



ECO-CREDIBILITY: MONETIZING BIODIVERSITY THROUGH DIGITAL  
SPECIES TRACKING IN CONSERVATION BUSINESS MODELS

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**Abstract**

*Biodiversity monitoring is fundamental to conservation, yet its potential to generate economic value remains largely untapped due to fragmented, often analog, data collection methods. This review introduces the "Eco-Credibility" model, a conservation business framework designed to monetize biodiversity by leveraging emerging technologies for transparent species tracking. We argue that the business value of verifiable species data is a significant, overlooked asset. The current state of monitoring, characterized by paper-based records and inconsistent protocols, results in missed opportunities in ethical tourism, green finance, and corporate Environmental, Social, and Governance (ESG) reporting. We explore how technologies such as Internet of Things (IoT) sensor networks, AI-powered camera traps, acoustic monitoring, environmental DNA (eDNA), and blockchain ledgers can automate the creation of immutable, timestamped biodiversity logs. The Eco-Credibility model proposes that these verifiable data streams can be transformed into marketable assets. By providing authenticated proof of a site's ecological health, conservation projects can attract premium ecotourism, secure results-based grants, and generate revenue through emerging biodiversity credit markets. Using potential pilot projects in South Asia such as monitoring the Indus River Dolphin or the fauna of the Margalla Hills National Park. Researcher illustrate the model's practical application. However, researchers also address the significant systemic constraints and ethical risks, including data misuse by poachers, the threat of digital colonialism, and technological biases. The review concludes that by embedding ethical governance and local community control, the Eco-Credibility model offers a viable pathway to align market incentives with conservation goals, transforming biodiversity into a self-sustaining economic asset.*

**Keywords:** Eco-Credibility, Biodiversity, Monetize, Verifiable, Blockchain

**Introduction**

Biodiversity monitoring is a critical pillar for the effective conservation of species and the ecosystems they inhabit, yet it remains a practice that is chronically under-resourced and systematically fragmented. Globally, the translation of ecological observations into actionable, accessible data is remarkably inefficient. It is estimated, for instance, that a mere 10% of biodiversity data collected are available in a usable digital format (Urbano et al., 2024). This profound disconnect means that invaluable species-occurrence records the very currency of conservation science often languish in field notebooks or disparate, non-standardized databases, severely limiting their potential for large-scale analysis and strategic application.



Concurrent with this data challenge is a market failure: the immense “business value” of transparent, verifiable species data is largely overlooked. Intact ecosystems provide staggering economic services, with one prominent estimate placing their global value at approximately \$150 trillion annually (World Economic Forum, 2021). Despite this, corporate and financial decision-making rarely factors in biodiversity as a tangible asset or liability. This review seeks to bridge this gap by linking the science of ecology with the practice of innovation in conservation entrepreneurship. We propose and elaborate on a new model called “Eco-Credibility,” which leverages digital species tracking to create marketable biodiversity credentials. The central aim of this approach is to unlock new and sustainable funding streams for conservation by proving and promoting a site’s biodiversity in near real-time. By doing so, it becomes possible to attract premium ethical tourism, qualify for data-driven green finance, and pioneer new revenue mechanisms like “biodiversity credits.” Ultimately, we seek to forge a durable alignment between conservation science and market incentives, transforming the verified presence of wildlife from a hidden ecological benefit into a quantifiable and monetizable asset.

### **Why Biodiversity Monitoring is Under-valued**

The systemic undervaluation of biodiversity monitoring stems directly from its conventional methodologies, which are often manual, inconsistent, and opaque, thereby crippling its potential economic and strategic value. In a significant number of protected areas and scientific field surveys across the globe, observational data is still meticulously recorded on paper forms or entered into non-standardized spreadsheets. This practice is not only labor-intensive but also prone to human error, data loss, and the creation of records that are difficult to digitize and share, leading to limited reuse (Urbano et al., 2024). Furthermore, data generated from different projects, even within the same ecosystem, are typically siloed in incompatible formats. This lack of interoperability is a direct consequence of widely varying field protocols and the absence of unified, accessible databases, preventing the kind of meta-analysis required for landscape-scale conservation and effective policy-making.

Consequently, both conservationists and conservation-aligned businesses miss crucial opportunities to leverage species data for economic and strategic gain. For example, the presence of pristine wildlife and flagship species is a primary driver for the ecotourism sector, yet operators can seldom provide verifiable, real-time proof of species presence to justify premium pricing or market their locations with confidence. A United Nations report highlights that tourism companies possess a “strong business case” for investing directly in conservation, as the long-term viability of their enterprise is intrinsically dependent on the health and appeal of natural areas (UNDP, 2020). Without a mechanism to certify this natural capital, its value remains speculative.

Similarly, a new class of biodiversity finance instruments, including nature-based credits, green bonds, and impact investments, explicitly requires measurable, verifiable outcomes. However, without a reliable flow of species data, many deserving conservation projects are unable to access these burgeoning funds. Emerging biodiversity credit programs, which function analogously to carbon credits, are fundamentally reliant on transparent and continuous monitoring to assure investors that real ecological benefits are being delivered. The Biodiversity Credit Alliance (2023) posits that such credits provide a tangible pathway for corporations to demonstrate “nature-positive strategies linked to investments in biodiversity and ecosystems.” If species logs were reliable, auditable, and accessible, governments and private investors could confidently reward proven conservation success with grants or credits; at present, this connection is aspirational rather than operational.

These gaps are particularly acute in many biodiversity-rich regions of the world, notably South Asia. Protected areas in countries like Pakistan and India are home to extraordinary wildlife but often lack the standardized digital systems needed to capitalize on this natural wealth. A recent study of Pakistan’s Margalla Hills National Park, for instance, meticulously documented 12,295 individual birds from 83 different species across a variety of habitats (Hadi et al., 2022). This scientifically valuable baseline, however, remains largely



untapped as a tool for attracting targeted funding or enhancing park management and tourism. Without a system for digital tracking and reporting, such critical biodiversity information remains confined to academic papers and internal reports. The result is a cycle of missed revenue and poor visibility: ethical tourists cannot verify the wildlife experiences being marketed, and corporations have no credible mechanism to invest in the park's biodiversity and receive credit for it. In short, conventional monitoring is profoundly undervalued because it fails to build the essential bridge between raw ecological data and its potential economic, financial, and branding applications. The Eco-Credibility model aims to create a bridge that transforms certified biodiversity into a valuable asset that can be marketed and sustained.

### **Emerging Technologies in Species Tracking**

The current technological advancements have brought forth a powerful set of tools that can potentially transform biodiversity monitoring into a process that is automated, continuous, and scalable. Such innovations provide the capacity to gather, process, and validate species data like never before in terms of efficiency and consistency.

This new approach is based on sensor networks and the Internet of Things (IoT), which allow the large-scale automation of field data collection. Modern conservation systems can now integrate a diverse array of hardware including high-resolution camera traps, GPS/telemetry tags on animals, autonomous acoustic recorders, satellite imagery, and citizen-science applications into a cohesive, data-generating network (Unbaro et al., 2024). Among these, camera traps coupled with artificial intelligence (AI) have become particularly transformative. By deploying deep-learning algorithms, these systems can autonomously identify wildlife from images, drastically reducing the need for manual human effort. A single research article has revealed that a deep-learning model can attain state-of-the-art classification accuracy on a 3.2 million-image dataset with 99.5% less manual annotation, indicating the vast opportunities to realize increased efficiency (Norouzzadeh et al., 2021). As a practical example, one of these nature reserves might be able to deploy hundreds of intelligent cameras that detect animals in near-real time, and automatically store validated species names, counts, and timestamps to a centralized database.

Parallel to visual monitoring, passive acoustic monitoring has emerged as a critical tool for assessing ecosystem health. This method uses special microphones to record environmental soundscapes, capturing the acoustic patterns of the ecosystem. Using machine-learning models, like convolutional neural networks, scientists can analyze large volumes of audio data to recognize and identify the call of a bird, frog, primate, or bat with impressive precision (Moller et al., 2023). This extends beyond mere species-level detection; by evaluating the evolving complexity and richness of a soundscape, AI-powered acoustic indices can predictively monitor ecological recovery, particularly in tropical forests (Muller et al., 2023), demonstrating soundscape analysis to be a non-invasive indicator of ecosystem health.

Environmental DNA (eDNA) analysis is another transformative method. Recent technology designed to work around direct observation has allowed researchers to collect environmental samples such as water, soil, or air and sequence any microscopic DNA traces left behind by organisms. Consequently, eDNA “has become a sensitive, efficient and non-invasive way to survey biodiversity and has revolutionized this methodology” (Çevik & Çevik, 2025). This approach is particularly well-suited for locating rare, elusive, or invasive species at extremely low population densities, and it can be applied to survey expansive and inaccessible terrain such as deep rivers or dense forests. Although eDNA is known to carry some bias (e.g., due to variable DNA degradation rates), it remains an invaluable addition to traditional survey tools, as it enables the confirmation of the presence or absence of important species.

Most importantly, to provide confidence in the quality of data generated by these various technologies, a layer of integrity and provenance is added at the base of trustworthy data sources using blockchain and similar secure distributed ledgers. Blockchain forms a tamper-proof, time-stamped record log that is decentralized (Ramachandran & Kantarcioglu, 2017; Shukla et al., 2025; Jaquet-Chiffelle et al., 2020). This technology is particularly well-suited for the safe management of wild game data because it is able to create





an immutable audit log that ensures the provenance and integrity of data. This method has already been tested in conservation contexts, such as the WWF Bison Rewilding Project, and can be applied to securely maintain geospatial data while enhancing transparency for both donors and tourists (Dryga et al., 2019). With the help of smart contracts and open provenance models, such systems can perform data trail verification and ensure that malicious alterations cannot occur as long as most network members are honest (Ramachandran & Kantarcioglu, 2018).

Although all these technologies present respective challenges such as high equipment costs, the difficulty of providing power sources in isolated locations, and issues related to data integration and standardization the advent of these tools demonstrates that real-time, digitized, and verifiable observation of biodiversity is becoming increasingly possible and scalable.

### The Eco-Credibility Model

Immediately on this body of technology, the Eco-Credibility model suggests an integrated business model in which verifiable online species logs are explicitly, digitally converted into actual economic incentives for conservation projects. In its simplest form, the model requires a protected area, conservancy, or community project to install an encircling smart monitoring network, using AI-capable cameras, acoustic recorders, and routinely deployed eDNA sampling points. The data from these sources are aggregated and funneled through secure platforms that create timestamped, georeferenced evidence of species presence. This raw data is then validated, either through automated consensus algorithms, AI-driven review, or expert verification, and logged on an immutable ledger. The resulting output is a certified, dynamic record of the site's biodiversity a credential attesting that the ecosystem is thriving with life, which can then be marketed to a variety of stakeholders.

This validated biodiversity credential becomes the central asset for attracting investment through three primary channels. First, it enables the creation of a premium, ethical tourism market. Tour operators can move beyond generic promises and instead advertise guaranteed, recent sightings of rare or charismatic species, substantiated by a public-facing dashboard with photos, sound clips, or even real-time live-streams from the field. Imagine a scenario where a wildlife lodge can show prospective visitors a dashboard confirming that tigers, river dolphins, or great hornbills have been sighted within the last 48 hours. This level of proof would dramatically boost the appeal for serious wildlife enthusiasts, who are often willing to pay more for authentic and verifiable experiences.

Second, the model directly addresses the increasing demand from grant-making bodies and philanthropic donors for projects with measurable, data-driven outcomes. Conservation projects equipped with a digital, transparent audit trail of their impact for example, showing the return of a key indicator species or increased habitat utilization following a restoration effort are far more competitive for funding from major foundations, governments, and international aid agencies. The Eco-Credibility logs provide the unambiguous proof of performance that is often the missing link in grant applications.

Third, and perhaps most innovatively, the model provides the foundational data layer required for the issuance and sale of biodiversity credits. Functioning as an analogue to carbon credits, a "bio-credit" represents a quantifiable and verified unit of conservation gain, such as the restoration of one hectare of habitat to a state that supports a proven level of species diversity. Corporations seeking to build nature-positive brands, fulfill ESG commitments, or voluntarily offset their ecological footprint could purchase these credits to demonstrate tangible environmental stewardship (Biodiversity Credit Alliance, 2023). The primary obstacle to the global biodiversity market has been the lack of a standardized and credible verification system. The Eco-Credibility model's immutable logs provide precisely the audit trail needed to ensure these credits represent real, on-the-ground ecological value.

To illustrate this framework, consider two potential pilot projects in Pakistan:

- **Indus River Dolphin Sanctuary:** The endangered Indus River Dolphin could be monitored using a combination of satellite tags and a network of underwater acoustic sensors placed in key river stretches. Real-time tag data and sonar detections of dolphin vocalizations would be logged on a



secure, perhaps blockchain-based, platform, verifying their presence and movement patterns within the sanctuary. This verified data could then be used to market exclusive, low-impact eco-tourism boat trips. Furthermore, this continuous data stream, as envisioned beyond the initial scientific goals of WWF-Pakistan's tagging efforts (WWF-Pakistan, 2022), could demonstrate to corporate donors and government agencies that conservation measures, such as pollution control or the restoration of riparian habitats, are directly benefiting the dolphin population, thus making it easier to secure long-term funding.

- **Margalla Hills National Park:** This Park, a critical biodiversity hotspot on the edge of a major city, could deploy a network of AI-powered camera traps along its hiking trails and deep forest paths. These cameras would confirm the presence of key species like the common leopard, pangolins, and the rich avian fauna, which includes over 117 resident and migratory bird species (Aslam & Yasmeen, 2021; Hadi, 2022). The Park also hosts a significant diversity of herpetofauna, with at least 27 reptile and 7 amphibian species recorded across its varied habitats (Rais et al., 2021). All of this data could be managed and analyzed on a global platform like Wildlife Insights, which uses AI to automate species identification and data management (Thau et al., 2019). The resulting verified biodiversity dashboard could be used to justify enhanced park entry fees for specialized wildlife tours, attract corporate sponsorships for trail maintenance, or support applications for municipal "green city" grants.

These pilots exemplify the model's core logic: collect digital evidence of wildlife, certify its integrity, and monetize that credibility. By making biodiversity data transparent and accessible, the model also serves as a powerful antidote to "greenwashing," building trust among consumers, investors, and local communities that investments in nature are delivering real and lasting benefits (Biodiversity Credit Alliance, 2023).

#### **Systemic Constraints and Ethical Risks**

Despite its transformative potential, the Eco-Credibility model is fraught with serious systemic constraints and profound ethical risks that must be proactively addressed for its responsible implementation. A primary concern is the potential for data misuse, particularly the risk that openly sharing animal location data could inadvertently aid poachers and illegal wildlife traffickers. The conservation community has long grappled with this "poacher's dilemma." In a well-known case, Australian officials deliberately withheld precise location data of a rediscovered night parrot to shield the critically endangered species from collectors (Pain, 2018). The decision-making framework developed by Tulloch et al. (2018) provides a useful guide: if publishing data is likely to heighten the risk of exploitation as with fish spawning aggregations or the exact nesting sites of rare fauna—then that data should be aggregated, obscured, or withheld from public view. Any application of the Eco-Credibility model must therefore incorporate robust safeguards, such as masking precise GPS coordinates for sensitive species, introducing time delays for public data release, and implementing tiered access controls, thereby ensuring the privacy of the species it aims to protect.

A second, equally pressing concern is the danger of digital colonialism. Many of the high-tech monitoring solutions are developed and controlled by institutions in wealthy, Global North countries. If Western conservation organizations or tech companies impose these AI-driven monitoring systems in developing regions without genuine partnership and community co-design, they risk perpetuating a modern form of "data colonialism." This entails extracting local environmental data and knowledge for external benefit without ensuring equitable benefit-sharing or control for the local communities who are the primary stewards of these ecosystems. To be ethical, the model must be inclusive by design. Local and indigenous communities, who often possess generations of traditional ecological knowledge, must be empowered as partners with control over how their environmental data is collected, governed, and utilized (Vizzuality, 2025). Their consent, participation, and leadership must be a central component of any project, not a peripheral consideration, to uphold data sovereignty and ensure the model empowers rather than alienates its most important stakeholders.

Finally, the inherent challenges of algorithmic bias and the digital divide must be carefully managed. Machine-learning models trained predominantly on wildlife from one continent may perform poorly when



tasked with identifying species elsewhere, leading to inaccurate biodiversity logs and flawed conservation insights. This technology has the potential to erode the credibility that the model seeks to establish. More importantly, the implementation of sensor networks depends on infrastructure such as stable electricity and internet connectivity, which is still limited in the most remote and biologically diverse regions. This poses a risk of deepening the digital divide, with parks in affluent areas often better funded becoming digitally advanced and able to monetize biodiversity resources, while under-resourced parks fall increasingly behind. Addressing this requires a commitment to developing open-source, locally adaptable AI models and ensuring the equitable distribution of funds and capacity-building initiatives, so that technology transfer remains inclusive and empowering.

In summary, data carries significant responsibility in addition to power (Tulloch et al., 2018). The effectiveness and legitimacy of the Eco-Credibility model depend entirely on its ability to incorporate ethical design and practices: safeguarding sensitive information, fostering collaboration between governing bodies and local communities, and ensuring equitable access to technology. Through the integration of innovative tracking methods and robust ethical safeguards, digital biodiversity data can serve as a powerful engine for ecological recovery and restoration.

## Conclusion

The history of modern conservation is too often a story of conflict; a steady uphill fight over resources against the relentless destruction of habitat and extinction of species. This battle is exacerbated by a failure of the global market: biodiversity, as one of the most valuable global assets, is seen as an externality without any price tag; therefore, it becomes invisible in mainstream economic processes. To rectify this failure, this review proposes the Eco-Credibility model as one strategic framework to address the invisibility of biodiversity in markets. Through a suite of digital tools such as AI-powered cameras and blockchain-verified ledgers, biodiversity will be made visible, verifiable, and economically valuable.

The model's advantage is the alignment of incentives. It forms a direct, physical linkage between verified ecological well-being and long-term financial returns. Using mechanisms such as high-quality ecotourism, results-based grant funding, and the innovative new market in biodiversity credits, conservation moves beyond the issue of infinite cost to becoming cost-neutral or cost-beneficial. With a transparent, certified, and continuous flow of data, the health of an ecosystem becomes its greatest investment argument. Whether it is a scientific fact or not, the confirmed existence of a thriving community of species is no longer a purely scientific phenomenon but a marketable asset that attracts investment, generates economic activity, and compensates responsible management.

However, this technological optimism should be tempered with ethical vigilance. The route to the monetization of nature is fraught with dangers, including the potential misuse of biodiversity data by poachers, the reproduction of colonial power dynamics, and the development of a new digital divide in conservation. Thus, the Eco-Credibility model can be successful not only in its technological advancement but also in its ethical soundness. These risks can be addressed by focusing on species privacy, ensuring that data sovereignty principles are embedded, and by actively addressing technological bias.

Finally, the Eco-Credibility model is not merely a new source of funding but a paradigm shift in how we understand and engage with nature. It provides a way forward toward developing a regenerative economy where the measure of ecological health is as meaningful as the measure of financial health, and investments in nature yield ecological and economic returns. By rendering the value of nature visible to the market, we are able to unlock private capital and public will to cherish and repair nature for many generations to come.

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