# The business case for investing in biodiversity data

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## Author contributions

FH conceptualised the paper. FH, JN, CA, APD, ME, AH, VJ, OVP, RMG, FR, FR and TR took part in workshop discussions that further developed the framework and ideas throughout the manuscript. FH created the financial model for private-sector investment towards biodiversity data. FH drafted the manuscript, and all authors contributed critically to writing all drafts.

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## Conflict of Interest

David M. Baker and Fabian Roger are affiliated with nature-tech companies (Archireef and DNAir AG, respectively) which are used as case studies in this article. These affiliations are disclosed in the interest of transparency. The authors declare that these relationships have not influenced the objectivity or integrity of the manuscript.


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# The business case for investing in biodiversity data

## Abstract

1. There is urgent demand for biodiversity data driven by the need to assess impacts, dependencies, risks, and to implement nature-based solutions. In a data-driven economy, without access to robust data and the tools built from it, public and private sector actors cannot reliably evaluate their relationships with biodiversity or the outcomes of any sustainable nature-positive intervention.
2. We identify three key barriers to effective biodiversity action: (1) the lack of biodiversity data; (2) limited biodiversity data literacy and the domain expertise required to apply data products in decision-making; and (3) the limited financing facilitation to channel capital, particularly from the private sector, toward reliable, high-impact open biodiversity data.
3. Building on this, we present a streamlined end-to-end framework of the key stages from biodiversity data to nature-positive action, mapping biodiversity data to data products and business use cases, establishing biodiversity data as a critical investment.
4. First, we explain the origins of primary biodiversity data and the interdependence of specimen-based primary biodiversity data with data generated from new technologies including environmental DNA, computer vision and acoustic monitoring. These, collectively feed open biodiversity infrastructures like the Global Biodiversity Information Facility (GBIF).
5. Then, we discuss biodiversity data products, focusing on the ability to interpret and effectively apply biodiversity models, metrics, and tools in relevant contexts. We address the challenges posed by the complexity of biodiversity, the importance of its definitions, and the use of aggregated metrics for biodiversity and ecosystem services in reporting, including the role of nature-tech. We show case studies from a finance-academia partnership, multinational industry, a tropical biodiversity hotspot and nature-tech to illustrate both progress, gaps and opportunities.
6. Finally, we propose an innovative blended financing model to incentivize and reward direct investments in biodiversity data from multiple sources, with specific attention to business and private capital funds. We conclude that investing in biodiversity data is the urgent step in enabling nature-positive action and driving scalable, data-driven solutions to the biodiversity crisis.

## Key words

Biodiversity data, Business and biodiversity, blended finance, data mobilisation, financing biodiversity, Sustainable Finance, Global Biodiversity Information Facility (GBIF), Natural History Collections, Nature-tech, Nature-based Solutions

## Introduction

Biodiversity underpins ecosystem functioning and the flow of nature’s contributions to people, including climate regulation, clean air and water, food security, and disease control (Díaz et al., 2018; Mace et al., 2012). However, anthropogenic pressures including land-use intensification, pollution, invasive species, and climate change are driving rapid biodiversity loss, threatening planetary boundaries (Steffen et al., 2015). This degradation is not only ecological but economic. Despite mounting evidence, the 2024 Global Risks Report by the World Economic Forum suggests that biodiversity risks will only become significant in the next decade (WEF, 2024), downplaying the present-day severity of the crisis. Biodiversity loss is already costing the global economy over $5 trillion per year (Ranger et al., 2023). Despite this, there is still persistent underinvestment in high-quality biodiversity data that is essential for developing urgent, data-driven solutions of national and international importance (Gerber & Iacona, 2024). This neglect reflects a fundamental failure of economic, environmental and social governance and long-term planning for future generations.

In parallel, global policy and regulatory landscapes are evolving to mainstream biodiversity into financial and business decision-making. The Kunming-Montreal Global Biodiversity Framework (GBF), agreed at COP15, marks a turning point, with Target 15 requiring large businesses and financial institutions to assess and disclose their biodiversity-related impacts, risks and dependencies across operations, supply chains, and portfolios (COP15, 2022). In the EU, the Corporate Sustainability Reporting Directive (CSRD) mandates environmental reporting for nearly 50,000 companies by 2025 (Faqih & Kramer, 2024). Voluntary frameworks are also gaining momentum. The Taskforce on Nature-related Financial Disclosures (TNFD), now supported by over 500 organisations representing £17.7 trillion in assets, is developing guidance for integrating nature into financial decision-making (TNFD, 2024). Similarly, the Science Based Targets Network (SBTN), originally focused on climate, has expanded its scope to include biodiversity (SBTN, 2020). These frameworks aim to channel capital toward nature-positive solutions and encourage companies to embed biodiversity into sustainability strategies, just as the Paris Agreement catalysed corporate climate targets (Allen et al., 2025). Yet while these frameworks represent progress, their implementation relies heavily on the availability, accessibility, and interpretability of biodiversity data.

Without high-quality biodiversity data, neither companies nor policymakers can assess impacts, dependencies, risks, or implement effective nature-based solutions. This challenge is particularly acute because, unlike carbon accounting, where standardised units like $CO_2$-equivalents enable comparability, biodiversity lacks a unified metric (Jones & Solomon, 2013). Biodiversity data is multidimensional, spanning genetic, species, and ecosystem diversity, and is highly context-dependent (CBD, 2011; Exposito-Alonso et al., 2022). Essential Biodiversity Variables (EBVs) are an example of metrics developed to aid sustainability reporting on biodiversity (Pereira et al., 2013). Yet, these metrics are often derived from top-down approaches that rely on indirect data, which can be biased, incomplete, difficult to verify, and therefore misleading, highlighting the need for reliable, ground-truthed biodiversity data (Granqvist et al., 2025). Even seemingly simple metrics, such as species richness, can be misleading without appropriate ecological context (Hillebrand et al., 2018). It is little wonder that uncertainty persists as biodiversity models and metrics continue to evolve, with over 2,000 metrics currently available, their utility remains closely tied to the quality of underlying data (Burgess, 2024). Businesses, facing rising sustainability disclosure requirements, are increasingly turning to the Global Biodiversity Information Facility (GBIF), the largest biodiversity data infrastructure with over 2 billion records, to report on their biodiversity impacts, dependencies, risks, and implement effective nature-based solutions. This makes sense, as GBIF is the leading infrastructure for biodiversity data, and feeds into our global biosphere earth system models. However, it is important to have the domain knowledge to recognise that these data may not be suitable for use, particularly since they are unevenly distributed due to historical taxonomic and geographic biases in data collection, with 65% representing birds, which comprise only 0.5% of described species (GBIF, 2025; Troudet et al., 2017). Urgent investment towards biodiversity data collection and mobilisation is essential to expand the coverage and quality of open biodiversity data, enabling key stakeholders across both public and private sectors to make evidence-based decisions.

To achieve this, a concerted science communication effort is needed to clarify the biodiversity data pipeline: from data origins to usable products and business use cases (Figure 1). Yet, to our knowledge, no streamlined framework currently exists, risking the integrity of the pipeline. At the foundation of reliable biodiversity data lie often-overlooked natural history collections, including museums, herbaria, specimen repositories, and seed banks, that support species verification, biogeographic checklists, red-list assessments, and GBIF data uploads (Huybrechts et al., 2022; Mason Heberling et al., 2021; Davis, 2023). These collections provide critical data for emerging technologies such as eDNA reference libraries and training data for machine learning models, enabling advances like rapid eDNA assessment, remote sensing, acoustic monitoring, and computer vision to make biodiversity data collection faster, cheaper, and easier (Beery, 2023; Buxton et al., 2018; Deiner et al., 2021; van Klink et al., 2022). Another major barrier to progress remains the long-standing taxonomic impediment: a global shortage of taxonomists due to lack of funding prioritization and a critical bottleneck that limits our ability to understand and monitor biodiversity (Engel, 2021; Löbl et al., 2023). As demand for biodiversity data grows, organisations like the Nature Tech Collective, TNFD, and WWF have started to draw attention to the "biodiversity data gap," highlighting the importance of careful interpretation of biodiversity data (Goran, 2024; TNFD, 2024; WWF, 2024). Nature-tech experienced rapid growth as a response, and platforms have also proliferated, repackaging open-access data from GBIF behind paywalls, which attracted over USD 2 billion in investment in 2022, growing 52% annually since 2018 (Evison et al., 2022; Goren, 2024), reflecting strong investor interest. Yet, without stewarding the very foundation of the biodiversity data pipeline and channeling our resources to financing of biodiversity data (Figure 1), discovery of solutions to the biodiversity crisis stands on a crumbling foundation, leaving us blind to impacts, risks, and the success of nature-based solutions.

Limited biodiversity data remains a critical barrier to effective conservation, constraining both policy and investment decisions. This data gap parallels a persistent financing shortfall: only one-sixth of the required annual funding is currently met. While most biodiversity finance comes from public sources, private capital, accounting for less than 20% holds significant untapped potential to help bridge both the data and financing gaps essential for sustaining biodiversity (Beverdam et al, 2025). Addressing the biodiversity data gap requires channelling financial resources towards strengthening existing infrastructures like GBIF rather than duplicating efforts and fragmenting data. Without transparent biodiversity data and metadata, clear provenance, and proper validation, businesses that use these platforms risk producing unmeaningful analyses that jeopardize their operations. Biodiversity data and infrastructure are not just tools but valuable, investable assets with demonstrated returns: every €1 invested in GBIF generates an estimated €3 in direct user benefits and up to €12 in broader societal biodiversity impact, with clear implications for business value (Deloitte, 2023). Despite advances ushering in a new era of tools to collect big biodiversity data (Musvuugwa, 2021), financing models to support the large-scale collection and mobilisation of biodiversity data essential for generating high-quality, findable, accessible, interoperable, and reusable (FAIR) data (Wilkinson et al., 2016) remain scarce. Mobilising financial resources across sectors, particularly private finance, and developing blended finance models are urgent to enable evidence-based, sustainable solutions and to avoid greenwashing, reputational harm, and ineffective strategies for climate mitigation and adaptation (Mair et al., 2024;

Ingram et al., 2024; Smith et al., 2019; White et al., 2023). The urgency is amplified by emerging markets developing for nature-based credits, which must be data-driven to avoid irreversible harm (Swinfield, 2024). Recognising biodiversity data as a vital, investable public–private good will enable more accurate biosphere earth system modelling, forecasting biodiversity trends, reveal ecological and economic links, and drive transformative business action towards sustainability.

In this paper, we (1) present a framework for integrating biodiversity data into business use cases, (2) clarify the origins of primary biodiversity data, and (3) propose a blended innovative financig model that connects private capital to high-impact biodiversity data generation and mobilisation via a biodiversity data facilitator through open infrastructures such as GBIF. In doing so, we argue that the business case for investing in biodiversity data lies in its ability to unlock the value of information, enabling private and public sector actors to better address biodiversity impacts, dependencies, and risks, and to implement data-driven nature-based solutions for long term sustainability.

## An end-to-end framework from biodiversity data to business use cases

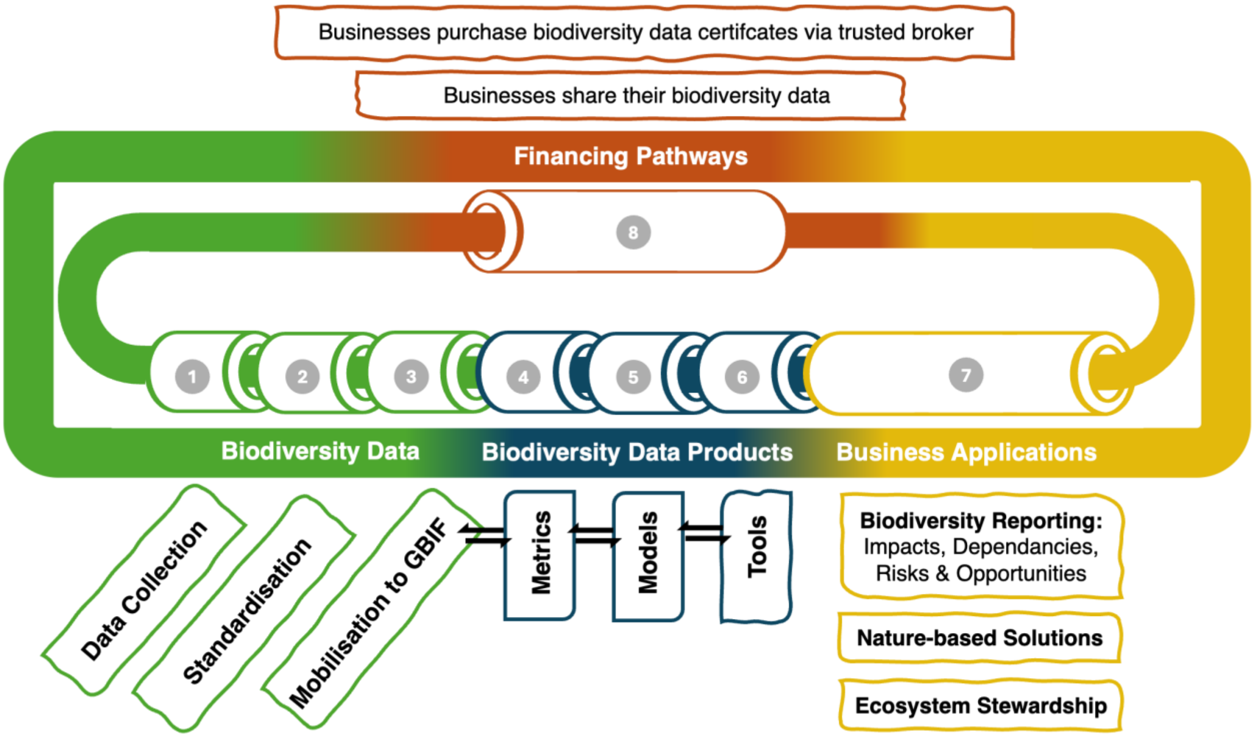


**Figure 1.** Framework for integrating biodiversity to business use-cases, grounded in data. This pipeline clarifies the steps to get from biodiversity data to biodiversity data products to business use cases. The process begins with biodiversity data (green), divided into three key components: (1) collection of biodiversity data from both the field and natural history collections using traditional and new technologies; (2) standardisation of this data in alignment with FAIR data principles and the biodiversity information standards (TDWG); and (3) mobilisation of these data into the Global Biodiversity Information Facility (GBIF), the world's largest biodiversity data repository. The next step involves biodiversity data products (blue), where biodiversity domain knowledge is needed to translate raw data into (4) biodiversity metrics (e.g., EBVs); (5) models and predictive models; and (6) data tools for users, which are iteratively updated as new data become available. This biodiversity expertise has traditionally been represented by academic research, consultancies, and public environmental agencies, but is increasingly adopted by the rapidly evolving nature-tech sector. Finally, business (yellow) represents the end-users of the data products (7). Important use cases for biodiversity data products include impacts, dependencies and risk reporting, investments in nature-based solutions (NbS) and monitoring of their outcomes, as well as better management practices through ecosystem stewardship. There are two important feedback loops in the framework. First, businesses are encouraged to invest in data collection and mobilisation of these data to the public domain, to improve their reporting and public image (8). Second, we propose a mechanism to incentivise direct investment in biodiversity data mobilization via a

biodiversity data facilitator (9). This flow emphasises that biodiversity data is a central priority of the entire pipeline. Without high-quality biodiversity data, none of the subsequent steps are possible.

## 1 Biodiversity data

To address the biodiversity data gap, we must understand biodiversity data origins and data types. Primary biodiversity data, or occurrence data, constitutes the majority of data published through GBIF (GBIF, 2024) and includes three key components: taxonomic level (e.g., species, genus), location, and date (Spear et al., 2023). Observation- and specimen-based biodiversity data are interdependent and must be prioritized together to address the biodiversity data gaps (Figure 2).

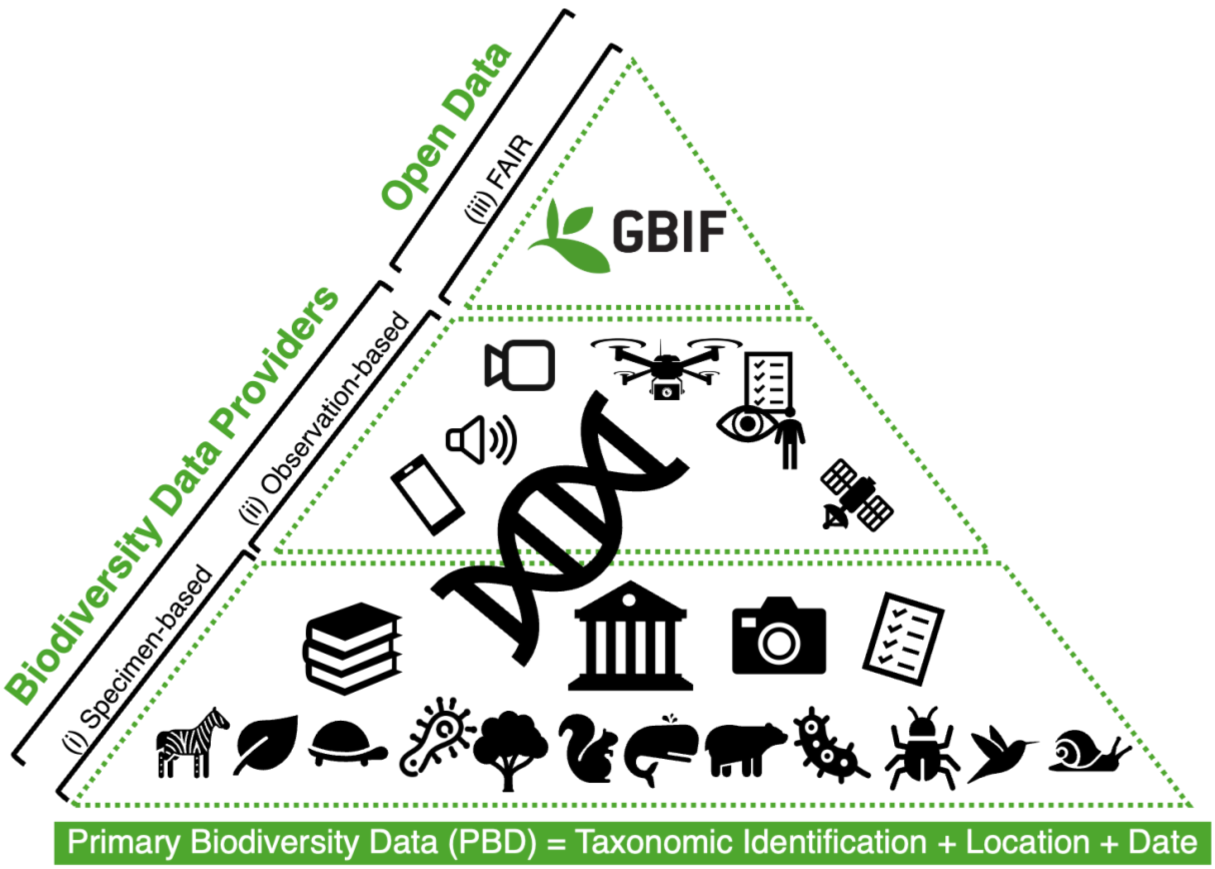


**Figure 2.** Pyramid diagram illustrating sources of primary biodiversity data showing that specimen-based data are foundational to observation-based data, which are foundational to integrated primary biodiversity data. (i) Specimen-based data: Derived from physical specimens in natural history collections, including image files, checklists, and archival materials; (ii) Observation-based data: Derived from traditional species inventories and technologies such as DNA methods, camera traps, audio recordings, and citizen science. DNA methods (eDNA and metabarcoding, metagenomics) overlap with both specimen and

observation data, as they require physical sample collection to generate verifiable species names; and (iii) Mobilised primary biodiversity data: Integrated specimen- and observation-based data on open access biodiversity infrastructure, such as GBIF.

The big data revolution has already expanded biodiversity data, and we are in an excellent point in history to start prioritising resources to fill data gaps in taxa and geographic coverage (Bayraktarov et al., 2019; Musvuugwa et al., 2021; Troudet et al., 2017). Digitisation and AI are accelerating data extraction from specimens in natural history collections, providing temporal biodiversity data. High-throughput systems like ALICE can rapidly digitise insect specimens for upload to GBIF (Dupont & Price, 2019; Garner et al., 2024). Techniques such as Named Entity Recognition (NER) and Optical Character Recognition (OCR) convert label text to digital format, enabling rapid processing of tens of thousands of specimens (Takano et al., 2024). Digitised herbarium specimens provide additional biodiversity data, such as trait data comparable to fresh tissues (Davis, 2023). While significant progress has been made, billions of specimens remain undigitised from European collections alone, requiring continued mobilisation efforts (Huybrechts et al., 2022). New scalable observation-based technologies are transforming biodiversity monitoring. eDNA and metabarcoding enable rapid species detection from water, soil, or air samples are useful for hidden taxa like fungi and insects, potentially completing centuries of manual inventory work in a single year (Deiner et al., 2021; Ronquist et al., 2020). Passive acoustic monitoring captures species sounds, enabling AI-driven species identification across taxa including birds, primates, and even soil organisms (Hildebrand et al., 2024; Buxton et al., 2018). Camera traps and global camera networks offer real-time species monitoring (Bjerge et al., 2021; Steenweg et al., 2017, Høye et al 2021), while citizen science platforms like iNaturalist leverage smartphones to gather data and train deep learning models (August et al., 2015; Beery, 2023). Advanced sensors on drones and UAVs, including thermal, LIDAR, hyperspectral, and RGB, further enhance species tracking and vegetation analysis. These tools enable species-level plant identification and habitat mapping (Larsen et al., 2023; Mäyrä et al., 2021). However, consistent data standardisation is necessary to ensure biodiversity data from diverse sources are actually useful to science and society. Biodiversity data must be curated to meet FAIR principles (Findable, Accessible, Interoperable, Reusable) and align with Open Science practices (Carroll et al., 2021; Wilkinson et al., 2016).

The Biodiversity Information Standards group (TDWG) maintains standards like Darwin Core (DwC), which enables interoperability through standardised terms and vocabularies. Extensions such as the Humboldt Ecological Inventory and networks like DiSSCo further support standardised ecological and specimen-based data sharing. However, integrating big biodiversity data faces challenges with metadata standards for cross-scale analysis (Maldonado et al., 2015; Hardisty et al., 2022). Metadata defines data context, without which we would not make full use of stitching together data from diverse sources. For instance, dnaDerivedData with MIxS provides structured metadata on DNA sampling and sequencing (Abarenkov et al., 2023). The Camera Trap Data Package (Camtrap DP) standardises image data sharing and is being expanded to include insects (Bubnicki et al., 2023). Ecological Metadata Language (EML) also supports detailed documentation across biodiversity datasets. Despite progress, challenges remain: such as data duplication, inconsistent quality, and interoperability issues (Pyle et al., 2021). Taxonomic inconsistencies and errors can be managed through automation and expert validation (ChecklistBank, 2025; Whitley et al., 2024). These advances support platforms like GBIF, which mobilise open-access biodiversity data and bridge data gaps. Motivating data sharing remains difficult. Academic incentives include DOI citations and data papers, while businesses are beginning to see strategic value in sharing data. Companies can publish data via GBIF's Integrated Publishing Toolkit (IPT), usually free, and track impact through assigned DOIs and UUIDs (Case Study S2). Nonetheless, the business sector currently contributes only 0.3% of GBIF records, indicating a opportunity for greater engagement.

## 2 Biodiversity data products

There is a growing demand to transform raw biodiversity data into metrics and data products that can cater to diverse use cases and needs across different industry sectors (Burgess et al., 2024). This task requires reducing the complexity of biodiversity into manageable metrics, which arguably is an exercise of great oversimplification, yet a necessary one. With this inherent constraint in mind, we reflect on several issues in the current state-of-the-art of biodiversity reporting and the underlying data-products.

In the context of biodiversity impact reporting, data products that provide regional or global heatmaps of biodiversity metrics are in high demand, as they allow easy area-based calculation of biodiversity value and impact. One example of such a data product is the Biodiversity Intactness Index (BII, Newbold et al., 2015; Phillips et al., 2021), which is proposed as a component indicator in the COP 16 draft of the GBF monitoring framework (CBD, 2024). Another example of a biodiversity model used in business context is GLOBIO (Schipper et al, 2020), also proposed as a GBF indicator (CBD, 2024). However, many of such global heat maps generated (Myers et al., 2000) are only weakly linked to the evaluation of the biodiversity impact of *specific decisions and actions*. For biodiversity data products to be actionable in a corporate setting, they need to relate biodiversity impacts and risks to operational and financial decisions taken by companies, so that impact tradeoff analysis can be performed. Examples include spatial planning for forest and agricultural land management, deciding from which countries and regions to source materials and products, and investments into new factories and logistics facilities. A common denominator for many use cases is the urgent need for regional and local data and models (as opposed to global) to ensure high-quality analysis and drawing the right conclusions.

While the BII and other similar data-products are being used for company impact assessment and reporting, a concern raised is that the underlying models are largely untested for their predictive performance and their agreement with other indicators of biodiversity impact (Martin et al., 2019, Nyström, 2024). We see a big risk that insufficiently tested data products provide the foundations for company impact reporting and nature investments, with potentially negative consequences. This problem is further exacerbated by the quickly developing nature tech market, driven by the demand for attractive, ready-to-use biodiversity solutions and data. The absence of a thorough quality-checking and peer-review process in this context lends reason for concern and makes it difficult for customers to distinguish between "snake-oil salesmen" with questionable data products and those built on solid foundations. However, as outlined above, even models and data products that have been reviewed by the academic peer-review process, risk being mis-applied for purposes they were not designed for. Part of the reason for this misapplication is a lack of guidance on the use of existing and emerging biodiversity data products and metrics, which we identify as the challenge of biodiversity data literacy.

Despite best efforts regarding methodological considerations and quality assessments, data products are only as reliable as the data they are derived from. At present, the biggest bottleneck to better biodiversity models is arguably the lack of contextualized data, particularly in view of the vast taxonomic and spatial biases that exist. Closing the biodiversity data gaps is critical for enhancing the accuracy and reliability of biodiversity metrics for business use cases.

# 3 Business use cases

**Improved biodiversity impacts, dependencies and risk reporting**

Businesses face increasing demands to assess and disclose biodiversity impacts, dependencies, and risks under regulations such as the EU Corporate Sustainability Reporting Directive (CSRD) and frameworks like the Taskforce on Nature-related Financial Disclosures (TNFD) (Figure 1). Meeting these requirements needs long-term investment in high-quality biodiversity data to develop reliable data products and metrics that support science-based targets and withstand regulatory and investor scrutiny (ESRS E4, 2023). Current biodiversity data gaps and biases undermine the accuracy of risk assessments. The TNFD's 2023 scoping study identified existing "nature data" as outdated, inconsistent, and insufficiently detailed for confident decision-making (TNFD, 2023). Addressing these deficiencies requires sustained investment in biodiversity data collection, standardisation, and mobilisation to improve data accessibility, comparability, verifiability, and assurability. Initiatives like the proposed "Nature Data Public Facility" aim to leverage platforms such as GBIF to provide decision-useful data products essential for corporate reporting and risk management (TNFD, 2024). Companies proactively investing in biodiversity data collection and publishing primary data on GBIF will enhance transparency and generate credible biodiversity metrics which may be used as key performance indicators in sustainability disclosures. For instance, TotalEnergies has shared over 51,000 biodiversity records from environmental impact assessments since 2019, supporting compliance with the Kunming-Montreal Global Biodiversity Framework (GBF Target 19) and bolstering accountability (Case Study S2; Figueira et al., 2023).

**Nature-based solutions and sustainable ecosystem stewardship**

Nature-based solutions (NbS) require robust biodiversity data to quantify ecosystem outcomes (Seddon et al., 2020; Díaz et al., 2023). Longitudinal biodiversity monitoring underpins the development of data products and metrics that validate NbS effectiveness and enable adaptive management (Griscom et al., 2017; Pettorelli et al., 2021. Across industries, baseline biodiversity data are needed to quantify impacts and inform sustainable resource management. For example, in agriculture, investments in monitoring soil biodiversity, nutrient cycling, carbon sequestration, and water retention allow companies to substantiate claims of regenerative practices such as no-till farming and crop rotation (Case Study S1). Beyond supply chains, NbS projects, such as coral reef restoration (Case Study S4) also depend on high-resolution biodiversity data for baselines, to build on active biodiversity monitoring often obtained through eDNA, remote sensing, and manual efforts. In biodiversity hotspots such as Borneo (Case Study S3), there is significant potential if biodiversity data are effectively mobilised. This would enable the development of data-driven, nature-based interventions that can protect biodiversity, support local communities, and foster a blue-green economy (Ferraro & Hanauer, 2014; Struebig et al., 2015).

Nature-tech companies further leverage these biodiversity data products within innovative technologies to support sustainable development and deliver scalable conservation outcomes (Case Study S4; Watson et al., 2021). Moreover, investment in biodiversity data supports rigorous baseline data for, reporting, and verification frameworks essential for biodiversity credits, offsets, and other market-based instruments (Swinfield, 2024; Aide, 2024). Ensuring transparency and verifiability through data products enhances investor confidence and safeguards the integrity of biodiversity-positive projects (Faqih, 2024; TNFD, 2023). Sustained investment in biodiversity data collection, standardisation, and mobilisation is therefore fundamental to producing credible data products and metrics that underpin NbS efficacy, ecosystem stewardship, and long-term biodiversity conservation (Díaz et al., 2019; Mace et al., 2018; Pettorelli et al., 2021).

# 4 An Innovative Financing Model to Address the Biodiversity Data Gap

Addressing the global biodiversity data gap demands a sustainable financing model that incentivises the large-scale collection, standardisation, and mobilisation of biodiversity data. Biodiversity data certification offers such a solution by linking investment to measurable contributions in data generation and sharing. With this blended finance model, combining public, private, and philanthropic capital allows for targeted investment in biodiversity data and data infrastructures by reducing risk and aligning incentives across sectors (Flammer et al, 2025; Beverdam et al, 2025). It is particularly well-suited to financing the mobilisation of biodiversity data in regions and ecosystems where private capital alone is insufficient, such as the tropics (Case Study S3). This framework provides businesses and investors with certified recognition, while securing sustainable financing for data providers to contribute high-quality open-access biodiversity data via GBIF.

For example, the proposed biodiversity data certification model will offer a verifiable, data-driven mechanism to assess and demonstrate positive biodiversity impact. By linking investment to certified biodiversity data contributions, it reduces greenwashing risks and enhances transparency, enabling investors to allocate capital more effectively towards nature-positive outcomes. For instance, the Swedish MISTRA FinBio programme is developing eDNA monitoring and standardised data protocols for reliable biodiversity metrics that inform financial decision-making in agriculture and land management (Case Study S1). The project will publish its data to GBIF, ensuring open access and long-term utility, but once these methods are used, the biodiversity data facilitator can support the long-term biodiversity data mobilisation of these sites and other farms that will participate in biodiversity monitoring. Embedding biodiversity data stewardship with ecosystem stewardship to investment frameworks can show how the certification model can strengthen accountability and drive credible, impact-focused in the finance sector. TotalEnergies, a multinational company, already publishes biodiversity data from their environmental impact assessments directly to GBIF (Case Study S2). By leveraging in-house expertise and adhering to FAIR principles, the company exemplifies how private sector actors can integrate biodiversity data mobilisation into corporate sustainability frameworks, producing verifiable key performance indicators (KPIs) (Case Study S2). However, many companies may lack the capacity for employing internal data management, highlighting the need for a biodiversity data facilitator to broaden and incentivise private sector contributions to open biodiversity data (Figure 3).

The innovative financing model is particularly crucial for Earth's biodiversity-rich regions such as the tropics, where data gaps remain vast despite immense ecological importance. In Sabah, Malaysian Borneo (Case Study S3), decades of ecological research and millions of dollars from private sector stakeholders, including SimeDarby and IKEA, have generated extensive biodiversity data that remain largely inaccessible or unpublished on GBIF. Mobilising these data through certified financing can unlock valuable insights for sustainable land management and conservation, supporting both biodiversity and employment in local communities. Similarly, in the blue-green economy, nature-based solutions like those developed by Archireef - a nature-tech startup focused on coral reef restoration (Case Study S4) - demonstrate the potential for data-driven approaches to drive scalable ecosystem restoration and biodiversity monitoring. Innovative financing models can also support early-stage companies, such as Archireef, in sustaining their nature-positive impacts by funding efforts to mobilise and enhance biodiversity data. Ultimately, this financing model protects the reputational integrity of both investors and data providers. It mitigates greenwashing, strengthens ESG action, and positions biodiversity data as a strategic asset for long-term sustainability. Together, these cases illustrate how targeted, verifiable sustainable blended financing can accelerate biodiversity data mobilisation and support nature-positive outcomes in critical terrestrial and marine ecosystems.

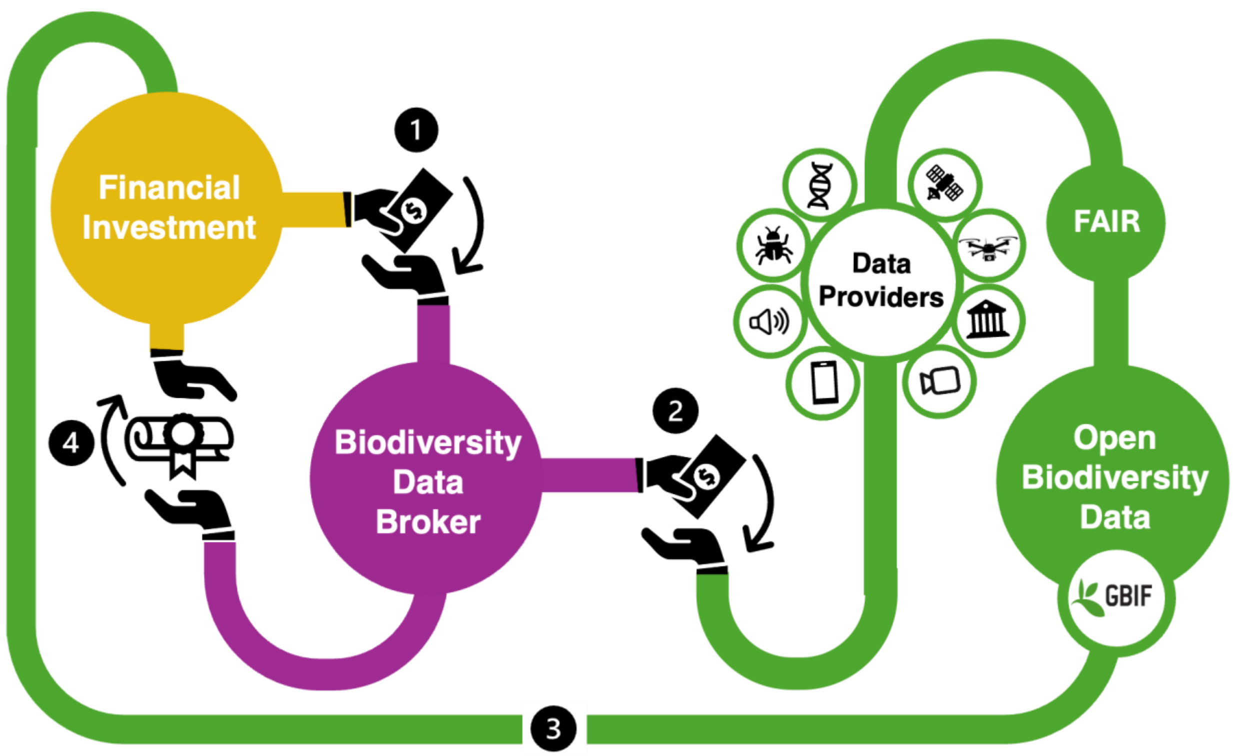


**Figure 3.** Innovative financing model for bridging the biodiversity data gap: (1) Private sector and other financial investors (yellow) provide funding to the biodiversity data facilitator (purple) to support data mobilisation; (2) the biodiversity data facilitator allocates these funds to partners for biodiversity data

collection, advancement of data standards, and mobilisation of data onto GBIF; (3) biodiversity data mobilised from all investors is made openly available on GBIF, allowing private sector and other investors to download and monitor their biodiversity impact; and (4) in return, businesses receive biodiversity data certification, providing verification of their positive biodiversity impact.

## 5 Summary and call-to-action

The biodiversity crisis exposes material impacts, dependencies, and risks for the private sector, compounded by persistent failures of governance and underinvestment in biodiversity data. Despite advances in technology and open infrastructures like GBIF, critical data gaps undermine effective nature-based solutions. We call on businesses to lead in financing biodiversity data collection and mobilization through an innovative blended finance model. This approach reduces reputational risk, enables informed decision-making, and strengthens long-term sustainability for both business and nature.

# Supporting Information

## Case study S1. Biodiversity data for financial metrics: MISTRA FinBio, Sweden

**Figure S1.** Photo of Malaise traps in pilot fields, taken by E Granqvist May 2024.

As part of the FinBio Research program hosted at the Stockholm Resilience Centre (FinBio, 2023), the "Biodiversity Data for Financial Metrics" work package aims to connect biodiversity data to financial decision-making to support financial institutions in contributing to biodiversity and nature-positive outcomes, particularly in Sweden and the Nordics. FinBio operates as a collaborative partnership between academic and financial institutions, bringing together academic and impact partners to develop practical tools that guide investment decisions, promoting both the greening of finance and the financing of green initiatives that can be adopted throughout the financial sector. Specifically, the “Biodiversity Data for Financial Metrics” work package focuses on the application of modern monitoring technologies such as environmental DNA (eDNA) and Earth Observations for assessing biodiversity impact. This includes methods for assessing Essential Biodiversity Variables (EBVs) using standardised eDNA collection from Malaise traps and soil samples, with laboratory and bioinformatic protocols, accuracy measurements, and abundance estimation, with trend analyses covering a five-year period in Sweden. One pilot project, in collaboration with Svensk Kolinlagring - a non-profit organization - connects stakeholders to improve soil health and increase carbon storage in Swedish agricultural soils. The project works with approximately 40 farms and focuses on measuring farmland biodiversity as part of its efforts to enhance carbon sequestration, which the IPCC recognizes as one of the most cost-effective and scalable climate solutions. The project aims to deliver several key outcomes, including biodiversity data from the agricultural sector using eDNA monitoring methods, analysis of biodiversity changes in carbon sequestration management systems, and the development of a standardized data-driven biodiversity index for farmers. This index will serve as both a measurement tool and a component of potential business cases to attract investment in sustainable agricultural practices. Open data and open methods are core principles within the Biodiversity Data for Financial Metrics work package, and the collected pilot data will be shared via GBIF upon completion of the project.

## Case study S2. Total Energies share biodiversity data on GBIF

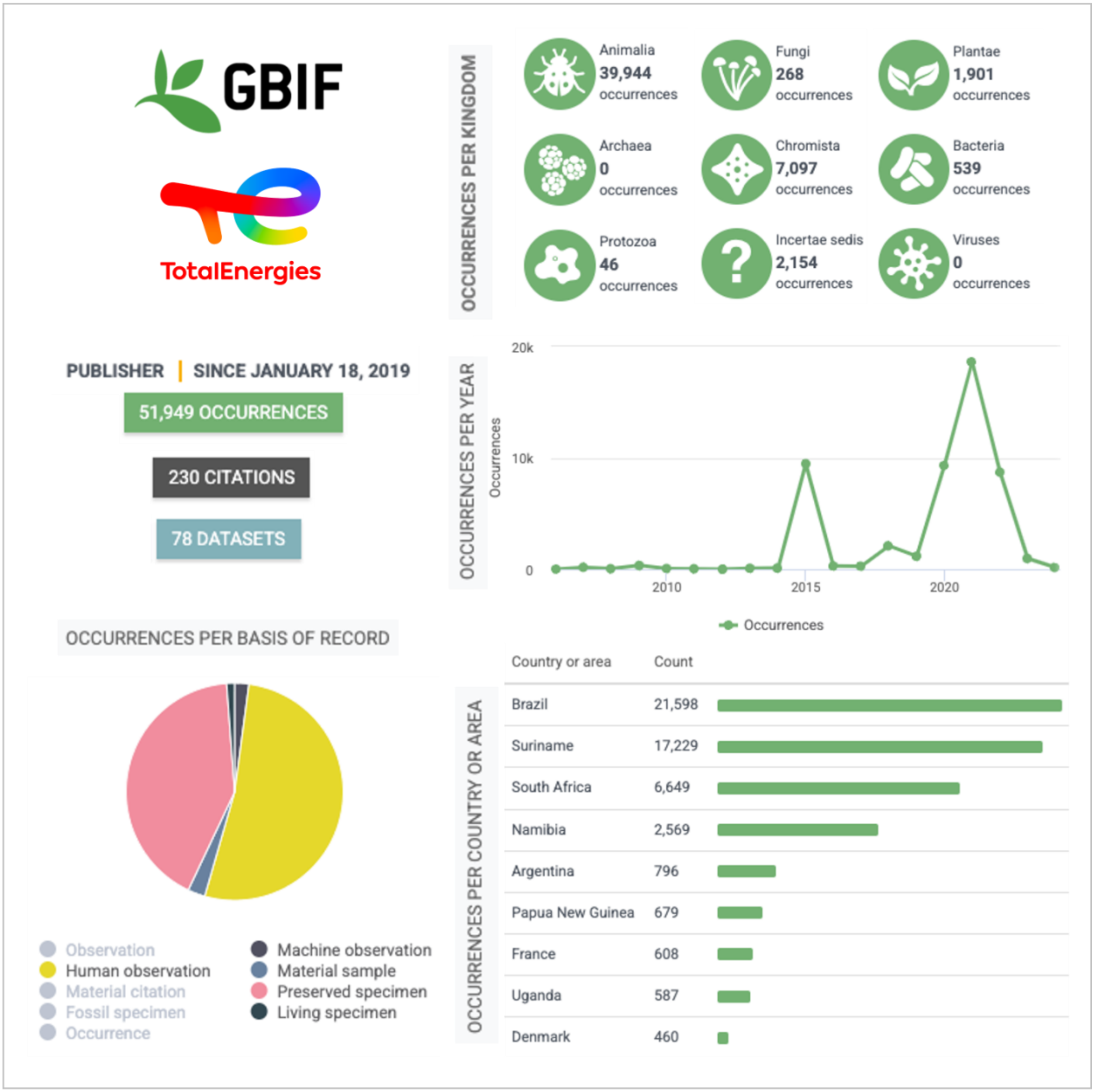


**Figure S2.** TotalEnergies data publisher metrics displayed on their GBIF publisher page, showcasing key performance indicators (KPIs) for company reporting. Metrics include: occurrences per kingdom, occurrences per year, occurrences per country or area, and occurrences per basis of record. These metrics provide insights into data distribution and can be used to evaluate the company's contribution to biodiversity monitoring.

Companies may publish biodiversity data directly to GBIF by establishing institutional agreements and complying with GBIF's Data Publisher and Data User Agreements. Registration as a data publisher requires endorsement from a national GBIF node. The process typically involves collaboration with contractors and field technicians to ensure data and metadata quality. Companies must establish internal workflows, select and prepare biodiversity data according to the DarwinCore (DwC) standard, define access restrictions, and publish under a Creative Commons license.

TotalEnergies is a global energy company operating in 120 countries and became a biodiversity data publisher on GBIF in 2018 to strengthen their long-term biodiversity impact. The company committed to sharing biodiversity data collected through in-house environmental impact assessments, including field surveys in remote and offshore locations, with both the scientific community and the public. By publishing its data to GBIF, TotalEnergies considers it a valuable contribution to global scientific research and international conservation efforts. To date, they have published 51,949 occurrences on GBIF (Figure S2). The company employs a variety of data collection methods, such as sediment, soil, and water sampling, camera transects, and passive acoustic monitoring and opportunistic observations of marine megafauna and birds. These data also include hydrocarbons, metals, microbiology, and benthic fauna—environmental data that allow assessments of habitat sensitivity. TotalEnergies' biodiversity data adheres to GBIF's quality standards by following the DwC standard and FAIR principles. They have committed to contributing data annually from a minimum of five projects or sites to GBIF, with regular reporting on these contributions. By doing so, TotalEnergies enhances its reputation through collaboration with a reputable organization and gains measurable data from GBIF biodiversity occurrences, which they can reference in their sustainability reports.

## Case study S3. The untapped tropical biodiversity data potential in Sabah, Malaysian Borneo

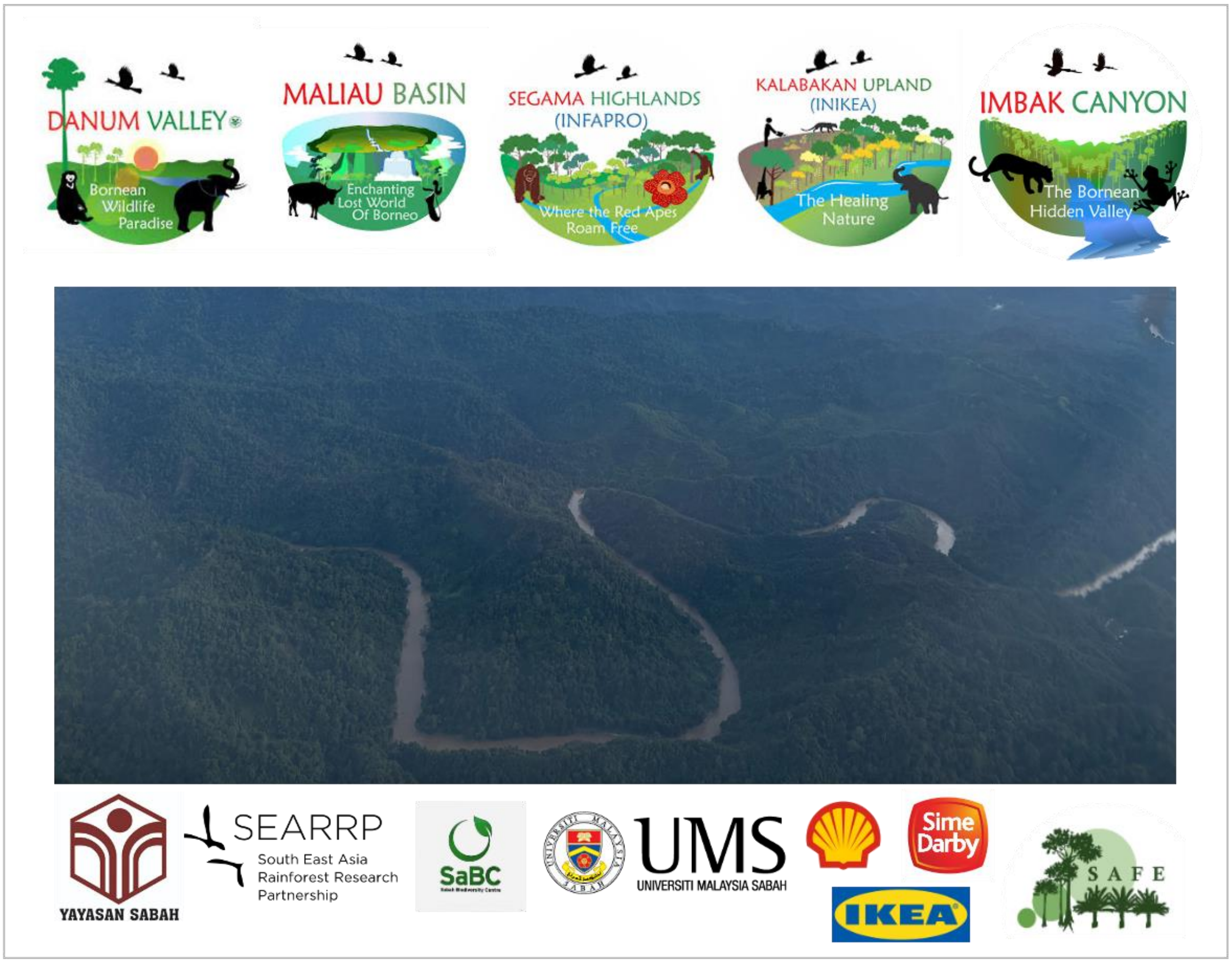


**Figure S3.** Logos of selected conservation areas in Sabah, Malaysian Borneo (top row), with long-term biodiversity data not yet available on GBIF, and key research and conservation stakeholders (bottom row): Yayasan Sabah, SEARRP, Sabah Biodiversity Center, Universiti Malaysia Sabah, Shell, Sime Darby, IKEA and the SAFE Project. Aerial image: lowland rainforest near Lahad Datu, Sabah photo by Fevziye Hasan.

Tropical rainforests around the world are biodiversity hotspots but face intense pressure from logging and agricultural conversion. Sustainable management and informed decision-making using long term biodiversity data, are essential for both conservation areas and agricultural landscapes. Sabah, a Malaysian state on the island of Borneo, contains extensive areas of primary tropical rainforest with high levels of biodiversity and endemism. Over several decades, a combination of institutional, research, and private-sector initiatives has generated substantial ecological and biodiversity data, much of which remains unpublished or inaccessible, especially through GBIF.

The Yayasan Sabah Group (Sabah Foundation), which manages large forest areas, has fostered long-term conservation and research partnerships, notably with the Southeast Asia Rainforest Research Partnership (SEARRP) (see Figure S3). Through these collaborations, they have established permanent research plots, compiled species inventories, and developed long-term ecological datasets — all providing valuable insights into biodiversity changes over time.

One key example is the Sow-A-Seed project, funded by IKEA and launched in 1998 in Kalabakan. This large-scale restoration effort aimed to rehabilitate 18,500 hectares of logged and fire-damaged forest and continued for 25 years. Data from the project demonstrated that tailored restoration techniques, ongoing biodiversity monitoring, and cooperation with forestry operations helped drive ecosystem recovery. The restored area was eventually designated as a Class 1 protected forest, highlighting the success of these efforts (Axelsson et al., 2024).

The *Stability of Altered Forest Ecosystems (SAFE) Project*, funded in part by Sime Darby, the world's largest producer of Certified Sustainable Palm Oil, was one of the largest ecological experiments in the world, lasting over a decade until funding constraints due to the COVID-19 pandemic. The project produced more than 150 datasets covering biodiversity and ecosystem processes across various land uses, including selectively logged forests and oil palm plantations. SAFE's research covers a wide range of organisms, from soil microbes and invertebrates to vertebrates, and includes detailed studies of ecological and biogeochemical processes. While these datasets are publicly accessible on Zenodo, they have yet to be integrated into GBIF.

With a huge value of information for key stakeholders in government, conservation, and business, these two projects have generated hundreds of thousands—possibly millions—of valuable biodiversity data points. This resource holds strong potential to support efforts to protect biodiversity on one of the world's most diverse islands.

Mobilizing Sabah's biodiversity data from past, current, and future research provides a cost-effective way to improve data access and inform conservation and sustainable land management.

Investing in the mobilisation of these data should go hand in hand with supporting conservation and sustainable solutions. Together, these efforts can help ensure long-term biodiversity conservation that benefits people, the environment, and local economies.

# Case study S4. Biodiversity data-driven nature-tech for coral ecosystem restoration

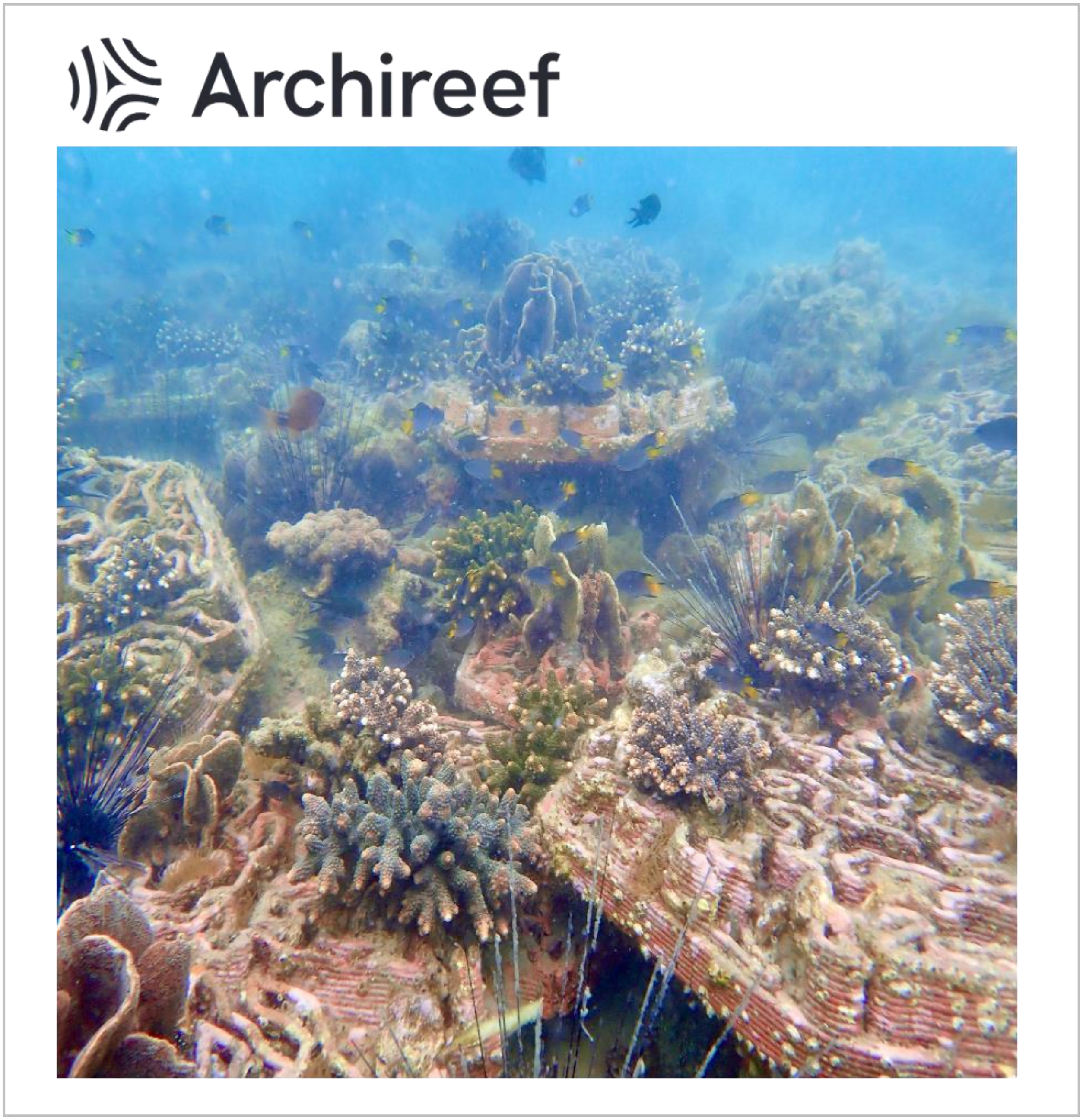


**Figure S4.** Photo of Archireef 3D-printed ceramic Reef Tiles™, photo by David Baker.

Archireef is a pioneering nature-tech startup that spun off from groundbreaking coral restoration research at the University of Hong Kong. As a new nature -tech company using GBIF data, Archireef is committed to sharing biodiversity data through GBIF and is currently exploring viable approaches to achieve this.

The company tackles the global crisis of degrading coral reefs by developing innovative, scalable solutions that combine marine biology with advanced engineering. Their flagship product – 3D-printed ceramic Reef Tiles™ – represents a major leap forward in restoration technology. These specially designed tiles stabilize degraded seabeds and mimic natural reef structures when assembled into modular "hives" underwater. The artificial reefs are then seeded with resilient coral fragments either salvaged from damaged areas or cultivated in nurseries. This approach has proven remarkably effective, with a Hong Kong government-funded pilot project achieving an exceptional 91% survival rate across three coral species over four years, far outperforming traditional restoration methods.

The company operates on a unique business-to-business model that helps corporations meet their ESG commitments and CSR goals through meaningful environmental action. Archireef works with clients across industries including real estate, maritime shipping, and financial services, enabling them to make measurable contributions to marine conservation. As an early adopter of the Taskforce on Nature-related Financial Disclosures (TNFD) framework, Archireef is helping shape how businesses report and account for their biodiversity impact. Their comprehensive "Reef as a Service" offering covers everything from tile production and installation to three years of intensive monitoring and maintenance at restoration sites.

To scientifically validate their impact, Archireef employs cutting-edge monitoring techniques including detailed coral health assessments, 3D photogrammetry to measure reef complexity, and environmental DNA (eDNA) analysis to track biodiversity changes. By cross-referencing their findings with global biodiversity databases like GBIF and Barcode of Life Data System (BOLD), the company has demonstrated that their artificial reefs increase local biodiversity by an impressive 25% compared to unrestored areas. This data-driven approach not only proves the effectiveness of their solution but also provides corporate partners with concrete metrics to demonstrate their environmental contributions. Through this combination of scientific rigor, technological innovation, and sustainable business practices, Archireef is setting new standards for large-scale marine ecosystem restoration while creating tangible opportunities for businesses to support ocean conservation.

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