SARPS - Journal of Advanced Research in Plant Science
July-September 2026 2(2)
https://journalofplantscience.com

Original Article

BIODIVERSITY CONSERVATION IN AN ERA OF RAPID GLOBAL ENVIRONMENTAL CHANGE

Aman Tiwari [1*], Shubham Kumar [2], Nainika Rosy [3], Astuti Tiwari [4]
[1] Assistant Professor, Department of Botany, M.M.M.P.G. College, Bhatpar Rani, Deoria, Uttar Pradesh, India
[2] Department of Botany (Unit CMP), University of Allahabad, Prayagraj, Uttar Pradesh, India
[3] Department of Botany, University of Delhi, New Delhi, India
[4] Department of Botany, Banaras Hindu University, Varanasi, Uttar Pradesh, India

ABSTRACT

Biodiversity is essential to the sustainability of ecosystems, their ability to recover from disturbance, and the services they provide for human life. The rapidly changing environment has made biodiversity even less relevant. According to Intergovernmental Panel on Climate Change. (2022), "climate change has caused substantial damages, and increasingly irreversible losses, in terrestrial, freshwater and coastal and open ocean marine ecosystems." This has profound effects on plants, animals, and humans. "Observed wildlife populations have seen a devastating 69% drop on average since 1970" World Wildlife Fund. (2024), "more than 44,000 species are threatened with extinction" International Union for Conservation of Nature. (2024), and "the biodiversity that underpins our food systems is disappearing" Food and Agriculture Organization of the United Nations. (2019). This review describes current status of biodiversity conservation and challenges associated with human activity. It acknowledges that "climate change puts additional stresses on land, enhancing existing risks to livelihoods, biodiversity, human and ecosystem health" Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). There are new approaches for the mitigation of biodiversity stress, including ecosystem-based adaptation and nature-based solutions, which affirms that "protecting biodiversity and ecosystems is fundamental to climate resilient development" Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2023). The paper recommends linking science to adaptive governance, sustainable development, and international conservation efforts to attain long-term goals. Future research should include developing predictive models and monitoring biodiversity closely to conservation targets. Biological diversity loss in a world where environmental change is rapid requires urgent and effective action.

Keywords: Biodiversity Conservation, Global Environmental Change, Ecosystem Resilience, Nature-Based Solutions, Ecological Restoration, Sustainable Development

INTRODUCTION
BIODIVERSITY AND ITS IMPORTANCE

Biodiversity encompasses the diversity of genes, species, and ecosystems that sustain ecological processes, evolutionary potential, and human well-being. According to the Convention on Biological Diversity (CBD), biodiversity includes the differences found among living organisms in different environments such as land, water, and oceans. Genetic diversity helps species adapt to changes, species diversity contributes to the productivity and stability of ecosystems, and ecosystem diversity supports the functions

*Corresponding Author:
Email address: Aman Tiwari (amantiwarihere@gmail.com)

Received: 18 June 2026; **Accepted:** 23 July 2026; **Published** 19 August 2026
DOI: 10.29121/SARPS.v2.i2.2026.32
Page Number: 7-14
Journal Title: SARPS - Journal of Advanced Research in Plant Science
Journal Abbreviation: SARPS- J. Adv. Res. Plant Sci.
Online ISSN: 3108-2521, **Print ISSN:** 3139-3004
Publisher: Granthaalayah Publications and Printers, India
Conflict of Interests: The authors declare that they have no competing interests.
Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
Authors' Contributions: Each author made an equal contribution to the conception and design of the study. All authors have reviewed and approved the final version of the manuscript for publication.
Transparency: The authors affirm that this manuscript presents an honest, accurate, and transparent account of the study. All essential aspects have been included, and any deviations from the original study plan have been clearly explained. The writing process strictly adhered to established ethical standards.
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of ecosystems across different areas. Biodiversity is essential for key ecological processes like the movement of nutrients, production of energy, breaking down of materials, pollination, and the flow of energy through ecosystems. It also provides various benefits such as food, water, climate regulation, carbon storage, water cleaning, soil development, and recycling of nutrients.

GLOBAL ENVIRONMENTAL CHANGE

Global biodiversity is increasingly threatened by anthropogenic environmental change. Factors such as climate change, changes in land use, pollution, invasive species, and overuse of natural resources are changing where species live, how ecosystems function, and the condition of their habitats. Activities like cutting down forests, expanding agriculture, building cities, mining, and developing infrastructure continue to divide natural areas. The combination of these various pressures weakens the ability of ecosystems to recover, speeds up the loss of species, and undermines the services that ecosystems provide, which are crucial for sustainable development.

RATIONALE AND OBJECTIVES

The rapid loss of biodiversity has become a significant challenge for the environment, economy, and society, demanding urgent, science-based conservation action. Meeting international goals such as the Sustainable Development Goals, the Kunming–Montreal Global Biodiversity Framework, and the Paris Agreement requires a coordinated approach to conservation, supported by flexible governance and the involvement of various stakeholders. This review looks at the current situation of biodiversity worldwide, identifies the main causes of biodiversity loss, assesses existing and new conservation methods, and highlights important research areas to improve biodiversity conservation in the face of rapid environmental changes.

CURRENT STATUS OF GLOBAL BIODIVERSITY

Global biodiversity is undergoing unprecedented decline, with widespread losses of species, populations, and ecosystems driven primarily by human activities. These changes are disrupting ecological processes and threatening the stability of Earth's life-support systems.

GLOBAL BIODIVERSITY PATTERNS

The distribution of biodiversity depends on evolutionary history, climate, and geography.

Terrestrial biodiversity: Forests, grasslands, and deserts are home to the majority of terrestrial species. Tropical rainforests hold more than half of the world’s biodiversity, although they cover less than 10% of Earth’s land. Over 75% of terrestrial areas have been significantly changed by human actions, especially the expansion of agriculture, according to the IPBES.

Freshwater biodiversity: Freshwater ecosystems cover less than 1% of Earth’s surface but support about 10% of all known species. More than 85% of wetlands that existed in 1700 have been lost, and freshwater species are facing the highest extinction rates.

Marine biodiversity: Oceans are home to Earth’s largest ecosystems, with the greatest diversity found in coral reefs and estuaries. About 66% of marine environments are becoming increasingly affected by fishing, coastal development, ocean warming, and acidification, which are linked to climate change.

CURRENT TRENDS

Global biodiversity is currently going through a rapidly worsening crisis, widely recognized as the sixth mass extinction.

Species extinction: The current rate of species loss is much higher than what is normally expected in nature. The IPBES Global Assessment estimates that around one million plant and animal species are at risk of extinction, with many likely to disappear within the next few decades.

Population decline: The World Wildlife Fund. (2024) shows an average decline of 73% in monitored vertebrate populations between 1970 and 2020. Freshwater populations have declined by 85%, terrestrial populations by 69%, and marine populations by 56%.

Habitat degradation: Activities such as deforestation, draining wetlands, expanding agriculture, and changing land use continue to damage habitats, reducing biodiversity and weakening the services that ecosystems provide.

Ecosystem collapse: Various pressures are pushing ecosystems past their ecological limits. Examples include mass coral bleaching and the reduced carbon storage capacity of the Amazon, which show the growing risks of irreversible ecosystem collapse and loss of important ecological functions.

GLOBAL ASSESSMENTS

Scientific understanding of biodiversity loss is shared through several major global assessments and frameworks.

IPBES: The 2019 Global Assessment Report identified changes in land and sea use, direct use of natural resources, climate change, pollution, and invasive species as the top five causes of biodiversity loss. It states that current trajectories will fail to meet global conservation goals.

IUCN Red List: This list serves as a key indicator of the health of biological systems. Recent assessments show that over 28% of species studied, including 41% of amphibians and 26% of mammals, are at risk of extinction, showing a strong vulnerability across different groups of species.

WWF Living Planet Report: The 2024 report highlights serious differences in population declines. Latin America and the Caribbean have seen a drastic 95% drop in monitored vertebrate populations in the last 50 years.

Convention on Biological Diversity (CBD): The CBD's Kunming-Montreal Global Biodiversity Framework sets urgent goals to stop and reverse the loss of nature by 2030. It emphasizes protecting 30% of the world's land and oceans.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019), Intergovernmental Panel on Climate Change. (2022), Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2023), The Food and Agriculture Organization (FAO) reports that the loss of genetic diversity in domestic animals and plants is speeding up, which threatens food production. At the same time, the Intergovernmental Panel on Climate Change. (2022), Intergovernmental Panel on Climate Change. (2023) connects climate change to biodiversity loss. The IPCC states that going over a 1.5°C temperature rise will cause serious and irreversible damage to both land and marine life, increasing the risk of extinction for many species worldwide.

BIODIVERSITY HOTSPOTS AND PRIORITY REGIONS

Conservation efforts often focus on "biodiversity hotspots"—regions with a high number of unique species that are also under great pressure from habitat loss. To be considered a hotspot, a region must have at least 1,500 species of flowering plants that are native to the area and have lost at least 70% of its original vegetation. Priority areas include the Tropical Andes, Mesoamerica, the Mediterranean Basin, and the Sundaland region in Southeast Asia. These areas are crucial for preserving genetic diversity. Additionally, new conservation ideas are recognizing the Amazon Basin, the Congo Basin, and untouched boreal forests not just as hotspots, but as large-scale priority regions vital for the stability of the planet's biosphere. Protecting these highly threatened areas is essential for safeguarding global ecological balance and preventing a chain of species extinctions.

MAJOR DRIVERS OF BIODIVERSITY LOSS UNDER GLOBAL CHANGE

Global biodiversity decline is driven by multiple anthropogenic pressures affecting terrestrial, freshwater, and marine ecosystems. The Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019) has identified five main reasons for the loss of biodiversity: changes in land use, direct use of living organisms, climate change, pollution, and invasive species. These factors often work together, which makes the damage to ecosystems worse and raises the chance of species becoming extinct.

CLIMATE CHANGE

Climate change is among the most significant threats to biodiversity. Global mean surface temperature has increased by approximately 1.1°C above the 1850–1900 average Intergovernmental Panel on Climate Change. (2023), changing where species live, how ecosystems function, and how species interact. Higher temperatures especially affect alpine plants, amphibians, and coral reef creatures that can't handle extreme heat. Human-induced climate change has made extreme weather events more frequent and intense, such as heatwaves, droughts, floods, storms, and wildfires Intergovernmental Panel on Climate Change. (2022). These events lead to large numbers of deaths, reduced ability to reproduce, and problems in ecosystems. The 2023 global coral bleaching event further demonstrated the vulnerability of marine ecosystems to thermal stress.

More than 90% of excess atmospheric heat has been absorbed by the oceans Intergovernmental Panel on Climate Change. (2023), causing them to warm up, leading to coral bleaching, changing where marine species live, and altering food chains. Ocean acidification has also lowered the average surface pH by about 0.1 units, which is a 30% increase in acidity, harming organisms that build shells, like corals and molluscs. Climate change also changes when species do things like flower, breed, or migrate. This disrupts relationships between species, like pollinators and plants. Many species are forced to move to cooler areas, but those that can't adapt or move are at higher risk of extinction.

LAND USE AND HABITAT LOSS

Land-use change remains the leading driver of terrestrial biodiversity loss. According to Food and Agriculture Organization of the United Nations. (2020), around 420 million hectares of forest were lost worldwide between 1990 and 2020, mostly in tropical areas that have a lot of biodiversity. Converting forests into farmland, plantations, pastures, and cities destroys habitats and makes ecosystems less complex. Agricultural expansion covers nearly 50% of the world's habitable land (Our World in Data, based on FAO data). Intensive farming simplifies the landscape, reduces native plants, and uses more chemicals, which harms biodiversity. Infrastructure projects like roads, dams, mining, energy sites, and urban areas break up habitats, limit the movement of species, and separate populations. This makes them more vulnerable to genetic problems and local extinction. Freshwater ecosystems are especially affected by dams and other barriers that block rivers.

POLLUTION

Pollution is a major driver of biodiversity loss across all ecosystems. Global plastic production exceeds 400 million tonnes annually, while approximately 11 million tonnes of plastic enter the oceans each year United Nations Environment Programme. (2021). Plastic waste and microplastics harm wildlife, reduce their ability to eat properly, cause death, and pollute land, water, and air.

Too much nitrogen and phosphorus lead to nutrient-rich water, causing harmful algal blooms and areas with little or no oxygen, called dead zones.

The Gulf of Mexico is one of the largest examples. Heavy metals like mercury, lead, cadmium, and arsenic build up in food chains and affect both wildlife and people's health. Persistent organic pollutants, pesticides, medicines, chemicals that affect hormones, and industrial waste harm reproduction, development, immunity, and behavior in many species. Air pollution, including ozone, sulfur dioxide, nitrogen oxides, and particulate matter, harms plants, makes water more acidic, and reduces the productivity of ecosystems.

INVASIVE ALIEN SPECIES

Invasive species are plants or animals that are introduced to new areas through trade, shipping, aquaculture, gardening, tourism, the pet trade, and accidental transport.

According to the IPBES Thematic Assessment (2023), more than 37,000 alien species have been introduced globally, with over 3,500 being harmful invasive species.

These species often outcompete native ones, change habitats, mess with nutrient cycles and food chains, spread diseases, and have caused many extinctions, especially on islands and in fresh water.

The economic impact of invasive species worldwide is over US$423 billion each year Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2023), affecting farming, fishing, forestry, infrastructure, and public health.

OVEREXPLOITATION

Direct exploitation of biological resources remains a major cause of biodiversity loss. Food and Agriculture Organization of the United Nations. (2024) reported that 37.7% of assessed marine fish stocks are overfished, while only 62.3% remain within biologically sustainable levels. Overfishing reduces the number of fish, changes the age of fish populations, and disrupts marine food webs.

Unsustainable hunting for food, traditional medicine, and commercial products has led to sharp declines in wildlife. The illegal wildlife trade, which is worth billions of dollars each year, endangers species like pangolins, elephants, rhinoceroses, big cats, reptiles, birds, and orchids. Similarly, over-harvesting of timber, medicinal plants, fuelwood, and other non-timber forest products often surpasses the natural ability of these resources to recover, leading to long-term population losses and damage to ecosystems.

CURRENT BIODIVERSITY CONSERVATION STRATEGIES

The rapid loss of biodiversity has led to the development of integrated conservation approaches that combine efforts to protect ecosystems, restore habitats, recover species, involve communities, and implement international policies.

Modern conservation efforts recognize the connection between ecological, social, and economic systems and focus on adaptive, science-driven management practices.

PROTECTED AREAS

Protected areas play a central role in global biodiversity conservation by preserving important habitats, ecological processes, and endangered species.

Terrestrial protected areas, such as national parks and wildlife sanctuaries, help maintain representative ecosystems, support genetic diversity, and sustain key ecological functions. National parks are mainly focused on ensuring long-term environmental health, while wildlife sanctuaries are dedicated to the protection of threatened wildlife and their habitats. Marine Protected Areas (MPAs) are designed to protect a wide range of marine environments, including coral reefs, mangroves, seagrass beds, estuaries, and deep-sea ecosystems. Well-managed MPAs can boost fish populations, recover marine biodiversity, and increase the ability of these ecosystems to withstand the effects of climate change.

HABITAT RESTORATION

Habitat restoration aims to bring back damaged ecosystems and re-establish ecological functions that support biodiversity.

Forest restoration through natural regeneration, planting trees, reforesting areas, and encouraging natural growth helps in capturing carbon, protecting watersheds, and providing suitable habitats for wildlife.Wetland restoration improves water flow, water quality, and provides important habitats for migratory birds, amphibians, aquatic plants, and freshwater species, while also helping to manage floods and droughts. Grassland restoration helps rebuild native plant communities, enhances soil health, and supports pollinators, herbivores, and ground-dwelling animals. The restoration of mangroves, salt marshes, seagrass beds, and coral reefs strengthens coastal defenses, boosts fishery productivity, and helps in reducing climate change by storing blue carbon. Effective restoration projects focus on using native species, ensuring connectivity across landscapes, and ongoing monitoring of ecological health.

SPECIES-BASED CONSERVATION

Species-based conservation supports ecosystem-level management by preventing species from becoming extinct and helping to rebuild their populations.

In situ conservation protects species within their natural environments through protected forests, biosphere reserves, community reserves, and other natural habitats, thereby maintaining interactions within ecosystems, evolutionary processes, and genetic variety.

Ex situ conservation protects species that are highly at risk by keeping them outside of their natural habitats. This includes botanical gardens, seed banks, field gene banks, tissue culture collections, cryopreservation facilities, and pollen banks, which help preserve rare, medicinal, endemic, and wild relatives of crops, ex situ conservation also involves zoos, aquariums, captive breeding centres, and genome resource banks. Captive breeding programs assist in saving endangered animals, while techniques such as micropropagation and seed banking are used to conserve threatened plant species. Reintroduction programs aim to create self-sustaining populations after habitat improvement and the reduction of threats, and their success depends on factors like genetic diversity, habitat conditions, reduced human impact, and ongoing monitoring after release.

COMMUNITY-BASED CONSERVATION

Community-based conservation acknowledges Indigenous peoples and local communities as vital partners in the effort to protect biodiversity. Indigenous knowledge offers important insights into sustainable resource use and ecosystem management, and when combined with scientific research, it enhances the planning and execution of conservation and restoration projects. Local involvement improves the effectiveness of conservation by promoting better management of natural resources and supporting sustainable livelihoods through activities like ecotourism, agroforestry, sustainable harvesting, and restoration work. Collaborative management, involving governments, researchers, conservation groups, and local communities, encourages joint decision-making, fair distribution of benefits, and flexible management practices, resulting in better environmental and economic outcomes.

INTERNATIONAL CONSERVATION FRAMEWORKS

Global biodiversity conservation is supported by several international agreements that guide national policies and collaborative efforts. The Convention on Biological Diversity (CBD) provides the main international framework for biodiversity conservation, the sustainable use of biological resources, and the fair sharing of benefits from genetic resources. The Kunming–Montreal Global Biodiversity Framework (2022) sets ambitious global goals to halt and reverse biodiversity loss by 2030, including the conservation of at least 30% of terrestrial and marine ecosystems.

The Ramsar Convention focuses on the conservation and wise use of wetlands of international importance, while the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulates international trade to prevent the overexploitation of protected species.

Biodiversity conservation is also integrated into the United Nations Sustainable Development Goals (SDGs), particularly Goals 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land). Additional support is provided by the Paris Agreement, which highlights the essential role of healthy ecosystems in climate change mitigation and adaptation by promoting the conservation, restoration, and use of nature-based solutions. Together, these international frameworks offer a coordinated foundation for strengthening biodiversity conservation amidst ongoing global environmental changes.

EMERGING APPROACHES FOR BIODIVERSITY CONSERVATION

The environment is changing quickly, new methods for protecting biodiversity are needed. These methods should work along with traditional approaches to make conservation efforts more effective. Progress in ecological science, molecular biology, geospatial tools, and digital technologies is changing how we assess, monitor, and plan for biodiversity conservation. These new approaches help make better decisions based on evidence, improve how we adjust conservation strategies, and make ecosystems more resilient in the face of climate change and human activities.

NATURE-BASED SOLUTIONS

Nature-Based Solutions (NbS) focus on protecting, managing, and restoring natural and modified ecosystems in order to tackle societal challenges while supporting biodiversity and improving human well-being. These solutions work with natural ecological processes to help address climate change, reduce disaster risks, ensure food and water security, and support sustainable livelihoods. Examples of such solutions include planting trees, restoring forests and wetlands, rehabilitating mangroves, creating green spaces in cities, practicing agroforestry, and managing watersheds. These approaches help to increase biodiversity, enhance carbon storage, improve the connection between ecosystems, reduce soil erosion, and make ecosystems more resilient.

ECOSYSTEM-BASED ADAPTATION

Ecosystem-Based Adaptation (EbA) uses the diversity of life and the services provided by ecosystems to reduce the effects of climate change while maintaining the health and integrity of these ecosystems.

Unlike man-made solutions, EbA depends on the natural functions of ecosystems to boost resilience to climate impacts. For instance, conserving forests helps in protecting water sources and regulating the climate, while wetlands help to prevent flooding and improve groundwater supply. Mangroves and coral reefs act as natural barriers against storm surges and rising sea levels. Practicing sustainable land use, growing a variety of crops, and protecting soil also enhances the resilience of agriculture. EbA offers environmental, economic, and social benefits at the same time, making it a powerful approach for adapting to climate change and protecting biodiversity.

CONSERVATION GENOMICS

Conservation genomics employs advanced DNA sequencing technologies, whole-genome analysis, population genetics, and molecular markers to study genetic diversity, population structures, and the potential for adaptation. In plants, these tools help to identify genetically unique populations, protect rare and native species, preserve wild relatives of crops, and enhance ecological restoration efforts. In wildlife, they aid in managing isolated populations, detecting inbreeding, identifying illegal wildlife products, and maintaining genetic diversity in captive breeding programs. Using genomics in conservation planning helps to improve the resilience of species and increases the chances of long-term conservation success.

ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is playing a key role in the conservation of biodiversity. Machine learning and deep learning techniques allow for the automatic identification of species based on photographs, herbarium samples, camera trap images, bioacoustic recordings, and drone footage. AI can accurately recognize plant species by analyzing leaves, flowers, bark, fruits, and digital herbarium data, supporting field surveys, taxonomic research, and the detection of invasive species. AI also processes large ecological datasets collected from satellites, drones, sensors, and citizen science platforms to improve the monitoring of biodiversity. Predictive models help to forecast species distributions, locate biodiversity hotspots, assess habitat suitability, estimate the risk of extinction, and prioritize conservation actions, enabling more effective and proactive management of ecosystems.

REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Remote sensing and Geographic Information Systems (GIS) are essential for assessing biodiversity and planning conservation efforts. Satellite imagery and LiDAR technology provide continuous data on land cover changes, vegetation conditions, deforestation, wetlands, wildfires, and habitat fragmentation, enabling accurate mapping of habitats. GIS combines spatial, ecological, climatic, and socio-economic data to evaluate habitat suitability, ecological connectivity, species distribution, and conservation priorities. When used together with ecological modeling, these technologies support landscape analysis, the design of protected areas, the planning of wildlife corridors, restoration projects, climate adaptation strategies, and evidence-based management of biodiversity.

ENVIRONMENTAL DNA (EDNA)

Environmental DNA (eDNA) is a highly sensitive and non-invasive method for assessing biodiversity. Organisms release DNA into their surroundings through skin cells, pollen, roots, mucus, scales, feces, spores, and other biological materials. By analyzing DNA collected from soil, freshwater, seawater, sediments, or the air, researchers can detect the presence of multiple species without directly observing or collecting them. eDNA is especially useful for monitoring rare, elusive, endangered, and invasive species, assessing aquatic biodiversity, evaluating the success of ecological restoration, and detecting early signs of biological invasions. As sequencing technology continues to improve, eDNA is expected to become a vital part of long-term biodiversity monitoring efforts.

CITIZEN SCIENCE

Citizen science plays a vital role in biodiversity conservation by involving volunteers, students, naturalists, and local communities in monitoring biodiversity. Tools like mobile apps, online platforms, and community initiatives help collect detailed information on plants, animals, fungi, and other organisms. These data support various scientific studies, including understanding species distribution, tracking seasonal changes, monitoring invasive species, and assessing biodiversity over time. In addition to building large scientific datasets, citizen science fosters environmental awareness, education, public involvement, and cooperation between researchers, policymakers, and local groups. When combined with standard procedures and advanced analytical methods, data collected by volunteers significantly improve biodiversity conservation efforts at both local and global levels.

FUTURE RESEARCH PRIORITIES

Future research on biodiversity should focus on predictive ecological modelling to anticipate how species might be distributed, what extinction risks they face, which habitats will remain suitable, and how ecosystems will react to changes in climate and land use, combining plant functional traits, phylogenetic diversity, and conservation genomics can help identify climate refuges, guide restoration efforts, and find populations that are genetically strong. Long-term ecological monitoring using fixed vegetation plots, satellite imagery, environmental DNA (eDNA), and automated observation systems is crucial for understanding how biodiversity is changing. Integrated conservation planning must improve the movement of species across landscapes, safeguard biodiversity hotspots, and support sustainable land management. Climate-resilient conservation should focus on restoring native ecosystems and preserving wild relatives of crops and rare plant species. Additionally, One Health and Planetary Health frameworks should shape future conservation efforts by highlighting the connections between plant diversity, ecosystem health, animal welfare, and human health. Tackling these challenges needs cooperation between botanists, ecologists, geneticists, climate scientists, social scientists, policymakers, and local communities to create effective and flexible conservation strategies based on solid scientific evidence.

CONCLUSION

Biodiversity plays a crucial role in maintaining the stability and resilience of ecosystems, as well as the ecosystem services that are vital for human well-being. Despite this, biodiversity is still declining because of climate change, habitat loss, pollution, invasive alien species, and overuse of natural resources. This review shows that successful conservation requires combining strategies such as protecting areas, restoring habitats, conserving species, involving local communities, and using new technologies like artificial intelligence, conservation genomics, remote sensing, and environmental DNA. It is important to connect scientific research with policy-making through decisions based on solid evidence and flexible governance to turn scientific knowledge into effective conservation actions. Strengthened international collaboration, supported by global agreements such as the Convention on Biological Diversity, the Kunming–Montreal Global Biodiversity Framework, the Paris Agreement, and the Sustainable Development Goals, remains essential for tackling environmental issues that cross borders. Future conservation efforts should focus on enhancing ecosystem resilience, promoting botanical diversity, restoring ecosystems, and managing resources sustainably through collaborative, interdisciplinary, and climate-aware approaches to ensure the long-term protection of global biodiversity.

ACKNOWLEDGMENTS

None.

REFERENCES

Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S., and Naeem, S. (2012). Biodiversity loss and its impact on humanity. Nature, 486(7401), 59–67. https://doi.org/10.1038/nature11148

Convention on Biological Diversity. (1992). Convention on Biological Diversity.

Convention on Biological Diversity. (2022). Kunming-Montreal Global Biodiversity Framework.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., and van den Belt, M. (1997). The Value of the world's ecosystem services and natural capital. Nature, 387, 253–260. https://doi.org/10.1038/387253a0

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., et al. (2019). Global Assessment Report on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Elmqvist, T., Andersson, E., Frantzeskaki, N., et al. (2019). Sustainability and Resilience for Transformation in the Urban Century. Nature Sustainability, 2, 267–273. https://doi.org/10.1038/s41893-019-0250-1

Faith, D. P. (1992). Conservation Evaluation and Phylogenetic Diversity. Biological Conservation, 61(1), 1–10. https://doi.org/10.1016/0006-3207(92)91201-3

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Chapin, T., and Rockström, J. (2010). Resilience Thinking: Integrating Resilience, Adaptability and Transformability. Ecology and Society, 15(4), Article 20. https://doi.org/10.5751/ES-03610-150420

Food and Agriculture Organization of the United Nations. (2019). The State of the World's Biodiversity for Food and Agriculture.

Food and Agriculture Organization of the United Nations. (2020). Global Forest Resources Assessment 2020: Main Report.

Food and Agriculture Organization of the United Nations. (2024). The State of World Fisheries and Aquaculture 2024.

Haddad, N. M., Brudvig, L. A., Clobert, J., et al. (2015). Habitat Fragmentation and Its Lasting Impact on Earth's Ecosystems. Science Advances, 1(2), e1500052. https://doi.org/10.1126/sciadv.1500052

Hobbs, R. J., Higgs, E., and Harris, J. A. (2009). Novel Ecosystems: Implications for Conservation and Restoration. Trends in Ecology and Evolution, 24(11), 599–605. https://doi.org/10.1016/j.tree.2009.05.012

Intergovernmental Panel on Climate Change. (2022). Climate change 2022: Impacts, Adaptation and Vulnerability. Cambridge University Press. https://doi.org/10.1017/9781009325844

Intergovernmental Panel on Climate Change. (2023). Climate Change 2023: Synthesis Report.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). Global Assessment Report on Biodiversity and Ecosystem Services.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2023). Thematic Assessment Report on Invasive Alien Species and Their Control.

International Union for Conservation of Nature. (2024). The IUCN Red List of Threatened Species (Version 2024-2).

Keith, D. A., Ferrer-Paris, J. R., Nicholson, E., and Kingsford, R. T. (Eds.). (2020). The IUCN Global Ecosystem Typology 2.0. International Union for Conservation of Nature.

Kremen, C., and Merenlender, A. M. (2018). Landscapes That Work for Biodiversity and People. Science, 362(6412), Eaau6020. https://doi.org/10.1126/science.aau6020

Leclère, D., Obersteiner, M., Barrett, M., et al. (2020). Bending the Curve of Terrestrial Biodiversity Needs an Integrated Strategy. Nature, 585, 551–556.

Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-Being: Biodiversity Synthesis. World Resources Institute.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., and Kent, J. (2000). Biodiversity Hotspots for Conservation Priorities. Nature, 403, 853–858. https://doi.org/10.1038/35002501

Oldekop, J. A., Holmes, G., Harris, W. E., and Evans, K. L. (2016). A Global Assessment of the Social and Conservation Outcomes of Protected Areas. Conservation Biology, 30(1), 133–141. https://doi.org/10.1111/cobi.12568

Our World in Data. (2024). Land use.

Pörtner, H. O., Scholes, R. J., Agard, J., et al. (2021). Scientific outcome of the IPBES-IPCC Co-Sponsored Workshop on Biodiversity and Climate Change. IPBES Secretariat.

Ramsar Convention Secretariat. (2021). The Ramsar Convention on Wetlands: Texts of the Convention and its Protocol.

Rees, H. C., Maddison, B. C., Middleditch, D. J., Patmore, J. R. M., and Gough, K. C. (2014). The Detection of Aquatic Animal Species Using Environmental DNA. Journal of Applied Ecology, 51(5), 1450–1459. https://doi.org/10.1111/1365-2664.12306

Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. (2023). The CITES Convention.

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., and Turner, B. (2020). Understanding the Value and Limits of Nature-Based Solutions to Climate Change and Other Global Challenges. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794), 20190120. https://doi.org/10.1098/rstb.2019.0120

Taberlet, P., Coissac, E., Hajibabaei, M., and Rieseberg, L. H. (2012). Environmental DNA. Molecular Ecology, 21(8), 1789–1793. https://doi.org/10.1111/j.1365-294X.2012.05542.x

Tilman, D., Isbell, F., and Cowles, J. M. (2014). Biodiversity and Ecosystem Functioning. Annual Review of Ecology, Evolution, and Systematics, 45, 471–493. https://doi.org/10.1146/annurev-ecolsys-120213-091917

United Nations Environment Programme. (2021). From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution.

United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development.

World Wildlife Fund. (2024). Living Planet Report 2024: A System in Peril.

Zabel, F., Delzeit, R., Schneider, J. M., et al. (2019). Global Impacts of Future Cropland Expansion and Intensification on Agricultural Markets and Biodiversity. Nature Communications, 10, Article 2844. https://doi.org/10.1038/s41467-019-10775-z