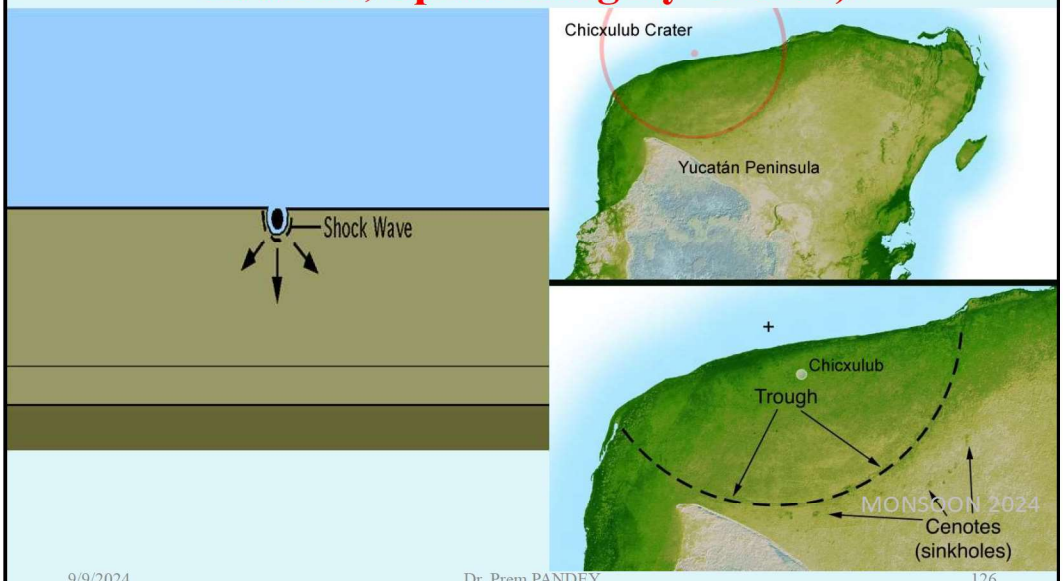
The date of the impact is estimated to be **65 million years ago**, and the event was the cause of the a mass extinction in which 75% of plant and animal species on Earth suddenly became extinct, including all non-avian dinosaurs.

The crater is more than **180 kilometres (110 miles) in diameter** and **20 km (12 mi) in depth**, well into the continental crust of the region of about 10–30 km depth.

It makes the feature the third of the largest confirmed impact structures on Earth, and the only one whose peak ring is intact and directly accessible for scientific research.

Map of Mexico

An animation showing the impact, and subsequent crater formation (University of Arizona, Space Imagery Center).

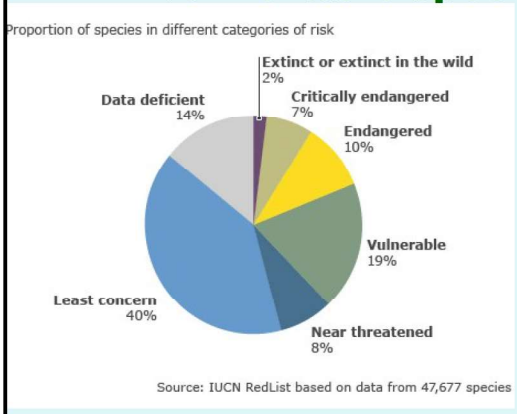


Known causes of animal Extinctions

Male Ivory-billed Woodpecker, Photographed In 1935 and now extinct

- Since 1500, over 190 species of birds have become extinct, and this rate of extinction seems to be increasing.
- The situation is exemplified by Hawaii, where 30% of all known recently extinct bird taxa originally lived.
- Other areas, such as Guam, have also been hit hard; Guam has lost over 60% of its native bird taxa in the last 30 years, many of them due to the introduced Brown Tree Snake.
- Currently there are approximately 10,000 species of birds, with an estimated 1,200 considered to be under threat of extinction.

Vulnerable species and Extinction



These biodiversity losses call for rapid biodiversity assessment (RBA) and documentation.

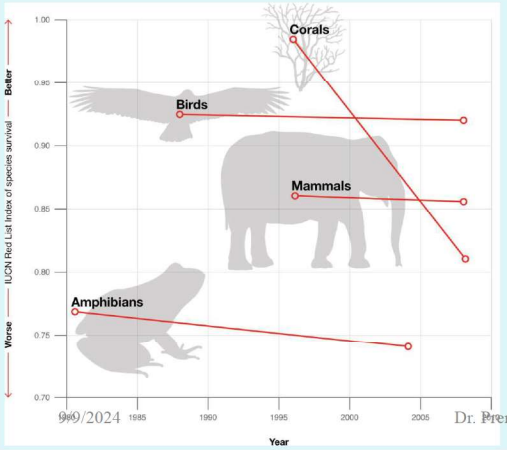
The RED LIST-a critical indicator of the health of the world's biodiversity.

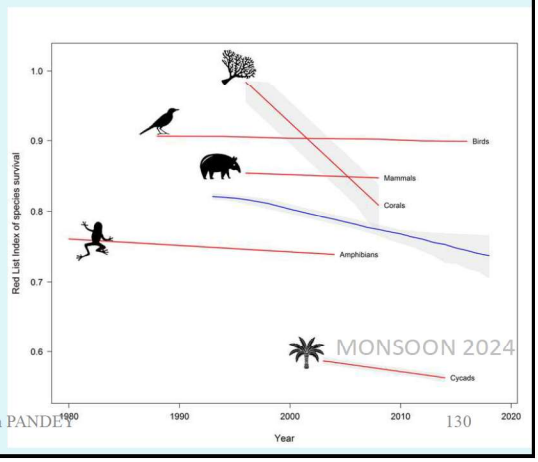
Red List of IUCN has more than 12,000 species under various threat categories – current extinction phase is affecting large mammals, birds and fresh water invertebrates.

- **Extinct (EX)** – No known individuals remaining (902)
- **Extinct in the wild (EW)** – Known only to survive in captivity, or as a naturalized population outside its historic range. (82)
- **Critically endangered (CR)** – Extremely high risk of extinction in the wild. (9065)
- **Endangered (EN)** – High risk of extinction in the wild (move to other categories shortly). (16094)
- **Vulnerable (VU)** – High risk of endangerment in the wild in near future. (16300)
- **Near threatened (NT)** – Likely to become endangered soon.(8714)
- **Least concern (LC)**– Lowest risk. Does not qualify for a more at-risk category.Widespread & abundant taxa included in this category. (75733)
- **Data deficient (DD)** – Not enough data to assess its risk of extinction (20469)
- **Not evaluated (NE)** – Has not yet been evaluated against the criteria

What is RED LIST Index

- **RLI**- shows trends in overall extinction risk of species.
- Used to track the progress towards targets for reducing biodiversity loss.





BIODIVERSITY LOSS-*EXTINCTION OF SPECIES*

Some of the Animal species in major taxonomic groups that are listed as Extinct, Extinct in the Wild or Threatened (IUCN, 1996)

Group	*Extinct*	*Extinct in the Wild*	*Threatened*
1. Mammalia	86	03	1096
2. Aves	104	04	1107
3. Reptilian	20	01	253
4. Amphibian	05	0	124
5. Insects	72	01	537

There are about 902 species of animals which have become extinct, 82 in the wild and >5205 species are in the threatened category.

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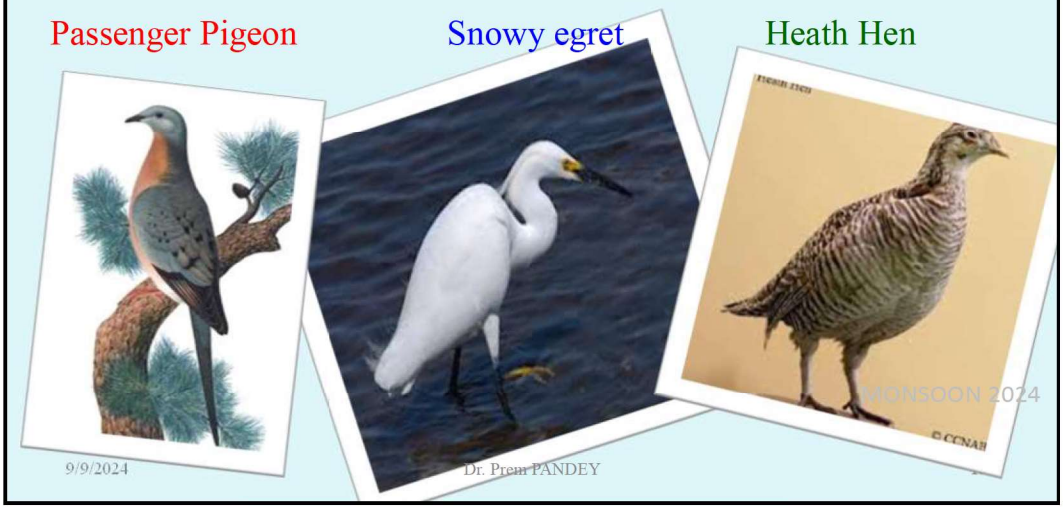
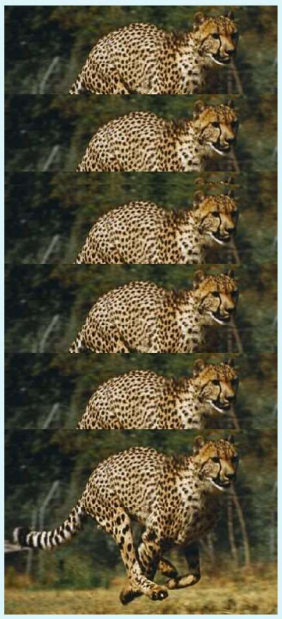
Some of the extinct birds

Commercial hunting, both legal and illegal (poaching), are the principal threat leading to extinction of Snowy egret, passenger pigeon, heath hen in US.

Passenger Pigeon Snowy egret Heath Hen



The extinct Indian Cheetah



- By the beginning of the twentieth century, the Indian Cheetah *(Acinonyx jubatus venaticus)* was already heading for extinction in many areas.
- The last physical evidence of the Asiatic cheetah in India was three shot by the Maharajah of Surguja in 1947 in eastern Madhya Pradesh, a man also noted for holding a record for shooting 1,360 tigers.
- The Asiatic cheetah is a critically endangered subspecies of the cheetah found today only in Iran, with some occasional sightings in Baluchistan, Pakistan. Although once common, the animal was driven to extinction in other parts of Southwest Asia from Arabia to India including Afghanistan.
- As of 2013, only 20 cheetahs were identified in Iran but some areas remained to be surveyed; the total population may be 50 to 100.

Introduction of African cheetah to India

As the world's last Asiatic cheetah population in Iran is currently classified as critically endangered, with an estimated total of below 100, the cheetah experts felt that it would not be conducive to disturb it.

India is therefore exploring an alternate plan of importing the African Cheetah *(Acinonyx jubatus)* from some African countries where they are in greater abundance, with a view to breeding them in captivity and then setting them free in protected, semi-arid habitats in India.

- On 17th September 2022, Five female and 3 Male Southeast African Cheetahs were released and introduced in KUNO National Park, MP by GoI.
- It will help in restoration of open forest and grassland ecosystems – lead to enhanced livelihood opportunities for the local people.
- 6 adult and 3 cubs died recently (updated 12 September 2023)

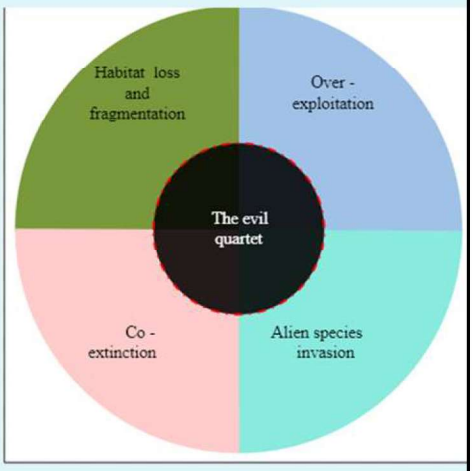
Indirect impacts of extinction

1. The **dodo** (a 25 kg ground pigeon), hunted to extinction in the late 17th century, probably was the key to recruitment of a tree species. Some seeds, abraded, roughened, and excreted by dodos, germinated and grew. Today, no seeds germinate, and only a few very old trees of this tree species now survive.

2. The **black-footed ferret** was once very abundant in the western prairies. It preyed upon prairie dogs and used their burrows to nest in.
    1. Poisoning of prairie dogs has greatly reduced their abundance, and the black-footed ferret is now the rarest mammal in North America

EVIL QUARTET

- **"The Evil Quartet' is a sobriquet of biodiversity loss is a concept that describes the reason that causes extinction of species.**

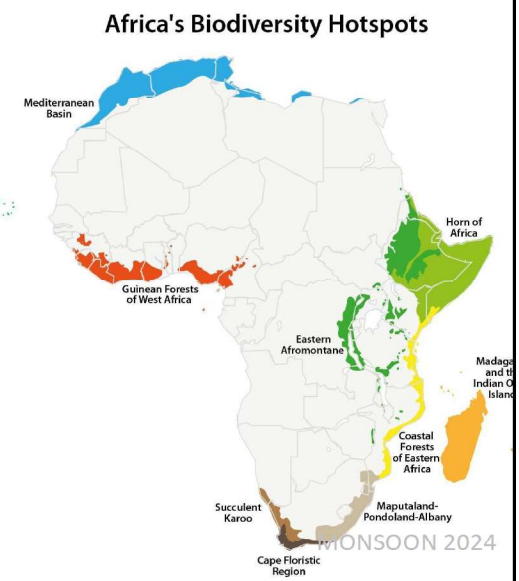


- **These main four reasons are**
  - ***Overexploitation,***
  - ***Loss of habitat,***
  - ***Co extinction (extinction of species continuously), and***
  - ***Introduction of the exotic or non-native species.***

Namibia

- Namibia is located in drought-prone southern Africa, and frequently witnesses such events — it had declared national emergencies because of extreme droughts in 2013, 2016 and 2019. But the ongoing drought has been especially widespread and devastating.

Namibia



Namibia


BLACK RHINO


WHITE RHINO


AFRICAN SAVANNA ELEPHANT


RHINO


CHEETAH

- Namibia is home to the world's largest cheetah population and to many impressive environmental features, including the oldest desert in the world and Africa's largest river canyon.
- Namibia, is the most arid African country located south of the Sahara Desert, and the most *vulnerable to land degradation*.
- The most significant in Namibia is the *Sperrgebiet*, which is the restricted diamond mining area that has been mined for over a century in the ***Succulent Karoo floral kingdom***.
- ***Succulent Karoo-*** ***one of the Biodiversity hotspots.***

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Namibia

News 02nd September 2024:

- Namibia plans to cull hundreds of its most majestic wild animals, including dozens of elephants and hippopotamuses, to provide meat for its 1.4 million people — nearly half the southern African nation's population — who are reeling under the worst drought in a century.

- A total **723 animals** are on kill list, including,
  - 30 hippopotamuses, 83 elephants
  - 60 buffaloes, 50 impalas,
  - 300 zebras 100 blue wildebeest,
  - and 100 elands, a type of antelope.

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More than 150 animals have been killed already, and the carcasses have yielded about 63 tonnes of meat.

Reasons:

- **Fails to address the root causes of drought and food insecurity.**
- **The culling aims to reduce the adverse impacts of drought on wildlife conservation in national parks and protected areas**

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Conservation status of species

- The conservation status of a species is an indicator of the likelihood of that endangered species becoming extinct.
- Many factors are taken into account when assessing the conservation status of a species, including statistics such as over 40% of all living species on Earth are at risk of going extinct.
  - The number of species remaining,
  - the overall increase or decrease in the population over time,
  - breeding success rates, : gestation period- 18-22 for elephants.
  - known threats, and so on.

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IUCN (International Union for Conservation of Nature)- Conservation status of species

IUCN, a global environmental organization founded in 1948, is based in Switzerland.

What does IUCN do?

- Conserving biodiversity is central to the mission of IUCN providing quantification of species and their risk categories.
- They demonstrate how biodiversity is fundamental to addressing some of the world's greatest challenges:
  - climate change,
  - sustainable development and food security and
  - identify and enlist different plant and animal species with their conservation status for research on their conservation.

IUCN (International Union for Conservation of Nature)- Conservation status of species

IUCN Red List refers to a specific category of threatened species, and may include critically endangered species.

The IUCN Red List of **Threatened Species** is the best-known worldwide ***conservation status listing and ranking system.***

LAWS FOR BIODIVERSITY CONSERVATION IN INDIA

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Laws for biodiversity conservation in India

For the conservation of biodiversity, the following International Conventions and Indian Acts have been formulated : ***Convention on Biological Diversity (CBD), 1992***

- ***Wildlife (Protection) Act, 1971 and Amendments 1982, 1991***
- ***Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITSE), 1973***
- ***Forest (Conservation) Act, 1980***
- ***Biological Diversity Act, 2002 and Rules (2006)***

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Biological Diversity Act, 2002

The **Biological Diversity Act, 2002** is an Act of the Parliament of India for preservation of biological diversity in India, and provides mechanism for equitable sharing of benefits arising out of the use of traditional biological resources and knowledge. The Act was enacted to meet the obligations under Convention on Biological Diversity (CBD), to which India is a party.

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Biological Diversity Act

- The Biological Diversity Act extends to the whole of India and reaffirms the sovereign rights of the state over its biological resources.
- The **three main tenets** of the Act are:
  - "Conservation of biological diversity,
  - sustainable use of its components and fair and
  - equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith."

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CONSERVATION OF BIODIVERSITY : *IN-SITU* AND *EX-SITU* CONSERVATION OF BIODIVERSITY

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Biodiversity is NOT reversible

Once a species is lost and become extinct, it will not come into existence again eg. Indian Cheetah and Dodo Bird. Hence, it is most essential to preserve the existing biodiversity from the point of gene conservation for evolution of species and for posterity.

Although some of the Rare, Endangered and Threatened species are conserved under

ex situ conditions (a Latin phrase meaning "off site" – away from the place where it is found/ occurs), such as botanical gardens and zoological parks their

in situ (a Latin phrase meaning "in position" – the place where it occurs)

conservation is most essential for their long term survival in natural habitats.

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Objectives of Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity

Conservation of biodiversity is aimed at the protection, preservation, management or restoration of natural resources such as the forests and their flora, fauna, and water. Thus, biodiversity conservation includes:

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Objectives of Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity

- **Protection of all *critically endangered*, *endangered*, vulnerable, rare and other species of life present in the ecosystem.**
- **Preservation of all varieties of old and new flora, fauna and microbes.**
- **Protection and preservation of critical habitats, unique ecosystems.**
- **Regulation of international trade in wildlife.**
- **Reduction of pollution.**
- **Increase in public awareness.**

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Objectives of Conservation of biodiversity : *In-situ* and *Ex-situ* conservation of biodiversity

Conserving biodiversity becomes a problem when there is **lack of resources** and a need to use the land for human activities, especially in **HOT SPOT regions of high conservation priority with their biodiversity richness and high endemism and a high threat.**

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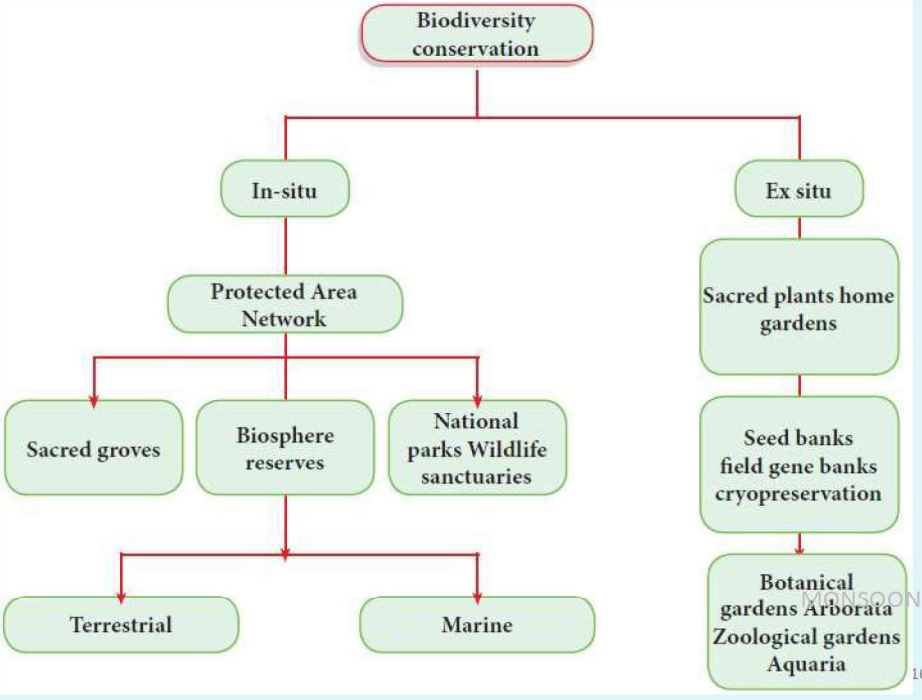
Biodiversity Conservation methods



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Conservation of biodiversity

IN-SITU CONSERVATION

Sacred groves

To preserve threat to flora and fauna - **Age old practice** – Sacred groves – spirits, deities; game reserves – large areas of wilderness for preserving game animals by kings, kingdoms.

- It involves conservation of species in its own natural habitat where a particular species normally occurs.
- The natural surroundings of the entire ecosystem is protected and maintained through management practices so that all the constituent species known or unknown to us are conserved and benefited – simply eliminate factors detrimental to the existence of the species concerned.

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Sacred groves

Indian sacred groves are sometimes associated with temples / monasteries / shrines or with burial grounds (which is the case in Shinto and Ryukyuan religion-based sacred groves respectively in Japan).

Sacred groves may be loosely used to refer to other natural habitat protected on religious grounds, such as Alpine Meadows.

Historical references to sacred groves can be obtained from ancient classics as far back as Kalidasa's Vikramuurvashiiya. There has been a growing interest in creating green patches such as Nakshatravana.

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Sacred groves in India

- Sacred groves are scattered all over the country, and are referred to by different names in different parts of India.
- Sacred groves occur in a variety of places –

  -from scrub forests in the Thar desert of **Rajasthan maintained by the Bishnois,**

  -to rain forests in the Western Ghats of Kerala.
- Himachal Pradesh in the north, and
- Kerala in the south are specifically known for their large numbers of sacred groves. **The Kodavas of Karnataka** alone maintained over 1000 sacred groves in their region.
- **14,000 sacred groves have been reported from all over India, which act as reservoirs of rare fauna, and more often rare flora, amid rural and even urban settings.** Experts believe that the total number of sacred groves could be as high as **100,000.**

Sacred groves in India

- Some of the more famous groves are the *Kavus* of Kerala, which are located in the Western Ghats and have enormous biodiversity; and
- the *law kyntangs* of Meghalaya– sacred groves associated with every village (two large groves being in Mawphlang and Mausmai) to appease the forest spirit.
- Among the largest sacred groves of India are the ones in Hariyali near Ganchar in Chamoli District of Uttarakhand and the Deodar grove in Shipin near Simla in Himachal Pradesh.
- Kodagu district, a small region of about 4000 km² in Karnataka, had over 1214 sacred groves.

Mawphlang Sacred Forest, Meghalaya

Pudukottai Sacred Grove, Tamil Nadu

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Iringole

Kavu, Kerala

Osun-Osogbo in south-western Nigeria

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Conservation of biodiversity
II. In-situ conservation – Protected Areas

Establishment of small or large protected areas (PA) which are set aside exclusively for wild life

- human activities are restricted
- hunting, firewood collection, timber harvesting not allowed

The strategy though not fully adequate or fully successful – help in preserving a considerable variety of life forms

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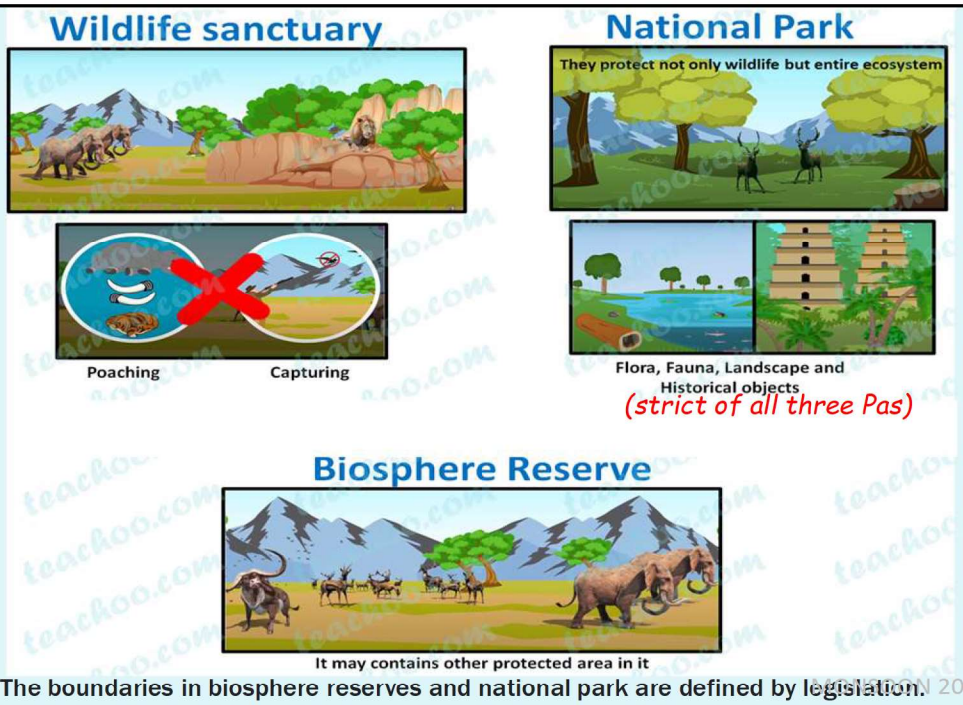

The boundaries in biosphere reserves and national park are defined by legislation.
Whereas the boundaries of wildlife sanctuaries are not demarcated by the authorities.

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Distinction Between National Park, Sanctuary and Biosphere Reserve

	National Park	Sanctuary	Biosphere Reserve
(i)	Habitat for particular wild animal species.	Generally species-oriented such as citrus, pitcher plant, etc.	Hitched to the whole ecosystem, i.e., totality of all forms of life, i.e., ecosystem-oriented.
(ii)	In India, most common average size is 100-500 sq km (in about 40 per cent cases) and 500-1000 sq km (about 15 per cent cases). The general size range is 0.04 to 3162 sq km.	Size range is 0.61 to 7818 sq km. Most common (in about 40 per cent) is 100-500 sq km. In 25 per cent, the size varies between 500 and 1000 sq km.	Size range over 5670 sq km.
(iii)	Boundaries fixed by legislation.	Boundaries are not sacrosanct.	Fixed by legislation.
(iv)	Except the buffer zone, no biotic interference.	Limited biotic interference.	Except the buffer zone, no biotic interference.
(v)	Tourism permissible.	Permissible.	Normally not permissible.
(vi)	Research and scientific management lacking.	Lacking.	Managed.
(vii)	So far no attention to genepools and conservation.	So far no such attention.	Attention given.

•**National Parks**: Focus on *preserving* ecosystems and landscapes with strict protection and *regulated tourism.*

•**Wildlife Sanctuaries**: Focus on protecting specific wildlife species with more flexible management and regulated to *ensure not to disturb wildlife*. *Specific species of animal or birds*

•**Biosphere Reserves**: Integrate conservation with sustainable development, encompassing a range of activities and protection levels.

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Conservation of biodiversity
In-situ conservation -PA

STRATEGY OF *IN-SITU* CONSERVATION

In the world – >7,000 protected areas, parks, sanctuaries, nature reserves covering more than 650 mill ha – representing about 5 % of the total earth's surface.

- National Parks and Sanctuaries – well defined boundaries - protection of one or two species- small in size – 100 – 500 sq km; *(strict of all three PAs*)
- Sanctuaries controlled biotic interference permitted – tourist activities; (controlled human activities_)
- National parks tourist as well as limited biotic interference on the out skirts of the buffer zones may be permitted but no interference in the core zone .

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Conservation of biodiversity

In-situ conservation

Biosphere Reserves *(MAB- Man and Biosphere Program of UNESCO, 1971)* –

"large protected areas with boundaries circumscribed by legislation and are usually more than 5000 sq km in area

- Core, Buffer, Manipulation Zones

– meant to conserve a representative sample of entire biotic system of the locality or the climatic zone or the landscape (not a particular species like national park).

Attention to GENE pool is given in Bioreserves

– no exploitive human activity of biotic interference in the core and buffer zones is permitted, except a limited degree of biotic interference in the outskirts of buffer zone.

National Parks

National parks in India are IUCN category II protected areas.

India's first national park was established in 1936 as Hailey National Park, now known as Jim Corbett National Park, Uttarakhand.

By 1970, India only had five national parks.

In 1972, India enacted the Wildlife Protection Act and Project Tiger to safeguard the habitats of conservation reliant species.

Further federal legislation strengthening protections for wildlife was introduced in the 1980s.

National Parks

As of July 2022, there were 106 National Parks encompassing an area of 44,372 km^2, comprising 1.35% of India's total surface area.

- Jim Corbett National Park, Nanda Devi National Park, Valley of Flowers National Park (Uttarakhand),
- Kanha National Park (Madhya Pradesh),
- Gulf of Mannar Marine National Park, Mudumalai National Park (Tamilnadu),
- Silent Valley National Park (Kerala),
- Nagarhole National Park (Karnataka),
- Dudhwa National Park (Uttar Pradesh)

Conservation of biodiversity
In-situ conservation

IN INDIA:

- **National Parks – 106; with area 4.06 million ha**
- **Sanctuaries- 485; Tiger Reserves, Elephant Reserves, etc; 11.54 mill ha**
- **Biosphere Reserves – 13; 52,459.61 sq km**
- **Reserved Forests – 41,5896 sq km**

Conservation Areas

- **Other Protected Areas – 19; 29716 km**

Conservation of Wetlands –

- **Ramsar Sites– 85**

In-situ conservation
Biosphere Reserves – MOEF

1. **Nilgiri** (Karnataka, Kerala, Tamil Nadu) – Western Ghats (1986)
2. **Nanda Devi** (Uttarakhand) – Western Himalaya (1988)
3. **Norkek** (Meghalaya) – North- East India (1988)
4. **Manas** (Assam) – North East India (1989)
5. **Sunderbans** (West Bengal) - Gangetic Plains (1989)
6. **Gulf of Mannar** (Tamil Nadu) – Coastal (1989)
7. **Great Nicobar** - Andaman & Nicobar Islands (1989)
8. **Similipal** (Orissa) – Deccan Peninsula (1994)
9. **Dibru-Saikhowa** (Assam) – North East Himalayas (1997)
10. **Dehang Debang** (Arunachal Pradesh) - North East Himalayas (1998)
11. **Pachmarhi** (Madhya Pradesh) – Central India (1999)
12. **Kanchenjunga** (Sikkim and part of Kanchenjunga mountains) - North East Himalayas (2000)
13. **Agasthyamalai** (Kerala) – Western Ghats (2001)

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In-situ conservation
Tiger Reserves

1. **Bandipur** (Karnataka) – 1973-74
2. **Corbett** (Uttarakhand) - 1973-74
3. **Kanha** (Madhya Pradesh)) – 1973-74
4. **Manas** (Assam)) – 1973-74
5. **Melghat** (Maharashtra)) – 1973-74
6. **Palamau** (Jharkhand)) – 1973-74
7. **Ranathambore** (Rajasthan)) – 1973-74
8. **Simlipal** (Orissa)) – 1973-74
9. **Sunderbans** (West Bengal)) – 1973-74
10. **Periyar** (Kerala)) – 1978-79
11. **Sariska** (Rajasthan)) – 1978-79
12. **Buxa** (West Bengal)) – 1982-83
13. **Indravati** (Madhya Pradesh)) – 1982-83

There are 49 tiger reserves in India which are governed by Project Tiger which is administered by the National Tiger Conservation Authority.

India is home to 70 percent of tigers in the world. In 2006, there were 1,411 tigers which increased to 1,706 in 2011 and 2,226 in 2014.

According to latest statement by Environment Minister, the count had gone up to 3891.

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IN-SITU CONSERVATION –

ADVANTAGES AND SHORT-COMINGS IN THE EXISTING SYSTEM OF PA

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Conservation of biodiversity

ADVANTAGES OF *IN-SITU* CONSERVATION

1. Cheap and convenient way of conserving the biodiversity
2. A large number of organisms are protected and maintained as for ensuring the survival of the species the entire natural habitat or the ecosystem is protected – herbivores and predators
3. In this natural ecosystem organism, not only survive and multiply but evolve as well (free play of natural agencies) drought, floods, fires, snow, etc.

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In-situ conservation

SHORT-COMINGS IN THE EXISTING SYSTEM OF PA

- Human settlements present around or within the PAs are often detrimental to the cause of wild life conservation.
- In high populated areas it is difficult to find areas of wilderness devoid of people or human settlements or interference as required for proper and adequate wild life protection efforts.

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SHORT-COMINGS IN THE EXISTING SYSTEM OF PA

Human settlements present around or within the PAs

- Native and indigenous people who largely depend on wild plants and animals for their sustenance usually frequent even those areas of wilderness where modern societies, agriculture, rail roads have not reached.
- Wild life conservation efforts tend to rob these people of the vital resources on which they have been living since times immemorial.
- This brings conflict with the local people. The local people do not cooperate and at times develop hostile attitude, which defeats the very purpose of the conservation efforts.

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In-situ conservation

SHORT-COMINGS IN THE EXISTING SYSTEM OF PA

Indigenous people are rarely asked to participate in conservation efforts - many of the world's healthiest and richest ecosystems occur in regions under their control having knowledge of nature and wild life, which is usually ignored by planners and policy makers.

Most of the PAs, parks and Sanctuaries have been established during the past four- five decades but many native societies have been consciously protecting natural habitats for centuries.

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EX-SITU CONSERVATION

(A LATIN PHRASE MEANING "OFF SITE" – AWAY FROM THE PLACE WHERE IT IS FOUND/ OCCURS)

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Ex-situ conservation of biodiversity

- *EX-situ conservation involves maintenance and breeding of endangered plants and animal species under partially or wholly controlled conditions in zoos, gardens, nurseries and laboratories.*

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EX-SITU CONSERVATION

IDENTIFICATION OF SPECIES AND METHODS

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Ex-situ conservation

Age old practice – man has been practicing ex-situ conservation of plants and animals – captive breeding from time immemorial.

Today captive breeding is a strategy for in-situ conservation of wildlife involving

(i) Identification Of Species To Be Conserved – Selection Criteria

- Vulnerability of the species to extinction:
  - *Rarity,*
  - *Dispersal Ability,*
  - Degree of specialization,
  - *Niche location, Population variability, Trophic status of the species,*
  - Adult survival Rate,
  - *Longevity*
- Economic, ecological or aesthetic IMPORTANCE of the species:

  Resources are limited- can be applied to only selected species which may be important to man now or in future

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EX-SITU CONSERVATION

IDENTIFICATION OF SPECIES AND METHODS

1. LONG TERM BREEDING

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THE STRATEGY OF EX-SITU CONSERVATION

The Methods Of Ex-situ Conservation

The practice of ex-situ conservation involves techniques which are essentially meant to maintain, multiply or help the species to survive under natural conditions.

1. Long term Breeding

Method involves capture, maintenance and breeding in captivity on long-term basis of individuals of the *endangered species* –

for those species which have lost their habitats permanently or there are factors which will make it extinct poaching excessive hunting come in under direct conflict.

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(I)THE STRATEGY OF EX-SITU CONSERVATION

1. Long term Breeding

Zoos and Botanical Gardens – plants and animals are bred in captivity

- 1. Pere David's Deer *(Elaphurus davidianus)*- from one pair left in wild in China nearly 400 animals were raised and now only in captivity in zoos

- 2. Prezewalski's Horse *(Equus przewalskii)* – the animal which roamed in the plains of Central Asia and Europe - a few animals were left in wild in Mangolia and kept in zoos in Munich and Prague - now only found in captivity in zoos 500 – 600 animals.

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Breeding in captivity

Prezewalski's Horse

Pere David's Deer

Long term Breeding

3. Similar is the case with Siberian Tiger *(Panthera tigris altaica)* (about 300-400 in wild are still there) and Addax *(Addax nosomaculatus)*

4. Lion Tailed Macaque *(macaca silenus)*, world's most endangered primate in the evergreen forests of Western Ghats – only about 500 animals left in wild about 100 in zoos in India.

long-term breeding

Captive Breeding of Biodiversity in Zoos

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(I)THE STRATEGY OF EX-SITU CONSERVATION

Conservation methods - endangered animals in Zoos

Other examples are:

European Bison,
Edward's Pheasant,
Bali Myna,
White caped Crane,
Slender horned Gazelle,
Scimitar horned Oryx,
Gaur,
Gravy's Zebra,
Puerto Rican horned Toad,
Chinese alligator,
Mauritius Pink Pigeon,
Madagascar radiated tortoise,
Aruba Island's rattle snake, etc.

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Endangered Animals

Siberian Crane

Golden Lion Tamarin

Philippine Eagle

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EX-SITU CONSERVATION

2. SHORT TERM BREEDING AND RELEASE

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(I) The Strategy Of Ex-situ Conservation

Short-term propagation and release

There are a number of successful attempts in captive breeding and release in wild by using ex-situ conservation strategy.

Cheetah,
Wolf,
Red-wolf,
American bison,
Arabian Oryx
Andean condor,
Bald eagle,
Peregrine falcon,
Hawaiian goose,
Lord Howe Island wood rail,
Guam rail,
European eagle,
Owl,
Guam kingfisher,
Galapagos giant turtle
Galapagos land iguana

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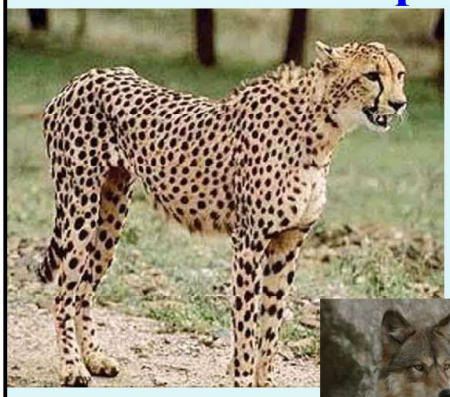
Short-term propagation and release



Cheetah

Red Wolf

Wolf

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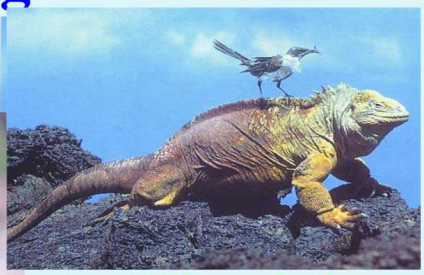
Short-term breeding and release

Galapagos Giant Land Turtle

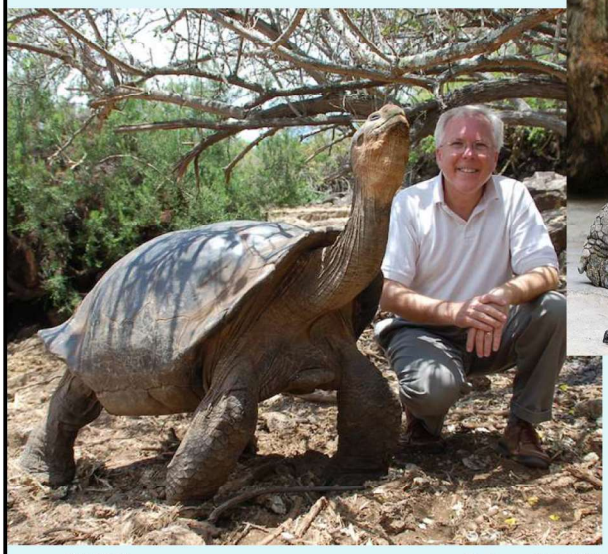
Andean Condor



Galapagos Land Ig

Guam Rail Bird

Short-term breeding and release



Galapagos Giant Land Turtle

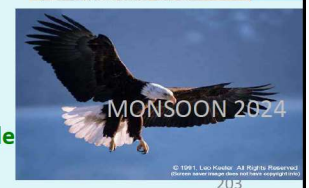
Short-term propagation and release

Arabian Oryx

Guam Kingfisher-extinct in the wild

Peregrine Falcon

American Bison



Bald Eagle

EX-SITU CONSERVATION

3. ANIMAL TRANSLOCATION

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Methods of Ex-situ Conservation

(iii) Animal Translocation

Translocation involves release in a new locality of animals which come from anywhere else other than the place in which they are being released.

The capture, transfer and release of animals from one locality to another usually involves maintenance of animals in captivity for some time.

However, care should be taken that during this period of captivity should as short as possible.

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Animal Translocation

Probably the first attempt of big birds was in Europe:

- **Big Heathcock *(Tetrao urogallus)* once abundant in Scotland and Northern England in 19th century.**
- **By 20th century their population declined and completely disappeared.**
- **In 1937-38 about 40 grouse were brought from Sweden and released back.**
- **now this bird is flourishing in Scotland**

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Animal Translocation

HEATHCOCK (TETRAO UROGALLUS)

MANATEE

-MANATEE (TRICHECHUS MANATUS) IN BRAZIL, WEST INDIES, FLORIDA

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Golden Lion Tamarins *(Leontopithecus rosalia rosalia)-* squirrel sized monkey endemic to Rio de Janeiro.

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EX-SITU CONSERVATION

4. ANIMAL REINTRODUCTION

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Methods of Ex-situ Conservation

(iv) Animal Reintroduction

1. Circumstances under which captive breeding and reintroduction are undertaken

ANIMAL REINTRODUCTION – SUCCESS STORIES

Animal reintroduction involves release of animals either borne in captivity or caught in infancy from the wild and grown in captivity, in to an area from which they have either declined or disappeared.

These reintroductions may also involve rehabilitation of the species as well.

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(iv) Animal Reintroduction

The animals may have to be trained about their survival in wild before introduction in natural habitat – rehabilitation.

Rehabilitation is a very important step in the reintroduction procedure involving intelligent animals such as primates in which learning plays an important role in the development from infancy to adulthood.

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(iv) Animal Reintroduction

1. Circumstances under which captive breeding and reintroduction are undertaken

One of the earliest successful reintroductions following captive breeding was in the case of American Bison *(Bison bison)* which were bred in Bronx Zoo and reintroduced in to their original habitat in North America.

Since 1950, efforts were underway in Fed Rep of Germany and Sweden to introduce the Eagle Owl *(Bubo bubo).* By 1985 new breeding populations were introduced in both the countries.

White tailed Sea eagle *(Haliaeetus albicilla)* and Goshawk *(Accipiter gentilis)* have been re-established in their natural habitats in Great Britain through captive breeding and re-introduction.

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Captive breeding and reintroduction

Eagle Owl *(Bubo bubo)*

Goshawk *(Accipiter gentilis)*

White tailed sea eagle *(Haliaceetus albicilla)*

(IV) ANIMAL REINTRODUCTION

BALD EAGLE

OSPREY

HARRIS'S HAWK

GRIFFON'S VULTURE

EX-SITU CONSERVATION

5. ADVANCED TECHNOLOGY IN SERVICE OF ENDANGERED SPECIES

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Ex-situ conservation

Advanced Technology In Service Of Endangered Species

It is necessary to maintain population of about 100-300 individuals of a species obtained from different wild geographic areas to retain 80-90 % of the species genetic diversity for about 150-200 years.

Since a large number of species are categorized as threatened and we cannot conserve all the species at the same time ***due to financial and logistic problems*** like space in Zoos / gardens

We have to expand our conservatories and use advanced technology for the management, multiplication and preservation of the threatened species.

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EX-SITU CONSERVATION

ADVANCED TECHNOLOGY IN SERVICE OF ENDANGERED SPECIES (I)

-CHEMICAL IMMOBILIZATION AND ANESTHESIA
-NUTRITION, MAINTENANCE AND HEALTH CARE OF ANIMALS IN CAPTIVITY

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(II) Advanced Technology In Service Of Endangered Species

For the past few decades advance science and technology has greatly extended the effectiveness of the methodology of *ex-situ* conservation. Major contributions of advance technology for *ex-situ* conservation cover the following aspects:

1. Chemical immobilization and anesthesia

- Safe Drugs with no side effects to immobilize - Ketamine, Xylazine, Etorphine- Dart guns, blow pipes from a safe distance, even remote controlled devices

2. Nutrition, maintenance and health care of animals in captivity

-Prepared nutritive balanced diets

-Availability of preventive medicines, systematic vaccination, antibiotics

-Management of disease in wild populations – vaccines in baits

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Endangered Species in captivity

Black footed ferrets (Mutela nigripes)

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Ex-situ conservation Advanced Technology In Service Of Endangered Species

(ii) Advances in reproductive technology and cryobiology

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(II)Advanced Technology In Service Of Endangered Species

4. Advances in reproductive technology and cryobiology

One of the **biggest problems** of *ex-situ* conservation is the loss of genetic diversity – *animals bred in Zoos as well as in small free living populations, occurring in isolated fragments – both plants and animals.*

Genetic diversity is the key to survival of species in nature – enough variation within its genome to enable it to adopt to changes in environmental conditions.

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(ii)Advanced Technology In Service Of Endangered Species

Repeated inbreeding causes homogenization of the species genetic make-up and results in decrease in fertility, high infant mortality and birth defects.

For example: Population of Douc Langur *(Pygathrix nemaeus)*, a primate from south-east Asia is now virtually extinct in the wild – a few individuals in captivity do not possess sufficient genetic diversity to enable the species to survive in wild.

For long-term preservation of germ plasm and maintenance of genetic diversity advanced reproductive technology is used involving:

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4. Advances in reproductive technology and cryobiology

(i) Artificial Insemination

It involves introduction of semen in the vagina/cervix of female animal by artificial means – ancient methods used by Arabs – first documented for Dogs in 1784; by 1930 artificial insemination of live-stock was widely used practice in Russia.

In 1920 Arthur Walton demonstrated transporting genes by carrying semen of livestock instead of shipping live animals from one place to another (Betteridge,1981)

Today the technique of freezing and recovery of viable sperms has become well established and widely used for live stock as well as for wild animals.

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Artificial Insemination

First successful artificial insemination of wild species was done in 1973 in Wolfs – then in gorillas.

Today wild animals such as Addax, Guanaco, Blackbuck, Bighorn sheep, Reindeer, Red deer, Speck' gazelles, Giant Panda, Ferrets, Wolfs, Rhesus monkey, Chimpanzee and number of birds like Cranes, Waterfowls, Pheasants can be bred by using artificial insemination technology.

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Animals bred by using artificial insemination technology

ADDAX

GUANACO

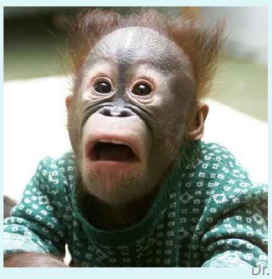
RHESUS MONKEY

REINDEER

CHIMPANZEE

Breeding in captivity through artificial insemination technology

Rare Bornean Orungutan



GORILLA

Embryo Transfer Technology

Technology involves introduction of embryo recovered from the reproductive tract of donor females (genetic mother) in to the reproductive tract of recipient female (surrogate mother), in whom the embryo develops into full-term fetus.

- **The first successful transfer of mammalian embryo was performed in rabbit by Heap in 1891 but it came to light not un till 1950.**
- **Embryo transfer in mice and cattle has become a routine matter**
- **Artificial insemination and embryo transfer in wild species is less common.**

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Embryo Transfer Technology

- First successful embryo transfer done in Baboon *(Papio cyanocephalus)* in 1975
- Interspecic Embryo transfer from wild sheep *(Ovis musimon)* to domestic sheep *(Ovis aries)*
- From wild species of *Gaur (Bos gaurus)* to domestic species *(Bos taurus)*
- First non-surgical embryo transfer in 1983 in antelope (*Tragelaphus oryx*); in this species first time frozen embryo and semen preserved for more than 1 $\frac{1}{2}$ years tried successfully.

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Animals bred through Embryo transfer technology

BABOON

Eland ANTELOPE

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Animals bred through Embryo transfer technology

BABOON

Eland ANTELOPE

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(II)ADVANCED TECHNOLOGY IN SERVICE OF ENDANGERED SPECIES

(iii) Cryopreservation of gametes and embryos

Cryopreservation which involves preservation and maintenance of tissues at very low temperature, usually under liquid nitrogen at -179°C (very low temperature).

- ***Preservation of semen***

Only about 15% recovery of motile sperms after cryopreservation – sufficient for all practical purposes. Today sperms from about 200 species have been frozen but very little have been thawed out and tested!!! The liquid in which the sperms are preserved is very important- cryoprotectant – buffer solution such as glycerol, antibiotics and either milk or egg yolk – variations for different species

- ***Cryopreservation of ova and embryos***

1972 first mammalian embryo successfully frozen – mouse, rabbit, bovine, cow sheep, rats, horses, baboons, antelopes and cats- embryo routine technique – though great potential but in wild little progress due to bottlenecks.

Ex-situ conservation

Advanced Technology In Service Of Endangered Species

(iii) Advances in population biology and molecular genetics

5. Advances in population biology and molecular genetics

The latest methods of molecular biology and genetics for conservation of biodiversity;

Molecular techniques also used to measure heterozygocity in founder and captive populations

Karyotyping, electrophoresis, immunological comparison of proteins, sequencing of protein, DNA and comparison of DNA restriction fragment lengths polymorphism (RFLP) – to study genetic variability/structure of populations and relationships

Karyotyping of Orangutans from Borneo and Sumatra – established two separate sub-species;

African lions are founder populations of almost all the lions in captivity; in tigers not supported.

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Ex-situ conservation

Botanical Gardens
and
Zoological Gardens or Zoos

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(I)THE STRATEGY OF EX-SITU CONSERVATION

- A **botanical garden** or **botanic garden** is a garden dedicated to the **collection, cultivation and display** of a wide range of **plants labelled with their botanical names.**

- It may contain specialist plant collections such as:
  - cacti and other succulent plants,
  - herb gardens,
  - Xerophytes,
  - Palm
  - ferns
  - plants from particular parts of the world, and so on.
- There may be poly house, greenhouses, shade-houses, again with special collections such as tropical plants, alpine plants, or other exotic plants.

(I)THE STRATEGY OF EX-SITU CONSERVATION

The origin of modern **botanical gardens** is generally traced to the appointment of professors of botany to the medical faculties of universities in 16th century **Renaissance Italy**, which also entailed the **curation of a medicinal garden**.

However, the objectives, content, and audience of today's botanic gardens more closely resembles that of the grandiose gardens of antiquity and the educational garden of Theophrastus in the Lyceum of ancient Athens.

(I) THE STRATEGY OF EX-SITU CONSERVATION

A botanical garden is a place where plants, especially ferns, conifers and flowering plants, are grown and displayed for the purposes of research and education.

This distinguishes them from parks and pleasure gardens where plants, usually with beautiful flowers, are grown for public amenity.

Botanical gardens that specialize in trees are sometimes referred to as arboreta. They are occasionally associated with zoos.

Botanical Gardens : (33) 120,including Bambusetum, Cannetum, Medicinal and Aromatic Plants Gardens

Biodiversity Parks/Gardens

- **Zoos – (275)**
  - **15 large, 2317 ha;**
  - **17 medium , 983.82 ha;**
  - **32 small, 31848.31 ha;**
  - **(rest) mini zoos – 2827.88**
- **Butterfly Parks,**
- **Deer Parks,**
- **Aquaria**

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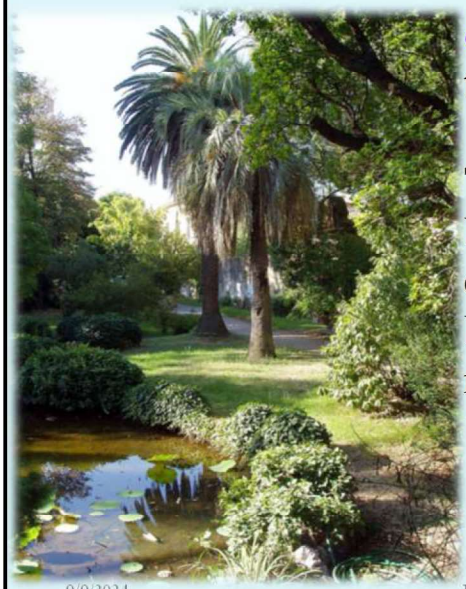
First university botanic garden in Europe



Orto botanico di Pisa operated by the University of Pisa:

This is the first university botanic garden in Europe, established in 1544 under **botanist Luca Ghini,** it was relocated in 1563 and again in 1591

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(III) ZOOS AND BOTANICAL GARDENS – INSTITUTIONS IN TRANSITION

The role of zoological gardens and botanical gardens have become important in *ex-situ* conservation as many of the species in zoos have already become extinct.

1. Zoological Gardens or Zoos

Old tradition/practice of keeping wild animals in captivity – 2500 BC in Egypt and 2000 BC in China - such several examples in in Europe.

In India – Lord Wellesley at Barrack pore in 1800 AD; first Indian Zoo by Raja Rajendra Bahadur Mallick at Marble palace in the heart of Calcutta in 1854.

Today Zoos maintain 500,000 individuals the world over of 3000 spp. of mammals, birds, reptiles and amphibians

There are 1140 Zoos all over the world with an average area of 55 hectares which are visited by 2-3 million people each year

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Zoological Gardens or Zoos

❖ *Participation in wild life conservation efforts*

- Maintenance and breeding of endangered species
- To provide populations of endangered species to be reintroduced in natural habitats
- Maintenance of ex-situ population for exhibition of research purposes from where these animals can easily be obtained

❖ *Study and Research*

- For acquisition of scientific knowledge which will ultimately benefit conservation efforts
- To obtain scientific knowledge on captive populations which could provide an insight into the basic biology of the species

❖ *Educational purposes*

- Zoos and animal exhibitions can treat public and political awareness about the conservation of wildlife and natural resources.

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Zoological Gardens or Zoos

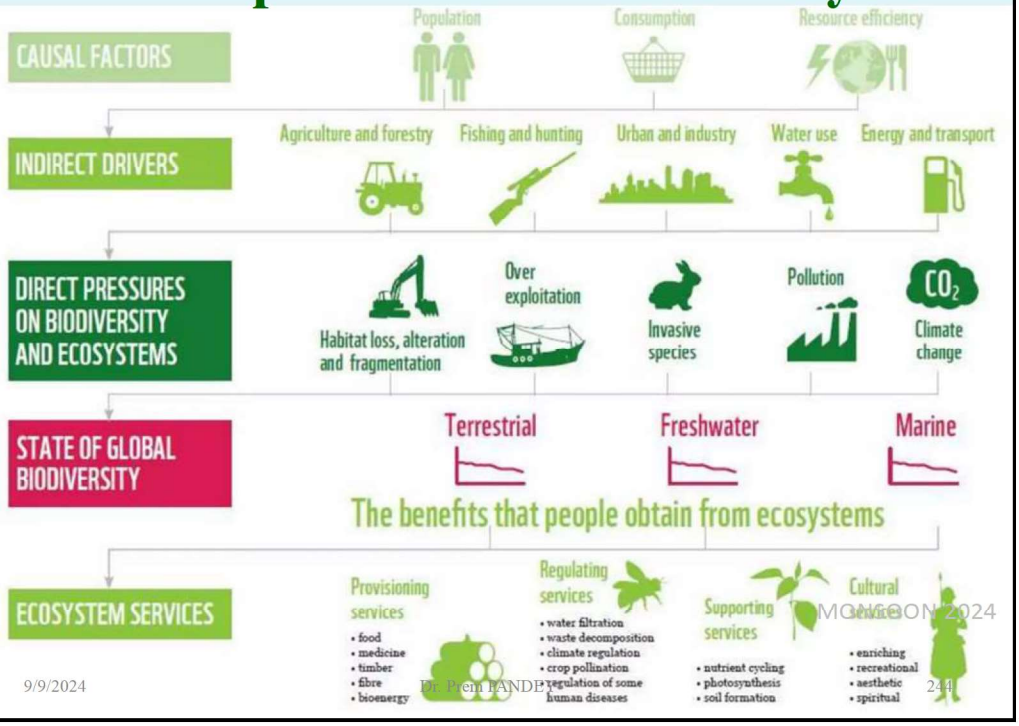
- Zoos have contributed significantly to wild life conservation.

Pere David Deer, Przwalskii horse, Oryx, Adax, Alpine Ibex, Ospreys, Harris' Hawk, Douc Langur survive in the world only because of the enormous efforts put in the zoos.

- Except, Douc Langur and Przwalskii horse all the rest have been introduced in the wild in their natural homes.
- Zoos have done excellent work in restocking, replenishing and re-strengthening the natural populations of a large number of species which occur as small fragmented populations. But for this many of the species could have become extinct such as:
  - Siberian tiger,
  - Lion tailed macaque,
  - Bearded vulture,
  - American bison,
  - Eagle owl,
  - Golden lion tamarin,
  - Goshawk,
  - Philippines eagle.
  - Black footed ferret,
  - White tailed sea eagle

This was possible due to painstaking efforts of capturing, maintenance, bred in captivity and release in wild.

6. Importance of Biodiversity



Introduction- Why is Biodiversity important?

- Every species has a right to exist because it has *intrinsic value* – that is completely independent of its usefulness to others
- *Instrumental value* – Economic, spiritual, scientific, educational, ecological, etc.
- Plants, animals and the microorganisms sustain, and recreate the quality of the water we drink, the air we breath and the soil on which we grow food.

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- **Human beings and animals are completely dependents on the biodiversity**
  - ***Wild plants and animals still constitute a substantial part of the diet of human beings.***
  - ***¾ of the world's population is directly dependent on wild plants and animals for its medicinal needs.***
  - ***Agriculture still depends on traditional crop varieties and wild relatives.***
  - ***Fisheries contribute about 100 million tones of food world wide.***

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Importance of Biodiversity

Importance of the maintenance of biodiversity

The biodiversity found on Earth today is the result of approximately 3.5 billion years of evolution.

Until the emergence of humans, the earth supported more biodiversity than any other period in geological history.

However, since the dominance of humans, biodiversity has begun a rapid decline, with one species after another suffering extinction.

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Importance of Biodiversity

The maintenance of biodiversity is important for the following reasons:

1. **Ecological stability**

- Each species performs a particular function within an ecosystem.
- They can capture and store energy, produce organic material, decompose organic material, help to cycle water and nutrients throughout the ecosystem, control erosion or pests, fix atmospheric gases, or help regulate climate.

Importance of Biodiversity

- Ecosystems provide support of production and services such as:
- soil fertility, pollinators of plants, predators, decomposition of wastes, purification of the air and water, stabilisation and moderation of the climate, decrease of flooding, drought and other environmental disasters.
- without which humans could not survive.

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Importance of Biodiversity

- Research show that the more diverse an ecosystem the better it can withstand environmental stress and the more productive it is.
- The loss of a species thus decreases the ability of the system to maintain itself or to recover in case of damage.
- There are very complex mechanisms underlying these ecological effects.

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Importance of Biodiversity

2. Economic benefits to humans

- For all humans, biodiversity is first a resource for daily life. Such 'crop diversity' is also called agro-biodiversity.
- Most people see biodiversity as a reservoir of resources to be drawn upon for the manufacture of food, pharmaceutical, and cosmetic products.
- Thus resource shortages may be related to the erosion of the biodiversity.

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Importance of Biodiversity - Economic commodities

Some of the important economic commodities that biodiversity supplies to humankind are:

- - **FOOD :** crops, livestock, forestry, and fish
- - **MEDICATION:** Wild plant species have been used for medicinal purposes since before the beginning of recorded history.
- For example, quinine (Used to treat malaria) comes from the bark of the Amazonian tree Cinchona tree; digitalis from the Foxglove plant (chronic heart trouble), and morphine from the Poppy plant (pain relief).

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Importance of Biodiversity

- According the National Cancer Institute of the USA, over 70 % of the promising anti-cancer drugs come from plants in the tropical rainforests.
- It is estimated that of the 250,000 known plant species, only 5,000 have been researched for possible medical applications.
- Animals also play an important role, in particular in maintaining the ecosystem, providing food, milk, and in research.

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Importance of Biodiversity

- - **INDUSTRY:** fibres for clothing, wood for shelter and warmth. Biodiversity may be a source of energy (such as biomass).
- Other industrial products are oils, lubricants, perfumes, fragrances, dyes, paper, waxes, rubber, latexes, resins, poisons and cork all are derived from various plant species.
- Supplies from animal origin are wool, silk, fur, leather, lubricants, waxes.
- Animals may also be used as a mode of transportation.

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Importance of Biodiversity

- **TOURISM & RECREATION:** Biodiversity is a source of economical wealth for many areas, such as many parks and forests, where wild nature and animals are a source of beauty and joy for many people.
- Ecotourism in particular, is a growing outdoor recreational activity.

3. Ethical reasons

The role of biodiversity is to be a mirror of our relationships with the other living species, an ethical view with rights, duties, and education.

If humans consider species have a right to exist, they cannot cause voluntarily their extinction.

Besides, biodiversity is also part of many cultures' spiritual heritage.

6. Value of Biodiversity

Value of Biodiversity

- Biodiversity is the most precious gift of nature mankind is blessed with.
- As all the organisms in an ecosystem are interlinked and interdependent, the value of biodiversity in the life of all the organisms including humans is enormous.
- The role of biodiversity in providing ecosystem services is two fold.

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Value of Biodiversity

- Biodiversity has a fundamental value to humans because we are so dependent on it for our cultural, economic, and environmental well-being.
- Elements of biodiversity can contribute to cultural identity, and many ecosystem characteristics are frequently incorporated into cultural traditions.

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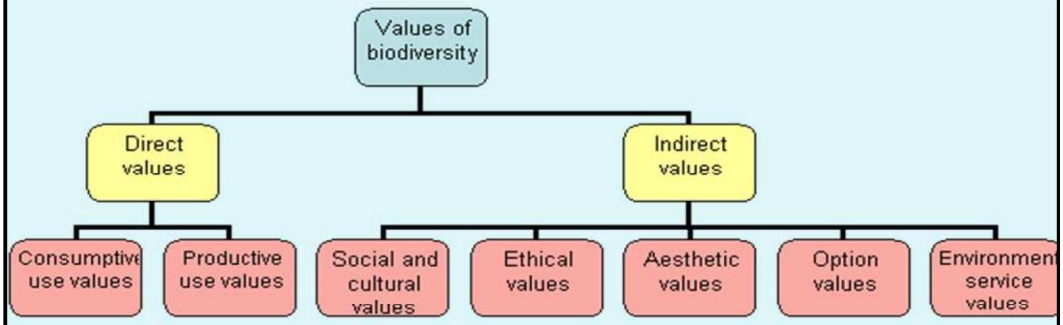
Value of biodiversity

The value of biodiversity is classified into direct and indirect values as shown in the below diagram.



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Consumptive use-Direct values

Direct values

The direct value include food resources like grains, vegetables, fruits which are obtained from plant resources and meat, fish, egg, milk and milk products from animal resources. These also include other values like medicine, fuel, timber, fiber, wool, wax, resin, rubber, silk and decorative items.

The direct values are of two types (i) Consumptive use value and (ii) Productive use value.

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Save biodiversity , conserve
biodiversity and Love biodiversity
Thanks
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