



# India's Flora and Fauna: A Study of Diversity and Conservation Practices

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Date of Submission: 01-07-2025

Date of Acceptance: 09-07-2025

## Abstract:

Biodiversity loss has emerged as a critical global concern. Biodiversity, encompassing the diversity of all life forms on Earth -including plants, animals, micro-organisms, their genetic material, and the terrestrial, marine, and freshwater ecosystems they inhabit—is vital for both ecological balance and human survival. It serves as the foundation for numerous environmental goods and services essential to life. India, recognized as one of the world's twelve mega-diverse countries, harbors approximately 7.7% of the planet's genetic resources. However, in recent decades, the nation has witnessed a significant decline in its biodiversity. Despite ongoing efforts to mitigate the threats and pressures on its biological resources, this downward trend persists. This paper aims to assess the current status of biodiversity in India, identify the major threats contributing to its decline, and examine the conservation strategies adopted by the government, scientific community, industries, and local populations to safeguard the country's rich ecological heritage.

**Keywords:** Biodiversity Loss, Ecosystems, Conservation Strategies, India, Global Environmental Crisis

## I. Introduction

The concept of biodiversity has been integral to human understanding since the earliest observations of life. The term *biological diversity* was first introduced by Robert E. Jenkins and Thomas Lovejoy in 1980, while the word *biodiversity* is believed to have been coined by W.G. Rosen in 1985. It gained broader recognition when it was used as the title of a symposium organized by the U.S. National Research Council in 1986. Around this period, as global awareness of species extinction intensified, biodiversity emerged as a central concern in environmental discussions. The term became widely known following the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil, in 1992,

where biodiversity was formally recognized as a critical environmental issue with a new global perspective.

## Understanding Biodiversity

The word biodiversity combines "bio" (life) and "diversity" (variety), referring to the immense range of living organisms and their interactions within ecosystems. It encompasses the variety of species, genetic differences within species, and the ecosystems they form. Biodiversity is essential for maintaining ecological balance and is one of nature's most valuable assets. As defined in international agreements, biodiversity includes "the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems." Every species—plant, animal, and micro-organism—plays a vital role in sustaining the intricate web of life on Earth.

## India: A Megadiverse Nation

The Earth is home to an estimated 5 to 50 million species, though only about 1.7 million have been scientifically described. These include approximately 4,27,205 species of green plants, fungi, bacteria, and viruses; 61,917 species of vertebrates and protochordates; and around 12,32,490 species of invertebrates, including protists. India ranks among the world's twelve *megadiverse* countries, housing two major biogeographic realms—the Palearctic and the Indo-Malayan—and three major biomes: tropical humid forests, tropical dry/deciduous forests, and warm deserts/semi-deserts.

India is further divided into ten biogeographic zones: the Trans-Himalayan, Himalayan, Indian Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plains, North-East India, Coastal zones, and Islands. This vast geographic and climatic variation supports a wide range of ecological habitats such as forests,



grasslands, wetlands, coastal and marine areas, and desert ecosystems, all of which contribute to the country's remarkable biodiversity.

Despite covering only 2.45% of the world's land area, India supports 16.7% of the global human population and 18% of the global livestock population, and contributes approximately 8.1% of the known global biodiversity. India currently ranks tenth in the world and fourth in Asia in terms of plant diversity. It also ranks tenth globally for the number of mammalian species and eleventh for endemic vertebrates. In agriculture and animal husbandry, it ranks seventh in terms of species richness.

India is home to two globally recognized biodiversity hotspots—the Himalayas and the Western Ghats—both of which harbor high levels of species richness and endemism. Furthermore, India is recognized as one of the important Vavilovian centers of origin and diversity, with over 167 cultivated plant species, 320 wild relatives of crops, and numerous domesticated animal species.

In terms of flora, India supports approximately 45,944 plant species, accounting for 10.75% of the world's known plant diversity. Among the estimated 18,000 angiosperm species, 36% are endemic and found within 26 distinct endemic centers. The country is also rich in fauna, with about 89,317 documented animal species—of which nearly 75% are insects. This includes 4,952 species of vertebrates and approximately 84,365 invertebrate species. Endemism rates are significant: 33% in reptiles, 41% in amphibians, 9% in mammals, and 4% in birds.

## Causes of Biodiversity Loss

### 1. Habitat Destruction

The most significant threat to biodiversity is the widespread destruction of natural habitats, primarily caused by human activities such as urban development, agriculture, mining, industrialization, highway construction, drainage, and the building of dams. When habitats are altered or destroyed, species are forced either to adapt, relocate, or face extinction due to predation, starvation, or disease. This threat impacts a substantial portion of biodiversity, affecting nearly 89% of all threatened bird species and 83% of endangered animals globally. In India, rapid habitat degradation—especially in ecologically sensitive regions like the Western Ghats—is pushing several rare butterfly species to the brink of extinction. Out of 370 butterfly species found in the Ghats, nearly 70 are currently endangered.

### 2. Hunting and Poaching

Historically, humans have hunted animals for subsistence. However, commercial hunting has become a major threat due to the demand for animal products such as hides, skins, tusks, antlers, meat, musk, fur, and other derivatives used in pharmaceuticals, perfumes, cosmetics, and decorative items. In India, animals like the rhinoceros (for its horn), tiger (for bones and skin), musk deer (for musk), elephant (for ivory), crocodile and gharial (for skin), and jackal (for fur) are targeted. One of the most notorious examples of commercial hunting is whaling, where whale bones (baleen) are used in manufacturing products like combs. Poaching of Indian tigers has surged due to the high demand from pharmaceutical industries that consume bones from approximately 100 tigers annually. This illegal trade continues despite conservation efforts like Project Tiger, with populations in reserves such as Ranthambore and Keoladeo significantly declining. Additionally, hunting for sport contributes to the loss of many wild species.

### 3. Overexploitation

The excessive harvesting of biological resources has led to the depletion and extinction of several economically and ecologically important species. This includes not only commercially valuable plants and animals but also unique species used in education and scientific research, such as *Nepenthes*, *Gnetum*, and *Psilotum*. For example, Indian wild mango trees have been excessively logged for plywood, and whales have been overhunted for their oil. Medicinal plants such as *Podophyllum hexandrum*, *Coptis teeta*, *Aconitum*, *Dioscorea deltoidea*, *Rauwolfia serpentina*, and *Paphiopedilum druryi*, along with ornamental plants like orchids and rhododendrons, have also been overexploited. Similarly, overharvesting of marine fauna, including fish, mollusks, sea cows, and sea turtles, has severely affected their populations and led to the extinction of some species.

### 4. Collection for Zoos and Scientific Research

Wild species are often collected globally for display in zoos or for use in biological research and medical studies. This practice also contributes to biodiversity decline. Primates such as monkeys and chimpanzees are frequently used in scientific experiments due to their close genetic, physiological, and anatomical similarities to humans, often resulting in the loss of individual animals and population declines in the wild.



### Introduction of Exotic Species

The introduction of non-native (exotic) species into new ecosystems often leads to intense competition with indigenous species for food, space, and other resources. This competition can displace or threaten native flora and fauna. A notable example is the introduction of goats and rabbits to islands in the Pacific and Indian Ocean regions, which has led to the destruction of natural habitats and the decline of various endemic plant, bird, and reptile species.

### Pollution

Pollution significantly alters and degrades natural habitats, posing a severe threat to biodiversity. Aquatic ecosystems, especially estuaries and coastal zones, are highly vulnerable to water pollution. Toxic substances discharged into water bodies disrupt food chains and ecological balance. Insecticides, pesticides, industrial chemicals, and emissions of sulfur dioxide and nitrogen oxides contribute to air and soil pollution, while phenomena like acid rain, ozone layer depletion, and global warming further exacerbate the stress on ecosystems. Coastal ecosystems are particularly affected—industrial runoff, oil spills, and offshore mining have led to the degradation of coral reefs. Additionally, noise pollution is increasingly recognized as a serious threat to wildlife. For example, Arctic whales face extinction risks due to elevated underwater noise from icebreakers and oil tankers.

### Deforestation

Rapid deforestation, largely driven by population growth and development pressures, is another major cause of biodiversity loss. Key factors include settlement expansion, shifting cultivation, infrastructure development, fuelwood extraction, and industrial demands for timber in sectors such as paper, pulp, furniture, and plywood. India currently faces a deforestation rate of approximately 13,000 square kilometers per year. If this trend continues, it could result in the irreversible loss of vast forest areas and the rich biodiversity they support. Globally, it is estimated that deforestation may contribute to the extinction of up to 100 species per day in the coming years.

### Biodiversity Conservation Strategies

Given that biodiversity underpins the health of ecosystems and is profoundly impacted by human activity, its conservation must be a shared global responsibility. Recognizing this, the **Convention on Biological Diversity (CBD)** was adopted in 1992 as a landmark international agreement. It marked a

significant advancement in promoting the conservation of biodiversity, the sustainable use of biological resources, and the equitable sharing of benefits derived from genetic materials. India was among the early signatories to this convention, demonstrating its commitment to global environmental governance.

Prior to the CBD, India had already established legal frameworks to conserve biodiversity, including:

- **The Indian Forest Act, 1927** – which governs the management and conservation of forests.
- **The Wildlife (Protection) Act, 1972** – enacted to protect wild animals, birds, and plants, and to ensure the ecological balance.

### Legal Framework and Conservation Approaches

**Forest (Conservation) Act, 1980**  
Over the past two decades, various global institutions—including the World Resources Institute (WRI) and the International Union for Conservation of Nature (IUCN), with support from the World Bank—have formulated comprehensive plans for biodiversity conservation. These strategies adopt a holistic approach, addressing the entire spectrum of life, from large-scale ecosystems to molecular-level DNA libraries. Broadly, biodiversity conservation strategies are categorized into two major approaches: **in situ** (on-site) and **ex situ** (off-site).

### In Situ Conservation

In situ conservation refers to the protection and maintenance of ecosystems, habitats, and viable populations of species within their natural environments, where they have evolved and developed their unique characteristics. This method primarily involves removing threats that endanger species survival, allowing multiple species to flourish within their original ecological settings. However, one notable drawback is the extensive land requirement, which limits space availability for an expanding human population.

### Protected areas designated for in situ conservation in India include:

- **National Parks**
- **Wildlife Sanctuaries**
- **Biosphere Reserves**

The **Wildlife (Protection) Act, 1972** empowers state governments to declare any area as a sanctuary or national park for the purpose of wildlife protection, propagation, and development. Key provisions are:

- Sections 18–34 and 38: Declaration of Wildlife Sanctuaries
- Sections 35 and 38: Designation of National Parks
- Section 37: Declaration of Closed Areas



As of now, India has established:

- **102 National Parks**
- **512 Wildlife Sanctuaries**
- **47 Conservation Reserves**
- **4 Community Reserves**

Together, these protected areas cover approximately **161,221.57 km<sup>2</sup>**, which is **4.90% of the country's total geographical area**.

#### Species-Specific Conservation Projects

##### Project Tiger (1973)

Launched in 1973, Project Tiger aimed to ensure the long-term survival of a viable tiger population in India, emphasizing the ecological, scientific, cultural, and aesthetic value of tigers. The initiative also focused on conserving biologically significant habitats as part of the national heritage. By June 2011, 44 tiger reserves had been established across 21 states, covering over **52,653 km<sup>2</sup>** of protected tiger habitats. Despite its initial success, intense poaching has led to a decline in tiger populations and degradation of tiger reserves. To enhance conservation efforts, the **National Tiger Conservation Authority (NTCA)** was established in 2006, followed by the **Wildlife Crime Control Bureau (WCCB)** in 2007. Tiger numbers dropped from around 4,026 in 1989 to approximately 1,233 in 2000. No tigers were sighted in Sariska since 2004, but a 2011 census reported a population of around **1,706 tigers**. Project Tiger remains a vital custodian of India's genetic resources and wildlife habitats.

##### Project Elephant (1992)

Initiated in 1992, Project Elephant focuses on the conservation of viable elephant populations and their habitats. Key components include restoring degraded habitats, creating migration corridors, mitigating human-elephant conflicts, and maintaining databases on elephant movement and population dynamics. The project also promotes the well-being of communities living around elephant habitats through sustainable development initiatives. Currently, it is being implemented in **13 states**, with **30 designated Elephant Reserves**.

##### Gir Lion Project

The Gir Forest, located in Gujarat's Saurashtra Peninsula, is the only natural habitat of the **Asiatic lion (*Panthera leo persica*)**. Due to deforestation, overgrazing, and agricultural expansion, lion populations declined significantly. In response, the Gujarat government launched the **Gir Lion Project** in 1972. The sanctuary now covers **1,412.12 km<sup>2</sup>**, with the core area of **258.71 km<sup>2</sup>** designated as a National Park in phases (1975 and 1978). As a result of conservation efforts, the lion population rose from

**177 in 1968 to 180 in 1974**, with continued increases in subsequent years.

#### Ex Situ Conservation

Ex situ conservation involves the preservation of components of biodiversity outside their natural habitats. This method includes cultivating rare plant species and breeding threatened animal species in controlled environments such as:

- **Botanical gardens**
- **Zoological parks**
- **Arboretums**
- **Gene banks**
- **Tissue culture facilities**

Several species, including the **cheetah (*Acinonyx jubatus*)**, which are nearly extinct in the wild, are being maintained through ex situ strategies in zoos and research centers.

However, due to high operational costs, **captive breeding programs** should only be undertaken when a species faces imminent extinction in the wild. Effective ex situ conservation involves:

- Establishing **minimum viable population targets** to preserve genetic diversity for at least 100 years.
- Developing and distributing **animal husbandry protocols** across breeding centers.
- Coordinating a **global management plan** to ensure genetic and demographic sustainability of captive populations.

#### Zoological Parks

Globally, zoological parks house nearly 500,000 mammals, birds, reptiles, and amphibians in captivity. Zoos contribute significantly to biodiversity conservation through the following functions:

- **Breeding and reintroduction** of endangered species into the wild.
- Acting as **research centers** to enhance the management of both captive and wild populations.
- Promoting **public education and awareness** regarding species conservation and ecosystem balance.
- Instilling appreciation for the intrinsic value of all life forms and their critical role in supporting ecological stability.

India's first zoo was established in **Madras (now Chennai)** in 1855, followed by others in **Trivandrum (1857), Bombay (1863), Calcutta (1875), Jaipur (1876), and Udaipur (1878)**. Post-independence, several prominent zoological parks have been set up, including:

- **Municipal Hill Garden Zoo (Ahmedabad)**
- **Delhi Zoological Park (Delhi)**



- Himalayan Zoological Park (Darjeeling)
- Nehru Zoological Park (Hyderabad)
- Assam State Zoo (Guwahati)
- Van Vihar National Park (Bhopal)
- Nandankanan Zoological Park (Bhubaneswar)
- Sakkarbaug Zoological Garden (Junagadh)

#### Aquaria

Aquariums play a pivotal role in the conservation of threatened freshwater species. The **Captive Breeding Specialist Group (CBSG)** of the IUCN is actively working on breeding programs for endangered fish, starting with species from **Lake Victoria**, **North American desert fish**, and **Appalachian stream species**. These initiatives not only aim at repopulating threatened species but also include **habitat restoration**, **public education**, and **protection of wild populations**.

#### Gene Banks

Gene banks are specialized institutions that conserve vital plant genetic materials at risk of disappearing from their natural or cultivated environments. They store both seeds and vegetative parts of plants under controlled conditions. Seeds are typically preserved in **dry, low-temperature, vacuum-sealed containers**, while **cryopreservation** (below  $-196^{\circ}\text{C}$ ) can extend the viability of certain species for over a century. These preserved genetic resources are critical for plant breeding and research, helping to develop new varieties suited to changing environmental needs. Gene banking is an efficient, reliable, and scalable solution for short-, medium-, and long-term conservation.

#### Pollen and Semen Conservation

Preserving **pollen grains** and **spores** plays a crucial role in conserving genetic diversity, especially for flowering and spore-bearing plants. Techniques used for pollen banks are similar to those in gene banks. Cryogenic preservation helps maintain pollen from flowering plants and spores from non-flowering plants such as mosses and ferns. Unlike seeds, pollen storage can capture a **wider genetic range** from a population and is easier to use for **cross-breeding**. In animals, **semen preservation** enables artificial insemination and supports species recovery. Pollen banks are particularly valuable in **self-sterile plant species** and facilitate international germplasm exchange.

#### Tissue Culture Techniques

Tissue culture is employed in biodiversity conservation when:

- A particular **genetic clone** needs to be preserved.
- Seed progeny display **genetic variability**.
- The species produces **recalcitrant seeds** (seeds that cannot be stored easily).

**Shoot tips** are often used because they are genetically stable, virus-free, easy to regenerate into whole plants, and suitable for global germplasm transfer.

#### Recombinant DNA Technology

Recombinant DNA (rDNA) technology enables the cloning of genes using microbial hosts such as *Escherichia coli*, and potentially other organisms like yeast. This method allows the **preservation of genetic material** even from plants that are no longer viable. Through DNA libraries, specific genes or gene combinations can be extracted and utilized for future applications. rDNA techniques offer the possibility of preserving **entire genomic content**, making them a powerful tool in the conservation of genetic diversity.

## II. Conclusion

Biodiversity is a complex, dynamic, and interconnected phenomenon with far-reaching implications for ecosystem stability and human well-being. Its impact on productivity and resilience varies depending on environmental conditions and the timescale of observation. Nonetheless, the essential role of biodiversity in both natural and managed ecosystems is undeniable, even though the relative effects of species diversity versus composition are still under investigation.

It is imperative that **policy-makers, conservationists, and the public** understand the fundamental science behind biodiversity to ensure its sustained preservation. If current trends in population growth, environmental degradation, and unsustainable resource use persist, we risk the **irreversible loss of vital species** and ecosystems.

This study has explored various conservation strategies implemented by the **government, non-governmental organizations, communities, and individuals**. These collective efforts play a pivotal role in preserving biodiversity. Humans are just one of many species sharing this planet and have no moral authority to dominate or eliminate others. Instead, we must treat all life forms with **respect, empathy, and responsibility**. Even small, individual actions can significantly contribute to the global mission of **protecting and conserving biodiversity** for current and future generations.



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