Artificial Intelligence in Urban Biodiversity Conservation: A Transformative Approach

Dr Manoj Kumar Singh
Principal (off.), Government I College Kunda Udham Singh Nagar, U.K., India

Introduction

As cities expand rapidly across the globe, urban environments are placing increasing pressure on native ecosystems and species. Habitat fragmentation, pollution, and human activity have led to significant declines in biodiversity within metropolitan areas. In response, conservationists and urban planners are turning to innovative tools to monitor and protect wildlife amidst the concrete jungle. Urbanization poses significant challenges to biodiversity, necessitating innovative solutions for conservation. Artificial Intelligence (AI) has emerged as a transformative force in this field, offering powerful capabilities to analyse complex environmental data, automate biodiversity monitoring, and support evidence-based decision-making. By integrating AI into urban biodiversity initiatives, cities can transition from reactive conservation to proactive, real-time ecological management. This approach not only enhances the accuracy and efficiency of conservation efforts but also fosters a more sustainable coexistence between urban development and natural ecosystems. Artificial Intelligence (AI) has emerged as a pivotal tool in enhancing urban biodiversity conservation efforts. By leveraging AI technologies, cities can monitor, manage, and protect biodiversity more effectively.

AI Applications in Urban Biodiversity Conservation

Urban biodiversity plays a crucial role in maintaining ecological balance and improving human well-being. However, increasing land-use pressure demands smarter, technology-driven approaches to preserve biodiversity within urban systems. AI offers scalable, precise, and cost-effective solutions that help bridge knowledge gaps, guide policy, and support real-time ecosystem monitoring.AI can play a key role in species monitoring, Acoustic Monitoring, Green Space Optimization and biodiversity mapping.

1. Species Detection and Monitoring

AI facilitates the identification and tracking of species within urban environments. Machine learning algorithms process data from various sources, such as camera traps and acoustic sensors, to detect and monitor wildlife populations. For instance, in the UK, AI is utilized to track hedgehog populations, helping to understand their decline and inform conservation strategies (The Guardian). One of the most promising applications of Artificial Intelligence in urban

biodiversity conservation is the **automated detection and monitoring of species**. Traditional biodiversity surveys—while valuable—are often time-consuming, resource-intensive, and limited in spatial or temporal scale. AI offers a scalable and more continuous alternative. AI models, particularly those based on **machine learning and deep learning**, are trained to recognize patterns in large datasets such as:

- **Camera trap images**
- **Acoustic recordings**
- **Satellite and drone imagery**
- **Citizen science reports**

Once trained, these models can identify species, count individuals, and even detect behaviour, often with accuracy surpassing human observers in noisy or complex environments.

- **City Wildlife Cameras**: In many cities like London and San Francisco, AI systems analyse thousands of camera trap images to identify urban mammals such as foxes, raccoons, or hedgehogs, helping researchers track their movement and population trends.
- **Acoustic Monitoring**: AI-enhanced audio processing tools are used to detect and classify bird calls, frog croaks, or bat echolocation signals. This is especially useful in dense urban settings where visual observations are difficult.
- **Hedgehog AI in the UK**: A pioneering project uses AI to monitor hedgehog populations via thermal cameras and citizen-submitted videos. This data helps assess population health and direct habitat restoration efforts more effectively.
- India's rich biodiversity faces significant challenges due to rapid urbanization, habitat loss, and human-wildlife conflicts. Artificial Intelligence (AI) has emerged as a transformative tool in addressing these challenges, particularly in species detection and monitoring within urban environments.
- **Tree-Level Change Detection in Ahmedabad**: Researchers utilized high-resolution satellite imagery and deep learning models, specifically the YOLOv7 instance segmentation model, to detect individual trees in Ahmedabad. The model achieved an accuracy of 80% in tree detection, facilitating urban planning and green space management. arXiv.
- **Monkey Population Tracking in Delhi**: To manage the growing monkey population in Delhi, AI-powered image recognition systems are being developed to identify and track monkeys non-invasively. This approach aids in monitoring sterilization efforts and mitigating human-animal conflicts. SmartStateIndia.

2. Acoustic Monitoring

Urban soundscapes provide valuable insights into biodiversity. AI-enhanced acoustic monitoring systems analyse audio recordings to identify species vocalizations, offering a non-invasive method to assess biodiversity. For example, CityBioNet, a neural network developed by UCL, effectively distinguishes between biotic and anthropogenic sounds in urban areas. Prism → Sustainability Directory+1arXiv+1British Ecological Society.

- **Bengaluru's Acoustic Surveillance**: At the Srishti Manipal Institute of Art Design and Technology in Bengaluru, a network of 20 acoustic recorders collects daily sound data from the environment. AI models analyze these recordings to identify species and detect changes in biodiversity, providing real-time surveillance without human intervention. IndiaAI.
- **Tiger Monitoring with M-STrIPES : M-STrIPES System**: The Monitoring System for Tigers - Intensive Protection and Ecological Status (M-STrIPES) is an Android-based software used across Indian tiger reserves. It assists forest guards in capturing data related to tiger sightings, deaths, wildlife crimes, and ecological observations during patrols, enhancing the effectiveness of tiger conservation efforts.
- **Comprehensive Biodiversity Monitoring**: Researchers have developed AI-enhanced acoustic analysis systems that process sound recordings from various ecosystems to identify and classify different species. These systems help in detecting subtle changes in species presence and behavior over time, aiding in effective conservation strategies.
- **Urban Wildlife Monitoring Systems** : **LynxScope Platform**: LynxScope is an AI-powered platform that enables real-time tracking of urban wildlife through CCTV networks. It generates heat maps to visualize wildlife activity patterns and provides custom alerts for specific species, assisting city planners and conservationists in monitoring urban fauna effectively.

3. Green Space Optimization

Urbanization is rapidly reshaping landscapes globally, leading to habitat fragmentation and loss of biodiversity. In this context, Artificial Intelligence (AI) is emerging as a powerful tool to support urban biodiversity conservation through intelligent planning, real-time monitoring, and optimized management of green spaces. By integrating AI with geospatial technologies, Internet of Things (IoT), and citizen science, cities in India and worldwide are beginning to adopt smarter, data-driven approaches to protect and enhance their natural ecosystems.

- **Smart Urban Planning and Design:** In India, cities like Bengaluru and Pune are exploring AI-driven GIS modelling to plan urban forests and green belts based on biodiversity

heatmaps. In abroad Singapore's "City in a Garden" initiative uses AI-integrated tools to model urban green corridors that maximize ecological connectivity.

- **Biodiversity Monitoring and Species Identification**: AI-powered image recognition (like iNaturalist and Plant Net) assists in identifying species through photos, which helps in biodiversity cataloging. Tools like Biodiversity Informatics Platforms (developed under the Indian Biodiversity Portal) utilize machine learning for species mapping in India. Several projects like Projects like Microsoft's AI for Earth support global biodiversity monitoring efforts using satellite data and neural networks.
- **Predictive Analytics for Threat Assessment**: Machine learning algorithms can predict the impact of urban development on biodiversity, enabling proactive policy interventions. AI is used to simulate future scenarios under different land use and climate models to inform planners.
- **Community Engagement and Citizen Science:** AI algorithms analyse inputs from mobile apps to engage citizens in real-time biodiversity mapping. Platforms like eBird and iNaturalist use AI to verify community submissions and enrich species databases globally and locally.

4. Biodiversity Mapping

AI aids in creating detailed maps of urban biodiversity by processing satellite imagery and data from unmanned aerial vehicles (UAVs). Projects like MIT's ECO-LENS utilize AI to produce accurate maps of species distribution, enabling informed conservation planning. Environmental Solutions Initiative

AI enhances biodiversity mapping by:

- Processing satellite and drone imagery to detect green cover and changes over time.
- Automating species identification using image recognition and deep learning.
- Integrating data from multiple sources (citizen science, sensors, environmental databases).
- Predicting species distribution under different environmental and urban growth scenarios.

There are several platforms involve in identification and mapping the diversity.

1. **Indian Biodiversity Portal (IBP)**: A participatory platform that integrates **machine learning** for species identification and spatial mapping. Collaborates with national and state biodiversity boards.

2. **National Biodiversity Authority (NBA) & ENVIS Centres:** Use AI and GIS technologies to collect and visualize biodiversity data across ecosystems. AI tools support predictive modelling for urban biodiversity loss.

3. **Bengaluru's Tree Mapping Project:** Uses drone imagery and AI-based analysis to assess tree health and density across urban wards.

4. **Wildlife Institute of India (WII) Projects:** Involved in remote sensing and AI for tracking endangered species and biodiversity hotspots in urban-fringe areas.

5. **i Naturalist (USA/Global):** A global citizen science platform supported by AI-powered computer vision to identify flora and fauna from photos. Data feeds into global biodiversity databases (GBIF, EOL).

6. **Microsoft AI for Earth (Global):** Funds projects that use AI for species detection, habitat analysis, and conservation forecasting. Supports projects in Brazil, Kenya, and Australia for real-time biodiversity tracking.

7. **Smart Green Infrastructure in Singapore:** Urban biodiversity mapping uses AI + LiDAR data to maintain ecological corridors. The National Parks Board employs AI to optimize urban green planning based on species presence and ecological connectivity.

8. **UK's Natural History Museum & Google DeepMind Collaboration:** Leveraging AI to digitize and analyze millions of biological specimens for biodiversity mapping and conservation research.

Comparative Insights: India vs Abroad

Criteria	**India**	**Abroad**
Data Infrastructure	Growing, fragmented	Centralized, well-funded (e.g., GBIF, NASA, ESA)
Citizen Engagement	Emerging (India Biodiversity Portal, iNaturalist)	Mature platforms, high user contribution
Government Support	Moderate, improving under Digital India programs	Strong support, especially in EU & US
AI Implementation	Mostly pilot projects, limited scalability	Scalable, integrated into national programs

Conclusion

Artificial Intelligence is revolutionizing the way we understand, monitor, and conserve urban biodiversity. By enabling real-time data collection, species identification, and predictive ecological modelling, AI offers cities a powerful toolset to address the challenges posed by rapid urbanization and environmental degradation. In both India and across the globe, AI-driven approaches are enhancing green space optimization, supporting evidence-based policymaking, and fostering greater public engagement through citizen science platforms. However, to fully harness AI's potential, it is essential to invest in robust data infrastructure, interdisciplinary collaboration, and ethical frameworks. As cities strive toward sustainability, AI stands as a transformative force that can help build greener, more resilient, and biodiverse urban environments for future generations. AI-driven biodiversity mapping offers transformative potential in safeguarding urban ecosystems. While India is making significant strides through national and citizen-led platforms, international examples show how integrated, well-funded AI systems can revolutionize biodiversity data collection and conservation planning. Scaling AI infrastructure, fostering cross-sector collaboration, and increasing public engagement will be key to India's success in this domain.AI has the potential to revolutionize urban biodiversity conservation by enabling more informed decision-making, efficient resource allocation, and participatory planning. In India and across the globe, the integration of AI in urban green space optimization can make cities not only smarter but also more sustainable and ecologically resilient. Artificial Intelligence is revolutionizing urban biodiversity conservation by providing innovative tools for monitoring, management, and protection. By addressing existing challenges and fostering collaboration, AI can play a pivotal role in creating sustainable urban ecosystems that support diverse species and promote ecological balance

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