ISBN: 978-81-992068-7-8

BIODIVERSITY

Development and Conservation

Editors:
Dr. Sanjay Khajuria
Dr. Dinesh D. Wanule
Dr. Pravin D. Patil
Dr. Kandula Jayapaul

Bhumi Publishing, India

First Edition: August 2025

Title: Biodiversity 360°: Development and Conservation

Editors: Dr. Sanjay Khajuria, Dr. Dinesh D. Wanule, Dr. Pravin D. Patil, Dr. Kandula Jayapaul

First Edition: August 2025

ISBN: 978-81-992068-7-8

DOI: https://doi.org/10.5281/zenodo.17042704

Published by Bhumi Publishing,

a publishing unit of Bhumi Gramin Vikas Sanstha

Bhumi Publishing

Nigave Khalasa, Tal – Karveer, Dist – Kolhapur, Maharashtra, INDIA 416 207

E-mail: bhumipublishing@gmail.com

TABLE OF CONTENT

Bhumi Publishing, India
August 2025

THE FUTURE OF BIODIVERSITY: INTEGRATING INNOVATION, POLICY, AND ETHICS BY 360⁰

Pooja Narang*[1], Meenu[1] and Vandana Grover[2]

[1]Department of Botany, School of Sciences, IFTM University, Moradabad 244102, India

[2]Department of Chemistry, BBD NIIT, Lucknow, Uttar Pradesh, India

*Corresponding author E-mail: pooja.narang@iftmuniversity.ac.in

Abstract:

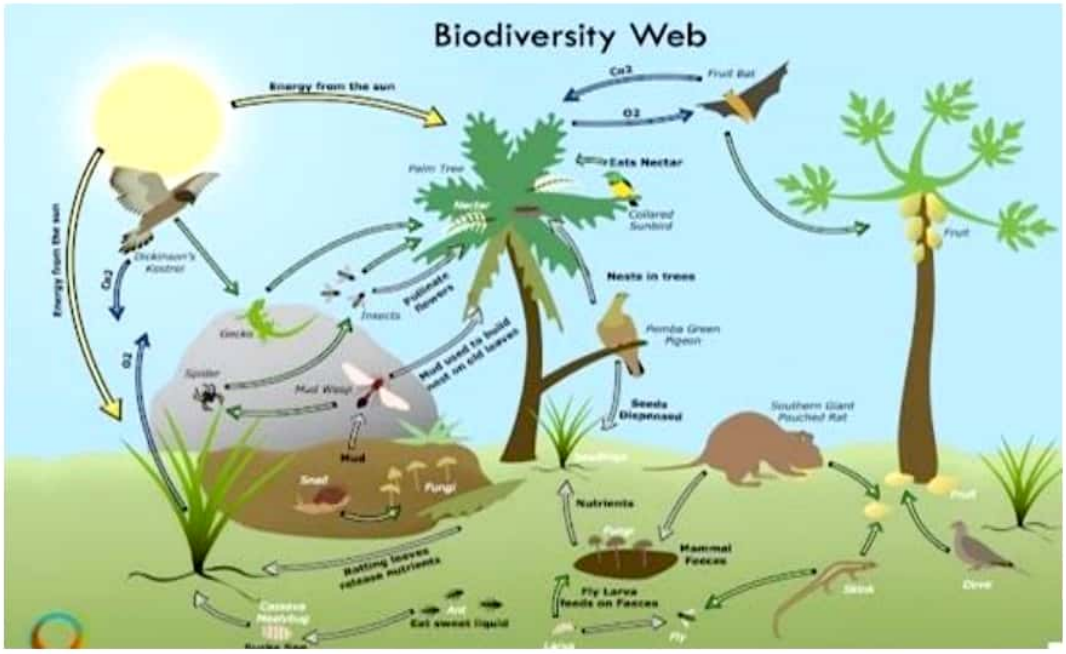
Biodiversity, the cornerstone of thriving ecosystems, is increasingly threatened by human-driven development in the Anthropocene. This chapter, Biodiversity 360 Degree, presents a comprehensive examination of the interplay between development and conservation, envisioning sustainable coexistence by the year 3600. It explores how urbanization, industrial expansion, and climate change impact species diversity, ecosystem functionality, and ecological resilience. Through case studies and advanced modeling, the chapter evaluates innovative solutions, such as AI-powered conservation tools, synthetic biology, and ecosystem restoration, to mitigate biodiversity loss while supporting global development. It underscores the importance of integrated policy frameworks, international cooperation, and grassroots initiatives to balance human needs with environmental stewardship. By addressing ethical and equitable approaches to resource management, the chapter proposes a holistic strategy for preserving Earth's biological diversity. This forward-looking perspective advocates for adaptive, inclusive conservation practices to safeguard ecosystems for future generations, ensuring biodiversity thrives alongside human progress.

Keywords: Biodiversity, Conservation, Development, Sustainability, Ecosystem Resilience

Introduction:

Biological diversity is defined as "the variability among living organisms from all sources including, inter alia, 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," as stated in the Convention on Biological Diversity. The term "biological diversity" or "biodiversity" refers to the approximately 8 million different types of species, including plants, animals, fungi, and bacteria, as well as the environments that sustain them, such as forests, oceans, mountainous areas, and coral reefs. Because every species plays a vital role in maintaining the natural order and the health of ecosystems, biodiversity is a significant part of our everyday lives.

While the term "biodiversity" is a relatively recent compound word, biological diversity—which refers to the number of species—is not. Its definition has been more reductionist within the past ten years. The number of species is perhaps the most straightforward definition of biodiversity, devoid of context or specialization. However, a lot of people contend that biodiversity is not the same as the number of species present in a region. This metric, which is merely one aspect of biodiversity, is called species richness (Fiedler and Jain, 1992). First used by Lovejoy (1980) in its extended form (biological diversity), the term "biodiversity" Additionally, biodiversity is more than species diversity, which some authors refer to as simply diversity. Species diversity is the number of species and their relative abundance in a given area (Pielou, 1977).



Source: https://www.sanskritiias.com/uploaded_files/images//biodiversity-web.jpg

DeLong (1996) provided a more thorough explanation:

An area's biodiversity is defined as the variation found within and among living things, living organism assemblages, biotic communities, and biotic processes, whether they are naturally occurring or have been altered by people. Genetic diversity, the number and identity of distinct species, species assemblages, biotic communities, and biotic processes, as well as the quantity (such as abundance, biomass, cover, and rate) and structure of each, can all be used to quantify biodiversity. Any geographical scale, from microsites and habitat patches to the entire biosphere, can be used to observe and quantify it.

This definition is flexible enough to change depending on the situation.

Different authors have offered precise and thorough clarifications of this definition. Three definitions of "biodiversity" were put out by Gaston and Spicer (1998): ecological diversity, genetic diversity, and organismal diversity. Other definitions combined the genetic and organismal components, leaving genetic diversity and ecological diversity as the main constituents. The two main "practical" value systems that Gaston and Spicer (1998) describe—direct use/genetics and indirect use/ecological—can be connected to these final two components. A hierarchical approach or hierarchies of living systems have been highlighted by several researchers.

The sustainable use of biological diversity, or biodiversity, and its components for the benefit of humanity are two of the most important issues confronting the globe today. Careless, unsustainable activities are causing biodiversity, a limited global resource with moral and economic significance for humanity, to be destroyed or lost forever. The most concerning aspect of the well-documented exponential loss of biodiversity is that it is not slowing down and could even get worse in the future.

The Convention on Biological Diversity (CBD) enshrines the fundamental significance of these issues, which were discussed at the 1992 Rio de Janeiro, Brazil, United Nations Conference on Environment and Development (UNCED). Its goals include

"The conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding"

One of the main causes of the recent anthropogenic activity is global climate change, which has occurred either directly or indirectly. reduction in the biodiversity of wildlife. According to scientists, climate warming may worsen the current threats to wildlife biodiversity and have a significant impact on ecosystems at all latitudes (Dobson *et al.*, 1989). The distribution of species, demographic rates, emergence and reemergence of diseases, genetic loss and extinction, habitat loss, loss of soil fertility, nutritional stress, population decline, and spread of invasive species are just a few of the many effects of climate change on the biodiversity of wildlife worldwide (Mawdsley *et al.*, 2009). The structure and function of ecosystems can be altered by changes in abiotic elements such seasonality, precipitation, wind patterns, and environmental temperature. This can lead to changes in the distribution patterns of related flora and animals (Markham and Malcom, 1996).

With approximately 91,000 known animal species and 45,500 known plant species, India is known for having a diversified ecosystem. Trees and forests encompass 23.39% of its territory.

India is home to four of the 36 biodiversity hotspots in the world: Sundaland, the Indo-Burma region, the Western Ghats, and the Himalayas. Two of these, Sundaland and the Indo-Burma region, are dispersed over South Asia and do not quite fall inside India's official borders. The term "hotspot" refers to areas that are highly prioritized for conservation due to their high endemism, substantial vulnerability, and extensive biodiversity. Locations having a high concentration of native species are considered biodiversity hotspots. The majority of hotspots are located in tropical and subtropical regions, where year-round high temperatures and humidity are common.

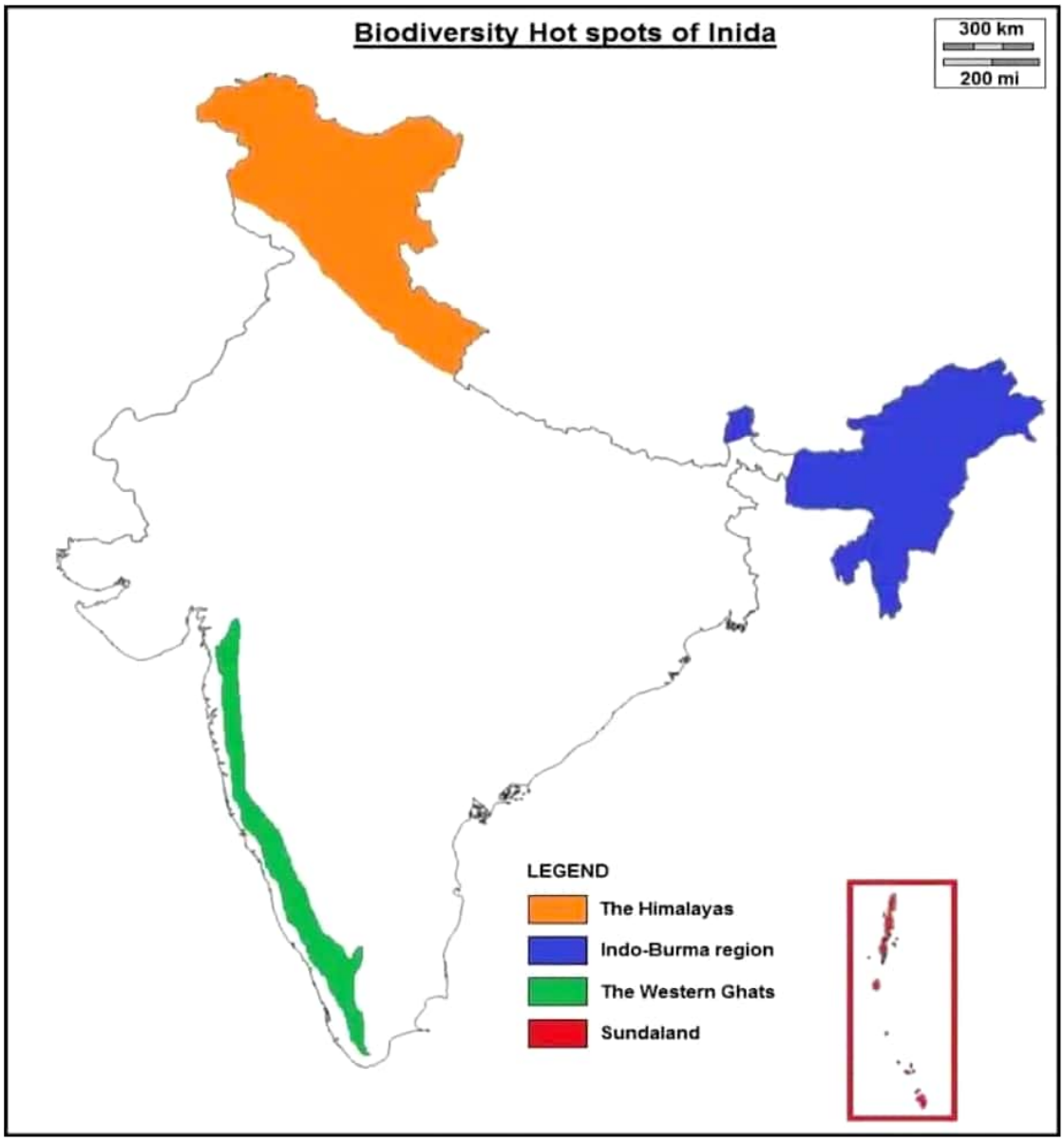
Biodiversity Hot Spots in India:

There are four Biodiversity Hotspots in India:

- Himalaya
- Indo-Burma
- Western Ghats
- Sunderland

❖ **The Himalayas**: The Himalayan hotspot, which stretches over 3,000 kilometers across northern Pakistan, Nepal, Bhutan, and the northwest and northeastern provinces of India, is home to all of the world's mountain peaks higher than 8,000 meters, including Mt. Everest (8,849 meters). Additionally, it contains a few of the world's deepest river canyons. The nearly 7.5 million square kilometer Himalayan mountain range is separated into two parts: the Western Himalaya, which includes parts of Kumaon-Garhwal, northwest Kashmir, and northern Pakistan, and the Eastern Himalaya, which includes parts of Nepal, Bhutan, and the northeastern Indian states of West Bengal, Sikkim, Assam, and Arunachal Pradesh.

❖ **Indo-Burma**: With a total size of 2,373,000 km^2, the Indo-Burma hotspot is the largest of the 36 hotspots recognized worldwide. Parts of Bangladesh, Malaysia, and northeastern India were once included in the Indo-Burma hotspot. However, because northeastern India is part of the Himalayan hotspot and the hotspot only stretches into Bangladesh and Malaysia, these countries are considered extralimital to the hotspot for the purposes of the ecosystem profile. With coasts along the Bay of Bengal, Andaman Sea, Gulf of Thailand, and South China Sea, as well as the tallest peak in Southeast Asia, the hotspot boasts an amazing geographic diversity.



Source: https://www.clearias.com/biodiversity-hotspots-in-india/

- **The Western Ghats:** The Malabar Plains and a range of mountains that stretch 30 to 50 kilometers inland and parallel to India's western coast make up the Western Ghats, often known locally as the Sahyadri Hills. They cover an area of more than 160,000 km^2, extending 1,600 km from the southernmost part of the country to Gujarat in the north, with only the 30 km Palakkad Gap between. The Western Ghats regulate how much rain falls on peninsular India by obstructing the southwestern monsoon winds. The western slopes of the Alps receive a lot of rain each year, most of it falling between June and September during the southwestern monsoon. Because of the Western Ghats' complex

geography and variable rainfall patterns, the area is home to a wide variety of vegetation species.

- **Sunderland:** The western portion of the Indo-Malayan archipelago, which consists of over 17,000 tropical islands, is part of the Sundaland hotspot. Two of the world's largest islands are Sumatra (427,300 km^2) and Borneo (725,000 km^2). Sundaland encompasses nearly all of Malaysia, including Peninsular Malaysia, the provinces of Sarawak and Sabah in East Malaysia in northern Borneo, Singapore at the tip of the Malay Peninsula, Brunei Darussalam, and the western part of Indonesia, including Kalimantan. The Indonesian parts of Borneo, Sumatra, Java, and Bali are also included, as are the provinces of Pattani, Yala, and Narathiwat in southern Thailand.

Typically, Biodiversity is Separated into Three Levels:

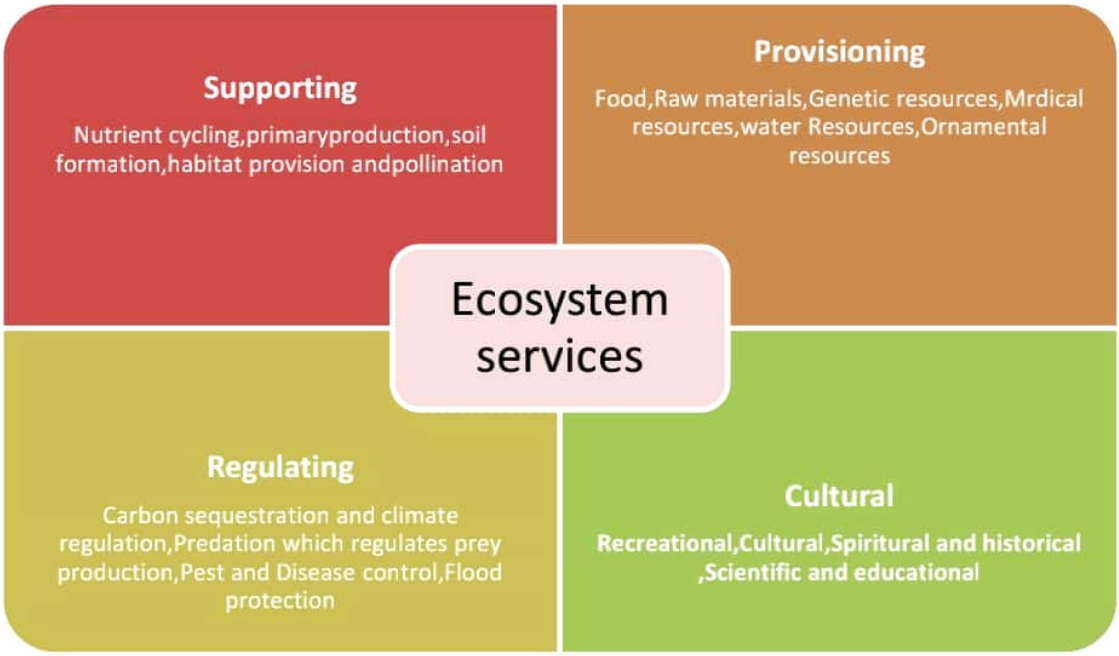
1. **Ecological Community:** The entire ecological community, or all living things in a particular location, is included in ecosystem diversity. Savannas, woods, lakes, oceans, marshes, deserts, and all the other habitats where a wide variety of animals exist and evolve are a few examples. Food chains, the interactions between different species, photosynthesis, the breakdown of plant matter, symbiosis between species, and other activities are all examples of ecosystem variety.
2. **Diversity of Organisms**: The wide variety and quantity of distinct organisms, encompassing all taxonomic levels (domain, kingdom, phylum, class, order, family, genus, and species), is referred to as the diversity of organisms. The likelihood of the environment adapting to changes may be higher if there are many different organisms, such as species or at different taxonomic levels. For instance, if rodent populations fall one year, predators such as owls or foxes can seek other prey if there are other options. Certain plants require wide space or particular soil types, while others are suited to lots of shade and do well in dense forests. Because many organisms rely on many natural environments during their life cycles, it is important to have a variety of natural habitats, which is why monocultures can be troublesome.
3. **Genetic Diversity**: An organism's or a population's genetic diversity is the range of genes present. A more varied array of traits is a result of genetic differences between individuals or within a community. The great diversity of species that exist today on Earth is mostly due to genetics as well as interactions and environmental pressures.

Importance of Biodiversity

Our survival is heavily reliant on biodiversity. The linkages can occasionally be quite straightforward. Plants are the source of the oxygen we breathe. Bees are necessary for

pollinating foods like fruit and nuts. Wood and other natural building materials are used to construct our dwellings. Some connections are more oblique. Plants' genetic variety provides us with both traditional medicine and pharmaceutical companies' raw materials. Additionally, biodiversity serves as an ecosystem's support system. For example, mangrove forests shield coasts.

Ecosystem services in four categories: provisioning services, regulating services, cultural services and supporting services as the basis.



Factor Influencing Biodiversity Loss

Even though the loss of biological diversity could have an economic and financial impact similar to that of climate change, it has gotten far less attention up to this point. The Living Planet Report 2022 states that between 1970 and 2018, the relative abundance of the world's observed wildlife populations decreased by an average of 69% as a direct result of ongoing unsustainable activities. Furthermore, one million plant and animal species are at risk of going extinct in the next decades, according to the IPBES Global Assessment Report on Biodiversity and Ecosystem Services' 2022 Summary for Policymakers.

Significant biodiversity loss is currently caused by five main factors: pollution, alteration of land and sea usage, direct overharvesting of creatures, climate change, and the introduction of invasive species. Indirect factors of change like trade, technical advancement, local and global governance, population dynamics and trends, production and consumption patterns, and societal values and behaviors have all contributed to these events. The strains causing biodiversity loss in our natural environment are further exacerbated by a wide range of commercial activity.

The Impact on the Environment of Biodiversity Loss

Ecosystem services are diminished and disturbance resistance is lowered as a result of biodiversity loss, which has a domino effect on ecosystems and the environment. Among the repercussions are:

1. **Genetic Resource Depletion**: Biodiversity is a storehouse of genetic resources that can be utilized to create new crops, medications, and forms of cultural expression.
2. **Modified Biogeochemical Cycles**: Ecosystems' ability to cycle nutrients like carbon, nitrogen, and phosphorus can be impacted by biodiversity loss. Changes in greenhouse gas emissions, water quality, and ecosystem productivity may result from this.
3. **Enhanced Risk of Species Extinction:** When one species disappears, it may have a domino effect on other species in the same habitat, resulting in more biodiversity losses and raising the possibility of several species becoming extinct.
4. **Ecosystem Stability Loss**: Biodiverse ecosystems are more resilient and stable against shocks like invading species, disease outbreaks, and climate change. Ecosystem collapse is more likely when biodiversity is lost since it can make it harder for an ecosystem to recover from these disruptions.
5. **Reduction in Ecosystem Services**: Vital services like soil formation pollination, carbon sequestration, climate regulation, and air and water purification are all provided by robust, diversified ecosystems. These services can be hampered by biodiversity loss, which lowers environmental quality.

Reasons for the Loss of Biodiversity

1. **Loss and Fragmentation of Habitats:** The main factor contributing to biodiversity loss is habitat destruction and fragmentation, which is brought on by the conversion of natural ecosystems into agricultural land, urban areas, and infrastructure development. In addition to reducing the amount of area available for native animals to live, feed, and reproduce, humans' encroachment on formerly wild regions also breaks the links between various ecosystems.
2. **Climate Change:** As a result of habitat changes brought about by global warming and the ensuing shifts in climatic patterns, organisms find it more difficult to carry out their innate tasks or adjust to novel environments. For instance, variations in temperature or precipitation patterns alter the growth or survival of some plants, which impacts the species that rely on them.
3. **Ocean Acidification:** Ocean acidification is caused by rising carbon dioxide levels, which makes it harder for marine life to retain its protective layer, such as corals,

plankton, and shellfish. As a result, the populations of these species and the animals that depend on them for food and shelter are declining.

4. **Ecosystem Simplification:** When complex, diverse ecosystems are reduced to simpler ones, like urban areas or monocultures, fewer species have access to niches and ecosystem resilience is lowered.
5. **Disease:** Human activity frequently contributes to the spread of infectious illnesses, which can decimate wildlife populations. Natural defenses against disease-causing microorganisms that are indigenous to their area have been created by organisms. However, native species are ill-prepared to fight off non-native microorganisms that human activity introduces into ecosystems.
6. **Genetic Pollution:** Genetic diversity, which is essential for a species' resistance and adaptation, might be lost as a result of the release of genetically engineered organisms or the hybridization of closely related species.
7. **Overhunting**: One of the primary causes of species extinction is the overhunting of a species for sport, due to pest control, or to satisfy the high demand for meat or animal derivatives. Populations are rapidly reduced by industrialized hunting, which ignores the impact of species decline on the ecosystem as a whole. For instance, otter fur was heavily commercialized in the 18th and 19th centuries in both Russia and the United States, almost driving the species to extinction. This led to the secondary consequences of fish population declines and kelp forest loss.
8. **Invasive Species:** Because ecosystems have developed to keep species populations relatively stable, non-native species that are brought to new areas have the potential to outcompete native species for resources, feed on them, or spread illnesses. Invasive species have the ability to reduce the numbers of the prey they consume when they are at higher levels of the food chain. On the other hand, invasive species that are at the bottom or middle of the food chain may cause a population boom for the native species that eat them, which could have an impact on the ecosystem as a whole.
9. **Overfishing:** As a result of industrialized fishing, highly sought-after species such as salmon, whales, and tuna are being reduced in order to satisfy global demand. Sea-floor ecosystems, which are crucial breeding grounds for numerous species, have also been damaged by unsustainable fishing practices like bottom trawling. By boosting the number of predators at the expense of their prey, this has had the unintended consequence of altering the architecture of marine ecosystems.
10. **Pollution:** Pollution of the air, soil, and water can damage species by causing habitat

degradation, physical impairment, or increased susceptibility to diseases or predators. Certain contaminants, such heavy metals and pesticides, can contaminate many layers of the environment by moving up the food chain.

Goals of Biological Resource Asset and Management

Contextual differences in the definition of biodiversity are contingent upon the asset management goal and the intended use of the biological resource asset, often known as the bioasset. Direct and indirect use, as well as option and non-use values, make up biological resource values. They can be further categorized as follows in order to evaluate their possible use:

1. The main extractive products' values for direct use. This would mostly comprise commercial fishing in the case of terrestrial and marine systems, as well as forestry for timber. These materials are transported and marketed in well-maintained facilities, and their extraction frequently requires huge, non-local companies to spend much in capital equipment.
2. Direct application of "minor" extractive products. These items, which are found naturally or semi-naturally, necessitate time-consuming collection or harvesting tasks that are frequently completed by locals. Seaweed, artisanal fisheries, aquarium fish, rattan, fuelwood, wild edibles, and medicinal herbs are a few examples. These could be gathered to sell, trade, or use at home.
3. Values for direct usage that only a little amount of biological material needs to be extracted for storage or ex situ investigation. This covers material extraction for industrial research, germplasm banks, and biological inventories. In order to gather representative samples of biological material, extraction is frequently carried out on brief or extended expeditions that travel over wide regions.
4. Non-extractive direct use values that frequently necessitate significant user involvement with the resource on-site. This comprises key "non-consumptive" activities that mostly take place in protected areas, such as ecotourism, recreation, and on-site research. The requirement to supply participants with food, housing, and transportation is what defines these activities.
5. Values accumulated off-site through indirect use. Depending on their relative importance to the support or protection of off-site economic activity, the value of these functions—such as watershed protection, natural ecosystems preserved as national parks in order to generate revenue from wildlife tourism, protection of fisheries nurseries and subsistence fisheries, and climate regulation—may be very large or very small.

6. Option values. Option values are only taken into consideration when they can be potentially significant in relation to the specific kind of product or service, as they can be linked to every use value.
7. Values that are not used. By definition, these values—such as stewardship, ethics, cultural belief, and aesthetics—occur at a distance from the resource and don't need to be extracted or physically interacted with.

Biodiversity Conservation Acts:

- Biological Diversity Act ,2002
- Wildlife (Protection) Act,1972
- Forest (Conservation) Act,1980
- Environment (Protection) Act, 1986
- Indian Forest Act,1972
- Water (Preservation and Control of Pollution) Act 1974
- Air (Preservation and Control of Pollution) Act ,1981
- Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Right) Act, 2006

Conclusion:

The future of biodiversity hinges on our ability to harmonize development with conservation in a rapidly changing world. Biodiversity 360 Degree underscores that sustainable progress requires a holistic approach, integrating advanced technologies like AI and synthetic biology with robust policy frameworks and community-driven efforts. By addressing the challenges of urbanization, industrialization, and climate change, we can forge a path where human advancement coexists with thriving ecosystems. The chapter's exploration of innovative tools and collaborative strategies highlights the potential to restore and protect biodiversity while meeting global developmental needs. Moving toward 3600, collective action—spanning governments, industries, and local communities—must prioritize equitable resource management and ecological resilience. Embracing adaptive, inclusive conservation practices ensures that Earth's rich biological heritage endures for future generations. This vision calls for unwavering commitment to balancing human aspirations with the stewardship of nature, fostering a world where biodiversity flourishes as a foundation for sustainable development.

References:

1. DeLong Jr, D. C. (1996). Defining biodiversity. *Wildlife society bulletin*, 738-749.

2. Dobson, A., Jolly, A., & Rubenstein, D. (1989). The greenhouse effect and biological diversity.
3. Fiedler, P. L., & Jain, S. K. (Eds.). (1992). *Conservation biology: The theory and practice of nature conservation, preservation and management*. Chapman and Hall.
4. Gaston, K. J., & Spicer, J. I. (1998). *Biodiversity: An introduction*. Blackwell Science.
5. Lovejoy, T. E. (1980). The Global 2000 Report to the President (G. O. Barney, Ed.), Vol. 2, The Technical Report (pp. 327–332). Penguin.
6. Markham, A., & Malcolm, J. (1996). Biodiversity and wildlife: adaptation to climate change. In *Adapting to Climate Change: An International Perspective* (pp. 384-401). New York, NY: Springer New York. https://doi.org/10.1007/978-1-4613-8471-7_33
7. Mawdsley, J. R., O'Malley, R., & Ojima, D. S. (2009). A review of climate-change adaptation strategies for wildlife management and biodiversity conservation. *Conservation Biology*, *23*(5), 1080-1089.https://doi.org/10.1111/j.1523-1739.2009.01264.x
8. Pielou, E. C. (1977). *Mathematical ecology*. John Wiley & Sons