

Biodiversity at a Crossroads: Challenges, Opportunities, and the Path Forward

Titiksha Kamal

Department of Botany, St. Bede's College, Shimla, India

ABSTRACT

Biodiversity is the foundation of life on Earth, supporting ecosystem stability, human well-being, and sustainable development. It encompasses the variety of genes, species, and ecosystems that collectively maintain ecological processes essential for life. However, rapid urbanization, habitat fragmentation, climate change, pollution, invasive species, and unsustainable exploitation of natural resources have accelerated biodiversity loss across the globe. The decline of biodiversity not only threatens ecological integrity but also undermines food security, public health, economic stability, and the resilience of natural systems to environmental change.

This paper explores the significance of biodiversity conservation in the context of contemporary environmental challenges and highlights the urgent need for coordinated conservation efforts. It discusses the role of protected areas, habitat restoration, sustainable resource management, and community-based conservation in safeguarding biological diversity. The integration of scientific research, technological innovations, traditional ecological knowledge, and environmental education is emphasized as a means of enhancing conservation effectiveness and promoting long-term ecological resilience. Furthermore, the paper examines the importance of policy interventions, stakeholder engagement, and international cooperation in achieving global biodiversity conservation goals. As the world faces unprecedented ecological challenges, biodiversity conservation must be recognized as a shared responsibility that transcends geographical and political boundaries. Protecting the diversity of life is not merely an environmental obligation but a necessity for ensuring a sustainable and resilient future. Through collective action, informed decision-making, and a commitment to sustainable practices, it is possible to halt biodiversity decline and preserve Earth's natural heritage for future generations.

Keywords: Biodiversity Conservation, Ecosystem Resilience, Climate Change, Habitat Restoration

INTRODUCTION

Biodiversity encompasses the rich variety of life on Earth, including the diversity found within species, among different species, and across ecosystems. It plays a vital role in maintaining healthy, stable, and resilient ecosystems while supporting human well being in numerous ways. From providing food, medicines, and fibre to supporting pollination, maintaining soil fertility, regulating the climate, and enriching cultural traditions, biodiversity is an essential foundation of both ecological and human well being (Cardinale et al., 2012; Díaz et al., 2018). Therefore, conserving biodiversity is essential for maintaining environmental sustainability and ensuring the well being and quality of life of people.

Despite its immense importance, biodiversity is declining rapidly across the world. Habitat loss and fragmentation, over exploitation of natural resources, pollution, climate change, and the spread of invasive alien species are among the major factors driving this decline. Most of these pressures are closely linked to human activities and often occur simultaneously, placing increasing stress on ecosystems and threatening the survival of many species (IPBES, 2019). Biodiversity loss can disturb the natural relationships among species, weaken the ability of ecosystems to cope with environmental changes, and put at risk the essential services that ecosystems provide to human societies (Ceballos et al., 2017).

Climate change is adding to these pressures by changing where species can survive, as well as affecting their growth, reproduction, and interactions with other organisms (Pecl et al., 2017). At the same time, the growing demand for land and natural resources is placing increasing pressure on forests, grasslands, wetlands, and other ecosystems that support rich and diverse forms of life.

The biodiversity crisis, while deeply concerning, also offers an opportunity to rethink and strengthen conservation efforts. Strategies such as ecological restoration, sustainable resource management, technological innovation, and active community participation can help protect and restore ecosystems while supporting human well being (IPBES, 2019).

Biodiversity is therefore at a crossroads. On one path lies continued environmental degradation, which could further accelerate the loss of species and ecosystems. On the other lies the opportunity to create a more sustainable and resilient future through integrated conservation efforts, ecological restoration, and responsible development. Recognizing the urgency of this challenge, the Kunming -Montreal Global Biodiversity Framework underscores the need for coordinated global action to conserve, restore, and sustainably manage biodiversity for the benefit of both nature and humanity (CBD, 2022). Against this backdrop, this paper examines the major challenges confronting biodiversity, highlights emerging opportunities for conservation and sustainable use, and discusses practical pathways for building a future where both nature and human societies can thrive.

BIODIVERSITY: CONCEPT AND SIGNIFICANCE

Biodiversity is the diversity of life on Earth, encompassing variation within species, differences between species, and the variety of ecosystems that support life (Noss, 1990). Biodiversity is essential for the functioning, stability, and resilience of ecosystems. It provides vital services such as food, medicine, pollination, nutrient cycling, and climate regulation (Cardinale et al., 2012; Díaz et al., 2018). Therefore, conserving biodiversity is crucial for environmental sustainability, human well-being, and long-term development.

Genetic, Species and Ecosystem Diversity

Biodiversity exists at three min levels: genetic, species, and ecosystem diversity. Genetic diversity enables species to adapt to environmental changes, species diversity reflects the variety of life forms and ecosystem diversity represents the range of habitats and ecological communities. Together they maintain healthy and resilient ecosystems (Reed & Frankham, 2003; Hooper et al., 2005). In plants, genetic diversity found in crops, traditional varieties, and their wild relatives provides useful traits such as drought and disease resistance, helping strengthen food security and adaptation to climate change (Hajjar & Hodgkin, 2007). Maintaining diversity at all three levels is essential for healthy ecosystems and their ability to withstand environmental changes.

Biodiversity, Ecological Stability and Resilience

Biodiversity supports ecosystem stability and resilience by helping species respond differently to environmental changes. This “Insurance effect” reduces the impact of disturbances, while species complementarity improves resource use and productivity (Yachi & Loreau, 1999; Loreau & Hector, 2001). Greater plant diversity can also increase resistance to climate extremes, while biodiversity loss can weaken ecosystem recovery (Isabell et al., 2015).

Biodiversity and Ecosystem Services

Biodiversity provides essential ecosystem services, including food, medicines, timber, pollination, carbon storage, soil conservation, water regulation, and cultural benefits (Hajjar & Hodgkin, 2007; Cardinale et al., 2012; Díaz et al., 2018).plant diversity is especially important because plants support food webs, nutrient cycling, and soil fertility. Consequently, biodiversity loss can disrupt ecosystem functioning and reduce the benefits that nature provides to people (Ollerton et al., 2011; Bardgett & van der Putten, 2014).

BIODIVERSITY AND HUMAN WELL-BEING

Biodiversity plays a vital role in human well-being by supporting food security, health, livelihoods, cultural values, and economic development (Millennium Ecosystem Assessment, 2005). Plants are especially important as sources of food, medicines, raw materials, and valuable genetic resources.

Food Security

Plant biodiversity is essential for food security, providing a wide range of crops, wild food plants, and genetic resources. Traditional crop varieties and wild relatives contain valuable traits such as drought, pest, and disease resistance, which help improve crop resilience. In addition, agricultural biodiversity supports pollinators, soil organisms, and natural pest control, contributing to sustainable food production (Hajjar & Hodgkin, 2007).

Medicinal Resources

Plants have been used for centuries for traditional and modern medicines. Their varied chemical compounds continue to support pharmaceutical research, while medicinal plants remain important to many rural and indigenous communities (Hamilton, 2004). However, habitat loss, over harvesting, and rising commercial demand are putting several medicinal plant species at risk, making sustainable harvesting and cultivation increasingly important (Chen et al., 2016).

Livelihoods

Millions of people rely on biodiversity for food, income, and livelihoods. Forests and other ecosystems provide timber, fuel wood, fruits, fibres, resins and medicinal plants, while non timber forest products support many rural communities (Shackleton et al., 2007).

Cultural and Economic Importance

Biodiversity has cultural, spiritual and economic value with plants linked to traditional knowledge and cultural identity. It also supports agriculture, forestry, pharmaceuticals and ecotourism although many ecosystem benefits remain undervalued economically (Díaz et al., 2018).

CURRENT STATUS OF BIODIVERSITY

Biodiversity is declining worldwide due to habitat loss, over exploitation, pollution, invasive species and climate change. In plant communities, these pressures are changing species distributions, compositions, and regeneration. As primary producers plants are vital to ecosystems and provide essential resources such as food, medicine and fibres (Cardinale et al., 2012; IPBES, 2019).

Global Biodiversity Trends

Global assessment show that species populations are declining and the risks of extinction is increasing. Habitat loss and degradation are major causes, especially in forests, grasslands and wetlands. Around one million species are estimated to face extinction in the coming decades if current trends continue (IPBES, 2019). plant diversity is particularly threatened by agricultural expansion, deforestation, urbanization, invasive species and

over harvesting. Habitat loss and fragmentation can reduce plant populations, genetic diversity and connectivity, further increasing extinction risks. Ecosystem transformation has significantly changed the composition and functioning of natural communities. Tropical forests continue to face pressure from land-use change, while grasslands and wetlands are increasingly converted for agriculture and infrastructure. These changes can reduce native plant diversity and disrupt important ecosystem processes such as carbon storage, nutrient cycling and soil conservation (Pimm et al., 2014).

Threatened Species and Ecosystems

Forest harbors a large proportions of global plant diversity but are increasingly threatened by deforestation, fragmentation, fires and climate change. Tropical forests are particularly important reservoirs of endemic and economically valuable plant species (Giam et al., 2010).

Wetlands support diverse aquatic and semi -aquatic vegetation and provide important services including water purification, flood regulation and habitat provision. Their conversion and degradation have resulted in significant biodiversity losses (**Davidson, 2014**).

Grasslands support diverse herbaceous plant communities and contribute to soil carbon storage, nutrient cycling and livelihoods. Agricultural expansion, overgrazing and woody encroachment are among the major pressure affecting grassland biodiversity (Bardgett et al., 2021).

Marine ecosystems, although not plant dominated, depend heavily on photosynthetic organisms such as phytoplankton and sea grasses. Climate change, pollution, eutrophication and habitat destruction threaten marine biodiversity and ecosystem functioning (Duffy et al., 2016).

Mountain ecosystems are particularly vulnerable because of their restricted climatic zones, high endemism and sensitivity to temperature changes. Shifts in temperature and precipitation can alter the distribution and phenology of mountain plants and increase pressure on already restricted species (Körner, 2007).

Biodiversity in India and the Himalayan Region

India is one of the world's megadiverse countries, supporting a remarkable variety of ecosystems, species, and genetic resources despite covering only a small share of the global land area (Ministry of Environment, Forest and Climate Change [MoEFCC], 2014). its diverse climate and geography create favourable conditions for rich plant diversity, including many endemic and economically valuable species.

The Himalayan region is a major centre of plant diversity and endemism, with habitats ranging from subtropical forests to alpine ecosystems and many medicinal and endemic plants. However, climate change, habitat fragmentation, development, tourism, over harvesting and invasive species increasingly threaten its flora. Climate change can shift plant ranges and alter flowering and regeneration, while medicinal plants face additional pressure from unsustainable harvesting (Telwala et al., 2013; Kala et al., 2006). conservation therefore requires habitat protection and restoration, sustainable use, ex-situ conservation and community participation.

MAJOR CHALLENGES TO BIODIVERSITY

Biodiversity loss results from multiple, interconnected pressures operating at local to global scales. Plant biodiversity is particularly vulnerable because plants are directly affected by land-use change, climate change, pollution, resource extraction and biological invasions (IPBES, 2019).

Habitat Loss and Fragmentation

Habitat loss and fragmentation caused by deforestation, agriculture, urbanization, mining and infrastructure development are major threats to plant diversity. Fragmentation reduces population size, dispersal and gene flow while increasing edge effects and vulnerability to environmental disturbances. Agricultural expansion often replaces diverse native vegetation with simplifies landscapes (Fahrig, 2003). In the Himalayas, expanding settlements and infrastructure can fragment forests and alpine habitats and restrict species' ability to shift their ranges under climatic change.

Climate Change

Climate change affects plant distribution, growth, reproduction and ecological interactions. Changes in temperature and precipitation influence germination, flowering, regeneration and survival. Mountain plants may shift towards higher elevations, but high altitude species have limited opportunities for further movement. Changes in flowering and leaf emergence can also disrupt plant pollinator and plant dispenser relationships. Droughts, heat waves, floods and wildfire further increase the pressure (Telwala et al., 2013).

Invasive Alien Species

Invasive alien species compete with native plants, modify habitats and alter ecosystem processes. Species like *Lantana camara*, *Parthenium hysterophorus* and *Chromolaena odorata* can suppress native regeneration, particularly in disturbed habitats. Aquatic invasive plants like *Eichhornia crassipes* can form dense mats, reducing light and oxygen availability. Globally, invasive plants are recognized as major drivers of biodiversity decline (Pyšek et al., 2020).

Pollution

Pesticides, fertilizers, plastics, heavy metals and air pollutants can directly or indirectly reduce biodiversity. Excess nutrients cause eutrophication, while pesticides affect non target organisms such as pollinators and soil microorganisms. Heavy metals can inhibit seed germination, photosynthesis and plant growth. Microplastics may also alter soil properties, plant growth and nutrient cycling (de Souza Machado et al., 2018).

Overexploitation

Unsustainable extraction of timber, fuelwood, non-timber forest products and medicinal plants can reduce population size and regeneration. Medicinal plants are particularly vulnerable because valuable species are often harvested directly from wild populations. Slow- growing and narrowly distributed species face greater risks (Chen et al., 2016). Sustainable harvesting, cultivation and community-based resource management are therefore essential.

Unsustainable Agriculture and Forestry

Mono cultures, genetic uniformity, excessive chemical inputs and replacement of native vegetation simplify ecosystems and reduce associated biodiversity. Replacement of traditional crop varieties with a limited number of modern varieties contributes to genetic erosion, reducing resources for future crop improvement and climate adaptation. Similarly, monoculture plantations generally support less biodiversity than natural or mixed- species forests. Agroforestry, crop diversification and conservation of native vegetation can help address these impacts.

Human–Wildlife Conflict

Habitat encroachment, agricultural expansion and infrastructure development increase interactions between people and wildlife. Crop damage and livestock losses may create economic pressures and lead to retaliatory actions. Changes in herbivores populations can also influence vegetation regeneration, while declines in pollinators and seed dispersers can affect plant reproduction. Habitat connectivity and community- based conflict management can reduce these pressures.

Fragmented Governance and Policy Gaps

Biodiversity conservation requires coordination among forestry, agriculture, water, infrastructure and development sectors. Fragmented governance, inadequate funding, weak implementation and limited long-term monitoring can reduce conservation effectiveness (IPBES, 2019). Strengthening environmental assessments, biodiversity monitoring, restoring requirements and interdepartmental coordination is essential. Greater investment in plant inventories, seed banks, botanical gardens and genetic-resource conservation is needed.

Loss of Traditional Knowledge

Traditional knowledge of medicinal plants, wild foods, fibres, fodder and sustainable harvesting is an important but declining component of biocultural diversity. Modernization migration and reduced interaction with natural environments can accelerate knowledge loss (IPBES, 2019). Documentation, intergenerational knowledge transfer and community participation can help preserve this knowledge and support sustainable biodiversity management. Addressing biodiversity loss therefore requires an integrated approach combining habitat protection, restoration, sustainable resource use, climate adaptation, invasive-species management, genetic-resource conservation and community participation.

OPPORTUNITIES FOR BIODIVERSITY CONSERVATION

The continuing decline of biodiversity highlights the need to move beyond documenting threats towards practical, innovative and inclusive conservation solutions. Plant biodiversity should receive particular attention because plants form the structural and functional foundation of most terrestrial ecosystems and provide food, medicines, fibres, carbon storage and other ecosystem services. Opportunities for conservation increasingly combine ecosystem restoration, protected areas, ex-situ approaches, new technologies, community participation and nature-based solutions (IPBES, 2019; CBD, 2022).

Ecosystem Restoration

Ecosystem restoration offers an important opportunity to recover degraded habitats and rebuild native plant communities. Forest restoration can involve natural regeneration, assisted regeneration and planting of appropriate native species. Restoration approaches that prioritize local species diversity and ecological processes are generally more beneficial for biodiversity than plantations dominated by a few species (Chazdon, 2008).

Wetland restoration can recover aquatic and semi-aquatic vegetation, improve water quality and restore important ecological functions. Similarly, grassland restoration through controlled grazing, removal of invasive plants and reintroduction of native species can improve plant diversity and ecosystem functioning. Restoration should therefore focus not simply on increasing vegetation cover but on recovering native species composition, genetic diversity, ecological interactions and ecosystem processes (Aronson & Alexander, 2013).

Protected Areas and Ecological Corridors

Protected areas remain fundamental for conserving plant species and their habitats. However, isolated protected areas may become less effective when surrounding landscapes are highly fragmented. Landscape-level conservation and ecological corridors can improve connectivity between habitat patches and facilitate movement of seeds, pollen and organisms.

For plants, habitat connectivity is particularly important for maintaining gene flow and allowing populations to respond to changing climatic conditions. Corridors can connect fragmented forests, mountain habitats and other biodiversity-rich landscapes, thereby reducing isolation and supporting long-term population viability (Hilty et al., 2020). Conservation planning should consequently integrate protected areas with surrounding agricultural and community-managed landscapes.

Ex-situ Conservation

Ex-situ conservation provides an important safeguard for threatened plant species and genetic resources outside their natural habitats. Seed banks, field gene banks, botanical gardens and living collections can conserve genetic material for research, restoration and future reintroduction.

Seed banking is particularly effective for species producing desiccation-tolerant (orthodox) seeds, while species with recalcitrant seeds may require alternative approaches such as tissue culture or cryopreservation (Walters et al., 2013). Botanical gardens can also support propagation, research and public education. For rare Himalayan medicinal plants and other threatened species, combining ex-situ conservation with habitat protection can provide an additional layer of security against extinction.

Emerging Technologies

Technological advances are creating new opportunities for rapid and accurate biodiversity assessment. GIS and remote sensing can map vegetation, habitat fragmentation and land-use change over large areas, while drones can provide high-resolution information on plant communities and habitat condition.

Molecular approaches such as DNA barcoding and environmental DNA (eDNA) can assist in species identification and detection, particularly where conventional identification is difficult (Taberlet et al., 2018). Artificial intelligence and machine-learning tools can analyse large datasets and improve species recognition, vegetation mapping and biodiversity monitoring. Such technologies can complement field-based botanical surveys and provide more efficient approaches to monitoring threatened plant populations.

Citizen Science

Citizen science provides an opportunity to involve the public directly in biodiversity documentation and monitoring. Digital platforms allow students, researchers and local communities to record plant species, flowering periods, distributions and invasive species. Large-scale observations can contribute to biodiversity databases and provide valuable information on species distributions and phenological changes.

For plant conservation, citizen participation can be particularly useful in documenting local flora, rare species, phenological changes and invasive plants. Citizen-generated observations, when appropriately verified, can complement professional biodiversity surveys and increase public awareness of plant conservation (Chandler et al., 2017).

Indigenous and Local Knowledge

Indigenous peoples and local communities possess extensive knowledge concerning medicinal plants, wild foods, forest resources and sustainable harvesting practices. Integrating this traditional ecological knowledge (TEK) with scientific approaches can improve conservation and resource management (IPBES, 2019).

Community participation is especially important in landscapes where local people depend directly on forests and other natural ecosystems. Community-managed forests and locally developed harvesting practices can contribute to both biodiversity conservation and livelihoods. Conservation initiatives should therefore recognize local communities not merely as beneficiaries but as active partners and knowledge holders.

Nature-based Solutions

Nature-based Solutions (NbS) use ecosystems and their functions to address environmental and societal challenges while simultaneously supporting biodiversity. Forest restoration, watershed protection, urban green spaces, wetland conservation and ecosystem-based adaptation can provide multiple benefits.

Restored forests can sequester carbon, protect soils and regulate water while providing habitat for diverse plant species. Wetlands can reduce flooding and improve water quality, whereas urban forests and green spaces can provide habitat for native plants and moderate urban temperatures. Importantly, nature-based solutions should prioritize native and ecologically appropriate plant species rather than relying exclusively on fast-growing or non-native species (Seddon et al., 2020).

Together, these approaches demonstrate that biodiversity conservation can move from a reactive strategy towards a proactive and integrated model. Combining restoration, habitat connectivity, ex-situ conservation, technological innovation, citizen science, traditional knowledge and nature-based solutions can strengthen the conservation of plant diversity while simultaneously supporting climate adaptation, ecosystem resilience and human well-being.

POLICY AND GOVERNANCE

Effective biodiversity conservation relies on strong policies, effective institutions and coordinated governance. Clear policies and cooperation among different sectors help ensure protection, sustainable use and long term management of biodiversity resources.

International Frameworks

The Convention on Biological Diversity (CBD) is the main international agreement guiding biodiversity conservation, sustainable use of biological resources and the fair sharing of benefits from genetic resources (CBD, 1992) it plays an important role in conserving plant diversity, genetic resources and threatened species and habitats.

The Kunming-Montreal Global Biodiversity Framework (GBF), adopted in 2022, established global targets for conserving, restoring and sustainably managing biodiversity. It emphasizes the effective conservation of terrestrial, inland water, coastal and marine areas, ecosystem restoration and the sustainable use of wild species (CBD, 2022). These targets provide an important framework for protecting plant-rich ecosystems and restoring degraded habitats.

The Sustainable Development Goals (SDG) also recognize the importance of biodiversity. SDG 2 addresses sustainable agriculture and food security, while SDGs 13, 14 and 15 address climate action, aquatic ecosystems and terrestrial biodiversity, respectively (United Nations, 2015). Their integration provides opportunities to link plant conservation with food security, climate adaptation and sustainable development.

Indian Biodiversity Governance

India has developed a multi-level institutional framework for biodiversity conservation. The Biological Diversity Act, 2002, provides a legal framework for conservation, sustainable use and access and benefit sharing related to biological resources. The framework was strengthened through the Biological Diversity Act, 2002, as amended in 2023, and associated rules and regulations (Government of India, 2023).

The National Biodiversity Authority (NBA) operates at the national level, while State Biodiversity Boards (SBBs) support biodiversity governance at the state level. At the local level, Biodiversity Management Committees (BMCs) are established by local bodies to document and manage biological resources and associated knowledge.

An important instrument is the People's Biodiversity Register (PBR), which documents locally available biological resources and associated traditional knowledge. For plant biodiversity, PBRs can provide valuable information on medicinal plants, wild edible species, crop varieties, economically important plants and traditional uses. They can therefore contribute to both conservation planning and recognition of community knowledge (NBA, 2013).

Challenges in Implementation

Despite strong policy framework, a gap often exists between policy and implementation due to limited funding, inadequate monitoring, weak institutional coordination, and

insufficient technical capacity. Strengthening coordination, financing and scientific monitoring while integrating biodiversity conservation with sustainable livelihoods and climate action will be essential for long-term success (IPBES, 2019)

THE PATH FORWARD

Biodiversity conservation requires a more integrated, inclusive, and long-term approach combining ecosystem protection, restoration, sustainable resource use, technology, and community participation (IPBES, 2019; CBD, 2022).

From Species Protection to Ecosystem Conservation

Conservation should focus not only on threatened species but also on ecosystem integrity, connectivity, and resilience, supported by protected areas and ecological corridors (CBD, 2022).

Integrating Biodiversity into Development

Biodiversity should be considered in agriculture, infrastructure, tourism, urbanization, mining and energy planning to reduce environmental impacts (IPBES, 2019; CBD, 2022).

Restoration as a Conservation Strategy

Restoring forests, wetlands, grasslands, rivers and agriculture landscapes can recover ecosystem functions, improve connectivity and strengthen climate resilience (CBD, 2022).

Community-Centred Conservation

Greater involvement of local communities and Indigenous peoples, along with traditional knowledge and fair benefit-sharing, can make conservation more effective and sustainable (CBD, 2022).

Sustainable Agriculture and Forestry

Approaches such as agroforestry, crop diversification, conservation agriculture, and sustainable forest management can reduce pressure on natural ecosystems. They promote efficient resource use, maintain soil and ecosystem health, and support biodiversity. At the same time, these practices provide diverse sources of food, income, and other resources, thereby strengthening local livelihoods and promoting long-term sustainability.

Technology-Driven Monitoring

Tools such as remote sensing, GIS, drones, eDNA, DNA metabarcoding and AI can improve the speed and effectiveness of biodiversity monitoring (Thomsen & Willerslev, 2015; CBD, 2023).

Sustainable Bioeconomy

Responsible management of biological resources, waste reduction, and adoption of circular practices can promote economic growth while ensuring that resource use remains within ecological limits (CBD, 2022).

Biodiversity Financing

Long term conservation requires adequate and reliable funding through public investment and innovation financing mechanisms (CBD, 2022).

Education and Capacity Building

Strengthening biodiversity education, research and professional capacity is essential for effective conservation and restoration. Closer collaboration among researches, governments, communities, civil society and businesses can help translate scientific knowledge into practical conservation action (IPBES, 2024).

RESEARCH GAPS AND FUTURE DIRECTIONS

Future research should focus on how biodiversity responds to climate change, changes in species and ecosystem, and the role of genetic and functional diversity. More work is also needed on plant genetic resources, microbial diversity, and ecological restoration. New tools such as AI, remote sensing, eDNA and DNA metabarcoding can make biodiversity monitoring faster and more effective (Thomsen & Willerslev, 2015). Future biodiversity research should bring together ecology, genetics, climate sciences, data sciences and social sciences to better understand and address conservation challenges.

CONCLUSION

Biodiversity is at a crossroads, and the choices we make today will shape the health of ecosystems and the well being of future generations. Its continued loss threatens not only plants, animals and habitats but also food security, water resources, livelihoods, human health and our ability to cope with climate change.

Conservation efforts therefore need to shift from reactive to preventive approaches, from focusing mainly on individual species to protecting and restoring entire ecosystem, and from being largely government- driven to actively involving local communities. Biodiversity conservation should also be integrated into sustainable development rather than treated as a separate environmental concern. New technologies can strengthen biodiversity monitoring, while long term and adaptive management can help conservation efforts respond to changing environmental conditions.

Ultimately, protecting biodiversity requires more than creating protected areas. It calls for a broader approach to assess, protect, restore, sustainably use, monitor, adapt and

transform the way we interact with nature. The future of biodiversity will depend on finding a balance between human needs and ecological limits ensuring a healthier and more resilient future for both nature and society.

REFERENCES

- Aronson, J., & Alexander, S. (2013). Ecosystem restoration is now a global priority.
- Bardgett, R. D., & van der Putten, W. H. (2014). Belowground biodiversity and ecosystem functioning. *Nature*, 515, 505–511.
- Bardgett, R. D., et al. (2021). Combatting global grassland degradation. *Nature Reviews Earth & Environment*, 2, 720–735.
- Cardinale, B. J., et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, 486, 59–67.
- CBD. (1992). *Convention on Biological Diversity*. United Nations.
- CBD. (2022). *Kunming–Montreal Global Biodiversity Framework*. Convention on Biological Diversity.
- CBD. (2023). *Monitoring framework for the Kunming–Montreal Global Biodiversity Framework*. Convention on Biological Diversity.
- Chazdon, R. L. (2008). Beyond deforestation: restoring forests and ecosystem services on degraded lands. *science*, 320(5882), 1458–1460.
- Chen, S. L., et al. (2016). Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. *Chinese Medicine*, 11, 37.
- Chen, S. L., Yu, H., Luo, H. M., Wu, Q., Li, C. F., & Steinmetz, A. (2016). Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. *Chinese Medicine*, 11, 37.
- Davidson, N. C. (2014). How much wetland has the world lost? *Marine and Freshwater Research*, 65, 934–941.
- De Souza Machado, A. A., et al. (2018). Microplastics as an emerging threat to terrestrial ecosystems. *Global Change Biology*, 24, 1405–1416.
- De Souza Machado, A. A., Lau, C. W., Till, J., Kloas, W., Lehmann, A., Becker, R., & Rillig, Díaz, S., et al. (2018). Assessing nature's contributions to people. *Science*, 359, 270–272.
- Díaz, S., Settele, J., Brondízio, E. S., et al. (2019). Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science*, 366(6471), eaax3100. <https://doi.org/10.1126/science.aax3100>
- Duffy, J. E., et al. (2016). Biodiversity and ecosystem functioning in the global ocean. *Proceedings of the National Academy of Sciences*, 113, 11927–11932.
- Fahrig, L. (2003). Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics*, 34, 487–515.
- FAO. (2019). *The State of the World's Biodiversity for Food and Agriculture*. Food and Agriculture Organization of the United Nations, Rome.
- Giam, X., et al. (2010). Future habitat loss and the conservation of tropical biodiversity. *Biological Conservation*, 143, 1594–1602.
- Government of India. (2023). *Biological Diversity Act, 2002 (as amended in 2023)*. Ministry of Environment, Forest and Climate Change, Government of India.
- Hajjar, R., & Hodgkin, T. (2007). The use of wild relatives in crop improvement: a survey of developments over the last 20 years. *Euphytica*, 156(1), 1–13.

- Hamilton, A. C. (2004). Medicinal plants, conservation and livelihoods. *Biodiversity and Conservation*, 13, 1477–1517.
- Hooper, D. U., et al. (2012). A global synthesis reveals biodiversity loss as a major driver of ecosystem change. *Nature*, 486, 105–108.
- IPBES. (2019). *Global Assessment Report on Biodiversity and Ecosystem Services*. IPBES Secretariat.
- Isbell, F., et al. (2015). Biodiversity increases the resistance of ecosystem productivity to climate extremes. *Nature*, 526, 574–577.
- Kala, C. P., Dhyani, P. P., & Sajwan, B. S. (2006). Developing the medicinal plants sector in northern India: Challenges and opportunities. *Journal of Ethnobiology and Ethnomedicine*, 2, 32.
- Körner, C. (2007). The use of “altitude” in ecological research. *Trends in Ecology & Evolution*, 22, 569–574.
- C. (2018). Microplastics can change soil properties and affect plant performance. *Environmental Science & Technology*, 52(17), 9656–9665. <https://doi.org/10.1021/acs.est.8b02212>
- MoEFCC. (2014). *India's Fifth National Report to the Convention on Biological Diversity*. Ministry of Environment, Forest and Climate Change, Government of India.
- NBA. (2013). *Guidelines for Preparation of People's Biodiversity Register*. National Biodiversity Authority, Government of India.
- Noss, R. F. (1990). Indicators for monitoring biodiversity. *Conservation Biology*, 4, 355–364.
- Oliver, T. H., et al. (2015). Biodiversity and resilience of ecosystem functions. *Nature Communications*, 6, 10122.
- Pecl, G. T., Araújo, M. B., Bell, J. D., et al. (2017). Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science*, 355(6332), eaai9214. <https://doi.org/10.1126/science.aai9214>
- Pecl, G. T., et al. (2017). Biodiversity redistribution under climate change. *Science*, 355, eaai9214.
- Pimm, S. L., et al. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science*, 344, 1246752.
- PLoS ONE*, 8(2), e57103. <https://doi.org/10.1371/journal.pone.0057103>
- Pyšek, P., Hulme, P. E., Simberloff, D., et al. (2020). Scientists' warning on invasive alien species. *Biological Reviews*, 95(6), 1511–1534. <https://doi.org/10.1111/brv.12627>
- Reed, D. H., & Frankham, R. (2003). Correlation between fitness and genetic diversity. *Conservation Biology*, 17, 230–237.
- Telwala, Y., Brook, B. W., Manish, K., & Pandit, M. K. (2013). Climate-induced elevational range shifts and increase in plant species richness in a Himalayan biodiversity epicentre. *PLoS ONE*, 8, e57103.
- Thomsen, P. F., & Willerslev, E. (2015). Environmental DNA—An emerging tool in conservation for monitoring past and present biodiversity. *Biological Conservation*, 183, 4–18
- United Nations. (2015). *Transforming our World: The 2030 Agenda for Sustainable Development*. United Nations.
- Yachi, S., & Loreau, M. (1999). Biodiversity and ecosystem productivity in a fluctuating environment. *PNAS*, 96, 1463–1468.