

Biodiversity Monitoring: Using Artificial Intelligence (AI) to Integrate Diverse Real-time Data Streams to Track Endangered Habitats and Assess Ecosystem Health at Scale

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Abstract

This paper discusses how Artificial Intelligence (AI) can be appropriately harnessed to strengthen biodiversity monitoring. The paper posits that with the world witnessing an alarming rate of biodiversity loss, effective biodiversity monitoring is necessary towards strengthening conservation efforts for Sustainable Development. In particular, the paper observes that AI provides vital solutions that can be integrated into biodiversity monitoring frameworks for sustainable conservation efforts. In order to realise this goal, the paper discusses how AI can be utilised to integrate diverse real-time data streams to track endangered habitats and assess ecosystem health at scale towards effective biodiversity monitoring and conservation.

1.0 Introduction

Effective biodiversity conservation is necessary towards harnessing the role of nature for Sustainable Development. It has been observed that biodiversity forms the web of life, of which humans are integral and upon which people and the planet depend on for their health and well-being¹. The United Nations observes that humanity depends on biodiversity for its survival and well-being since it provides and sustains food, water, medicine, clean air and a stable climate². Consequently, through sound and effective biodiversity conservation, it is possible to maintain the functioning of natural ecosystems on the planet and the services they provide, such as clean air and water, soil fertility, climate regulation, and the production of food, fiber, energy and natural medicines³. In particular, since over half of the world's Gross Domestic Product (GDP) is dependent on nature, bolstering biodiversity conservation is necessary towards harnessing ecosystem services and functions for Sustainable Development⁴.

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¹ United Nations Environment Programme., 'UNEP and Biodiversity' Available at <https://www.unep.org/unep-and-biodiversity#:~:text=Biological%20diversity%20is%20the%20variety,of%20human%20influence%20as%20well> (Accessed on 24/08/2026)

² United Nations., 'Biodiversity - our strongest natural defense against climate change' Available at <https://www.un.org/en/climatechange/science/climate-issues/biodiversity> (Accessed on 24/08/2026)

³ Biodiversity Conservation., Available at <https://www.adec-innovations.com/glossary/biodiversity-conservation/> (Accessed on 24/08/2026)

⁴ United Nations., 'Biodiversity - our strongest natural defense against climate change' Op Cit

Effective biodiversity conservation has become a key global agenda in light of ongoing global biodiversity loss. The United Nations Environment Programme (UNEP) notes that the world is witnessing an alarming loss of biodiversity with species disappearing hundreds, or even thousands, of times faster than the natural background rate of extinction⁵. Global biodiversity loss is accelerating at an unprecedented rate all over the world, with approximately 1 million species at risk of extinction and critical ecosystems and habitats being degraded and destroyed⁶. It has been observed that as ecosystems, species and habitats degrade and disappear worldwide, the interconnectedness of all forms of life on our planet is at risk hence the need for effective and appropriate biodiversity conservation⁷.

Biodiversity conservation focuses on protection, restoration, and management of natural ecosystems and species diversity in order to maintain and enhance biodiversity for the benefit of people and planet⁸. This approach aims to prevent extinction of species, maintain ecosystem functions and processes, and promote sustainable use of natural resources towards Sustainable Development⁹. In particular, biodiversity monitoring has been identified as a vital conservation approach since it provides the basis for understanding the health of ecosystems, identifying threats to species and habitats, and measuring the success of conservation efforts¹⁰. Strengthening biodiversity monitoring is therefore necessary towards promoting sound biodiversity conservation for Sustainable Development.

This paper discusses how Artificial Intelligence (AI) can be appropriately harnessed to strengthen biodiversity monitoring. The paper posits that with the world witnessing an alarming rate of biodiversity loss, effective biodiversity monitoring is necessary towards strengthening conservation efforts for Sustainable Development. In particular, the paper observes that AI provides vital solutions that can be integrated into biodiversity monitoring frameworks for sustainable conservation efforts. In order to realise this goal, the paper discusses how AI can be utilised to integrate diverse real-time data streams to track endangered habitats and assess ecosystem health at scale towards effective biodiversity monitoring and conservation.

⁵ United Nations Environment Programme., 'UNEP and Biodiversity' Op Cit

⁶ World Health Organization., 'Biodiversity' Available at <https://www.who.int/news-room/fact-sheets/detail/biodiversity> (Accessed on 24/08/2026)

⁷ Biodiversity Explained: Facts, Myths, and the Race to Protect It., Available at https://unfoundation.org/blog/post/biodiversity-explained-facts-myths-and-the-race-to-protect-it/?gad_source=1&gad_campaignid=19554869486&gbraid=0AAAAAD9kiAfgBc0uc6CSshGD05hCKTRGz&gclid=Cj0KCQjwm8bTBhDWARIsAC9Hi8nzqWafhaKluAIUwIpJAng27vC1mQXa3i_RZjgQGppC9zEidVQjYscaAvcwEALw_wcB (Accessed on 24/08/2026)

⁸ Biodiversity Conservation., Op Cit

⁹ United Nations Educational, Scientific and Cultural Organization., 'Biodiversity Conservation' Available at <https://www.unesco.org/en/query-list/b/biodiversity-conservation> (Accessed on 24/08/2026)

¹⁰ United Nations Environment Programme., 'Biodiversity Monitoring Frameworks' Available at <https://www.unep.org/topics/nature-action/global-biodiversity-framework/biodiversity-monitoring-frameworks> (Accessed on 24/08/2026)

2.0 Role of Artificial Intelligence in Biodiversity Monitoring

Biodiversity monitoring involves observing, measuring, and tracking changes in the abundance, distribution, and composition of species and ecosystems over time¹¹. In addition, biodiversity monitoring has been defined as a systematic approach designed to track and assess the status and trends in biodiversity over time¹². Through biodiversity monitoring, it is possible to systematically observe, record, and analyze changes in species, ecosystems, and genetic diversity over time¹³.

Effective monitoring is a key biodiversity conservation strategy. For example, it has been observed that biodiversity monitoring is essential towards understanding changes in species and ecosystems, protecting endangered species and habitats, and making informed conservation decisions¹⁴. According to UNEP, biodiversity monitoring is crucial in sound biodiversity conservation since it provides essential data and insights that inform effective policy decisions, track progress towards conservation goals, and enhance accountability in biodiversity governance¹⁵. In particular, with the world facing a mounting biodiversity loss crisis, effective monitoring is key towards halting and reversing nature loss towards protecting people and planet¹⁶. It has been observed that by establishing robust monitoring systems, countries can make sound and informed decisions that align with global biodiversity commitments, such as those outlined under the Convention on Biological Diversity and the Kunming-Montreal Global Biodiversity Framework (GBF)¹⁷.

Technology and AI provide effective tools and solutions that can strengthen biodiversity monitoring for sound conservation efforts. It has been observed that technology in general provides decision makers with tools and approaches to monitor, model, and mitigate biodiversity loss more creatively and effectively than ever before¹⁸. Modern technologies including AI, big data, machine learning, remote sensing (RS), and geographic information systems (GIS) are

¹¹ Biodiversity Monitoring: Use Cases and Resources., Available at <https://marine.copernicus.eu/services/use-cases-by-topic/biodiversity-monitoring> (Accessed on 24/08/2026)

¹² United Nations Environment Programme., 'Biodiversity Monitoring Frameworks' Op Cit

¹³ Biodiversity Monitoring: Why it Matters and How it Works., Available at <https://flypix.ai/biodiversity-monitoring/> (Accessed on 24/08/2026)

¹⁴ Ibid

¹⁵ Ibid

¹⁶ Biodiversity Monitoring: Use Cases and Resources., Op Cit

¹⁷ Ibid

¹⁸ Introduction to Conservation Technology., Available at <https://wildlabs.net/courses/introduction-conservation-technology#:~:text=As%20environmental%20challenges%20intensify%2C%20conservation,technical%20expertise%2C%20and%20resource%20constraints> (Accessed on 24/08/2026)

strengthening global biodiversity conservation efforts¹⁹. It has been observed that these technologies have the ability to monitor ecosystems, predict environmental changes, and address threats to biodiversity such as poaching, illegal logging, and habitat degradation²⁰. Through modern technologies, it is possible to effectively monitor large and often inaccessible areas, tracking changes in habitats and land use thus being able to detect challenges such as deforestation, habitat fragmentation, and other environmental changes in real-time for sound biodiversity conservation²¹.

In particular, AI is a modern technology that is improving biodiversity monitoring thus enabling sound conservation efforts. For example, AI is strengthening biodiversity monitoring by analyzing vast amounts of environmental data sets, tracking changes in species and habitats and identifying elusive species therefore providing solutions that are improving biodiversity governance²². AI tools including machine learning models can quickly and effectively analyze satellite imagery therefore delivering real-time data and insights into biodiversity patterns and threats²³. In addition, it has been observed that AI tools including remote sensing and analysis platforms can operate continuously and across a broader area of ecosystems providing accurate data on threats such as habitat degradation, illegal logging, illegal hunting, human-wildlife conflict, and species migration therefore informing sound biodiversity conservation approaches²⁴. AI has been identified as a powerful force in biodiversity conservation with applications ranging from monitoring species and ecosystems to collecting environmental DNA for effective conservation measures²⁵. It has been observed that AI has the potential to enhance our ability to monitor and safeguard habitats and ecosystems, mitigate human-wildlife conflicts and optimize the management of natural resources towards effective biodiversity conservation²⁶.

With the world facing an alarming rate of biodiversity loss, utilising technology and AI is crucial towards improving biodiversity monitoring in order to effectively halt and reverse nature loss. It

¹⁹ Harnessing Technology for Conservation: The Role of AI, Big Data, and GIS in Biodiversity Protection., Available at <https://www.frontiersin.org/research-topics/72622/harnessing-technology-for-conservation-the-role-of-ai-big-data-and-gis-in-biodiversity-protection> (Accessed on 24/08/2026)

²⁰ Ibid

²¹ Mbeti. S., 'New technologies for monitoring and conserving biodiversity' Available at <https://africasustainabilitymatters.com/new-technologies-for-monitoring-and-conserving-biodiversity/> (Accessed on 24/08/2026)

²² AI for Biodiversity: New Tools for Conservation., Available at <https://theaisanctuary.org/blog/conservation/ai-for-biodiversity-new-tools-for-conservation/> (Accessed on 24/08/2026)

²³ Ibid

²⁴ United Nations Development Programme., 'People-Centric AI for Conserving Biodiversity' Available at <https://www.undp.org/sites/g/files/zskgke326/files/2025-12/people-centric-ai-for-conserving-biodiversity.pdf> (Accessed on 24/08/2026)

²⁵ World Economic Forum., 'AI in conservation: Where we came from – and where we are heading' Available at <https://www.weforum.org/stories/2024/03/ai-in-conservation-where-we-came-from-and-where-we-are-heading/> (Accessed on 24/08/2026)

²⁶ Ibid

has been observed that effective biodiversity conservation requires detailed environmental knowledge on species distributions, population trends, ecosystem interactions, and environmental threats such as deforestation and habitat degradation, data that is often difficult to collect at scale using traditional methods²⁷. Consequently, AI has emerged as potent tool for monitoring biodiversity, since it allows for quick, precise, and extensive evaluation of species and ecosystems²⁸. AI tools have the capacity to monitor invasive and endangered species, enhance conservation planning, and offer real-time data for sound and well-informed decision-making²⁹.

The *Kunming-Montreal GBF*³⁰ recognises the role of science, technology and innovation in strengthening global biodiversity conservation efforts. It urges countries to embrace technical and scientific cooperation, including through promoting access to and transfer of technology in order to improve biodiversity governance for people and planet³¹. It is therefore necessary to harness and utilise modern technologies including AI towards improving biodiversity monitoring for sound conservation efforts. Consequently, countries have been urged to enhance investments and put in place adequate legal, policy and institutional arrangements that can bolster the use of AI in biodiversity conservation and environmental governance in general³².

3.0 Using Artificial Intelligence (AI) to Strengthen Biodiversity Monitoring and Governance

AI provides valuable solutions that can improve biodiversity monitoring for effective conservation efforts. With ongoing global biodiversity loss affecting both people and planet, the need for effective conservation tools and approaches aligns with advancements in technology and AI³³. It has been observed that AI offers immense value to biodiversity conservation by improving tracking and monitoring of changes in species, ecosystems and habitats over time³⁴.

It is therefore necessary to integrate AI into biodiversity monitoring frameworks and policies in order to bolster biodiversity conservation for Sustainable Development. In particular, integrating diverse real-time data to track endangered habitats and assess ecosystem health at scale is a suitable approach towards improving biodiversity monitoring through AI³⁵. For example, it has been observed that AI can strengthen biodiversity monitoring by processing vast quantities of

²⁷ AI for Biodiversity: New Tools for Conservation., Op Cit

²⁸ Artificial Intelligence in Biodiversity Monitoring., Available at <https://zenodo.org/records/21281748> (Accessed on 24/08/2026)

²⁹ Ibid

³⁰ Convention on Biological Diversity., 'Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity: 15/4. Kunming-Montreal Global Biodiversity Framework' Available at <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf> (Accessed on 24/08/2026)

³¹ Ibid

³² United Nations Environment Programme., 'Biodiversity Monitoring Frameworks' Op Cit

³³ Lhoumeau. S., Pinelo. J., & Borges. P.A.V., 'Artificial intelligence for biodiversity: Exploring the potential of recurrent neural networks in forecasting arthropod dynamics based on time series' *Ecological Indicators.*, Volume 171., 2025

³⁴ Ibid

³⁵ United Nations Development Programme., 'People-Centric AI for Conserving Biodiversity' Op Cit

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data from multiple sources including camera trap images, acoustic recordings and hyperspectral satellites – which can be used to monitor ecosystems, detect species, and track changes in land cover, deforestation, and habitat fragmentation with accurate precision³⁶. AI models can effectively combine diverse data sources into unified platforms to enable more integrated biodiversity analysis towards effective conservation³⁷. By integrating diverse real-time data streams, AI enhances understanding of complex ecological interactions, supports predictive modelling, and provides a basis for more strategic and proactive biodiversity conservation³⁸.

Through its ability to integrate diverse real-time data streams, AI can strengthen biodiversity monitoring by effectively tracking endangered habitats and species. For example, AI can effectively track changes such as deforestation, habitat degradation, the population of species and migratory routes therefore improving conservation efforts in endangered habitats³⁹. Further, by integrating diverse real-time data streams, AI can effectively assess ecosystem health at scale including through using data on climate, land use, and species interactions to predict ecosystem changes, disease outbreaks, or extinction risks⁴⁰.

It is therefore necessary to adopt and utilise AI in order to strengthen biodiversity monitoring towards sound conservation.

4.0 Conclusion

AI provides valuable solutions that can improve biodiversity monitoring. It is therefore necessary to effectively adopt and utilise technology and AI for sound biodiversity monitoring and governance. In particular, using AI to integrate diverse real-time data streams to track endangered habitats and assess ecosystem health at scale is an effective approach towards improving biodiversity monitoring for sound conservation efforts.

³⁶ Ibid

³⁷ Ibid

³⁸ Ibid

³⁹ AI for Biodiversity: New Tools for Conservation., Op Cit

⁴⁰ Ibid

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References

- AI for Biodiversity: New Tools for Conservation., Available at <https://theaisanctuary.org/blog/conservation/ai-for-biodiversity-new-tools-for-conservation/>
- Artificial Intelligence in Biodiversity Monitoring., Available at <https://zenodo.org/records/21281748>
- Biodiversity Conservation., Available at <https://www.adec-innovations.com/glossary/biodiversity-conservation/>
- Biodiversity Explained: Facts, Myths, and the Race to Protect It., Available at https://unfoundation.org/blog/post/biodiversity-explained-facts-myths-and-the-race-to-protect-it/?gad_source=1&gad_campaignid=19554869486&gbraid=0AAAAAD9kiAfgBc0uc6CSshGD05hCKTRGz&gclid=Cj0KCQjwm8bTBhDWARIsAC9Hi8nzqWafhaKluAIUwIpJAng27vC1mQXa3i_RZjgQGppC9zEidVQJYscaAvcwEALw_wcB
- Biodiversity Monitoring: Use Cases and Resources., Available at <https://marine.copernicus.eu/services/use-cases-by-topic/biodiversity-monitoring>
- Biodiversity Monitoring: Why it Matters and How it Works., Available at <https://flypix.ai/biodiversity-monitoring/>
- Convention on Biological Diversity., 'Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity: 15/4. Kunming-Montreal Global Biodiversity Framework' Available at <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf>
- Harnessing Technology for Conservation: The Role of AI, Big Data, and GIS in Biodiversity Protection., Available at <https://www.frontiersin.org/research-topics/72622/harnessing-technology-for-conservation-the-role-of-ai-big-data-and-gis-in-biodiversity-protection>
- Introduction to Conservation Technology., Available at <https://wildlabs.net/courses/introduction-conservation-technology#:~:text=As%20environmental%20challenges%20intensify%2C%20conservation,technical%20expertise%2C%20and%20resource%20constraints>
- Lhoumeau. S., Pinelo. J., & Borges. P.A.V., 'Artificial intelligence for biodiversity: Exploring the potential of recurrent neural networks in forecasting arthropod dynamics based on time series' *Ecological Indicators*., Volume 171., 2025

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Mbeti. S., 'New technologies for monitoring and conserving biodiversity' Available at <https://africasustainabilitymatters.com/new-technologies-for-monitoring-and-conserving-biodiversity/>

United Nations Development Programme., 'People-Centric AI for Conserving Biodiversity' Available at <https://www.undp.org/sites/g/files/zskgke326/files/2025-12/people-centric-ai-for-conserving-biodiversity.pdf>

United Nations Educational, Scientific and Cultural Organization., 'Biodiversity Conservation' Available at <https://www.unesco.org/en/query-list/b/biodiversity-conservation>

United Nations Environment Programme., 'Biodiversity Monitoring Frameworks' Available at <https://www.unep.org/topics/nature-action/global-biodiversity-framework/biodiversity-monitoring-frameworks>

United Nations Environment Programme., 'UNEP and Biodiversity' Available at <https://www.unep.org/unep-and-biodiversity#:~:text=Biological%20diversity%20is%20the%20variety,of%20human%20influence%20as%20well>

United Nations., 'Biodiversity - our strongest natural defense against climate change' Available at <https://www.un.org/en/climatechange/science/climate-issues/biodiversity>

World Economic Forum., 'AI in conservation: Where we came from — and where we are heading' Available at <https://www.weforum.org/stories/2024/03/ai-in-conservation-where-we-came-from-and-where-we-are-heading/>

World Health Organization., 'Biodiversity' Available at <https://www.who.int/news-room/fact-sheets/detail/biodiversity>