



Module 2: Biodiversity and its conservation

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- ↳ Introduction – Definition : genetic, species and ecosystem diversity.
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- ↳ India as a mega-diversity nation

Biodiversity

Biological diversity or Bio diversity is that part of nature which includes the differences in genes among the individuals of a species – Genetic diversity

The variety and richness of all the plant and animal species at different scales in space – locally, in a region, the country and the world – Species diversity

The types of ecosystems, both terrestrial and aquatic, within a defined area – Ecosystem diversity

Special Feature

Science

Why you should care about biodiversity

More than just an abundance of species, biodiversity helps shape all of life on Earth - including us.

By **Chris Bennett**

<https://www.earlham.ac.uk/articles/why-you-should-care-about-biodiversity>



Why to care about Biodiversity?

The diversity of living creatures in our environment forms a support system which has been used by human civilizations for their **growth and development**.

Those civilizations which have sustainably used the “bounty of nature” have survived; Those once which overused or misused disintegrated.

Science has attempted to classify and categorize the variability in nature for over a century. This has led to an understanding of its organization into communities of plants and animals.

Taxonomy

This information has helped in utilizing the earth's biological wealth for the benefit of humanity and has been integral to the process of 'development'.

Positive

Better health care, better crops and the use of these life forms as raw material for industrial growth which has led to a higher standard of living for the developed world.

Negative

Produced the modern consumerist society, which has had a negative effect on the diversity of biological resources upon which it is based.

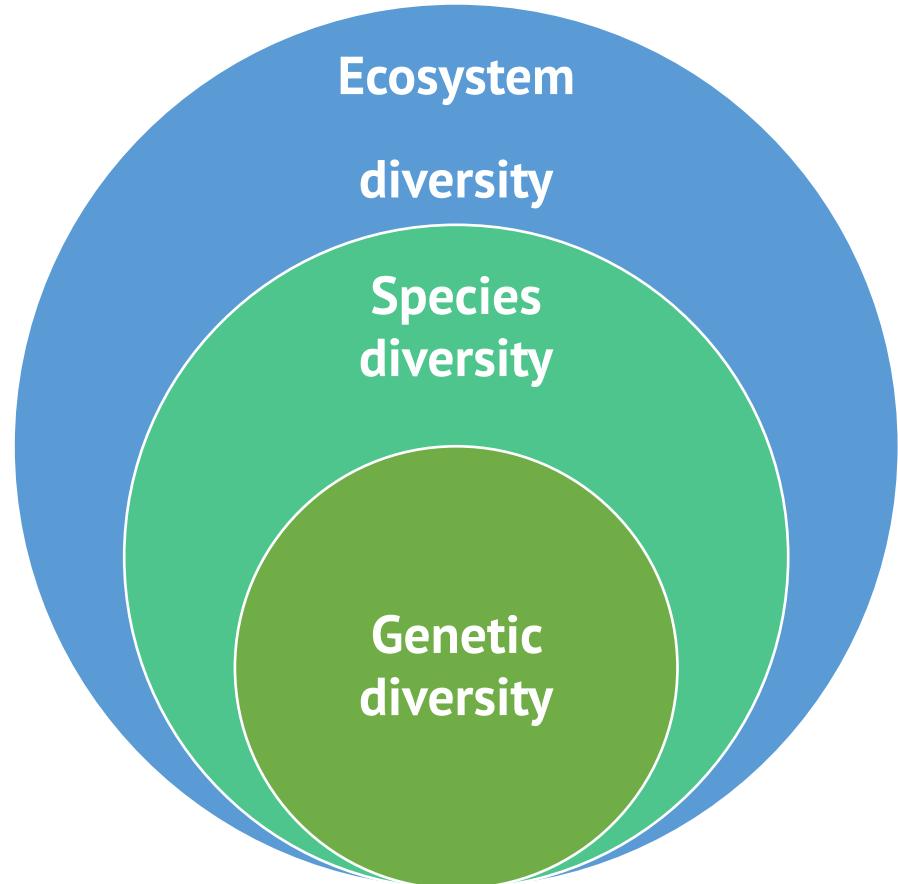
The diversity of life on earth is so great that if we use it **sustainably**, we can go on developing new products from biodiversity for many generations.

This can only happen if we **manage biodiversity** as a precious resource and prevent the extinction of species.

Levels of biodiversity?

Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels

- „ **Genetic diversity** - The genetic variability within a species
- „ **Species diversity** - The variety of species within a community
- „ **Ecosystem diversity** - The organization of species in an area into distinctive plant and animal communities



Levels of organization of the concept of biodiversity

Genetic Diversity

Genetic diversity refers to the diversity (or genetic variability) within species. Each individual species possesses genes which are the source of its own unique features. Example: Humans

Significance of genetic diversity?

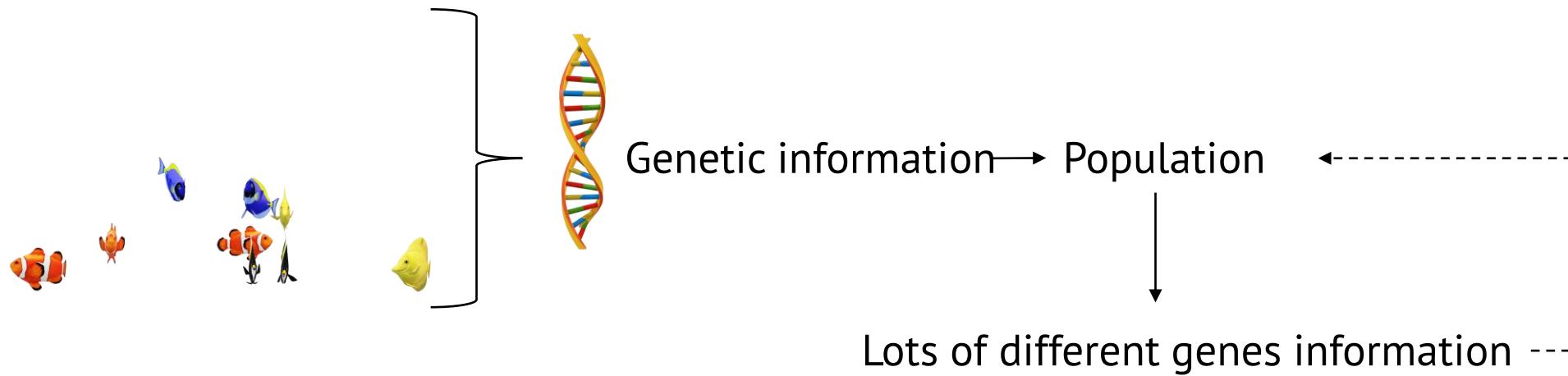
The huge variety of different gene sets also define an individual or a whole population's ability to tolerate stress from any given environmental factor



Susceptibility to disease



Source: <https://www.grandmagazine.com/2016/03/my-grandbaby-supporting-the-new-mother/>



→ **Gene Pool** - The complete set of genetic information within a population of given species or within a species itself

- ▶ Larger genetic pool – higher genetic diversity – rate of survival ↑
- ▶ Smaller genetic pool – restricted breeding options within the closely related member of the same population ↓

Ecosystem services – Conservation of the genetic diversity

Inbreeding

Species diversity

Number of species of plants and animals that are present in a region constitutes its species diversity. Example: natural ecosystems or artificial ecosystems

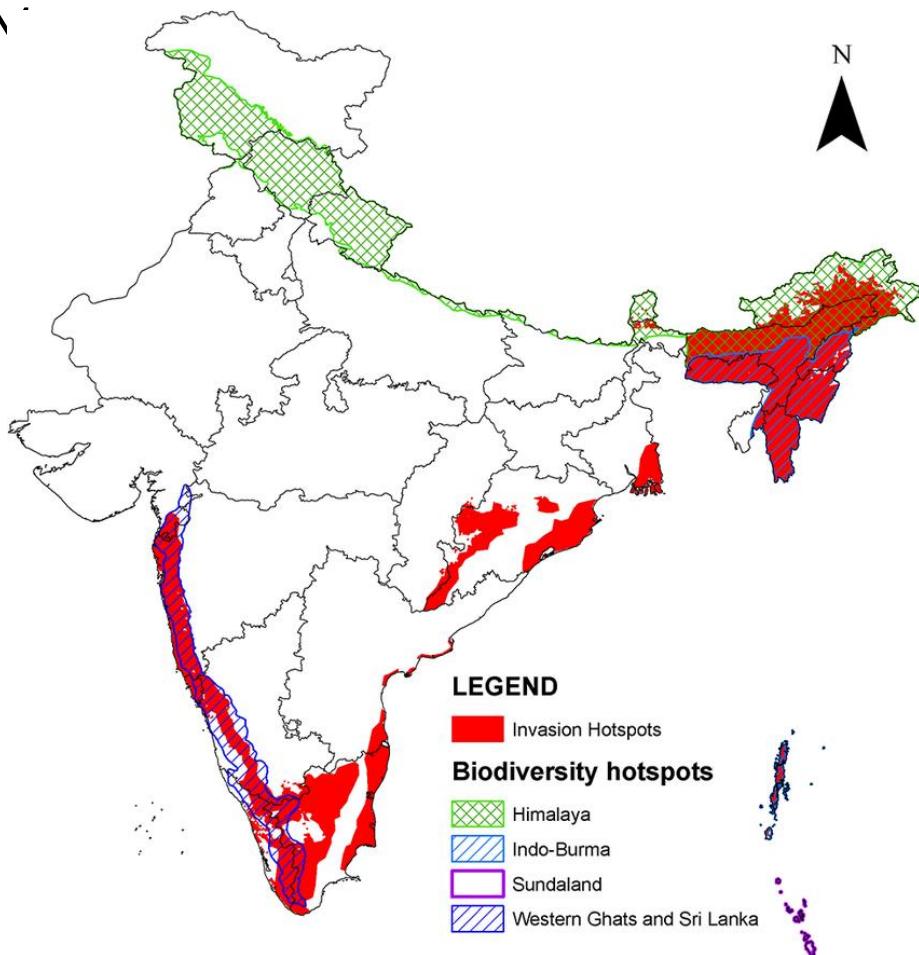
Forests regions rich > man - made other regions



Areas that are rich in species diversity are called '**biodiversity hotspots**' - coined by Norman



High species richness and endemism



Biodiversity hotspots in India

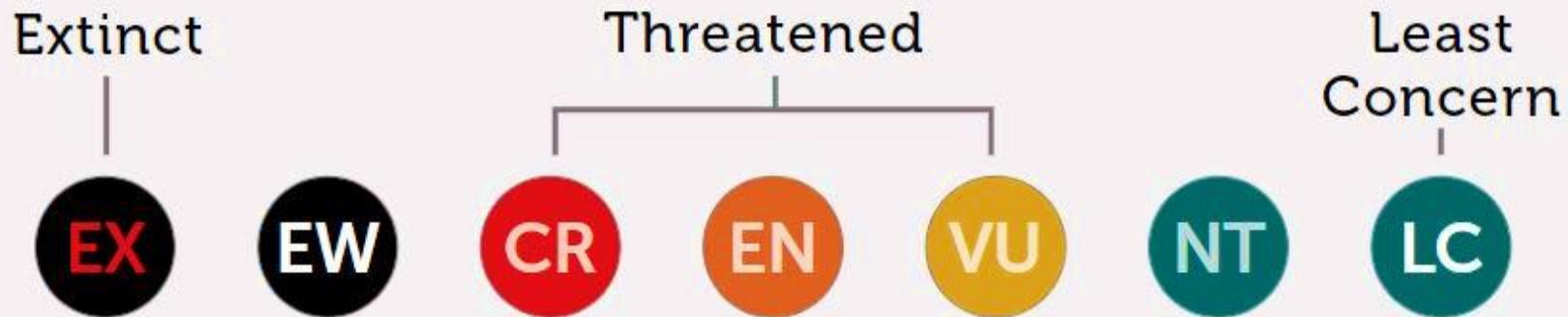
Criteria

1500 species of vascular plants – endemic

30% (or less) of its original habitat, i.e. it must be threatened

Source: Modelling Hotspots for Invasive Alien Plants in India, PLoS ONE,
Adhikari et al., 2015

THE RED LIST CATEGORIES



Extinct (EX): no reasonable doubt that the last individual has died

Extinct in the Wild (EW): known only to survive in captivity, cultivation or well outside its natural range

Critically Endangered (CR): facing extremely high risk of extinction in the wild

Endangered (EN): facing a very high risk of extinction in the wild,

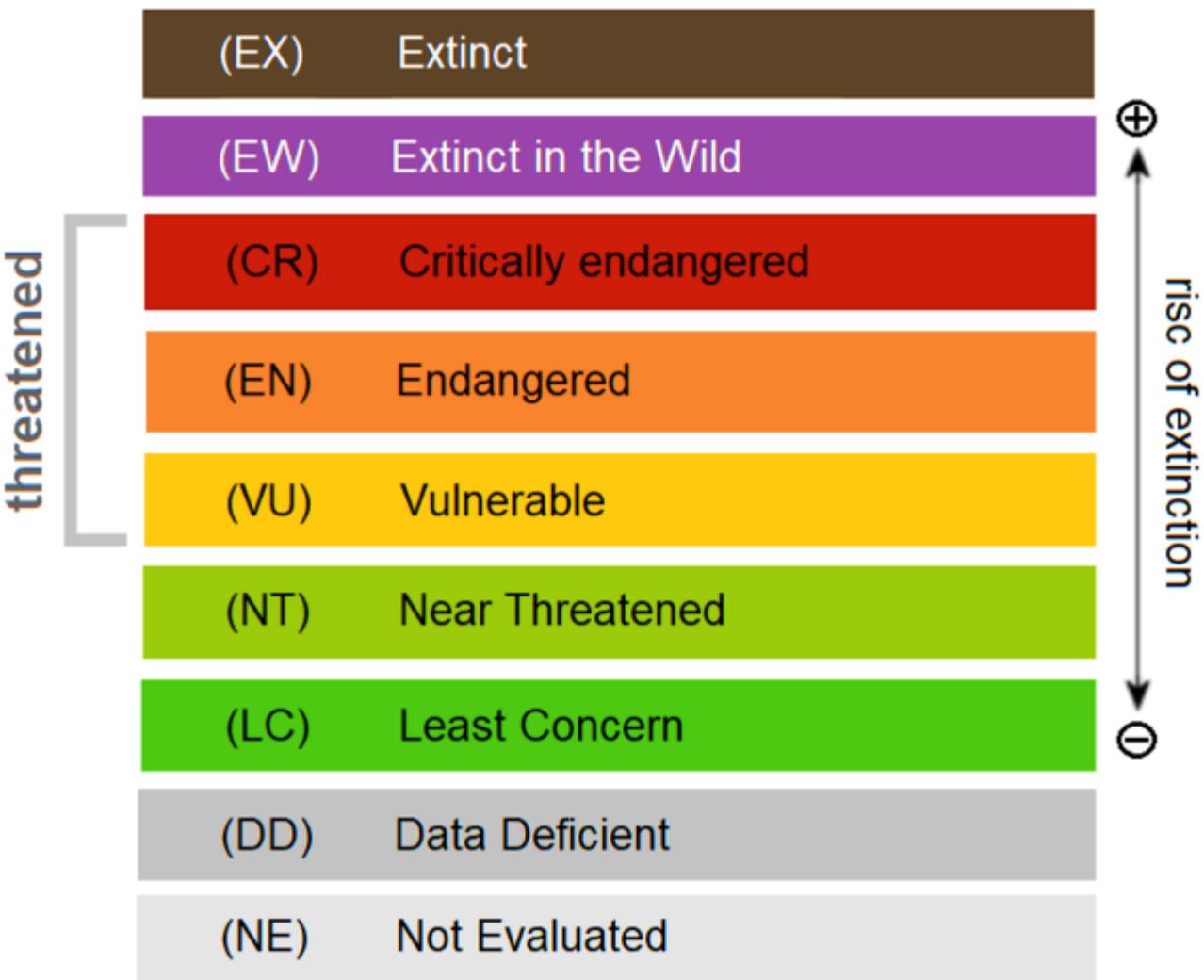
Vulnerable (VU): facing a high risk of extinction in the wild.

Near Threatened (NT): close to qualifying, or likely to qualify for a threatened category in the near future

Least Concern (LC): population is stable enough that it is unlikely to face extinction in the near future

Data Deficient (DD): not enough information on abundance or distribution to estimate its risk of extinction

Red List: Categories of the IUCN



https://commons.wikimedia.org/wiki/File:IUCN_-_Red_List_-_Categories.png

Why it is important?

The IUCN Red List is an authoritative indicator of the health of the world's biodiversity. The IUCN Red List is:

- a powerful tool to inform and catalyse action for biodiversity conservation and policy change,
- critical to protecting the natural resources we need to survive.
- provides information about range, population size, habitat and ecology, use and/or trade, threats,
- provides information about conservation actions that will help inform necessary conservation decisions.

Ecosystem diversity

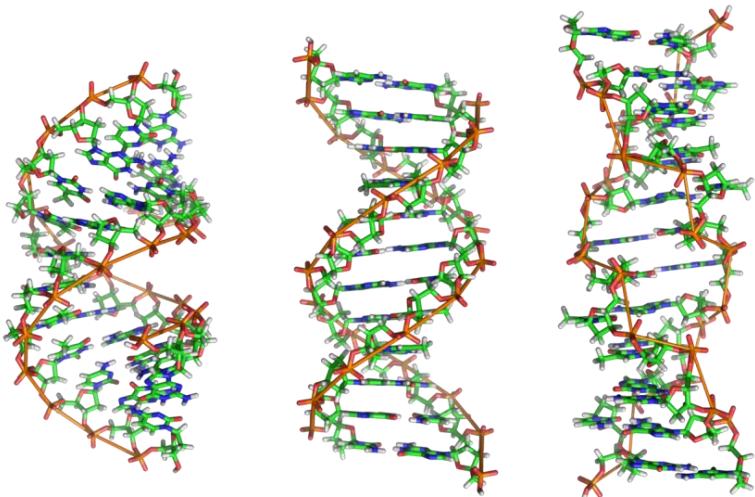
Ecosystem diversity can be described for a specific geographical region or a political region or a political entity such as country, a state or a taluka.

Distinctive ecosystems include landscapes like forests, grasslands, deserts and mountains as well as aquatic ecosystems like rivers, lakes and seas.

An ecosystem – referred to as ‘natural’ relatively undisturbed by human activities or modified when it is converted to other types of uses, such as farmland or urban areas.

Types of diversity

Genetic diversity



Species diversity



Ecosystem diversity

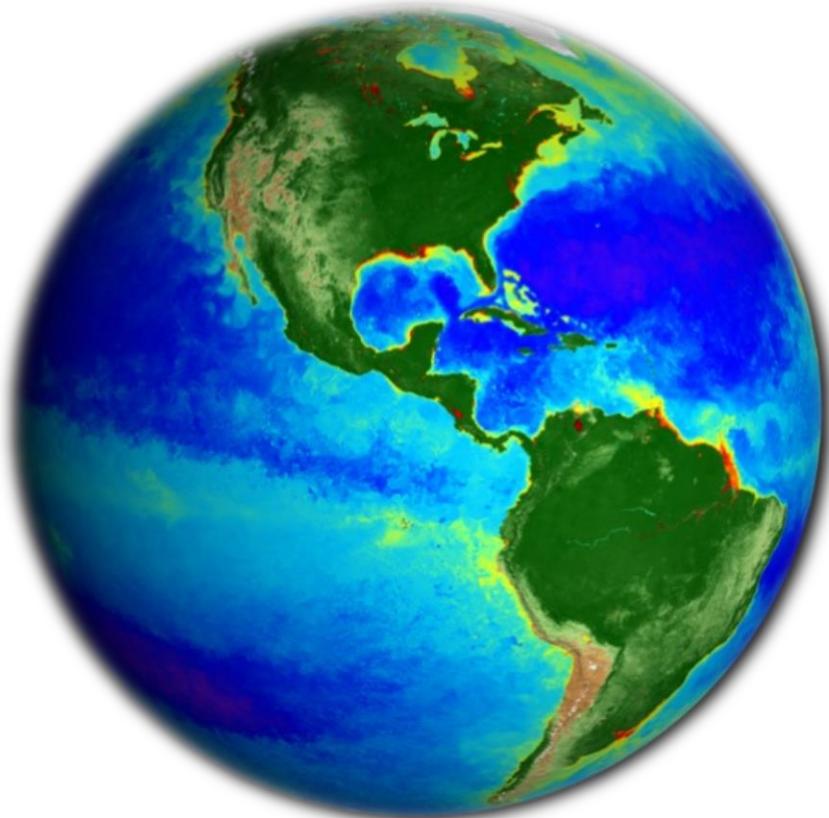


Diversity of genes within the species

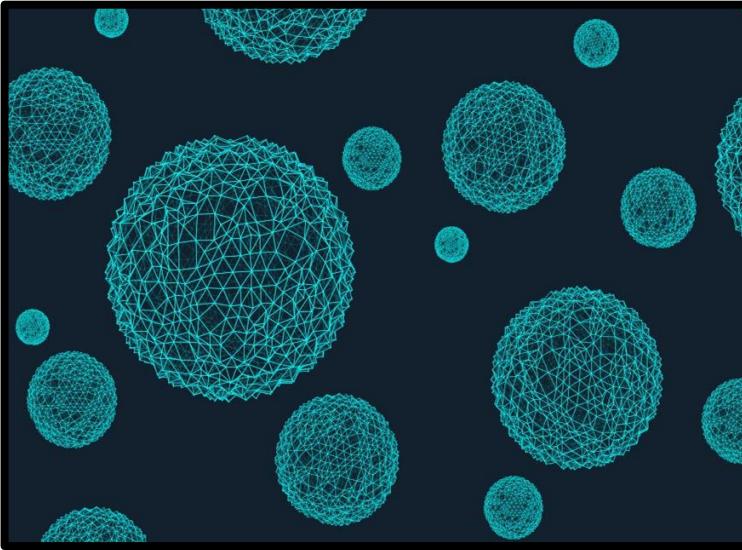
Diversity among species in an ecosystem

Diversity of habitat in a given unit area

Evolution of the genesis of biodiversity



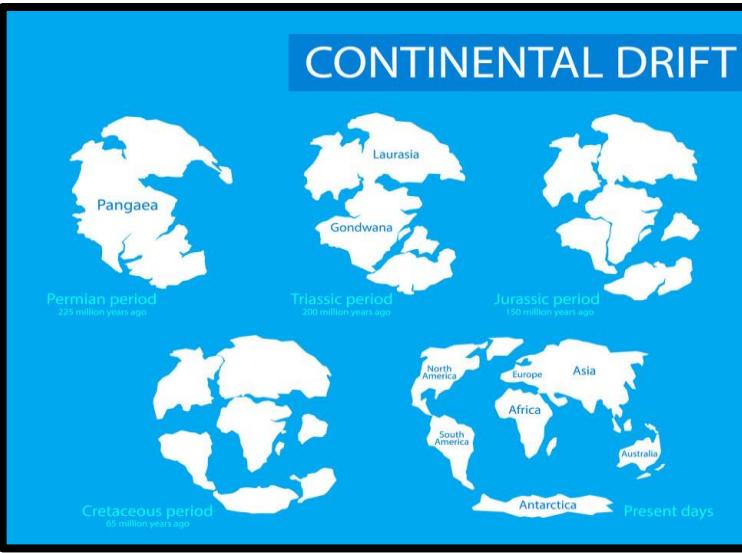
The origins of life on earth some three and a half billion years ago are obscure. Life was probably initiated as a product of organic reactions in the Earth's primordial seas. Alternative possibilities such as life beginning in a muddy ooze, or of life having been seeded from outer space have also been suggested.



Unicellular to multicellular organisms



Glaciation



Continental drift



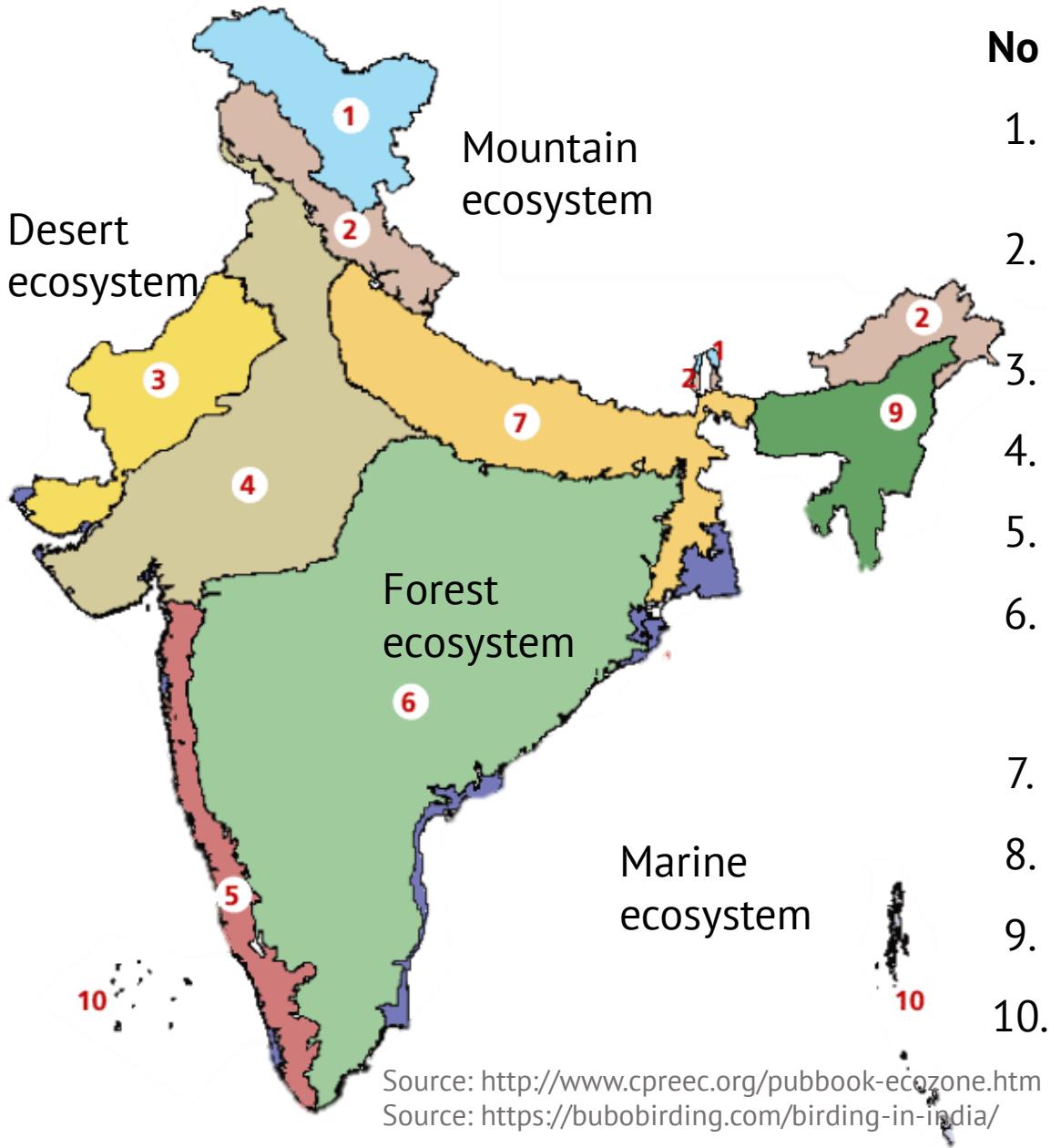
Atmospheric upheaval

- ↳ Behavioral patterns of the different species comprising a community of species links them to each other through their **breeding biology, feeding patterns, migrations**, etc.
- ↳ As ancient species became extinct due to geological upheavals, they left behind empty 'niches' in the habitat that stimulated existing species to fill them through the formation of new species.
- ↳ The Earth's ancient history has seen periods of mega extinctions, which have been followed by periods of formation of new species.
- ↳ Though these repeatedly led to a drastic reduction in the number of species, the diversity of life recuperated each time by gradually increasing the number of species existing on earth. This however took millions of years, as evolution is a very slow process.

- „ Thus when man came on the scene some 2 million years ago, the earth was more rich in species than ever before.
- „ During the recent past however, extinctions due to the activities of modern man have begun to take place so rapidly that nature has had no time to evolve new species.
- „ The earth is loosing species more rapidly than ever before.
- „ The diversity of life at all three organizational levels- genetic, species and ecosystem-is thus being rapidly modified by modern man. This is a great loss to future generations who will follow us.

Biogeographical classification of India

Based on climate, soil and biodiversity



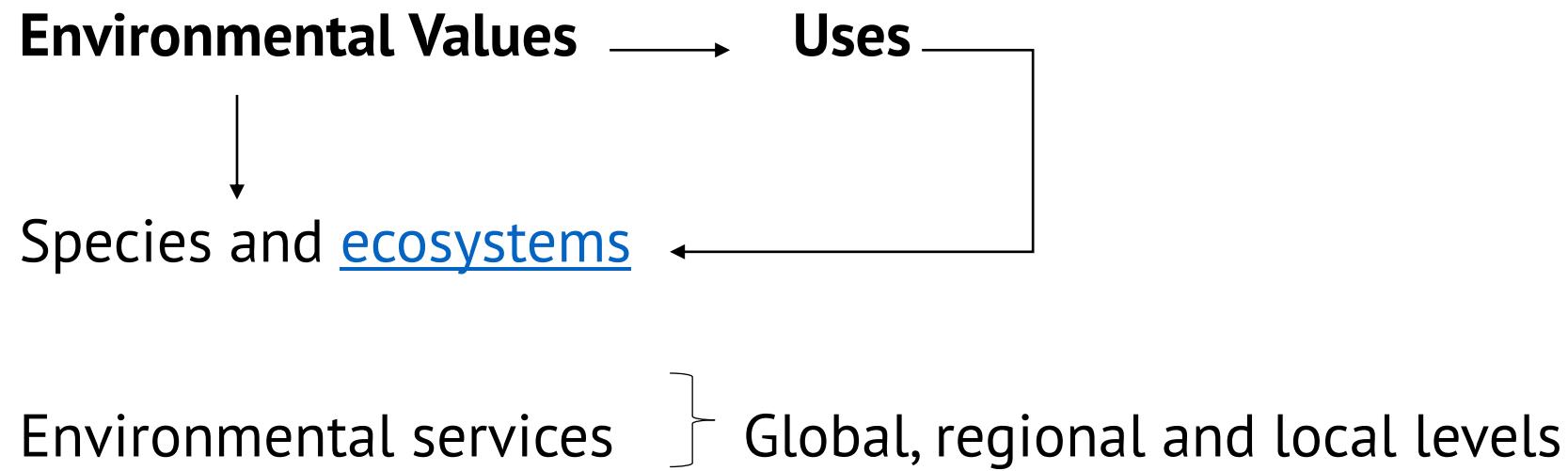
No Biogeographic zones Biotic provinces

- | | | |
|-----|------------------|--|
| 1. | Trans-Himalaya | Ladakh mountains, Tibetan plateau |
| 2. | Himalaya | Northwest, West, Central and East Himalayas |
| 3. | Desert | Thar, Kutch |
| 4. | Semi-arid | Punjab plains, Gujarat Rajputana |
| 5. | Western Ghats | Malabar plains, Western Ghats |
| 6. | Deccan Peninsula | Central highlands, Chotta-Nagpur, Eastern highlands, Central Plateau, Deccan South |
| 7. | Gangetic plains | Upper and Lower Gangetic plains |
| 8. | Coast | West and East coast, Lakshadweep |
| 9. | North-East | Brahmaputra valley, Northeast hills |
| 10. | Islands | Andaman and Nicobar |

Source: <http://www.cpreec.org/pubbook-ecozone.htm>

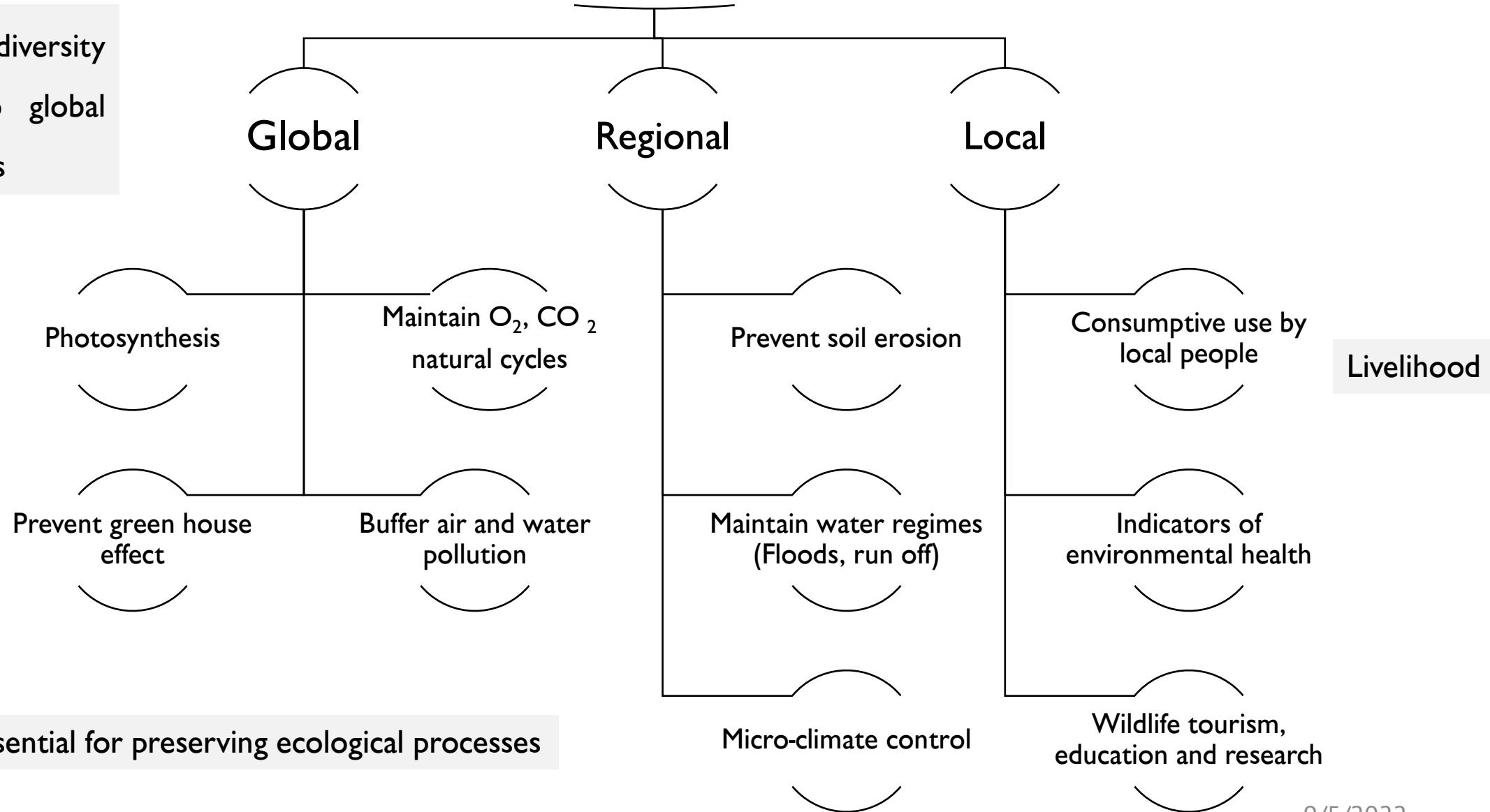
Source: <https://bubobirding.com/birding-in-india/>

Value of Biodiversity



Environmental services provided by ecosystems > species

The loss of biodiversity contributes to global climatic changes



Value of Biodiversity for human Society

- 1. Consumptive use value
 - 2. Productive use value
 - 3. Social Values
 - 4. Ethical and Moral Values
 - 5. Aesthetic value
 - 6. Option value
- Use Non-use
- Direct values Indirect values

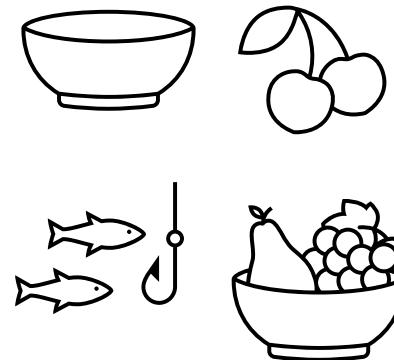
Ecosystem valuation

1. Consumptive use value

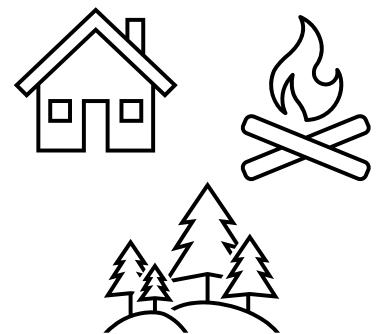
Forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products.

They use the produces with the knowledge of their quality and sensitivity.

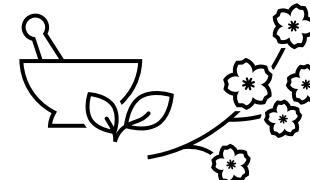
Fisherfolk are highly dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.



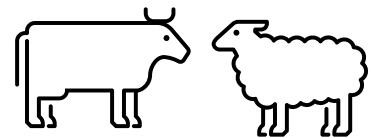
Food



Wood



Medicine



Fodder

2. Productive Use Value

The biotechnologist uses bio rich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock.

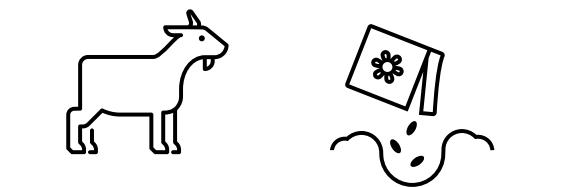
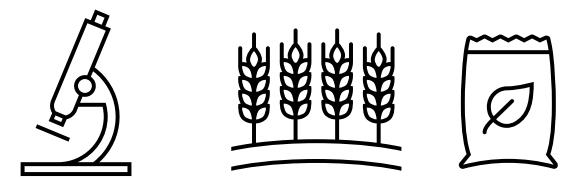
Agricultural scientist - genetic diversity enables scientists and farmers to develop better crops and domestic animals through careful breeding.

Genetic engineering - genetic material found in wild relatives of crop plants through biotechnology.

Pharmacist

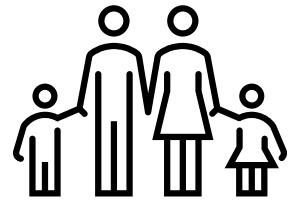
Industrialists - biological prospecting

Non-consumptive use



Scientific use

3. Social value



Values

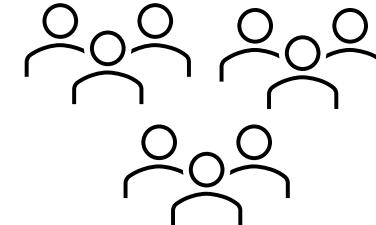
In context of biodiversity

Traditional society



Preserved bio-diversity as a supporting source

Modern society



Affluent society – more resources

How Biodiversity is preserved through Social values?

Consumptive and productive value of biodiversity is closely linked to **social concerns** in traditional communities.

What happens with loss of Social value?

Cultural and religious sentiments.

4. Ethical and Moral values

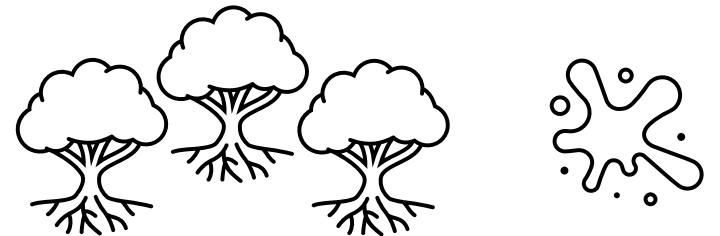
What is Ethical and Moral View?



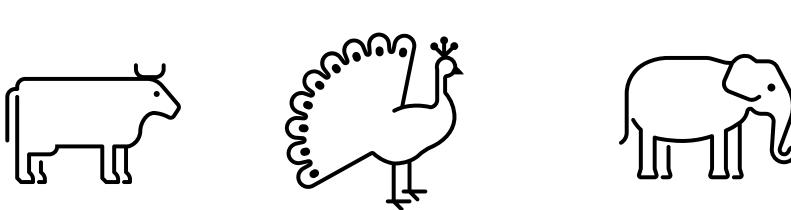
World view which respects the sanctity of all forms of life and protecting them is sacred commitment

Some Ethical Views Necessary for Conservation

All forms of life have the right to exist on earth.



Man is only a small part of the Earth's great family of species.



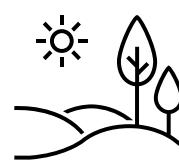
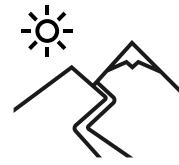
Associations with deity

Ethical views & practices of our tradition

Ancient philosophy - Many of our cultures

Sacred groves or 'deorais'

5. Aesthetic value



Tourist attraction

Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it.

Tourist attraction

Symbols from wild species – not only ethical and moral but as well for aesthetic value

6. Option value

Keeping future possibilities open for their use is called option value.

It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be of great use in the future.

To continue to improve cultivars and domestic livestock, we need to return to wild relatives of crop plants and animals.

Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

Biodiversity at Global, National and Local Levels

Biodiversity at Global, National and Local Levels



At present 1.8 million species known and documented by scientists in the world

Estimated - 1.5 to 20 billion!



South vs North – Bio rich areas

Exploitation of biodiversity



Countries with diversities higher than India are located in South America such as Brazil, and South East Asian countries such as Malaysia and Indonesia. The species found in these countries, however, are different from our own.

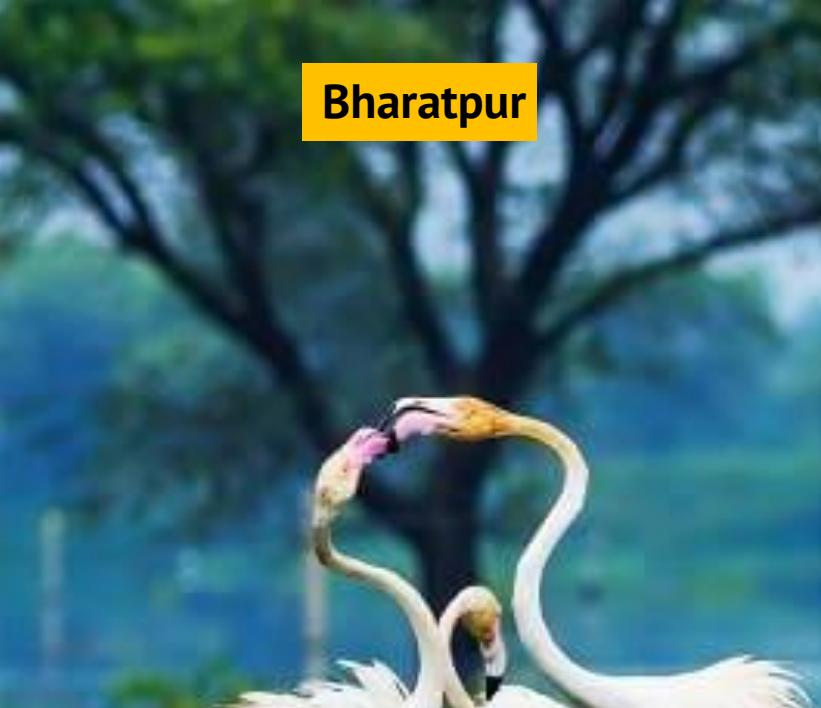
Throughout the world, the value of biologically rich natural areas is now being increasingly appreciated as being of unimaginable value.

International agreements such as the **World Heritage Convention** attempt to protect and support such areas.

India is a signatory to the convention and has included several protected Areas as **World Heritage sites**.

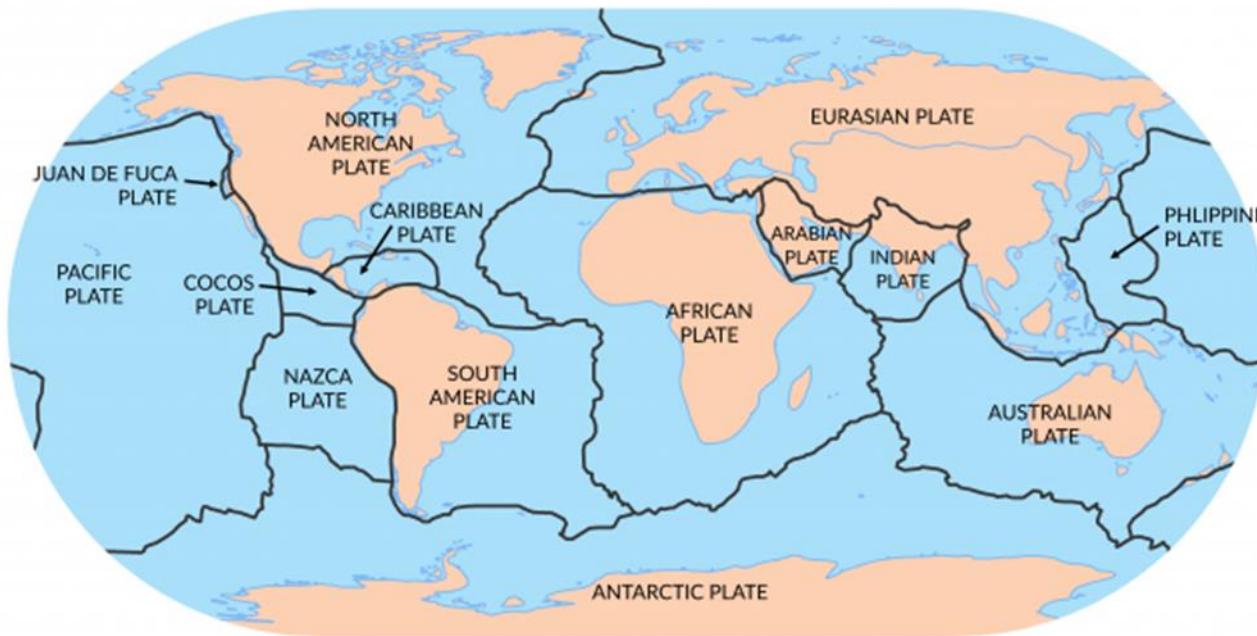
These include **Manas** on the border between Bhutan and India, **Kaziranga** in Assam, **Bharatpur** in Rajasthan., **Nandadevi** in the Himalayas, and the **Sunderbans** in the Ganges delta in West Bengal.

India has also signed the **Convention in the Trade of Endangered Species (CITES)** which is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in the pet trade.



India as a mega diversity nation

Evolution of India's Biodiversity



Source: <https://earthhow.com/7-major-tectonic-plates/>

Geological events in the landmass of India have provided conditions for high levels of biological diversity

India's special geographical position between three distinctive centres of biological evolution and radiation of species is responsible for our rich and varied biodiversity.

Positioning India's Biodiversity Among Mega Biodiversity Nations



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Why Are Megadiverse Countries Important?

Megadiversity is a term used to define the world's top biodiversity-rich countries. The concept is used to highlight awareness to conservation issues around the world. To qualify as a megadiverse country, it must have a high level of endemism and species diversity, as well as have a marine ecosystem along its border.



Why is species
diversity greater in the
tropics than at the
poles?

[Source: https://www.earth.com/news/species-diversity-greater-tropics-poles/](https://www.earth.com/news/species-diversity-greater-tropics-poles/)

1,200 species of birds (8th in the world)

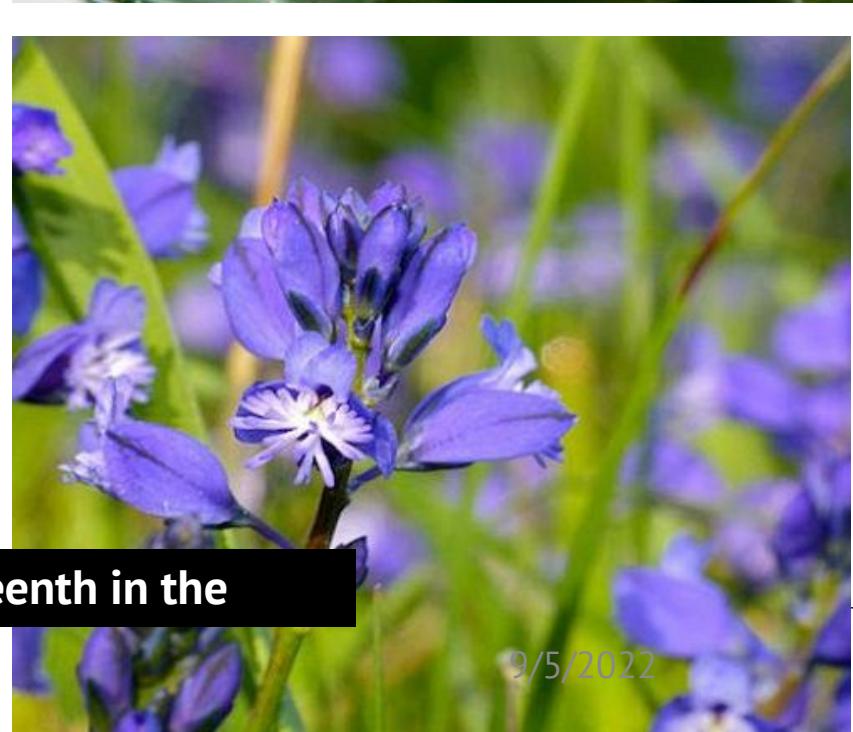




350 different mammals (rated eighth highest in the world)

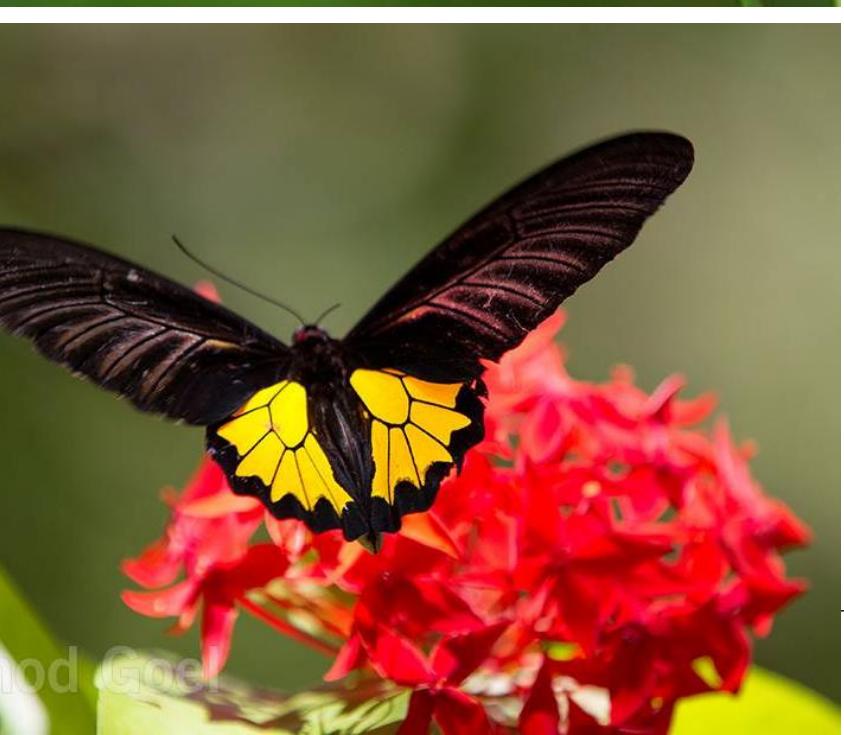


453 species of reptiles (fifth in the world)



45,000 plant species, of which most are angiosperms (fifteenth in the world).

13,000 butterflies and moths



50,000 known species of insects



Hotspots of Biodiversity

To qualify as a biodiversity hotspot, a region must **meet two strict criteria**:

It must have **at least 1,500 vascular plants as endemics** – which is to say, it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is **irreplaceable**.

It must have **30% or less of its original natural vegetation**. In other words, it must be threatened.

The Global 200 – ecoregions - the richest, rarest and most distinctive natural areas



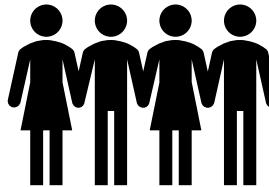
- ▶ The Himalayas
- ▶ North eastern India
- ▶ Western Ghats
- ▶ Andaman and Nicobar islands

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts

Threatening Situation

10 million species

Eliminated



2050

25% **Worlds' species will undergo extinction**

10 to 20 thousand species per year, a thousand to ten thousand times faster than the expected natural rate!

Much of this mega extinction spasm is related to human population growth, industrialization and changes in land-use patterns.

A major part of these extinctions will occur in '**biorich**' areas such as tropical forests, wetlands, and coral reefs.

Ways in Which Threats are Posed

Reason for rapid global destruction of biodiversity: The loss of wild habitats due to rapid human population growth and short term economic development.

Island flora and fauna having high endemism in small isolated areas surrounded by sea have so far been most seriously affected by human activity, which has already led to extinction of many island plants and animals (the dodo is a famous example).



© 2010 Encyclopædia Britannica, Inc.

Dodo

Habitat loss also results from man's introduction of species from one area into another, disturbing the balance in existing communities.

In the process, the purposely or accidentally introduced organisms (eupatorium, lantana, hyacinth, congress grass or Parthenium) have led to the extinction of many local species.



Hyacinth



Congress grass or Parthenium



Eupatorium



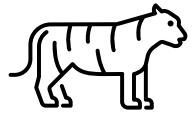
Lantana

- Loss of species occurs due to the destruction of natural ecosystems, either for conversion to agriculture or industry, or by over-extraction of their resources, or through pollution of air, water and soil.
- Mangroves have been cleared for fuelwood and prawn farming, which has led to a decrease in the habitat essential for breeding of marine fish.
- In India, forests and grasslands are continuously being changed to agricultural land.
- Encroachments have been legalized repeatedly. Similarly natural wetland systems have been drained to establish croplands resulting in loss of aquatic species.

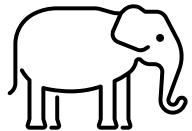


Threats to animals

Specific threats to certain animals are related **to poaching for large economic benefits**.



→ Skin and bones



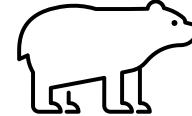
→ Ivory



→ Horns



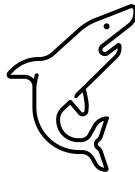
→ Gland



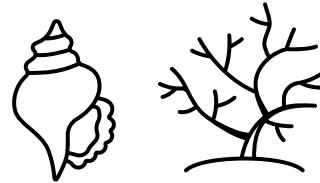
→ Gall bladder



→ Eggs, meat, skin, and shells



→ Meat and body parts



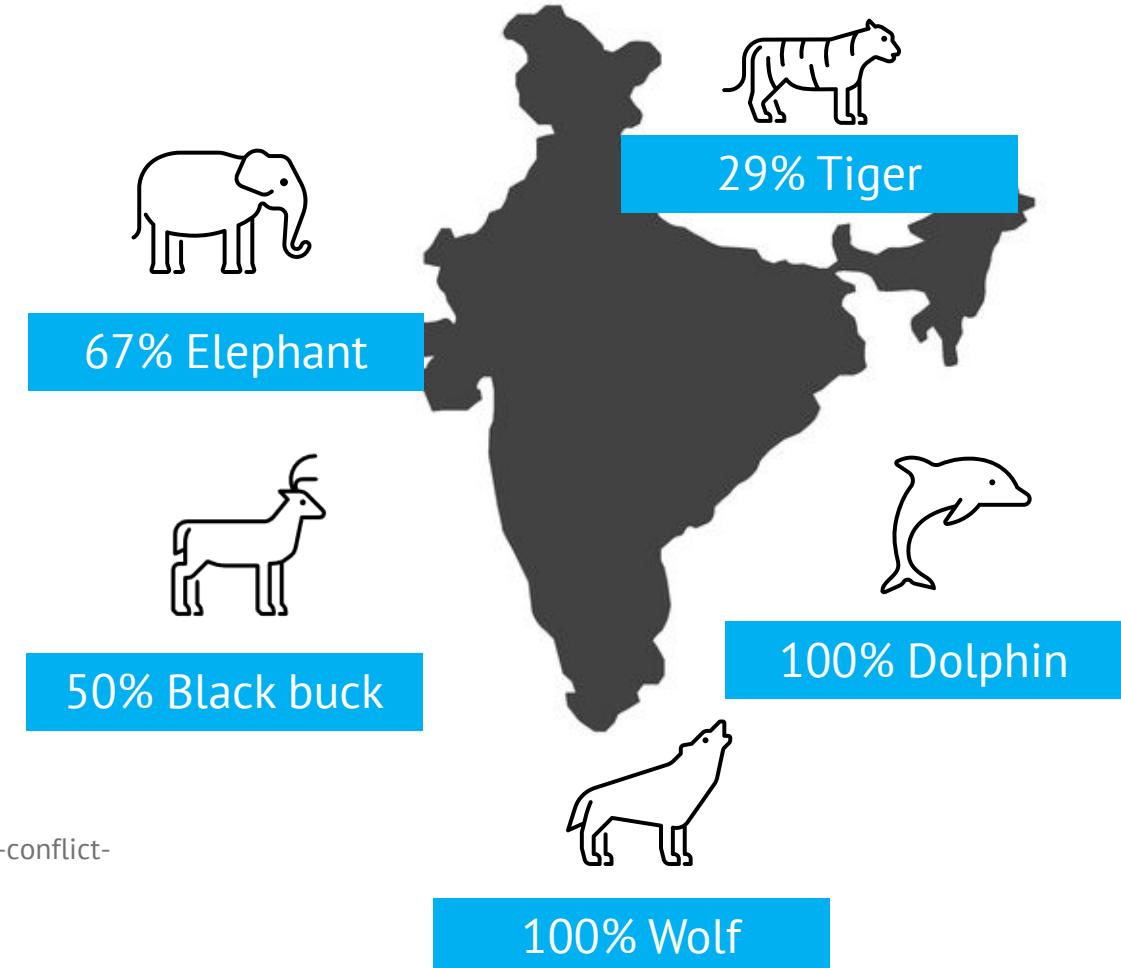
→ Exported

Human wild-life conflict

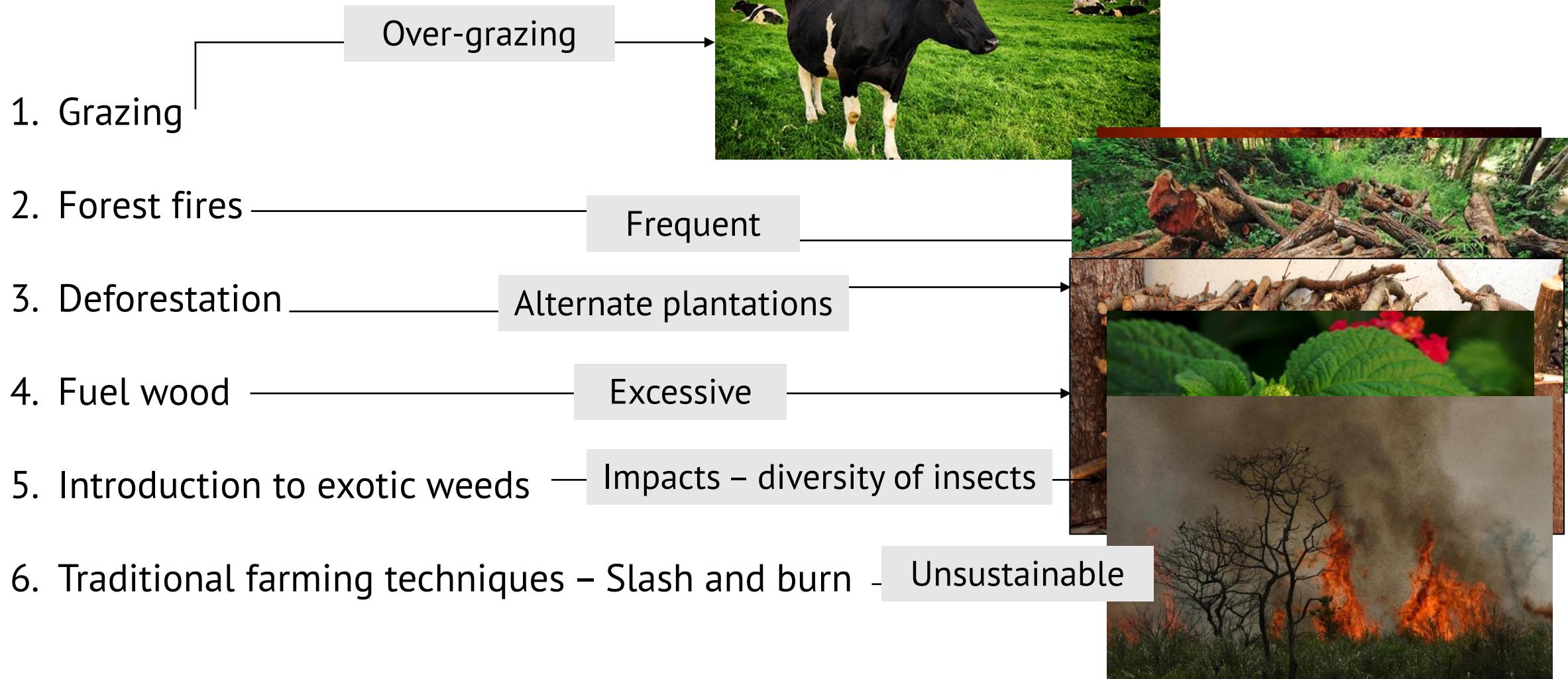
Human-wildlife conflict (HWC) occurs when animals pose a direct and recurring threat to the livelihood or safety of people, leading to the persecution of that species.

Presence of a large number of animals and birds outside the notified protected areas.

Source: <https://www.downtoearth.org.in/factsheet/everything-you-need-to-know-about-the-man-animal-conflict-54347>



Threats posed to biodiversity



Conservation of Biodiversity

Biodiversity conservation

In-situ

Primary conservation strategy

Protected Areas

- National parks
- Sanctuaries
- Biosphere reserves

Sacred forests and lakes

Ex-situ

Supportive role

Seed banks and Gene banks

- Long term captive breeding

- Animal translocations

- Tissue culture banks

- Cryopreservation of gametes and embryos

- Botanical Gardens

- Zoological Gardens and Zoos

In-Situ conservation

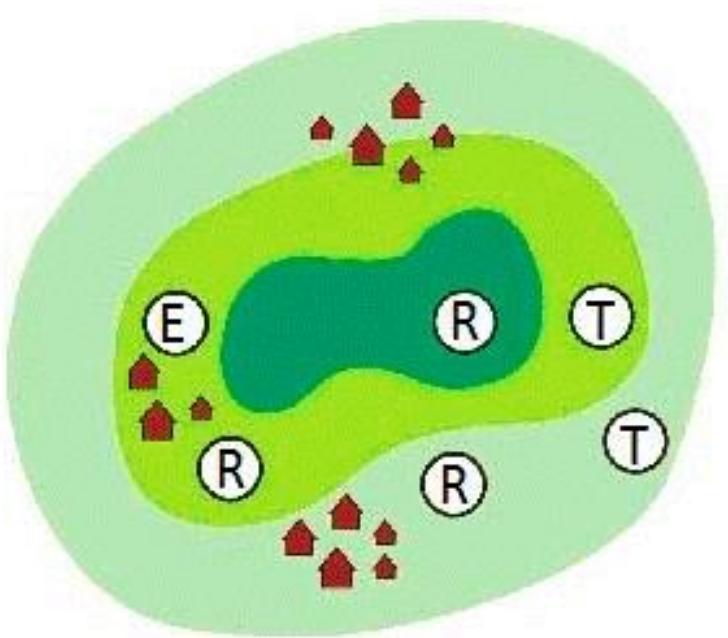
In-situ ('on site', 'in place') conservation is a set of conservation techniques involving the designation, management and monitoring of biodiversity in the same area where it is encountered.

In-situ management approaches can either be targeted at **populations of selected species** (species-centred approaches), or **whole ecosystems** (ecosystem-based approaches)

The ecosystem approach is primarily concerned with management at a systems level rather than focusing on individual species or habitats. It aims to take into account both the environmental and social contexts and thus provide a more integrated management methodology.

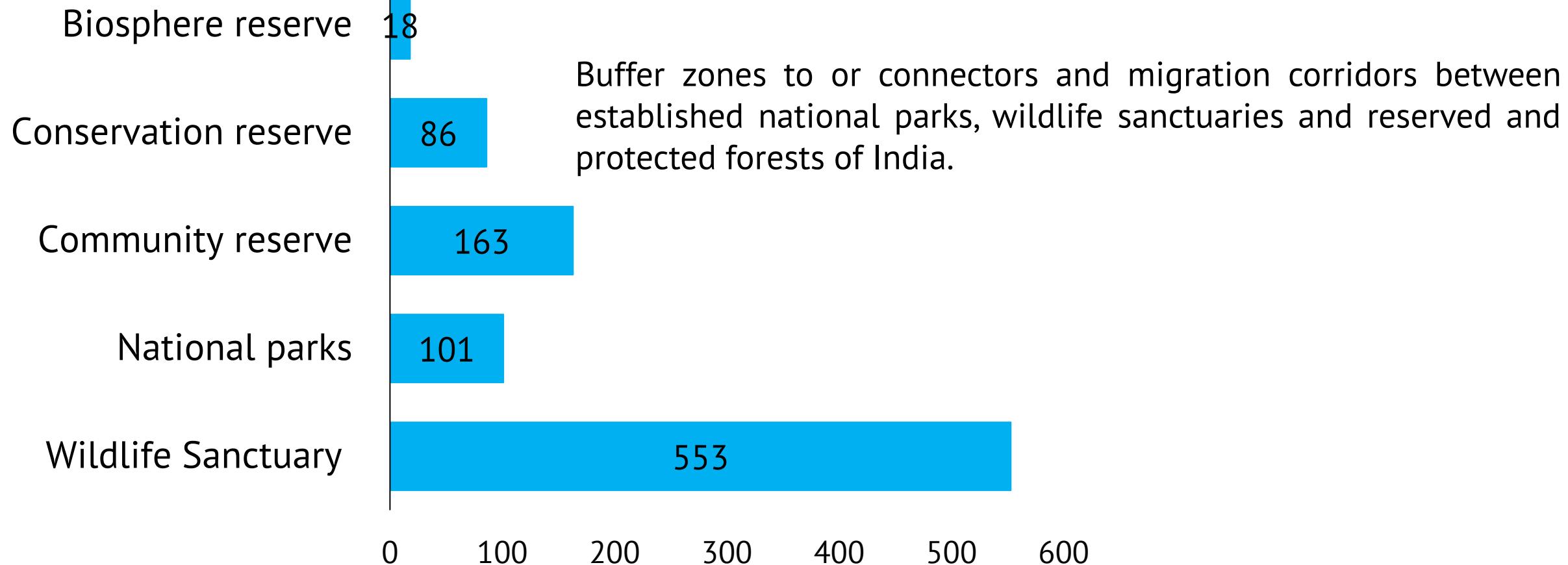
Wildlife Sanctuary	National Park	Biosphere Reserve
They are established for the protection of only wildlife (wild animals)	It protects plants, animals, historical objects and entire ecosystem (flora and fauna and non-living things)	It protects entire biodiversity (Biodiversity is variety of plants and animals living in area). It is also used for economic development of tribals living in area.
Boundaries are not fixed	Boundaries are fixed as per the law of the Government	Boundaries are fixed
There are less restrictions and human activity is allowed. Example: Grazing, Collecting medicinal plants and fire wood	Human activities are not allowed at all	There are more restrictions and human activity is not allowed in core zone. However, it may be allowed in outermost zone and buffer zone
Sanjay Gandhi Wildlife Sanctuary	Corbett National Park	Pachmarhi Biosphere Reserve

Biosphere Reserve



- Core Area
- Buffer Area
- Transition Area
- Human Settlement
- R Research
- E Education / Training
- T Tourism / Recreation

Protected areas in India



Source: http://www.wiienvis.nic.in/Database/cri_8229.aspx

NH 44 through Pench Tiger Reserve

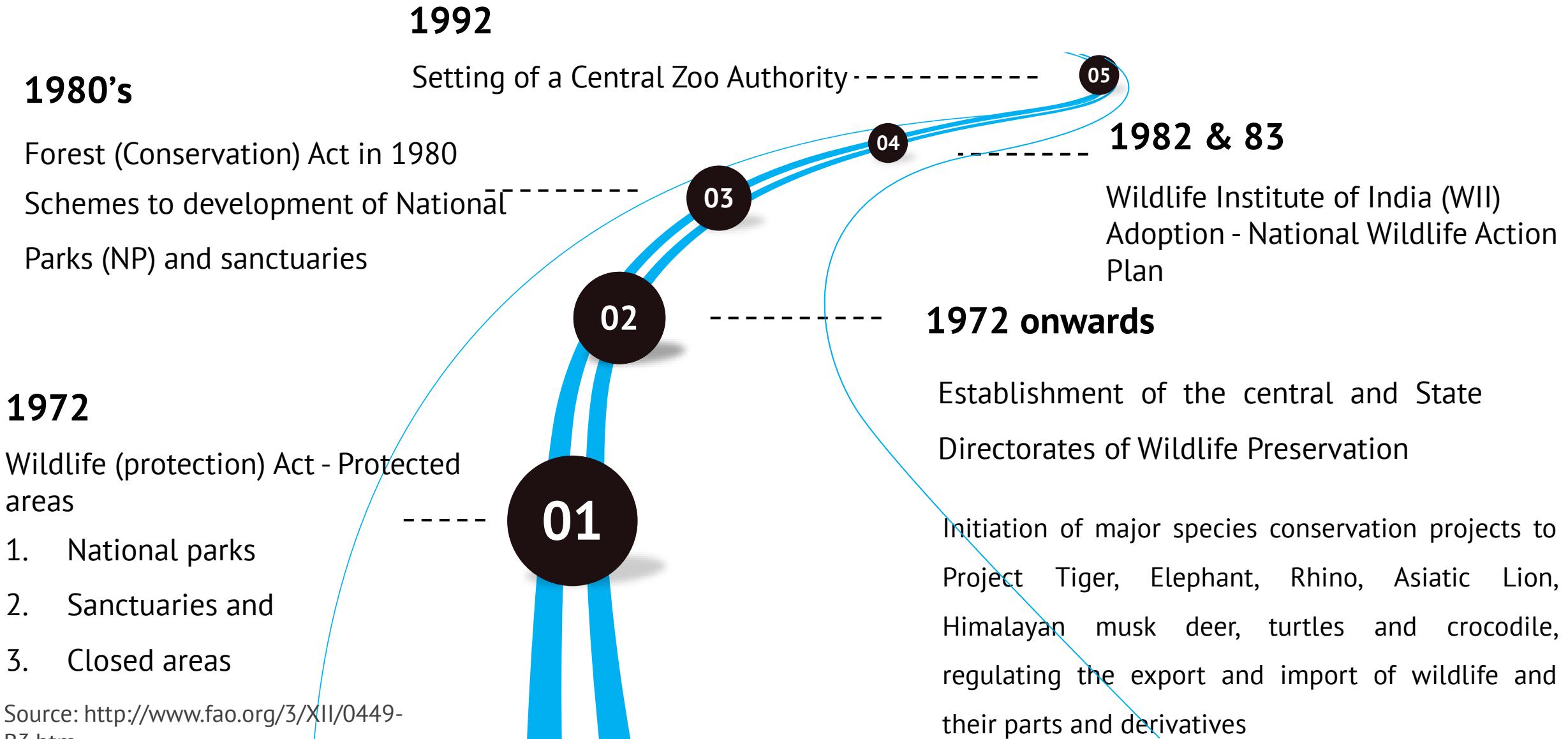


world's longest highway underpass

https://economictimes.indiatimes.com/industry/transportation/roadways/how-an-elevated-stretch-of-nh-44-through-pench-tiger-reserve-earned-a-distinction/articleshow/74260122.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Integrated Protected Area System (IPAS)

1970 - Indian Board for Wildlife - National wildlife policy – conservation of wildlife

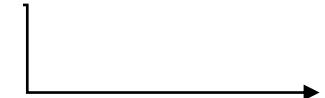


India is the world's largest home for Royal Bengal Tigers.

Prime targets for tiger hunters and poachers.

To overcome this threat Project Tiger was launched in 1973 in

India.



Project Tiger in India

Maintain the tiger's population
Protect them from Poaching and other threats

1973: 9 reserves

1984: 15 reserves

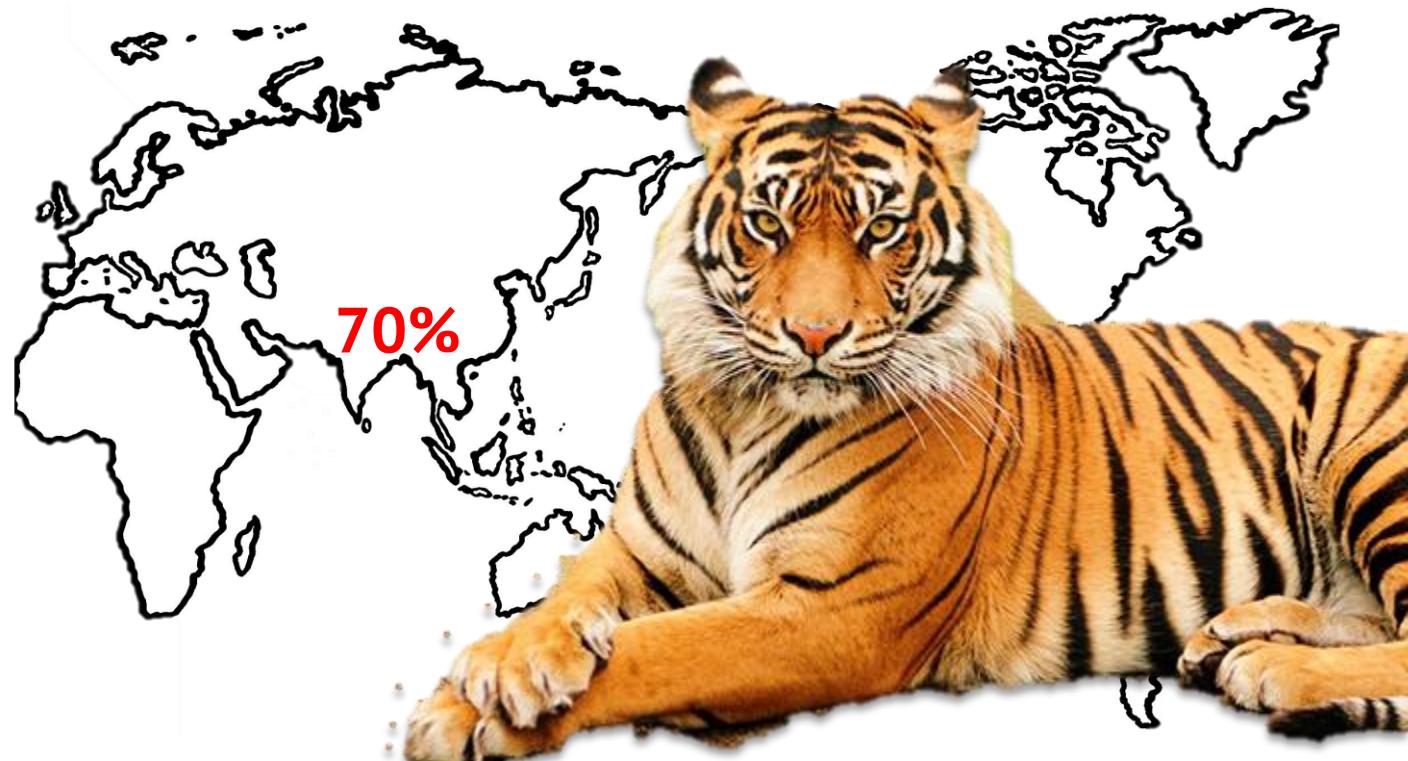
1997: 23 reserves

50 tiger reserves in India

No increase in tigers till 2006 later by 2014 increase was recorded

Tiger reserves are created on the basis of a 'core-buffer' strategy.

Source: <https://bigcatsindia.com/project-tiger-in-india/>





India Eco Development Project (IEDP)

Any conservation effort must involve the local people, based on their interests, skills, self-reliance and traditions and it must initiate programs that offer them spiritual and economic benefits (Schaller, 1993).

India Eco development Project was conceived as a pilot project in June 1994

- Eco tourism = allow nature conservation and economic gain

Examples of ex-situ conservation

- ↳ Seed banks and Gene banks
- ↳ Long term captive breeding
- ↳ Animal translocations
- ↳ Tissue culture banks
- ↳ Cryopreservation of gametes and embryos
- ↳ Botanical Gardens
- ↳ Zoological Gardens and Zoos

Ex-situ techniques target **plant and animal populations**

Techniques vary according to the characteristics of the species to be preserved, which dictates the type of material to be preserved (e.g. whole animals, pollen, seeds).

Plants - storing seeds, conserving pollen and through the storage of plant shoots in conditions of slow or suspended growth (in vitro conservation).

Animal populations - storage of embryos, semen/ovule/DNA, or captive breeding through the establishment of field gene banks and livestock parks.

Conservation of Cultivars and Livestock Breeds

Rice varieties – Gene banks

1. A seed bank preserves dried seeds by storing them at a very low temperature.
2. Tissue bank - buds, protocorm and meristematic cells are preserved through particular light and temperature arrangements in a nutrient medium
3. Cryobank a seed or embryo is preserved at very low temperatures
4. Storage of pollen grains

Animals

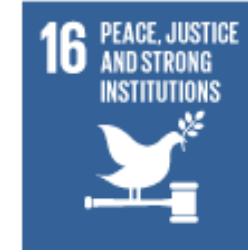
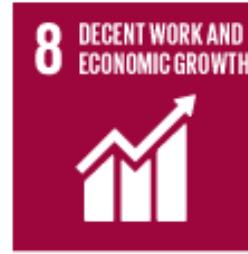
1. Zoo
2. Animal translocations
3. Long term captive breeding

Biodiversity and Sustainable development



SUSTAINABLE DEVELOPMENT GOALS

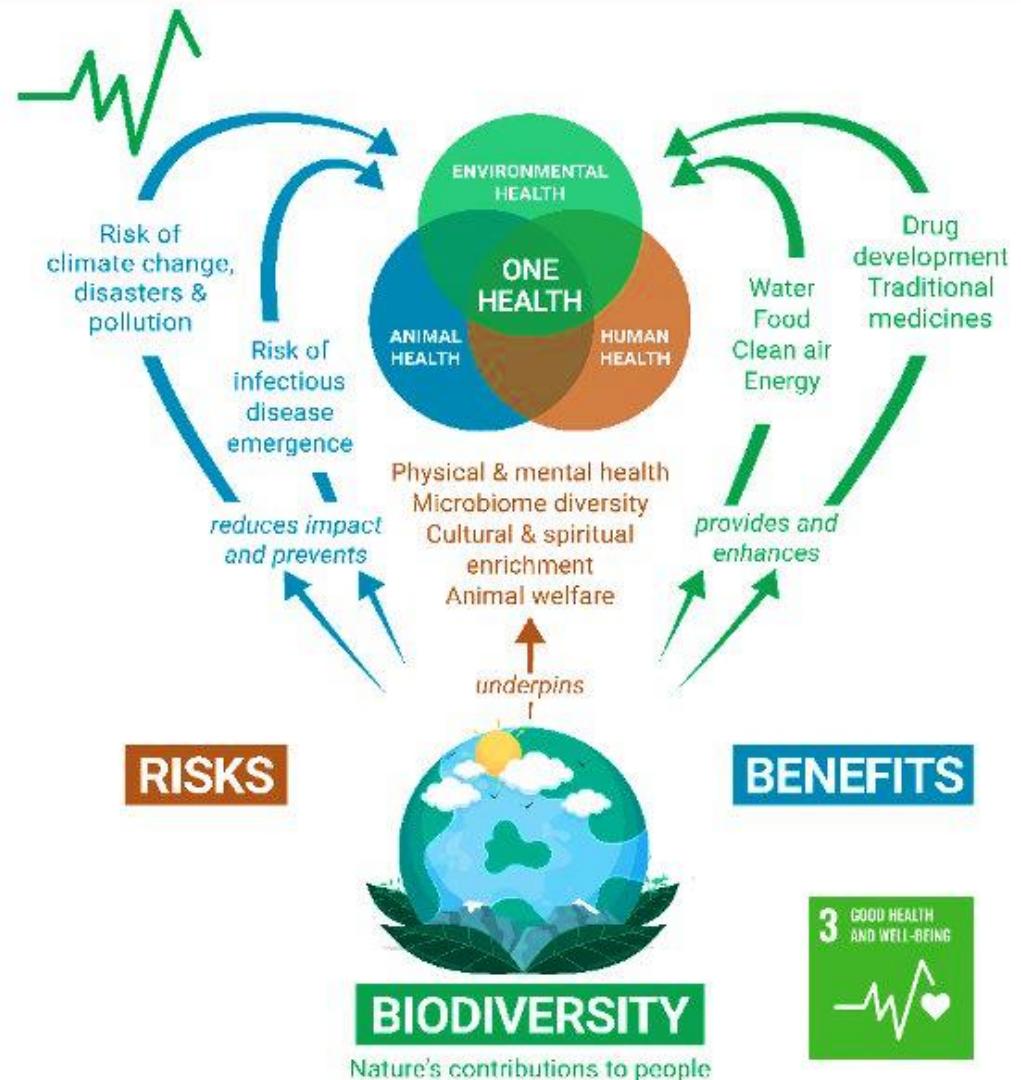
17 GOALS TO TRANSFORM OUR WORLD





Health & Biodiversity linkages

- Biodiversity encompasses all the complex interactions between living organisms that form the perfectly balanced ecosystems which support life: the air we breathe, the water we drink, the food we eat.
- Interlinkages across scales, from the planetary to individual human microbiota.
- Key message: Our health and well-being depend on nature. The decline of biodiversity at an unprecedented rate and scale undermines the web of life and the achievement of SDG3.



Disclaimer!

The author has taken attention to acknowledge most of the sources referred to in the presentation. However, if some citations/references have been missed, it has only been referred solely for educational purposes.