International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 10 Issue 2, Mar-Apr 2026 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Biodiversity: An Introduction

Paul A. Adekunte[1], Matthew N. O. Sadiku[2], Janet O. Sadiku[3]

[1]International Institute of Professional Security, Lagos, Nigeria
[2]Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA
[3]Juliana King University, Houston, TX, USA

ABSTRACT

Biodiversity (biological diversity) refers to the variety and variability of living organisms on earth, including genetic diversity, species diversity, and ecosystem diversity. It plays a crucial role in maintaining ecological balance and in supporting ecosystem services such as pollination, nutrient cycling, climate regulation, and food production. Biodiversity is essential for human survival, economic development, and environmental sustainability. However, this is currently being threatened by human activities such as habitat destruction, pollution, overexploitation, climate change, and invasive species. The loss of biodiversity can disrupt ecosystems and reduce their ability to provide essential services. For these reasons, therefore, there is need for conservation strategies such as protecting natural habitats, sustainable resource management, and global cooperation which are necessary to preserve biodiversity for present and future generations. The paper looks into the benefits and challenges to biodiversity and what it holds for humanity.

KEYWORDS: *Biodiversity, genetic diversity, species diversity, ecosystem diversity, ecological balance, environmental sustainability, pollution, overexploitation, climate change, invasive species, environmental technology.*

How to cite this paper: Paul A. Adekunte | Matthew N. O. Sadiku | Janet O. Sadiku "Biodiversity: An Introduction" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-10 | Issue-2, April 2026, pp.343-348, URL: www.ijtsrd.com/papers/ijtsrd101336.pdf

IJTSRD101336

INTRODUCTION

Biodiversity refers to the variety of life on earth, including the diversity of plants, animals, microorganisms, and the ecosystems in which they live, as shown Figures 1 and 2. This concept covers differences within species, between species, and among ecosystems. Biodiversity is fundamental to the functioning of natural systems and supports human survival by providing food, medicine, clean water, and ecological balance.

After the National Forum on BioDiversity in 1986 the term biodiversity became widely used, and was later popularized by Edward O. Wilson, a biologist who emphasized the importance of conserving life on Earth [1]. It is also defined as the variability among living organisms from all sources, including terrestrial, marine, and aquatic ecosystems, and the ecological complexes of which they are part. According to the Convention on Biological Diversity [2], biodiversity includes the diversity within species, between species, and of the ecosystems. Broadly speaking, biodiversity is generally studied at three main levels, which are:

1. Genetic Diversity – i.e., the variation of genes within a species, which allows species to adapt to environmental changes and resist diseases, e.g., different varieties of crops such as rice or maize having genetic variations that help them survive under different conditions;
2. Species Diversity – this refers to the variety and abundance of different species in a particular region. For example, regions like the Amazon Rainforest have extremely high species diversity because they contain thousands of plant and animal species; and
3. Ecosystem Diversity – this involves the variety of habitats, biological communities, and ecological processes, examples of which include forests, deserts, wetlands, grasslands, and coral reefs.

The importance of biodiversity is that it plays several crucial roles in:

- Ecological stability
- Economic value
- Cultural and aesthetic value, and

- Scientific value.

Some of the main threats facing biodiversity include:
- Habitat destruction
- Pollution
- Overexploitation of species
- Climate change, and
- Invasive species.

The major drivers of biodiversity loss, as shown in Figures 3 and 4, are due largely to human activities such as deforestation, urbanization, and industrialization, hence the urgent need for the conservation of biodiversity via:
- Protected areas such as national parks and wildlife reserves
- International agreements like the Convention on Biological Diversity
- Sustainable use of natural resources, and
- Public awareness and environmental education [3-5].

HISTORY

The history of biodiversity is a tale of evolution, exploration, and conservation.

1. Origin of biodiversity (Approximately 3.5-4 billion years ago)

Biodiversity began with the origin of life on earth, with the earliest life forms being simple single-celled organisms such as bacteria and archaea that appeared in the oceans around 3.5-3.8 billion years ago, as shown in Figure 5. These organisms gradually diversified through mutation, natural selection, and environmental change. The development of photosynthesis by cyanobacteria significantly altered Earth's atmosphere by producing oxygen.

A key event during this period was the Great Oxygenation Event (about 2.4 billion years ago), which drastically increased atmospheric oxygen and enabled the evolution of more complex life forms.

2. Emergence of complex life (approximately 600-541 million years ago)

It was later that multicellular organisms evolved, leading to more complex biological structures. Early soft-bodied organisms appeared during the **Ediacaran Period**, representing some of the earliest known complex life forms. Soon after, the **Cambrian explosion** (approximately 541 million years ago) occurred. During this relatively short evolutionary period, most major animal groups (phyla) appeared in the fossil record greatly increasing biodiversity.

3. Diversification in the Paleozoic Era (541-252 million years ago)

During the Paleozoic Era, biodiversity expanded rapidly. Some of the key developments included:
- Evolution of fish and marine invertebrates.
- Colonization of land by plants and insects
- Appearance of amphibians and early reptiles.

However, biodiversity was also shaped by extinction events. Thee most severe was the **Permian-Triassic Extinction Event** (approximately 252 million years ago), which eliminated about 90% of marine species and 70% of terrestrial vertebrates.

4. Age of Reptiles – Mesozoic Era (252-66 million years ago)

The **Mesozoic Era** saw the dominance of reptiles, including dinosaurs. During this era:
- Dinosaurs became the dominant terrestrial animals.
- Birds evolved from dinosaur ancestors
- Flowering plants (angiosperms) first appeared and diversified.

The era ended with the **Cretaceous-Paleogene Extinction Event** (approximately 66 million years ago, which wiped out about 75% of species, including most dinosaurs.

5. Rise of Mammals – Cenozoic Era (66 million years ago-present)

After the dinosaur extinction, mammals diversified rapidly during the **Cenozoic Era**. The important developments were:
- Evolution of large mammals and modern bird species.
- Spread of grasslands and flowering plants.
- Evolution of humans, including **Homosapiens** about 300,000 years ago.

Human activity has significantly influenced biodiversity through habitat destruction, climate change, pollution, and overexploitation of species.

6. Modern Biodiversity and the Anthropocene

Scientists believe Earth may currently be experiencing a **sixth mass extinction**, often called the **Holocene Extinction**, which is primarily driven by human activities such as deforestation, urbanization, and climate change.

Conservation efforts by organizations like **International Union for Conservation of Nature** aim to protect species and ecosystems worldwide [5-12].

LEVELS OR TYPES OF BIODIVERSITY

Biodiversity reflects how life is organized at different biological levels and how organisms interact with each other and with their physical environment. Biodiversity is commonly classified into three main levels, which are:

1. Genetic diversity

Genetic diversity refers to variation in genes within a species (i.e., differences in DNA among individuals of the same species). Individuals of the same species differ genetically, which enables populations to adapt to changing environmental conditions [13]. Hence, genetic diversity is the foundation of biodiversity because it provides the raw material for evolution and adaptation. Examples are: different varieties of rice or maize or wheat, variations among different breeds of dogs or cattle or chickens, and genetic differences among human populations. The importance is to:

- Enhance disease resistance
- Enables evolutionary adaptation to environmental changes
- Supports crop and livestock improvement/productivity through breeding

2. Species diversity

This is the variety of species within a particular habitat or region. It includes both:

- Species richness (number of species present)
- Species evenness or abundance (relative abundance or population of each species) [14]. Species diversity helps to maintain ecosystem stability and ecological balance [13].

The earth is estimated to contain about 8.7 million species, though many remain undiscovered [13]. Examples are:

- Tropical rainforests which contain thousands of plant and animal species.
- Coral reefs that host diverse or support many fish, corals and marine organisms.

3. Ecosystem diversity

This refers to the variety of ecosystems within a geographic region, including differences in habitats, biological communities, and ecological processes (i.e., each ecosystem has different – climate, soil, organisms, and ecological processes) [13]. Some examples of ecosystems include: forests, grasslands, deserts, wetlands, coral reefs, and freshwater ecosystems. Each ecosystem contains unique species interactions and environmental conditions.

IMPORTANCE OF BIODIVERSITY

Biodiversity provides numerous ecological, economic, and social benefits.

1. **Ecological importance/ecological balance**: Biodiversity maintains ecosystem stability and functioning. The key ecological roles include: nutrient cycling, pollination, soil formation, decomposition, climate regulation, and water purification – with each and different organisms performing specific roles. However, greater biodiversity often improves ecosystem productivity and resilience [13, 15].
2. **Economic importance**: Biodiversity supports many industries and livelihoods. Examples are: agriculture (crop diversity), fisheries, forestry, pharmaceuticals, biotechnology, and tourism and ecotourism.

Many medicines originate from plants and microorganisms found in biodiverse ecosystems (medicinal resources). A wide variety of plant and animal species provide food sources for humans – serving as food security [13]

3. **Social and cultural importance**: Biodiversity contributes to:
   - Cultural identity
   - Traditional medicine
   - Recreation and aesthetic values
   - Spiritual beliefs and indigenous knowledge
4. **Scientific and educational importance**: Biodiversity provides opportunities for scientific research and education. Studying biodiversity helps scientists understand:
   - Evolutionary processes
   - Ecological relationships, and
   - Biological adaptation
5. **Ecosystem services**: Biodiversity provides services such as:
   - Air and water purification
   - Soil fertility
   - Climate regulation, and
   - Pollination of crops [13].

PATTERNS OF BIODIVERSITY

1. Latitudinal gradient

Species diversity generally increases from the poles towards the equator, meaning that tropical regions contain the highest biodiversity.

2. Species-area relationship

Larger geographic areas tend to support more species, as they provide more habitats and resources.

THREATS/CHALLENGES TO BIODIVERSITY

As a result of human activities and environmental changes, biodiversity worldwide is declining. Under which are:

1. Habitat loss and fragmentation: In this case, habitat destruction is caused due to: deforestation, urbanization, agricultural expansion, and infrastructure development.

   This causes the reductions in population sizes and increases extinction risk [16-18].
2. Pollution: Chemical runoff, plastic waste, and air pollution.
3. Climate change: Altering ecosystems, affecting or disrupting species survival and interactions, as shown in Figure 6.

4. Human activities such as overexploitation of natural resources e.g., overfishing, excessive hunting, illegal wildlife trade, and unsustainable logging/harvesting [13].
5. Invasive species: Invasive species are organisms that are introduced into an ecosystem where they are none natives. These species may:

- Compete with native species for resources
- Spread diseases, and
- Alter habitats.

Impacts:

- Ecological disruption – Outcompete native species, alter ecosystems, and disrupt food chains.
- Economic losses – Cause damage to agriculture, forestry, fisheries, and tourism.
- Biodiversity loss – It contributes to species extinction.

Examples:

- Wateconservar hyacinth (in Nigeria) – This clogs waterways, harms aquatic life.
- Lionfish (Caribbean) – This prey on native fish, and disrupts coral reefs.

As a result, the native species population may decline [13, 19-23].

ARTIFICIAL INTELLIGENCE (AI), TECHNOLOGICAL INNOVATIONS AND MACHINE LEARNING IN BIODIVERSITY

These are useful for:

1. Species identification: AI-powered image recognition identifies species from camera trap images, sounds, or DNA sequences.
2. Habitat monitoring and tracking: Drones, camera traps, and sensors track species populations and habitats. Satellite imagery and drones track deforestation, and habitat fragmentation.
3. Predictive modeling: Machine learning (ML)/AI predicts species distributions, population trends, and extinction risks. AI and ML analyze ecological data, predict species distributions, identify species from images.
4. Conservation optimization: AI optimizes conservation efforts, resource allocation, and protected area management, as shown in Figure 7.
5. DNA analysis: Environmental DNA (eDNA) detects species presence, and genetic diversity.
6. Geographic Information System (GIS) and remote sensing: Map habitats, monitor deforestation, and plan conservation efforts.

The attendant benefits include:

- Efficient monitoring: Automate data collection, reduce costs, and increase accuracy.
- Data-driven decisions: Provides informed conservation strategies with AI-driven insights.
- Faster species discovery: AI accelerates species identification and description [24-29].

The 10 key technologies used in biodiversity conservation, as shown in Figure 8, are [30-32]:

1. Remote sensing
2. Geographic Information Systems (GIS)
3. Drones (Unmanned Aerial Vehicles)
4. Camera Traps
5. Artificial Intelligence (AI)
6. Environmental DNA (eDNA) technology
7. Bioacoustics Monitoring
8. Satellite Tracking and GPS Collars
9. Gene Banks and Seed Banks
10. Internet of Things (IoT) Environmental Sensors

CONCLUSION

The history of biodiversity reflects billions of years of evolution, environmental change, and extinction events. From simple microorganisms to complex ecosystems, biodiversity has continually adapted and diversified. Today, human actions play a major role in shaping the future of life on Earth. Protecting natural habitats, creating protected areas, reducing pollution, and promoting sustainable use of resources are critical steps to conserve biodiversity. Conserving biodiversity ensures ecosystem health, food security, scientific discoveries, and environmental sustainability for future generations. Biodiversity is fundamental to life on Earth, and its protection requires global cooperation, sustainable practices, and responsible environmental management. More information on Biodiversity can be obtained in books in [33-37] and the following related journals:

Biodiversity Data Journal
Biodiversity Informatics
Bothalia: African Biodiversity & Conservation
Caldasia
Conservation Biology
Biological Conservation
Global Ecology and Biogeography
Journal of Biogeography
Systematics and Biodiversity
Biodiversity and Conservation
Frontiers in Ecology and Evolution
Nature Reviews Biodiversity
Frontiers in Ecology and the Environment
Ecology Letters
Nature ecology & Evolution
Ecological Applications

REFERENCES

[1] E. O. Wilson (1988), *Biodiversity,* National Academy Press.

[2] Convention on Biological Diversity (1992), *Global Biodiversity Strategy*.

[3] World Wildlife Fund (2020), *Living Planet Report*.

[4] International Union for Conservation of Nature (IUCN), *Biodiversity Conservation Resources*.

[5] United Nations Environment Programme (UNEP) (2020), *Global Environment Outlook*.

[6] E. O. Wilson (1992), *The diversity of life*, Harvard University Press.

[7] N. A. Campbell et al. (2018), *Campbell biology* (11th ed.), Pearson Education.

[8] R. Dawkins (2009), *The greatest show on earth: The evidence for evolution*, Free Press.

[9] Convention on Biological Diversity, *Biodiversity history and conservation reports*.

[10] C. Darwin (1859), *On the origin of species*.

[11] E. O. Wilson (1988), *Biodiversity*, National Academy Press.

[12] National Research Council (1986), *Proceedings of the National Forum on Biodiversity*.

[13] SATHEE NEET (IIT Kanpur), "*Biodiversity and its types*," https://www.sathee.iitk.ac.in/article/biology/biodiversity-and-its-types

[14] "Types and importance of biodiversity explained with examples," https://www.vedantu.com/biology/biodiversity

[15] J. E. K. Bymes et al. (May 2013), "Investigating the relationship between biodiversity and ecosystem multifunctionality: Challenges and solutions," (PDF), https://arxiv.org/investigating-the-relationship-between-biodiversity-and-ecosystem-multifunctionality-challenges-and-solutions

[16] Greentumble (2023), "Biodiversity: Definition, importance and threats," https://greentumble.com/biodiversity-definition-importance-threats

[17] Convention on Biological Diversity (CBD) (2020), *Global Biodiversity Outlook*.

[18] United Nations Environment Programme (UNEP) (2020), *Biodiversity and Ecosystem Services*.

[19] IPBES (Intergovernmental Platform on Biodiversity and Ecosystem services) Reports: *Comprehensive assessment on biodiversity challenges.*

[20] UNEP, "The State of the World's Biodiversity: *Global overview."*

[21] IUCN, "Biodiversity and Ecosystem Services: *Explores conservation strategies."*

[22] IUCN, "Invasive species – *comprehensive guidance on management."*

[23] Nigerian Conservation Foundation, "Invasive Species in Nigeria*."*

[24] S. P. Carroll and C. W. Fox, "Conservation Biology: Foundations, concepts, and applications."

[25] Wildlife Conservation Society (WCS), "AI for conservation."

[26] Frontiers in Ecology and Evolution, "Machine Learning for Biodiversity."

[27] Z. Miao et al. (2025), "New frontiers in artificial intelligence for biodiversity research and conservation with multimodal language models," *Frontiers in Ecology and Evolution*.

[28] Conservation Biology Institute, "Conservation technology."

[29] NASA, "Remote sensing for biodiversity."

[30] International Union for Conservation of Nature (IUCN) (2020), *Global biodiversity outlook and conservation technology reports,* https://www.iucn.org/global-biodiversity-outlook-and-conservation-technology-reports

[31] World Wildlife Fund (WWF), Technology for wildlife conservation, https://www.worldwildlife.org/technology-for-wildlife-conservation

[32] United Nations Environment Programme (UEP), Digital technologies for the environment, https://www.unep.org/digital-technologies-for-the-environment

[33] K. J. Gaston (1996), "Biodiversity: An ecological perspective."

[34] S. A. Levin (ed.) (2000), *Encyclopedia of biodiversity*, Academy Press.

[35] R. H. MacArthur & E. O. Wilson (1967), *The theory of Island Biogeography*, Princeton University Press.

[36] K. Beazley & R. Baldwin (eds.) (2019), *Biodiversity and protected areas*, MDPI.

[37] S. C. Izah (2023), *Biodiversity in Africa: Potentials, threats and conservation*, Springer.

Figure 1. Biodiversity
Source: https://en.wikipedia.org/wiki/Biodiversity

Figure 2. Global biodiversity
Source:
https://en.wikipedia.org/wiki/Global_biodiversity

Figure 3. Biodiversity loss
Source:
https://en.wikipedia.org/wiki/Biodiversity_loss

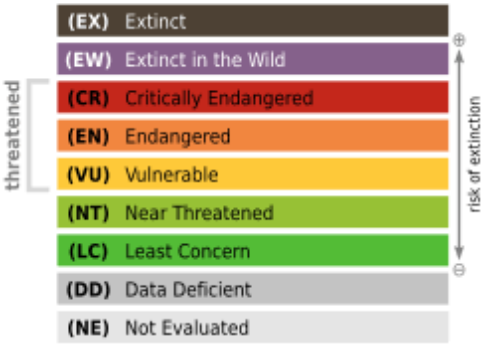

Figure 4. Biodiversity loss
Source:
https://en.wikipedia.org/wiki/Biodiversity_loss

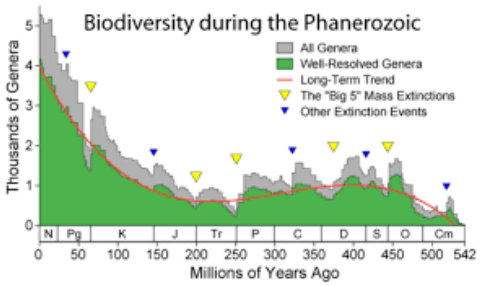

Figure 5. Biodiversity
Source: https://en.wikipedia.org/wiki/Biodiversity

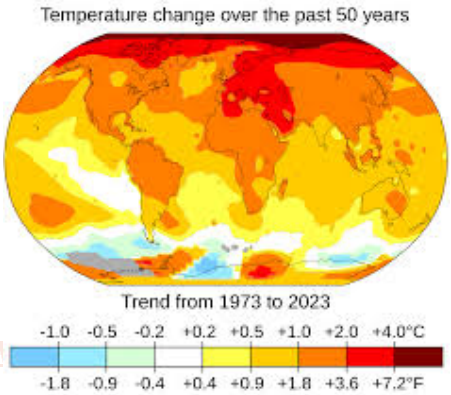

Figure 6. Climate change
Source:
https://en.wikipedia.org/wiki/Climate_change

Figure 7. Conservation biology
Source:
https://en.wikipedia.org/wiki/Conservation_biology

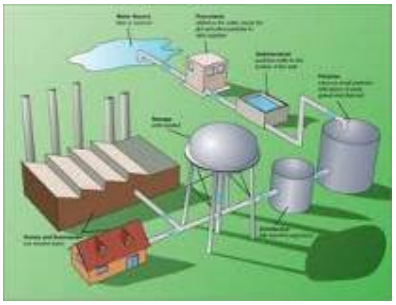

Figure 8. Environmental technology
Source:
https://en.wikipedia.org/wiki/Environmental_technology