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Biodiversity in India: Present Threats, Conservation Policies and the Role of Indian Legislation

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Abstract

India is one of the 17 megadiverse countries, hosting approximately 7–8% of all recorded species on just 2.4% of the world's land area. With four global biodiversity hotspots (Himalaya, Indo-Burma, Western Ghats–Sri Lanka and Sundaland), the country supports over 55,481 plant taxa and 105,244 animal species as of 2024 (Botanical Survey of India, 2025; Zoological Survey of India, 2025). Despite robust legal and policy frameworks, biodiversity faces severe threats from habitat fragmentation, deforestation (18,200 ha of primary humid forest lost in 2024), invasive alien species, pollution, overexploitation and climate change. This manuscript synthesizes the latest data from the Botanical Survey of India (BSI), Zoological Survey of India (ZSI), Global Forest Watch, India State of Forest Report 2023 and IUCN Red List, while critically examining India's biodiversity-related legislation: the Wildlife (Protection) Act 1972 (as amended 2022), Biological Diversity Act 2002 (Rules 2004 & Amendment 2023), Forest (Conservation) Act 1980 (amended 2023), Environment (Protection) Act 1986, Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 and recent regulations under the Jan Vishwas Act 2023 and Biological Diversity (Access and Benefit Sharing) Regulations 2025 (Government of India). The analysis reveals implementation gaps, judicial interventions and emerging opportunities under the Kunming-Montreal Global Biodiversity Framework. Strengthening enforcement, community rights, landscape-level planning and climate-resilient corridors is essential for achieving national targets of protecting 30% of land and water by 2030.

Keywords

Biodiversity, deforestation, invasive species, Wildlife Protection Act, Biological Diversity Act, Kunming-Montreal Framework

Introduction

India's extraordinary biodiversity is a product of its geographical diversity spanning altitudes from sea level to 8,598 m (Siachen), latitudes from 8°N to 37°N and rainfall regimes from <100 mm in the Thar Desert to >11,000 mm in Cherrapunji (Shivanna, 2022). This gradient has produced 10 biogeographic zones and 26 biotic provinces, nurturing four of the world's 36 global biodiversity hotspots (India Biodiversity Portal, 2024).

Biologically, India is home to:

- 12.6% of world's avian diversity (1,353 species including 2024 additions) (Lansley et al., 2025; Maheswaran & Alam 2024)
- 7.6% of mammalian diversity (423 species) (Solanki, 2025)
- 11.7% of piscine diversity (3,022 species) (India Biodiversity Portal, 2024)
- 61.2% endemic amphibian fauna (the highest among vertebrates) (IUCN, 2024)
- Nearly 28% endemic flowering plants in the Western Ghats alone (Botanical Survey of India, 2025)

Economically and culturally, biodiversity underpins ₹2.4 lakh crore worth of non-timber forest products, ₹50,000 crore annual fisheries and 60% of modern pharmaceuticals derived from traditional knowledge (Ministry of Statistics and Programme Implementation, 2022). Yet, the country stands at a critical juncture. Between 2001 and 2024, India lost 5.4% of its humid primary forests (348,000 ha), equivalent to 348 million tonnes of CO₂ emissions (Global Forest Watch, 2025). The Living Planet Report 2024 documents a 73% decline in monitored wildlife populations in India since 1970, one of the steepest globally (WWF, 2024).

Recognizing these threats, India has developed one of the most comprehensive legal architectures for biodiversity conservation in the developing world. From the colonial-era Indian Forest Act 1927 to the post-independence Wildlife (Protection) Act 1972, Forest (Conservation) Act 1980, Environment (Protection) Act 1986, Biological Diversity Act 2002, and Forest Rights Act 2006, the legislative journey reflects evolving understanding from state-centric control to recognition of community rights and access-benefit sharing (Government of India, 2023a; Government of India, 2023b; Vishwapriya & Devaiah, 2024).

Considering the importance and role of legislations in conservation of biodiversity, present manuscript provides an updated synthesis of biodiversity status (2023–2025 data), quantifies major threats, critically reviews the Indian legal and policy framework, identifies implementation bottlenecks and proposes pathways aligned with national and international commitments. Manuscript provides a critical outlook for policymakers, scholars, researchers and academicians to present threat and effective mitigation measures of biodiversity and their effectiveness in present scenario.

Materials and Methods

Data Sources

- Floral diversity: Plant Discoveries 2024 (BSI), EnvisStats India 2024 (Botanical Survey of India, 2025; Ministry of Statistics and Programme Implementation, 2024).

- Faunal diversity: Animal Discoveries 2024 (ZSI), Fauna of India Checklist Portal (Dec 2024 update) (Zoological Survey of India, 2025).
- Forest cover & loss: India State of Forest Report 2023, Global Forest Watch (Hansen/UMD/Google/USGS/NASA dataset, 2001–2024) (Forest Survey of India, 2023; Global Forest Watch, 2025).
- Threatened species: IUCN Red List 2024 India assessment, National Red Data Books (IUCN, 2024).
- Legal and policy documents: Gazette notifications, NBA, MoEFCC, Parliamentary Acts & Amendments (1972–2025) (Government of India, 2022; Government of India, 2023a).
- Judicial pronouncements: Supreme Court (T.N. Godavarman series, Lafarge, Orissa Mining, Aadhaar-PESA linkage cases) (Supreme court of India Civil Appellate Jurisdiction, 2024).
- International commitments: CBD National Reports (6th, 2024), Kunming-Montreal Framework National Targets (2024 submission) (Ministry of Environment, Forest and Climate Change, 2024; Convention on Biological Diversity, 2022).

2.2 Analytical Approach

Descriptive statistics for species richness, endemism and loss rates; trend analysis of primary forest loss (2002–2024); thematic legal analysis were conducted using doctrinal and gap-analysis methods. Policy efficacy evaluation against protected area expansion, conviction rates under WLPA and Forest Rights Act (FRA) claim settlement data (2024) (Ministry of Tribal Affairs, 2024) were analysed under Microsoft Excel 365 and data were tabulated and graphically presented with help of Microsoft Excel 365 and CorelDraw 2023. Data from other research manuscripts related to recent trends of Biodiversity and Conservation approach were also included and scrutinized before inclusion.

Results and Discussion

Status of Biodiversity in India

Flora

As of December 2024, India records 55,481 plant taxa (BSI, 2025), including:

- Angiosperms: 18,934 species (28.1% endemic) (Botanical Survey of India, 2025)
- Gymnosperms: 78 species
- Pteridophytes: 1,350 species
- Bryophytes: 2,560 species
- Lichens: 2,620 species
- Algae & Fungi: >30,000 taxa

The Western Ghats (4,780 endemic flowering plants) and Eastern Himalaya (4,200 endemics) remain the richest centres (India Biodiversity Portal, 2024). In 2024 alone, 433 new taxa were added, including 154 angiosperms, 62 bryophytes, and 98 lichens (The Hindu, 2025). Fig. 1 depicts the present status of total, endemic species, IUCN threatend and new species added in the year 2024.

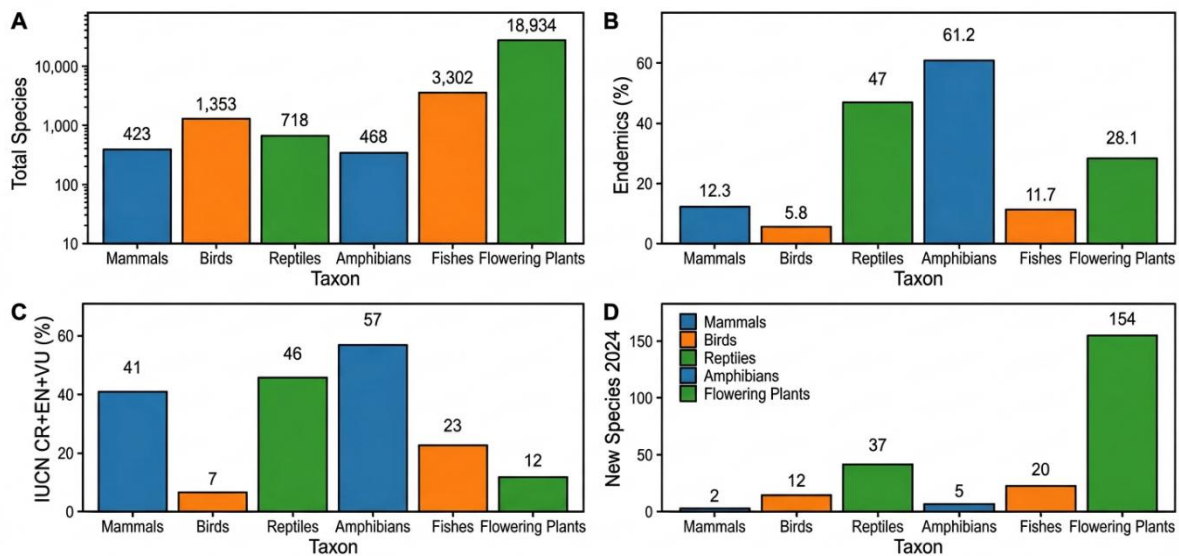


Fig. 1 Biodiversity richness and threat status (2024–2025) (A) Total Species present in India (B) Percent endemic species of each taxon (C) IUCN total added percent for CR-Critically Endangered; EN- Endangered and VU-Vulnerable (D) New species discovered for each taxon in the year 2024. Data source: Zoological Survey of India, 2025; Botanical Survey of India, 2025; and IUCN, 2024.

Fauna

ZSI's Animal Discoveries 2024 documented 683 new species and 224 new country records, bringing total faunal count to 105,244 species (Zoological Survey of India, 2025): Fig. 1 depicts the present status of Faunal species and new species added in the year 2024.

- Mammals: 423 (52 endemic, 41% threatened) (IUCN, 2024).
- Birds: 1,353 (78 endemic, 7% threatened) (The Hindu, 2023; Zoological Survey of India, 2025).
- Reptiles: 718 (47% endemic, 46% threatened).
- Amphibians: 468 (61.2% endemic, 57% threatened) (IUCN, 2024).
- Fishes: 3,302 (11.7% endemic, 70% freshwater threatened).
- Insects: 68,373 (59% of total fauna).

Protected Area Network (2025)

It refers to a thorough system of labelled geographical areas which is managed through legitimate or other lawful effective means. The major goal is to conserve these areas for long-term and protect nature, conserve biodiversity and most importantly to restore and even to increase

ecosystem services and cultural values of such areas. These areas function as the foundation of in-situ (on-site) conservation effort. A detailed outline of Protected Area Network of India is following.

- National Parks: 106 (43,617 km²).
- Wildlife Sanctuaries: 573 (123,342 km²).
- Conservation & Community Reserves: 163.
- Biosphere Reserves: 18 (13 UNESCO-listed).
- Total PA coverage: 5.32% of geographical area (target 10% by 2030 under NBT) (Forest Survey of India, 2023). Fig. 2 depicts growth in Indias protected area and forest cover.

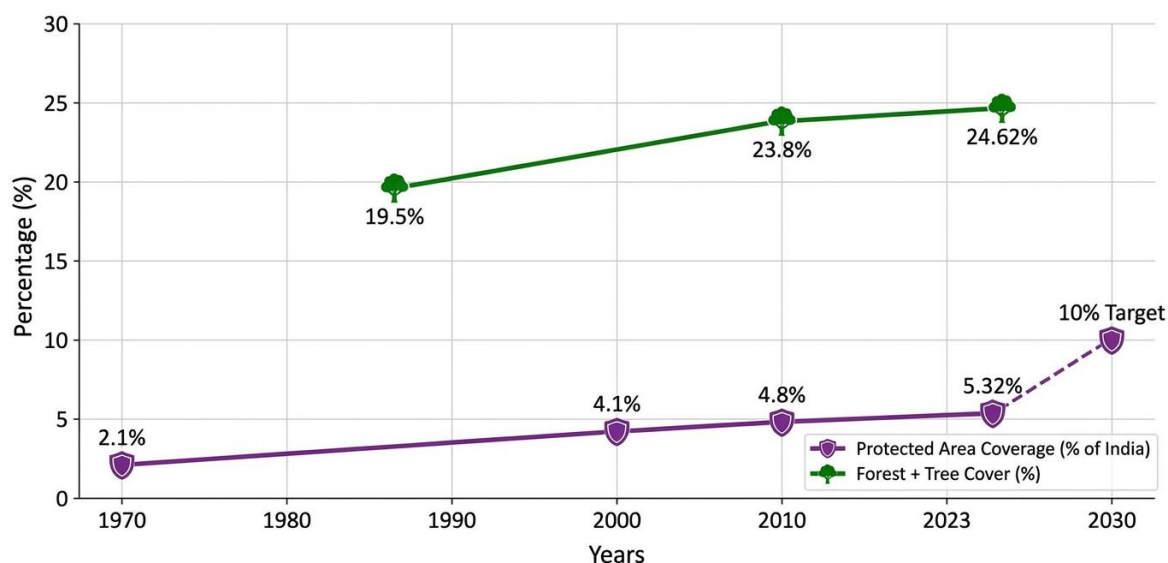


Fig. 2 Growth in Indias protected area and Forest cover from 1970 to 2024 with protected area target of 2030. Data source: Forest Survey of India (2023).

Existing Threats to Biodiversity

Habitat Loss and Fragmentation

Habitat loss is the direct damage of natural habitat to a level that it can be no longer supportive to its native or original species. It results in loss of natural species through indirect displacement or by death. Habitat fragmentation on the other hand is the fragmentation of large area into many smaller isolated patches. This process is mostly a result of anthropogenic activities such as construction of road, forest area to agriculture land or through a continuous process of urbanization (Table 1). It's a primary driver to biodiversity threat as 348,000 ha humid primary forest lost since 2002 (5.4% decline) (Global Forest Watch, 2025). Major causes which lead to habitat loss and fragmentation in last few decades are following:

- Linear infrastructure (roads, railways, power lines): 65,000 km added 2015–2024 (Forest Survey of India, 2023).
- Mining: 1,500+ leases in ecologically sensitive areas.

- Hydropower & irrigation projects: 47 large dams under construction in Himalaya.
- Urban expansion: 9 million ha agricultural land diverted 2000–2023 (Global Forest Watch, 2025; Pandey & Seto, 2015).

Table 1: Trend in humid primary forest loss in India (2002–2024). Data Source: Global Forest Watch (2025)

Year	Primary forest loss (ha)	% of 2001 primary forest	Main driver
2002–2010	~1,50,000 (cumulative)	-	Agriculture, logging
2011–2020	~1,30,000	-	Infrastructure
2021	18,300	0.41	Plantations & fires
2022	16,900	0.38	-
2023	17,700	0.40	-
2024	18,200	0.41	Plantations, wildfires

Invasive Alien Species

Invasive alien species are those species which are non-native organisms of that specific region although due to introduction through natural or anthropogenic way the alien species establish themselves and proliferate rapidly outnumbering the native species of that area, posing significant environmental, conservation, economical and health risks. They are considered as a major frontrunner of biodiversity loss due to impact on native ecosystems, agriculture as well as human livelihood. One of the most well-known examples are *Lantana camara* (40% forest undergrowth), *Prosopis juliflora* (15 million ha), *Chromolaena odorata* and aquatic invaders (African catfish, water hyacinth) (Table 2) cost ₹800 crore annually in control measures (Down to Earth, 2024). These species threaten 66% of India's natural systems, with *Lantana* covering 574,186 sq km (50% of natural areas) and *Prosopis* invading 94% of dry grasslands (Down to Earth, 2023a).

Overexploitation and Illegal Trade

Overexploitation or overharvesting refers to the unsustainable utilization or removal of natural resources or organisms from their native environment at a much faster rate than the natural environment can naturally refill. Overexploitation of natural resource is profound for most of the economically viable flora and fauna. Illegal trade of natural resources refers to the unlawful sale or exchange of inaccessible or regulated wild animals, plants and their derivatives such as woods or animal parts, obtained through illegal means, following are some notable examples:

- Tiger parts, rhino horn, pangolin scales: 1,200+ seizures (World Wide Fund for Nature, 2014).
- Sandalwood & red sanders smuggling: ₹3,000 crore black market (The Hindu, 2023).
- Marine turtle eggs, sea cucumber poaching in Gulf of Mannar (Times of India, 2021).

Table 2: Top five invasive alien species affecting Indian biodiversity. Data source: Down to Earth (2024)

Species	Native range	Area invaded (sq km or %)	Major ecosystem affected
<i>Lantana camara</i> L.	Tropical America	5,74,000 (50% natural areas)	Forests, grasslands
<i>Prosopis juliflora</i> (Sw.) DC.	South America	15 million ha	Dry forests, grasslands
<i>Chromolaena odorata</i> L.	Americas	Widespread in NE & south	Plantations, forests
Water hyacinth	Amazon basin	2,00,000 ha water bodies	Wetlands
African catfish	Africa	Most rivers & reservoirs	Freshwater

Pollution

Pollution poses a severe and manifold threat to India's rich biodiversity by directly harming organisms, natural mineral cycling, predator-prey relationship, soil microbial diversity, disrupting food webs, degrading habitats, increase of pollutants such as persistent organic pollutants (herbicides, pesticides, micro plastic) and compromising ecosystem resilience. In India air, water, soil and marine pollution have been a major issue of environmental concerned from last many decades, few notable examples are following:

- 46% rivers were polluted in year 2022 (CPCB, 2025).
- Pesticide residue in 40% vegetable samples (The Hindu, 2022).
- Plastic ingestion killing olive ridley turtles and gharials (The Hindu, 2018).

Climate Change

Climate change poses a significant empirical threat to India's substantial and varied biodiversity. Intensifying current pressures through habitat loss and pollution climate change gives an added an extra burden to existing scenario. Past few decades have shown rising temperatures, extreme weather events and erratic weather patterns, which in results have altered habitats faster than species can adapt naturally, which severely impacted critical ecosystems from the Himalayas to the rain forest to Indian Ocean. IPCC AR6 and Indian studies project:

- 1.5–2°C warming by 2050 which can led to 25–40% species range contraction in Western Ghats (IPCC, 2022).
- Himalayan glaciers retreating can cause 30% reduction in dry season flows affecting 500 million people and endemic schizothoracine fishes (Shivanna, 2022).
- Coral bleaching are early indicators of such change as 80% Lakshadweep reefs affected in 2024 event (Times of India, 2024).

Indian Laws and Policies for Biodiversity Protection

India has a strong framework of environmental laws and policies for protecting the diverse and rich biodiversity. Framework is based on both general environmental acts and specific legislation for proper conservation and for sustainable use of major natural resources (Table 3). Following are the major Constitutional Provisions for safeguarding the environment:

- Article 48A: State shall endeavour to protect and improve the environment.
- Article 51A(g): Fundamental duty of every citizen to protect wildlife and environment.
- Article 21: Right to clean environment (judicially expanded).

Wildlife (Protection) Act, 1972 (amended 2022)

It's a significant update to the original 1972 Act, primarily aimed to align India's national laws with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and enhance conservation efforts.

- Six schedules with varying protection levels (Government of India, 2022) now reduced to four (I. Highest protected animal species, II. Animal species with a high level of protection, III. Protected plant species, IV. Specimens listed in CITES Appendices for trade regulation).
- Schedule I (Tiger, Rhino, Elephant) – highest penalties (7 years imprisonment, ₹25 lakh fine post-2022).
- Creation of National Tiger Conservation Authority (NTCA), Wildlife Crime Control Bureau (WCCB).
- 2022 Amendment: Rationalized schedules, incorporated CITES appendices, increased penalties 10-fold.

Indian Forest Act, 1927 & Forest (Conservation) Act, 1980 (amended 2023)

The objective of this law is to consolidate laws related to the forest areas and regulate the movement of forest products (like timber) and to levy duties on them which provides primarily for revenue generation and state control. Following are the key recent developments:

- FCA 1980 made prior central approval mandatory for non-forest use (Government of India, 2023b)
- 2023 Amendment controversially exempted linear projects within 100 km of international borders and land up to 0.10 ha from approval.
- Supreme Court (2024) stayed certain provisions pending review.

Table 3: Major Indian laws for biodiversity conservation, timeline and key provisions

Year	Legislation	Key Provisions Relevant to Biodiversity	Recent Amendment
1972	Wildlife (Protection) Act	6 schedules, national parks, sanctuaries, NTCA	2022 higher penalties, CITES alignment
1980	Forest (Conservation) Act	Prior approval for diversion of forest land	2023 exemptions for border areas
1986	Environment (Protection) Act	Umbrella law, CRZ, ESZ, EIA notifications	-
2002	Biological Diversity Act	NBA, SBBs, BMCs, ABS mechanism	2023 + ABS Regulations 2025
2006	Forest Rights Act	Individual & community rights in forests & PAs	-
2011	CRZ Notification	Protection of mangroves, turtle nesting sites	2019 & draft 2024

Environment (Protection) Act, 1986

It's the primary legislation in India for the protection of environment and it also emphasise on the improvement of the environment. In recent time following legislations such as Umbrella legislation enabling CRZ Notification 2011, Eco-Sensitive Zones (ESZ) around PAs (1–10 km buffer), Hazardous Waste Rules, EIA Notification 2006 (amended 2020 & 2023) (Government of India, 2023a and 2023b) have been in action for protecting and rejuvenating the environment.

Biological Diversity Act, 2002 & Rules 2004 (major amendments 2023, Regulations 2025)

Main objective is to conserve biodiversity and to ensure sustainable use. It also emphasizes on achieving fair benefit-sharing from resource use and to keep the resource utilization sustainability not overly exploited as it happened in past. It forms a three-tier structure: National Biodiversity Authority (NBA), State Biodiversity Boards (SBBs), Biodiversity Management Committees (BMCs) at local level (2,77,688 formed) (Government of India, 2023a). It gives access and Benefit Sharing (ABS) for biological resources and traditional knowledge. A 2023 amendment decriminalized certain offences, eased research for Indians, introduced “registered entities” (ayush companies) (Government of India, 2023a). Biological Diversity (ABS) Regulations 2025 notified in March 2025 have mandates 0.2–0.6% of turnover as benefit sharing for large entities (Mongabay, 2025).

Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

- Recognizes individual and community forest rights (including in PAs).
- By Dec 2024: 4.4 million titles distributed (22 million ha) (Ministry of Tribal Affairs, 2024).
- Critical for community conserved areas and sacred groves.

Coastal Regulation Zone Notification, 2011 (amended 2019)

- Protects mangroves, turtle nesting sites, coral reefs.
- 2024 draft further dilutes protections for tourism (CRZ Notification, 2019).

National Wildlife Action Plan (2017–2031)

- Landscape-level planning, climate-smart conservation, human-wildlife conflict mitigation.

National Biodiversity Action Plan (2008, updated 2014 & 2019 addendum)

A National Biodiversity Action Plan (NBAP) is a country's main roadmap through which Convention on Biological Diversity (CBD) is implemented. It outlines the strategies to protect and conserve biodiversity; how natural sources should be sustainably used and most importantly to ensure equitable benefit sharing among all stakeholders. The major highlight is the 20 National Biodiversity Targets aligned with Aichi, now being revised for Kunming-Montreal Framework (30×30, subsidy reform, invasive species control) (Ministry of Environment, Forest and Climate Change, 2024).

Recent Judicial Landmarks

Recent judicial landmarks in the field of environment and biodiversity conservation have primarily focused on establishing the sustainable environment with right to a healthy environment as a fundamental right, reinforcing the ban on retrospective environmental clearances. It also ensures and strengthens the accountability for polluters from all sources and even government agencies. Following are the key recent judicial landmarks:

- T.N. Godavarman Thirumulpad vs Union of India (1996–ongoing): Expanded definition of “forest”, continuing mandamus (Kauffman et al., 2025)
- Lafarge Umiam Mining (2011): Ecologically Sensitive Areas require National Board for Wildlife (NBWL) clearance (Times of India, 2025).
- Orissa Mining Corporation vs MoEF (2013): Gram Sabha consent mandatory under Forest Rights Act (FRA) (Down To Earth 2023b).
- TN Cauvery Protection (2024): Directed 10% riparian buffer restoration for specific project goal, a local policy or a regulatory requirement (Cauvery River at a Glance, 2024).

Limitations of the Present Study

The study mostly relies on secondary data; microbial and soil biodiversity grossly understudied (Ministry of Statistics and Programme Implementation, 2024). GFW tree-cover loss includes plantations and agroforestry which may overestimates natural forest loss (Global Forest Watch, 2025). The FRA implementation data state-wise is inconsistent (Fig. 3) (Ministry of Tribal Affairs, 2024). Most of the data lacks longitudinal ecological monitoring for most taxa. Climate projections are mostly based on older CMIP5 models; CMIP6 suggests higher risks (IPCC, 2022).

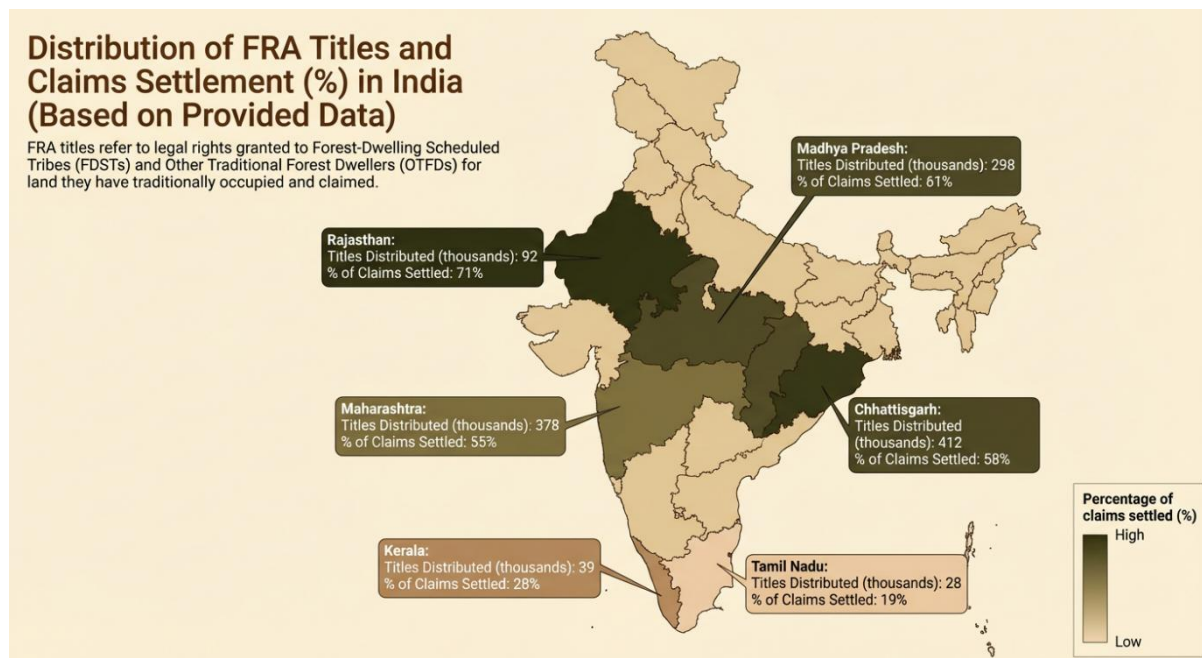


Fig. 3 Choropleth map of distribution of Forest act titles and claims settlement. Data source: Forest Survey of India (2023).

Future Perspectives

Achieving 30×30 target through “Other Effective Area-based Conservation Measures” (OECMs) sacred groves, community reserves (Convention on Biological Diversity, 2022) is challenging although manageable if consistent efforts are made. Operationalize National Restoration Mission (₹25,000 crore pledged 2025–2030), National Mission for a Green India, will help to increase green cover through forest and trees. Greening will certainly help in mitigating pollution and climate change. Integration of biodiversity into Nationally Determined Contributions will protect 26 million ha forests as carbon sinks, which will help India to reduce carbon emissions as well as Global warming. Strengthening of Biodiversity Management Committees as local custodians and linking them with Panchayati Raj (73rd Amendment) will strengthen biodiversity conservation and governance. It will also promote local people to be more involved in conservation practices. Use of artificial intelligence and satellite monitoring (Bhuvan, ISRO-AVBIS) for real-time poaching and encroachment alerts will certainly improve biodiversity monitoring and management. Repurpose of ₹1.5 lakh crore harmful subsidies (agriculture, energy) toward nature-positive incentives (Target 18, Kunming-Montreal) will boost active support to biodiversity as well as it will improve sustainable use of natural resources (Convention on Biological Diversity, 2022). Developing transboundary corridors (India-Myanmar, India-Nepal, India-Bhutan) will help in enhancing regional connectivity, boosting economic prosperity through trade and tourism, ensuring ecological security and wildlife conservation and strengthening diplomatic and strategic ties as the same time. Actions should be more focused on sustainable approaches which will be ecofriendly as well as beneficial for all stakeholders.

Conclusion

India possesses both extraordinary biodiversity wealth and a sophisticated legal framework to protect it. The Wildlife (Protection) Amendment Act 2022, Biological Diversity Act

amendments, and Forest Rights Act together represent one of the most progressive conservation legislations globally. Yet, persistent habitat loss, weak enforcement, and policy contradictions (2023 FCA dilutions) undermine gains. The discovery of 1,116 new species in 2024 alone underscores that India's biological exploration is far from complete (The Hindu, 2025). Protecting what remains and restoring what has been lost requires political will to fully implement existing laws, empower local communities, close implementation gaps and align development with ecological limits. By harmonizing its constitutional duties, statutory mandates and international commitments, India can not only safeguard its natural heritage but also emerge as a global leader in biodiversity conservation in the Anthropocene.

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Conflict of Interest: The authors declare no conflict of interest.

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