The business case for investing in biodiversity data

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55   **Author contributions**

56   FH conceptualized the paper. FH, JN, TA helped to develop the framework. FH developed the

57   innovative financial model for private sector investment towards biodiversity data. All authors

58   contributed critically to writing all drafts. FH drafted the manuscript and all authors contributed

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Conflict of Interest

The authors have declared that there are no competing interests.

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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.

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,

152   their implementation relies heavily on the availability, accessibility, and interpretability of biodiversity

153   data.

154

155   Without high-quality biodiversity data, neither companies nor policymakers can assess impacts,

156   dependencies, risks, or implement effective nature-based solutions. This challenge is particularly acute

157   because, unlike carbon accounting, where standardised units like CO_2-equivalents enable comparability,

158   biodiversity lacks a unified metric (Jones & Solomon, 2013). Biodiversity data is multidimensional,

159   spanning genetic, species, and ecosystem diversity, and is highly context-dependent (CBD, 2011;

160   Exposito-Alonso et al., 2022). Essential Biodiversity Variables (EBVs) are an example of metrics

161   developed to aid sustainability reporting on biodiversity (Pereira et al., 2013). Yet, these metrics are often

162   derived from top-down approaches that rely on indirect data, which can be biased, incomplete, difficult to

163   verify, and therefore misleading, highlighting the need for reliable, ground-truthed biodiversity data

164   (Granqvist et al., 2025). Even seemingly simple metrics, such as species richness, can be misleading

165   without appropriate ecological context (Hillebrand et al., 2018). It is little wonder that uncertainty persists

166   as biodiversity models and metrics continue to evolve, with over 2,000 metrics currently available, their

167   utility remains closely tied to the quality of underlying data (Burgess, 2024). Businesses, facing rising

168   sustainability disclosure requirements, are increasingly turning to the Global Biodiversity Information

169   Facility (GBIF), the largest biodiversity data infrastructure with over 2 billion records, to report on their

170   biodiversity impacts, dependencies, risks, and implement effective nature-based solutions. This makes

171   sense, as GBIF is the leading infrastructure for biodiversity data, and feeds into our global biosphere earth

172   system models. However, it is important to have the domain knowledge to recognise that these data may

173   not be suitable for use, particularly since they are unevenly distributed due to historical taxonomic and

174   geographic biases in data collection, with 65% representing birds, which comprise only 0.5% of described

175   species (GBIF, 2025; Troudet et al., 2017). Urgent investment towards biodiversity data collection and

176   mobilisation is essential to expand the coverage and quality of open biodiversity data, enabling key

177   stakeholders across both public and private sectors to make evidence-based decisions.

178

179   To achieve this, a concerted science communication effort is needed to clarify the biodiversity data

180   pipeline: from data origins to usable products and business use cases (Figure 1). Yet, to our knowledge,

181   no streamlined framework currently exists, risking the integrity of the pipeline. At the foundation of

182   reliable biodiversity data lie often-overlooked natural history collections, including museums, herbaria,

183   specimen repositories, and seed banks, that support species verification, biogeographic checklists, red-list

184   assessments, and GBIF data uploads (Huybrechts et al., 2022; Mason Heberling et al., 2021; Davis,

185   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;

220   Ingram et al., 2024; Smith et al., 2019; White et al., 2023). The urgency is amplified by emerging markets

221   developing for nature-based credits, which must be data-driven to avoid irreversible harm (Swinfield,

222   2024). Recognising biodiversity data as a vital, investable public–private good will enable more accurate

223   biosphere earth system modelling, forecasting biodiversity trends, reveal ecological and economic links,

224   and drive transformative business action towards sustainability.

225

226   In this paper, we (1) present a framework for integrating biodiversity data into business use cases, (2)

227   clarify the origins of primary biodiversity data, and (3) propose a blended innovative financig model that

228   connects private capital to high-impact biodiversity data generation and mobilisation via a biodiversity

229   data facilitator through open infrastructures such as GBIF. In doing so, we argue that the business case for

230   investing in biodiversity data lies in its ability to unlock the value of information, enabling private and

231   public sector actors to better address biodiversity impacts, dependencies, and risks, and to implement

232   data-driven nature-based solutions for long term sustainability.

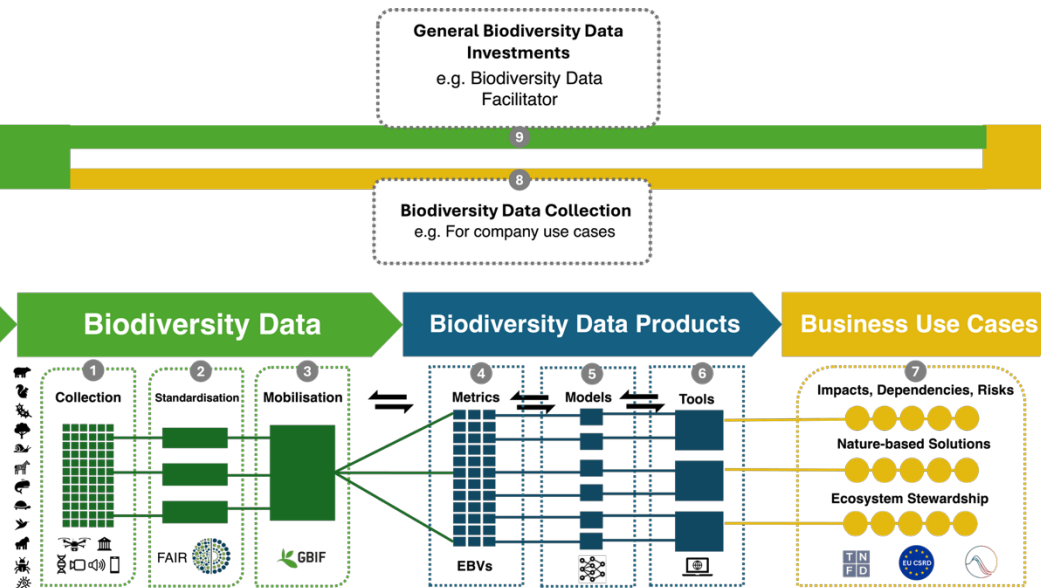## An end-to-end framework from biodiversity data to business use cases

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).
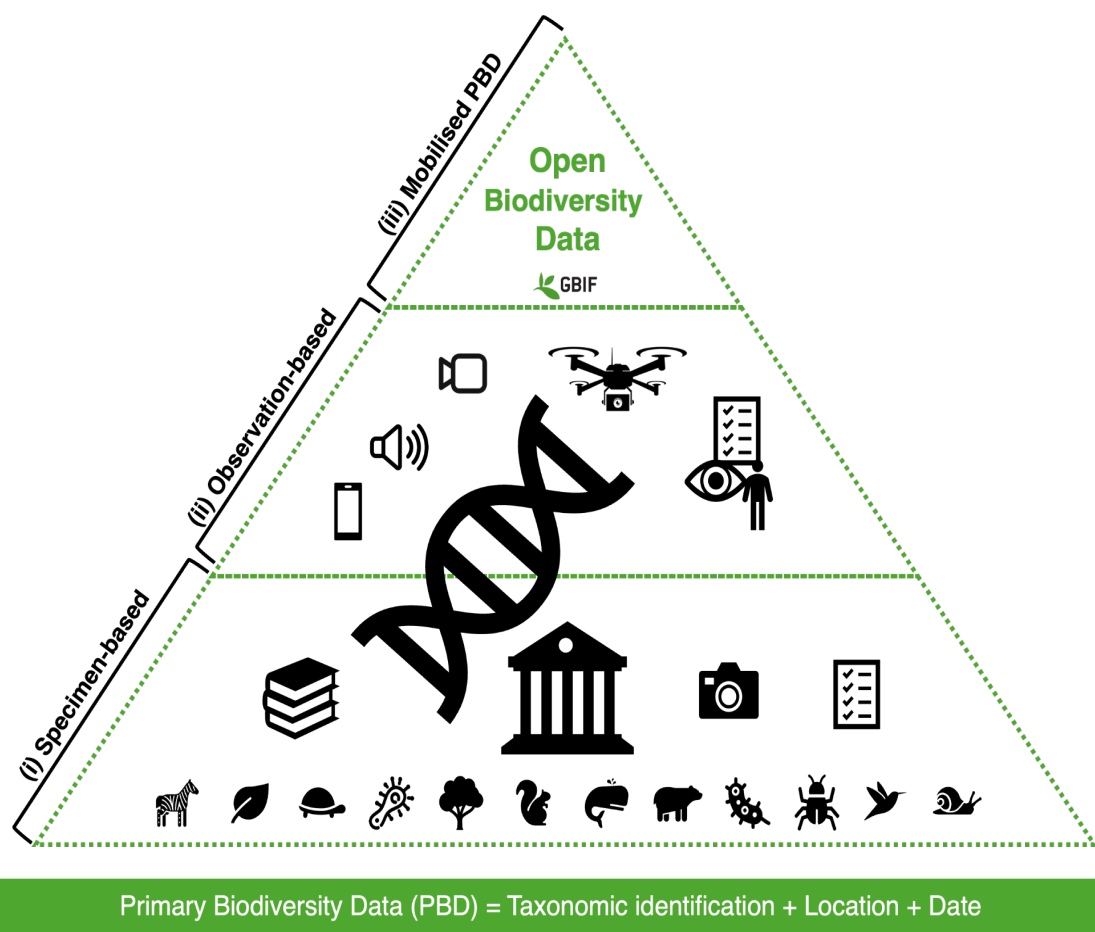

Figure 2. Pyramid diagram illustrating sources of primary biodiversity data showing that specimen-based data are foundational to observation-based data, which are foundational to integrated primary biodiversity data. (i) Specimen-based data: Derived from physical specimens in natural history collections, 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)

274 Mobilised primary biodiversity data: Integrated specimen- and observation-based data on open access

275 biodiversity infrastructure, such as GBIF.

276

277 The big data revolution has already expanded biodiversity data, and we are in an excellent point in history

278 to start prioritising resources to fill data gaps in taxa and geographic coverage (Bayraktarov et al., 2019;

279 Musvuugwa et al., 2021; Troudet et al., 2017). Digitisation and AI are accelerating data extraction from

280 specimens in natural history collections, providing temporal biodiversity data. High-throughput systems

281 like ALICE can rapidly digitise insect specimens for upload to GBIF (Dupont & Price, 2019; Garner et

282 al., 2024). Techniques such as Named Entity Recognition (NER) and Optical Character Recognition

283 (OCR) convert label text to digital format, enabling rapid processing of tens of thousands of specimens

284 (Takano et al., 2024). Digitised herbarium specimens provide additional biodiversity data, such as trait

285 data comparable to fresh tissues (Davis, 2023). While significant progress has been made, billions of

286 specimens remain undigitised from European collections alone, requiring continued mobilisation efforts

287 (Huybrechts et al., 2022). New scalable observation-based technologies are transforming biodiversity

288 monitoring. eDNA and metabarcoding enable rapid species detection from water, soil, or air samples are

289 useful for hidden taxa like fungi and insects, potentially completing centuries of manual inventory work

290 in a single year (Deiner et al., 2021; Ronquist et al., 2020). Passive acoustic monitoring captures species

291 sounds, enabling AI-driven species identification across taxa including birds, primates, and even soil

292 organisms (Hildebrand et al., 2024; Buxton et al., 2018). Camera traps and global camera networks offer

293 real-time species monitoring (Bjerge et al., 2021; Steenweg et al., 2017, Høye et al 2021), while citizen

294 science platforms like iNaturalist leverage smartphones to gather data and train deep learning models

295 (August et al., 2015; Beery, 2023). Advanced sensors on drones and UAVs, including thermal, LIDAR,

296 hyperspectral, and RGB, further enhance species tracking and vegetation analysis. These tools enable

297 species-level plant identification and habitat mapping (Larsen et al., 2023; Mäyrä et al., 2021). However,

298 consistent data standardisation is necessary to ensure biodiversity data from diverse sources are actually

299 useful to science and society. Biodiversity data must be curated to meet FAIR principles (Findable,

300 Accessible, Interoperable, Reusable) and align with Open Science practices (Carroll et al., 2021;

301 Wilkinson et al., 2016).

302

303 The Biodiversity Information Standards group (TDWG) maintains standards like Darwin Core (DwC),

304 which enables interoperability through standardised terms and vocabularies. Extensions such as the

305 Humboldt Ecological Inventory and networks like DiSSCo further support standardised ecological and

306 specimen-based data sharing. However, integrating big biodiversity data faces challenges with metadata

307 standards for cross-scale analysis (Maldonado et al., 2015; Hardisty et al., 2022). Metadata defines data

308 context, without which we would not make full use of stitching together data from diverse sources. For
309 instance, dnaDerivedData with MIxS provides structured metadata on DNA sampling and sequencing
310 (Abarenkov et al., 2023). The Camera Trap Data Package (Camtrap DP) standardises image data sharing
311 and is being expanded to include insects (Bubnicki et al., 2023). Ecological Metadata Language (EML)
312 also supports detailed documentation across biodiversity datasets. Despite progress, challenges remain:
313 such as data duplication, inconsistent quality, and interoperability issues (Pyle et al., 2021). Taxonomic
314 inconsistencies and errors can be managed through automation and expert validation (ChecklistBank,
315 2025; Whitley et al., 2024). These advances support platforms like GBIF, which mobilise open-access
316 biodiversity data and bridge data gaps. Motivating data sharing remains difficult. Academic incentives
317 include DOI citations and data papers, while businesses are beginning to see strategic value in sharing
318 data. Companies can publish data via GBIF's Integrated Publishing Toolkit (IPT), usually free, and track
319 impact through assigned DOIs and UUIDs (Case Study S2). Nonetheless, the business sector currently
320 contributes only 0.3% of GBIF records, indicating a opportunity for greater engagement.

321 ## 2 Biodiversity data products

322 There is a growing demand to transform raw biodiversity data into metrics and data products that can
323 cater to diverse use cases and needs across different industry sectors (Burgess et al., 2024). This task
324 requires reducing the complexity of biodiversity into manageable metrics, which arguably is an exercise
325 of great oversimplification, yet a necessary one. With this inherent constraint in mind, we reflect on
326 several issues in the current state-of-the-art of biodiversity reporting and the underlying data-products.
327
328 In the context of biodiversity impact reporting, data products that provide regional or global heatmaps of
329 biodiversity metrics are in high demand, as they allow easy area-based calculation of biodiversity value
330 and impact. One example of such a data product is the Biodiversity Intactness Index (BII, Newbold et al.,
331 2015; Phillips et al., 2021), which is proposed as a component indicator in the COP 16 draft of the GBF
332 monitoring framework (CBD, 2024). Another example of a biodiversity model used in business context is
333 GLOBIO (Schipper et al, 2020), also proposed as a GBF indicator (CBD, 2024). However, many of such
334 global heat maps generated (Myers et al., 2000) are only weakly linked to the evaluation of the
335 biodiversity impact of *specific decisions and actions*. For biodiversity data products to be actionable in a
336 corporate setting, they need to relate biodiversity impacts and risks to operational and financial decisions
337 taken by companies, so that impact tradeoff analysis can be performed. Examples include spatial planning
338 for forest and agricultural land management, deciding from which countries and regions to source
339 materials and products, and investments into new factories and logistics facilities. A common

340 denominator for many use cases is the urgent need for regional and local data and models (as opposed to
341 global) to ensure high-quality analysis and drawing the right conclusions.
342
343 While the BII and other similar data-products are being used for company impact assessment and
344 reporting, a concern raised is that the underlying models are largely untested for their predictive
345 performance and their agreement with other indicators of biodiversity impact (Martin et al., 2019,
346 Nyström, 2024). We see a big risk that insufficiently tested data products provide the foundations for
347 company impact reporting and nature investments, with potentially negative consequences. This problem
348 is further exacerbated by the quickly developing nature tech market, driven by the demand for attractive,
349 ready-to-use biodiversity solutions and data. The absence of a thorough quality-checking and peer-review
350 process in this context lends reason for concern and makes it difficult for customers to distinguish
351 between "snake-oil salesmen" with questionable data products and those built on solid foundations.
352 However, as outlined above, even models and data products that have been reviewed by the academic
353 peer-review process, risk being mis-applied for purposes they were not designed for. Part of the reason for
354 this misapplication is a lack of guidance on the use of existing and emerging biodiversity data products
355 and metrics, which we identify as the challenge of biodiversity data literacy.
356
357 Despite best efforts regarding methodological considerations and quality assessments, data products are
358 only as reliable as the data they are derived from. At present, the biggest bottleneck to better biodiversity
359 models is arguably the lack of contextualized data, particularly in view of the vast taxonomic and spatial
360 biases that exist. Closing the biodiversity data gaps is critical for enhancing the accuracy and reliability of
361 biodiversity metrics for business use cases.
362

363 3 Business use cases

364 Improved biodiversity impacts, dependencies and risk reporting
365 Businesses face increasing demands to assess and disclose biodiversity impacts, dependencies, and risks
366 under regulations such as the EU Corporate Sustainability Reporting Directive (CSRD) and frameworks
367 like the Taskforce on Nature-related Financial Disclosures (TNFD) (Figure 1). Meeting these
368 requirements needs long-term investment in high-quality biodiversity data to develop reliable data
369 products and metrics that support science-based targets and withstand regulatory and investor scrutiny
370 (ESRS E4, 2023). Current biodiversity data gaps and biases undermine the accuracy of risk assessments.
371 The TNFD's 2023 scoping study identified existing "nature data" as outdated, inconsistent, and
372 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

406 stewardship, and long-term biodiversity conservation (Díaz et al., 2019; Mace et al., 2018; Pettorelli et al.,
407 2021).

4 An Innovative Financing Model to Address the Biodiversity Data Gap

409 Addressing the global biodiversity data gap demands a sustainable financing model that incentivises the
410 large-scale collection, standardisation, and mobilisation of biodiversity data. Biodiversity data
411 certification offers such a solution by linking investment to measurable contributions in data generation
412 and sharing. With this blended finance model, combining public, private, and philanthropic capital allows
413 for targeted investment in biodiversity data and data infrastructures by reducing risk and aligning
414 incentives across sectors (Flammer et al, 2025; Beverdam et al, 2025). It is particularly well-suited to
415 financing the mobilisation of biodiversity data in regions and ecosystems where private capital alone is
416 insufficient, such as the tropics (Case Study S3). This framework provides businesses and investors with
417 certified recognition, while securing sustainable financing for data providers to contribute high-quality
418 open-access biodiversity data via GBIF.
419
420 For example, the proposed biodiversity data certification model will offer a verifiable, data-driven
421 mechanism to assess and demonstrate positive biodiversity impact. By linking investment to certified
422 biodiversity data contributions, it reduces greenwashing risks and enhances transparency, enabling
423 investors to allocate capital more effectively towards nature-positive outcomes. For instance, the Swedish
424 MISTRA FinBio programme is developing eDNA monitoring and standardised data protocols for reliable
425 biodiversity metrics that inform financial decision-making in agriculture and land management (Case
426 Study S1). The project will publish its data to GBIF, ensuring open access and long-term utility, but once
427 these methods are used, the biodiversity data facilitator can support the long-term biodiversity data
428 mobilisation of these sites and other farms that will participate in biodiversity monitoring. Embedding
429 biodiversity data stewardship with ecosystem stewardship to investment frameworks can show how the
430 certification model can strengthen accountability and drive credible, impact-focused in the finance sector.
431 TotalEnergies, a multinational company, already publishes biodiversity data from their environmental
432 impact assessments directly to GBIF (Case Study S2). By leveraging in-house expertise and adhering to
433 FAIR principles, the company exemplifies how private sector actors can integrate biodiversity data
434 mobilisation into corporate sustainability frameworks, producing verifiable key performance indicators
435 (KPIs) (Case Study S2). However, many companies may lack the capacity for employing internal data
436 management, highlighting the need for a biodiversity data facilitator to broaden and incentivise private
437 sector contributions to open biodiversity data (Figure 3).

438   The innovative financing model is particularly crucial for Earth's biodiversity-rich regions such as the

439   tropics, where data gaps remain vast despite immense ecological importance. In Sabah, Malaysian Borneo

440   (Case Study S3), decades of ecological research and millions of dollars from private sector stakeholders,

441   including SimeDarby and IKEA, have generated extensive biodiversity data that remain largely

442   inaccessible or unpublished on GBIF. Mobilising these data through certified financing can unlock

443   valuable insights for sustainable land management and conservation, supporting both biodiversity and

444   employment in local communities. Similarly, in the blue-green economy, nature-based solutions like

445   those developed by Archireef - a nature-tech startup focused on coral reef restoration (Case Study S4) -

446   demonstrate the potential for data-driven approaches to drive scalable ecosystem restoration and

447   biodiversity monitoring. Innovative financing models can also support early-stage companies, such as

448   Archireef, in sustaining their nature-positive impacts by funding efforts to mobilise and enhance

449   biodiversity data. Ultimately, this financing model protects the reputational integrity of both investors and

450   data providers. It mitigates greenwashing, strengthens ESG action, and positions biodiversity data as a

451   strategic asset for long-term sustainability. Together, these cases illustrate how targeted, verifiable

452   sustainable blended financing can accelerate biodiversity data mobilisation and support nature-positive

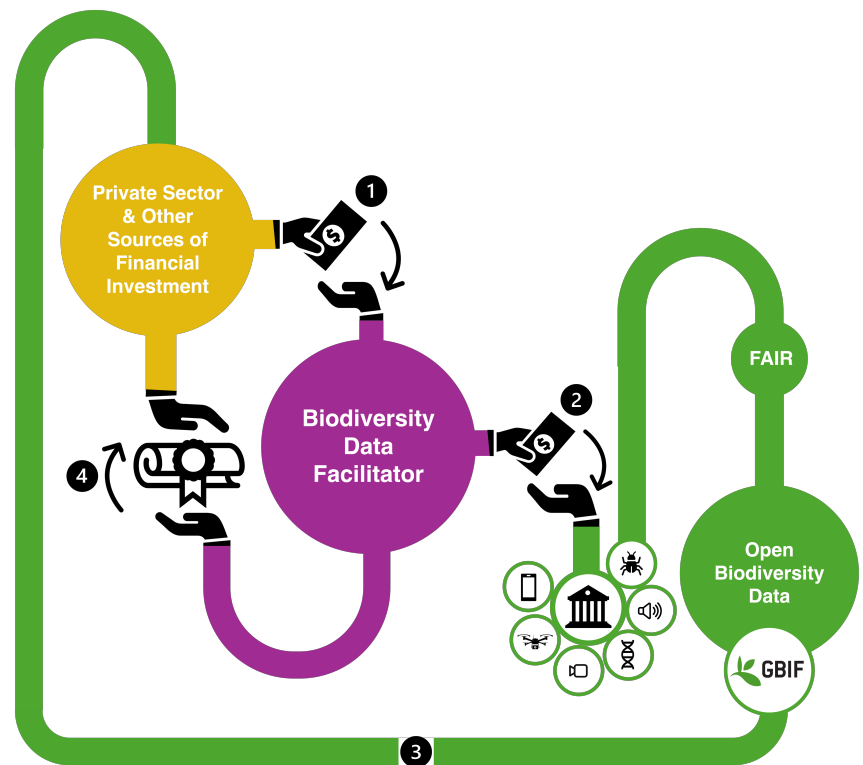453   outcomes in critical terrestrial and marine ecosystems.

454

455 **Figure 3.** Innovative financing model for bridging the biodiversity data gap: (1) Private sector and other

456 financial investors (yellow) provide funding to the biodiversity data facilitator (purple) to support data

457 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.

469 **Supporting Information**

470 **Case study S1. Biodiversity data for financial metrics: MISTRA FinBio,**

471 **Sweden**

472

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

474

475 As part of the FinBio Research program hosted at the Stockholm Resilience Centre (FinBio, 2023), the

476 "Biodiversity Data for Financial Metrics" work package aims to connect biodiversity data to financial

477 decision-making to support financial institutions in contributing to biodiversity and nature-positive

478 outcomes, particularly in Sweden and the Nordics. FinBio operates as a collaborative partnership between

479   academic and financial institutions, bringing together academic and impact partners to develop practical

480   tools that guide investment decisions, promoting both the greening of finance and the financing of green

481   initiatives that can be adopted throughout the financial sector. Specifically, the "Biodiversity Data for

482   Financial Metrics" work package focuses on the application of modern monitoring technologies such as

483   environmental DNA (eDNA) and Earth Observations for assessing biodiversity impact. This includes

484   methods for assessing Essential Biodiversity Variables (EBVs) using standardised eDNA collection from

485   Malaise traps and soil samples, with laboratory and bioinformatic protocols, accuracy measurements, and

486   abundance estimation, with trend analyses covering a five-year period in Sweden. One pilot project, in

487   collaboration with Svensk Kolinlagring - a non-profit organization - connects stakeholders to improve soil

488   health and increase carbon storage in Swedish agricultural soils. The project works with approximately 40

489   farms and focuses on measuring farmland biodiversity as part of its efforts to enhance carbon

490   sequestration, which the IPCC recognizes as one of the most cost-effective and scalable climate solutions.

491   The project aims to deliver several key outcomes, including biodiversity data from the agricultural sector

492   using eDNA monitoring methods, analysis of biodiversity changes in carbon sequestration management

493   systems, and the development of a standardized data-driven biodiversity index for farmers. This index

494   will serve as both a measurement tool and a component of potential business cases to attract investment in

495   sustainable agricultural practices. Open data and open methods are core principles within the Biodiversity

496   Data for Financial Metrics work package, and the collected pilot data will be shared via GBIF upon

497   completion of the project.

498

499 **Case study S2. Total Energies share biodiversity data on GBIF**
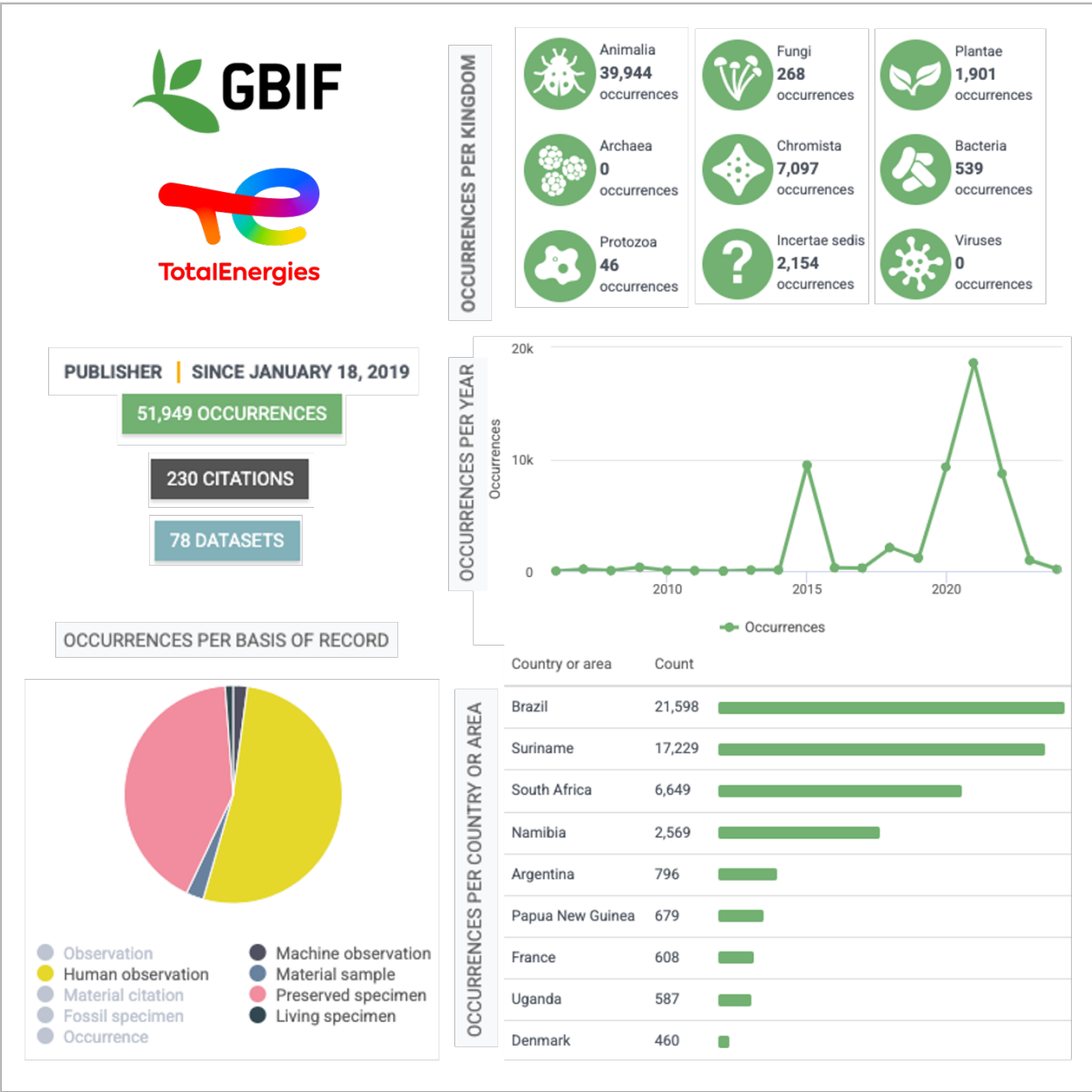

500

501 **Figure S2.** TotalEnergies data publisher metrics displayed on their GBIF publisher page, showcasing key

502 performance indicators (KPIs) for company reporting. Metrics include: occurrences per kingdom,

503 occurrences per year, occurrences per country or area, and occurrences per basis of record. These metrics

504 provide insights into data distribution and can be used to evaluate the company's contribution to

505 biodiversity monitoring.

506

507 Companies may publish biodiversity data directly to GBIF by establishing institutional agreements and

508   complying with GBIF's Data Publisher and Data User Agreements. Registration as a data publisher

509   requires endorsement from a national GBIF node. The process typically involves collaboration with

510   contractors and field technicians to ensure data and metadata quality. Companies must establish internal

511   workflows, select and prepare biodiversity data according to the DarwinCore (DwC) standard, define

512   access restrictions, and publish under a Creative Commons license.

513

514   TotalEnergies is a global energy company operating in 120 countries and became a biodiversity data

515   publisher on GBIF in 2018 to strengthen their long-term biodiversity impact. The company committed to

516   sharing biodiversity data collected through in-house environmental impact assessments, including field

517   surveys in remote and offshore locations, with both the scientific community and the public. By

518   publishing its data to GBIF, TotalEnergies considers it a valuable contribution to global scientific

519   research and international conservation efforts. To date, they have published 51,949 occurrences on GBIF

520   (Figure S2). The company employs a variety of data collection methods, such as sediment, soil, and water

521   sampling, camera transects, and passive acoustic monitoring and opportunistic observations of marine

522   megafauna and birds. These data also include hydrocarbons, metals, microbiology, and benthic fauna—

523   environmental data that allow assessments of habitat sensitivity. TotalEnergies' biodiversity data adheres

524   to GBIF's quality standards by following the DwC standard and FAIR principles. They have committed

525   to contributing data annually from a minimum of five projects or sites to GBIF, with regular reporting on

526   these contributions. By doing so, TotalEnergies enhances its reputation through collaboration with a

527   reputable organization and gains measurable data from GBIF biodiversity occurrences, which they can

528   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

543 private-sector initiatives has generated substantial ecological and biodiversity data, much of which
544 remains unpublished or inaccessible, especially through GBIF.
545 The Yayasan Sabah Group (Sabah Foundation), which manages large forest areas, has fostered long-term
546 conservation and research partnerships, notably with the Southeast Asia Rainforest Research Partnership
547 (SEARRP) (see Figure S3). Through these collaborations, they have established permanent research plots,
548 compiled species inventories, and developed long-term ecological datasets — all providing valuable
549 insights into biodiversity changes over time.
550 One key example is the Sow-A-Seed project, funded by IKEA and launched in 1998 in Kalabakan. This
551 large-scale restoration effort aimed to rehabilitate 18,500 hectares of logged and fire-damaged forest and
552 continued for 25 years. Data from the project demonstrated that tailored restoration techniques, ongoing
553 biodiversity monitoring, and cooperation with forestry operations helped drive ecosystem recovery. The
554 restored area was eventually designated as a Class 1 protected forest, highlighting the success of these
555 efforts (Axelsson et al., 2024).
556 The *Stability of Altered Forest Ecosystems (SAFE) Project*, funded in part by Sime Darby, the world's
557 largest producer of Certified Sustainable Palm Oil, was one of the largest ecological experiments in the
558 world, lasting over a decade until funding constraints due to the COVID-19 pandemic. The project
559 produced more than 150 datasets covering biodiversity and ecosystem processes across various land uses,
560 including selectively logged forests and oil palm plantations. SAFE's research covers a wide range of
561 organisms, from soil microbes and invertebrates to vertebrates, and includes detailed studies of ecological
562 and biogeochemical processes. While these datasets are publicly accessible on Zenodo, they have yet to
563 be integrated into GBIF.
564 With a huge value of information for key stakeholders in government, conservation, and business, these
565 two projects have generated hundreds of thousands—possibly millions—of valuable biodiversity data
566 points. This resource holds strong potential to support efforts to protect biodiversity on one of the world's
567 most diverse islands.
568 Mobilizing Sabah's biodiversity data from past, current, and future research provides a cost-effective way
569 to improve data access and inform conservation and sustainable land management.
570 Investing in the mobilisation of these data should go hand in hand with supporting conservation and
571 sustainable solutions. Together, these efforts can help ensure long-term biodiversity conservation that
572 benefits people, the environment, and local economies.
573
574
575
576

Case study S4. Biodiversity data-driven nature-tech for coral ecosystem restoration
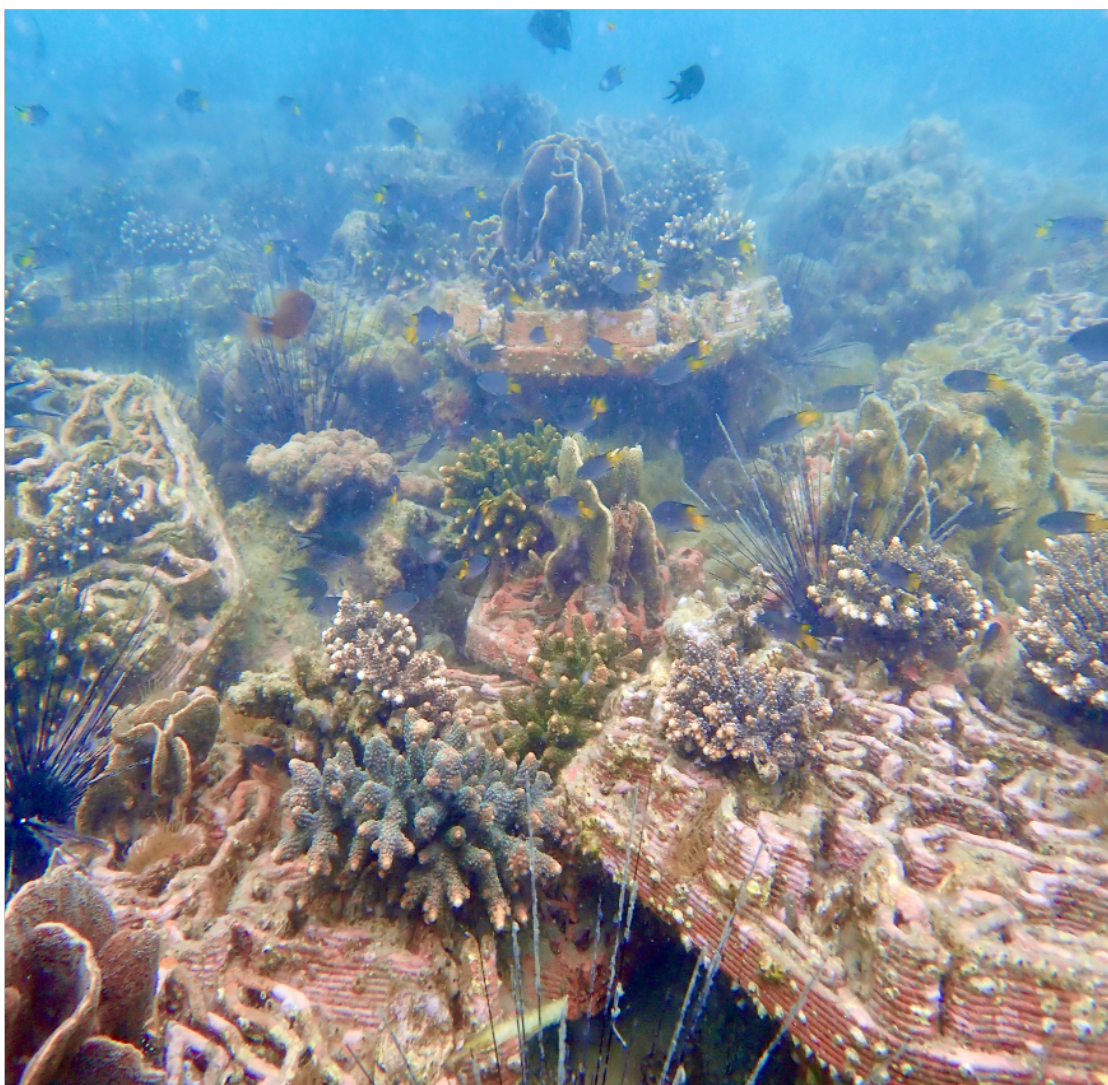
Figure S4. Photo of Archireef 3D-printed ceramic Reef Tiles^{TM}, photo by David Baker. Archireef is a pioneering nature-tech startup that spun off from groundbreaking coral restoration research at the University of Hong Kong. As a new nature -tech company using GBIF data, Archireef is committed to sharing 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.

References

Abarenkov, K., Andersson, A. F., Bissett, A., Finstad, A. G., Fossøy, F., Grosjean, M., Hope, M., Jeppesen, T. S., Kõljalg, U., Lundin, D., Nilsson, R. H., Prager, M., Provoost, P., Dmitry, Saara, S., Cecilie, S., Tobias, S., & Frøslev, G. (2023). *Publishing DNA-derived data through biodiversity data platforms*. https://doi.org/10.35035/doc-vf1a-nr22

Aide, T. M. (2024). The Biodiversity Credit Market needs rigorous baseline, monitoring, and validation practices. *Npj Biodiversity 2024 3:1*, *3*(1), 1–4. https://doi.org/10.1038/s44185-024-00062-6

Allen, M. R., Friedlingstein, P., Girardin, C. A. J., Jenkins, S., Malhi, Y., Mitchell-Larson, E., Peters, G. P., & Rajamani, L. (2025). *Annual Review of Environment and Resources Net Zero: Science, Origins, and Implications*. 58. https://doi.org/10.1146/annurev-environ-112320

August, T., Harvey, M., Lightfoot, P., Kilbey, D., Papadopoulos, T., & Jepson, P. (2015). Emerging technologies for biological recording. *Biological Journal of the Linnean Society*, *115*(3), 731–749. https://doi.org/10.1111/BIJ.12534

Bayraktarov, E., Ehmke, G., O'Connor, J., Burns, E. L., Nguyen, H. A., McRae, L., Possingham, H. P., & Lindenmayer, D. B. (2019). Do big unstructured biodiversity data mean more knowledge? *Frontiers in Ecology and Evolution*, *7*(JAN), 426167. https://doi.org/10.3389/FEVO.2018.00239/BIBTEX

Beery, S. M. (2023). *Where the Wild Things Are: Computer Vision for Global-Scale Biodiversity Monitoring*.

Beverdam J, Hubacek K, Scholtens B & Sijtsma F (2025). Improving biodiversity resilience requires both public and private finance: A life-cycle analysis of biodiversity finance. *Ecol Econ* **234**, 108607. https://doi.org/10.1016/j.ecolecon.2025.108607

Burgess, N. D., Ali, N., Bedford, J., Bhola, N., Brooks, S., Cierna, A., Correa, R., Harris, M., Hargey, A., Hughes, J., McDermott-Long, O., Miles, L., Ravilious, C., Rodrigues, A. R., Soesbergen, A. van, Sihvonen, H., Seager, A., Swindell, L., Vukelic, M., … Butchart, S. H. M. (2024). Global Metrics for Terrestrial Biodiversity. *Annual Review of Environment and Resources*, *49*(Volume 49, 2024), 673–709. https://doi.org/10.1146/ANNUREV-ENVIRON-121522-045106

Bjerge, K., Nielsen, J. B., Sepstrup, M. V., Helsing-Nielsen, F., & Høye, T. T. (2021). *An Automated Light Trap to Monitor Moths (Lepidoptera) Using Computer Vision-Based Tracking and Deep Learning*. https://doi.org/10.3390/s21020343

Boyd, R. J., Powney, G. D., & Pescott, O. L. (2023). We need to talk about nonprobability samples. *Trends in Ecology & Evolution*, *38*(6), 521–531. https://doi.org/10.1016/J.TREE.2023.01.001

643 Buxton, R. T., McKenna, M. F., Clapp, M., Meyer, E., Stabenau, E., Angeloni, L. M., Crooks, K., &
644   Wittemyer, G. (2018). Efficacy of extracting indices from large-scale acoustic recordings to monitor
645   biodiversity. *Conservation Biology*, *32*(5), 1174–1184. https://doi.org/10.1111/COBI.13119

646 Bubnicki, J. W., Norton, B., Baskauf, S. J., Bruce, T., Cagnacci, F., Casaer, J., Churski, M., Cromsigt, J.
647   P. G. M., Farra, S. D., Fiderer, C., Forrester, T. D., Hendry, H., Heurich, M., Hofmeester, T. R.,
648   Jansen, P. A., Kays, R., Kuijper, D. P. J., Liefting, Y., Linnell, J. D. C., … Desmet, P. (2024).
649   Camtrap DP: an open standard for the FAIR exchange and archiving of camera trap data. *Remote*
650   *Sensing in Ecology and Conservation*, *10*(3), 283–295. https://doi.org/10.1002/RSE2.374

651 Carroll, S. R., Herczog, E., Hudson, M., Russell, K., & Stall, S. (2021). Operationalizing the CARE and
652   FAIR Principles for Indigenous data futures. In *Scientific Data* (Vol. 8, Issue 1). Nature Research.
653   https://doi.org/10.1038/s41597-021-00892-0

654 CBD. (2011). *Convention on Biological Diversity : text and annexes / Secretariat of the Convention on*
655   *Biological Diversity*.

656 CBD. (2024). *Monitoring framework for the Kunming-Montreal Global Biodiversity Framework:*
657   *Sixteenth meeting Cali, Colombia, 21 October–1 November 2024 Agenda item 10 Mechanisms for*
658   *planning, monitoring, reporting and review*.
659   https://www.cbd.int/doc/c/5044/ea79/105d29801a3efae8df742c93/cop-16-l-26-en.pdf

660 *ChecklistBank*. (2025). https://www.checklistbank.org/

661 COP15. (2022). *The Convention on Biological Diversity Kunming-Montreal Global Biodiversity*
662   *Framework 15/4*.
663   https://www.cbd.int/conferences/post20202CBD/WG8J/11/7,CBD/SBSTTA/23/9,CBD/SBSTTA/24
664   /12andCBD/SBI/3/21,respectively.

665 Davis, C. C. (2023). The herbarium of the future. *Trends in Ecology & Evolution*, *38*(5), 412–423.
666   https://doi.org/10.1016/J.TREE.2022.11.015

667 D'Amato, D., La Notte, A., Damiani, M., & Sala, S. (2024). Biodiversity and ecosystem services in
668   business sustainability: Toward systematic, value chain-wide monitoring that aligns with public
669   accounting. *Journal of Industrial Ecology*, *28*(5), 1030–1044. https://doi.org/10.1111/JIEC.13521

670 Dasgupta, P. (2021). *The Economics of Biodiversity: The Dasgupta Review*.

671 Deloitte. (2023). *Economic valuation and assessment of the impact of the GBIF network*.
672   https://www.deloitte.com/au/en/services/economics/perspectives/total-economic-value-open-access-
673   database-living-world.html

674 Deiner, K., Yamanaka, H., & Bernatchez, L. (2021). The future of biodiversity monitoring and
675   conservation utilizing environmental DNA. *Environmental DNA*, *3*(1), 3–7.
676   https://doi.org/10.1002/EDN3.178

Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R. T., Molnár, Z., Hill, R., Chan, K. M. A., Baste, I. A., Brauman, K. A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P. W., Van Oudenhoven, A. P. E., Van Der Plaat, F., Schröter, M., Lavorel, S., … Shirayama, Y. (2018). Assessing nature's contributions to people: Recognizing culture, and diverse sources of knowledge, can improve assessments. In *Science* (Vol. 359, Issue 6373, pp. 270–272). American Association for the Advancement of Science. https://doi.org/10.1126/science.aap8826

Engel, M. S., Ceríaco, L. M. P., Daniel, G. M., Dellapé, P. M., Löbl, I., Marinov, M., Reis, R. E., Young, M. T., Dubois, A., Agarwal, I., Lehmann, P. A., Alvarado, M., Alvarez, N., Andreone, F., Araujo-Vieira, K., Ascher, J. S., Baêta, D., Baldo, D., Bandeira, S. A., … Zacharie, C. K. (2021). The taxonomic impediment: a shortage of taxonomists, not the lack of technical approaches. *Zoological Journal of the Linnean Society*, *193*(2), 381–387. https://doi.org/10.1093/ZOOLINNEAN/ZLAB072

ESRS E4. (2023). *Annex 1 - ESRS-E4: European Sustainability Reporting Standards Environmental standard No.4 - Biodiversity and Ecosystems, Delegated Act.* https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32023R2772#anx_I

Evison, W., Gill, E., Moussa, T., & O'Brien, D. (2022). *A surge in nature tech investing | PwC.* https://www.pwc.com/gx/en/services/sustainability/publications/surge-in-nature-tech-investing.html

Exposito-Alonso, M., Booker, T. R., Czech, L., Gillespie, L., Hateley, S., Kyriazis, C. C., Lang, P. L. M., Leventhal, L., Nogues-Bravo, D., Pagowski, V., Ruffley, M., Spence, J. P., Toro Arana, S. E., WeiÃŸ, C. L., & Zess, E. (2022). Genetic diversity loss in the Anthropocene. *Science (New York, N.Y.)*, *377*(6613), 1431–1435. https://doi.org/10.1126/SCIENCE.ABN5642

Faqih, A., & Kramer, R. (2024). The Corporate Sustainability Reporting Directive (CSRD): An Effective Approach to Implementation. *DIPONEGORO JOURNAL OF ACCOUNTING*, *13*(4), 1–9. http://ejournal-s1.undip.ac.id/index.php/accounting

Figueira, R., Beja, P., Villaverde, C., Vega, M., Cezón, K., Messina, T., Archambeau, A.-S., Rukaya, Dag, J., & Dairo Escobar, E., (2023). *Guidance for private companies to become data publishers through GBIF*. https://doi.org/10.35035/doc-b8hq-me03

FinBio. (2023). *FinBio annual report 2023*. https://finbio.org/wp-content/uploads/2024/04/FinBio-annual-report-2023.pdf

Flammer, Caroline, Thomas Giroux, and Geoffrey M. Heal. 2025. "The Economics of Blended Finance." *AEA Papers and Proceedings* 115: 397–402. DOI: 10.1257/pandp.20251072

Garner, B. H., Creedy, T. J., Allan, E. L., Crowther, R., Devenish, E., Kokkini, P., Livermore, L., Lohonya, K., Lowndes, N., Wing, P., & Vogler, A. P. (2024). The taxonomic composition and chronology of a museum collection of Coleoptera revealed through large-scale digitisation. Frontiers in Ecology and Evolution, 12. https://doi.org/10.3389/fevo.2024.1305931

711   *GBIF. (2024). https://www.gbif.org/*

712   GBIF. (2024). *GBIF Science Review No.11*.

713   https://www.gbif.org/document/5N9YVBkTP3y7kqhFQviowM/gbif-science-review-no-11

714   Gerber, L. R., & Iacona, G. D. (2024). Aligning data with decisions to address the biodiversity crisis.

715   *PLOS Biology*, *22*(6), e3002683. https://doi.org/10.1371/JOURNAL.PBIO.3002683

716   Gilman, E., King, N., Peterson, T., Chavan, V., Hahn, A. 2009. Building the Biodiversity

717   Data Commons - The Global Biodiversity Information Facility. PP. 79-99 IN Maurer,

718   L. (Ed.) ICT for Agriculture and Biodiversity Conservation. ICT Ensure, Graz University

719   of Technology, Graz, Austria.

720   Goren, G. (2024). *Developing the Nature Tech Taxonomy Framework*.

721   https://www.naturetechcollective.org/stories/nature-tech-taxonomy-

722   framework#Download%20Whitepaper

723   *Gonzalez, A., Chase, J. M., & O'Connor, M. I. (2023). A framework for the detection and attribution of*

724   *biodiversity change. Philosophical Transactions of the Royal Society B, 378(1881).*

725   *https://doi.org/10.1098/RSTB.2022.0182*

726   Granqvist, E., Goodsell, R. M., & Ronquist, F. (*In prep*). The transformative potential of eDNA-based

727   biodiversity. *Current Opinion in Environmental Sustainability*.

728   Hawkins, F. (2024). How will better data (and better use of data) enable us to save the planet? *PLOS*

729   *Biology*, *22*(6), e3002689. https://doi.org/10.1371/JOURNAL.PBIO.3002689

730   Hildebrand, J., Wiggins, S., Baumann-Pickering, S., Frasier, K., & Roch, M. A. (2024). The past, present

731   and future of underwater passive acoustic monitoring. *The Journal of the Acoustical Society of*

732   *America*, *155*(3_Supplement), A96–A96. https://doi.org/10.1121/10.0026934

733   Hillebrand, H., Blasius, B., Borer, E. T., Chase, J. M., Downing, J. A., Eriksson, B. K., Filstrup, C. T.,

734   Harpole, W. S., Hodapp, D., Larsen, S., Lewandowska, A. M., Seabloom, E. W., Van de Waal, D.

735   B., & Ryabov, A. B. (2018). Biodiversity change is uncoupled from species richness trends:

736   Consequences for conservation and monitoring. *Journal of Applied Ecology*, *55*(1), 169–184.

737   https://doi.org/10.1111/1365-2664.12959

738   Hill D, Fasham M, Tucker G, Shewry M & Shaw P. (2005). Handbook of Biodiversity

739   Methods: Survey, Evaluation and Monitoring. Cambridge: Cambridge University Press.

740   https://doi.org/10.1017/CBO9780511542084

741   Hobern, D., Baptiste, B., Copas, K., Guralnick, R., Hahn, A., van Huis, E., Kim, E. S., McGeoch, M.,

742   Naicker, I., Navarro, L., Noesgaard, D., Price, M., Rodrigues, A., Schigel, D., Sheffield, C. A., &

743   Wieczorek, J. (2019). Connecting data and expertise: A new alliance for biodiversity knowledge.

744   *Biodiversity Data Journal*, *7*. https://doi.org/10.3897/BDJ.7.e33679

745 Hoefer, S., McKnight, D. T., Allen-Ankins, S., Nordberg, E. J., & Schwarzkopf, L. (2023). Passive
746   acoustic monitoring in terrestrial vertebrates: a review. In *Bioacoustics* (Vol. 32, Issue 5, pp. 506–
747   531). Taylor and Francis Ltd. https://doi.org/10.1080/09524622.2023.2209052
748 Høye, T. T., Ärje, J., Bjerge, K., Hansen, O. L. P., Iosifidis, A., Leese, F., Mann, H. M. R., Meissner, K.,
749   Melvad, C., & Raitoharju, J. (2021). Deep learning and computer vision will transform entomology.
750   *Proceedings of the National Academy of Sciences of the United States of America*, *118*(2),
751   e2002545117. https://doi.org/10.1073/PNAS.2002545117/-/DCSUPPLEMENTAL
752 Hughes, A. C., Orr, M. C., Ma, K., Costello, M. J., Waller, J., Provoost, P., Yang, Q., Zhu, C., & Qiao, H.
753   (2021). Sampling biases shape our view of the natural world. *Ecography*, *44*(9), 1259–1269.
754   https://doi.org/10.1111/ECOG.05926
755 Huybrechts, P., Trekels, M., & Groom, Q. (2022). How Much of Biodiversity is Represented in
756   Collections: A big data workflow of aggregated occurrence data. *Biodiversity Information Science*
757   *and Standards 6: E94279*, *6*, e94279-. https://doi.org/10.3897/BISS.6.94279
758 Ingram, J. C., McKenzie, E. J., Bagstad, K. J., Finisdore, J., van den Berg, R., Fenichel, E., Vardon, M.,
759   Posner, S., Santamaria, M., Mandle, L., Barker, R., & Spurgeon, J. (2024). Leveraging natural
760   capital accounting to support businesses with nature-related risk assessments and disclosures.
761   *Philosophical Transactions of the Royal Society B*, *379*(1903).
762   https://doi.org/10.1098/RSTB.2022.0328
763 Jones, M. J., & Solomon, J. F. (2013). Problematising accounting for biodiversity. *Auditing &*
764   *Accountability Journal*, *26*(5), 668–687. https://doi.org/10.1108/AAAJ-03-2013-1255
765 Kahilainen, A., Puurtinen, M., & Kotiaho, J. S. (2014). Conservation implications of species–genetic
766   diversity correlations. *Global Ecology and Conservation*, *2*, 315–323.
767   https://doi.org/10.1016/J.GECCO.2014.10.013
768 Kulionis, V., Pfister, S., & Fernandez, J. (2024). Biodiversity impact assessment for finance. *Journal of*
769   *Industrial Ecology*, *28*(5), 1321–1335. https://doi.org/10.1111/JIEC.13515
770 Larsen, H. L., Møller-Lassesen, K., Enevoldsen, E. M. E., Madsen, S. B., Obsen, M. T., Povlsen, P.,
771   Bruhn, D., Pertoldi, C., & Pagh, S. (2023). Drone with Mounted Thermal Infrared Cameras for
772   Monitoring Terrestrial Mammals. *Drones*, *7*(11). https://doi.org/10.3390/drones7110680
773 Löbl, I., Klausnitzer, B., Hartmann, M., & Krell, F.-T. (2023). *The Silent Extinction of Species and*
774   *Taxonomists-An Appeal to Science Policymakers and Legislators*.
775   https://doi.org/10.3390/d15101053
776 Liu, D. (2024). We must train specialists in botany and zoology — or risk more devastating extinctions.
777   *Nature*, *633*(8031), 741. https://doi.org/10.1038/D41586-024-03072-3

Mace, G. M., Norris, K., & Fitter, A. H. (2012). Biodiversity and ecosystem services: A multilayered relationship. *Trends in Ecology and Evolution*, *27*(1), 19–26. https://doi.org/10.1016/J.TREE.2011.08.006/ASSET/0F6FA3A0-5727-4F75-8747-D6780EB3193C/MAIN.ASSETS/FX2.GIF

Mair, L., Elnahass, M., Xiang, E., Hawkins, F., Siikamaki, J., Hillis, L., Barrie, S., & McGowan, P. J. K. (2024). Corporate disclosures need a biodiversity outcome focus and regulatory backing to deliver global conservation goals. *Conservation Letters*, *17*(4), e13024. https://doi.org/10.1111/CONL.13024

Maldonado, C., Molina, C. I., Zizka, A., Persson, C., Taylor, C. M., Albán, J., Chilquillo, E., Rønsted, N., & Antonelli, A. (2015). Estimating species diversity and distribution in the era of Big Data: To what extent can we trust public databases? *Global Ecology and Biogeography*, *24*(8), 973–984. https://doi.org/10.1111/GEB.12326/SUPPINFO

Mason Heberling, J., Miller, J. T., Noesgaard, D., Weingart C , S. B., Schigel, D., & Soltis, D. E. (2021). *Data integration enables global biodiversity synthesis*. https://doi.org/10.1073/pnas.2018093118/-/DCSupplemental

Musvuugwa, T., Gladmond Dlomu, M., Adebowale, A., Mahmoud, M., & Antonio Gutiérrez, P. (2021). Big Data in Biodiversity Science: A Framework for Engagement. *Technologies 2021, Vol. 9, Page 60*, *9*(3), 60. https://doi.org/10.3390/TECHNOLOGIES9030060

Mäyrä, J., Keski-Saari, S., Kivinen, S., Tanhuanpää, T., Hurskainen, P., Kullberg, P., Poikolainen, L., Viinikka, A., Tuominen, S., Kumpula, T., & Vihervaara, P. (2021). Tree species classification from airborne hyperspectral and LiDAR data using 3D convolutional neural networks. *Remote Sensing of Environment*, *256*. https://doi.org/10.1016/j.rse.2021.112322

Martin, P. A., Green, R. E., & Balmford, A. (2019). The biodiversity intactness index may underestimate losses. *Nature Ecology & Evolution 2019 3:6*, *3*(6), 862–863. https://doi.org/10.1038/s41559-019-0895-1

Miraldo, A., Sundh, J., Iwaszkiewicz-Eggebrecht, E., Buczek, M., Goodsell, R., Johansson, H., Fisher, B., Raharinjanahary, D., Rajoelison, E., Ranaivo, C., Randrianandrasana, C., Rafanomezantsoa, J.-J., Manoharan, L., Granqvist, E., Dijk, L. van, Alberg, L., Åhlén, D., Aspebo, M., Åström, S., … Ronquist, F. (2024). Data of the Insect Biome Atlas: a metabarcoding survey of the terrestrial arthropods of Sweden and Madagascar. *BioRxiv*, 2024.10.24.619818. https://doi.org/10.1101/2024.10.24.619818

Mora, C., Tittensor, D. P., Adl, S., Simpson, A. G. B., & Worm, B. (2011). How Many Species Are There on Earth and in the Ocean? *PLOS Biology*, *9*(8), e1001127. https://doi.org/10.1371/JOURNAL.PBIO.1001127

812   Musvuugwa, T., Dlomu, M. G., & Adebowale, A. (2021). Big Data in Biodiversity Science: A

813   Framework for Engagement. In *Technologies* (Vol. 9, Issue 3). MDPI.

814   https://doi.org/10.3390/technologies9030060

815   Myers, N., Mittermeler, R. A., Mittermeler, C. G., Da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity

816   hotspots for conservation priorities. *Nature 2000 403:6772*, *403*(6772), 853–858.

817   https://doi.org/10.1038/35002501

818   Nature Tech Collective. (2024). *Nature Fintech Sector Map*. https://twitter.com/naturex_ntc

819   Newbold, T., Hudson, L. N., Hill, S. L. L., Contu, S., Lysenko, I., Senior, R. A., Börger, L., Bennett, D.

820   J., Choimes, A., Collen, B., Day, J., De Palma, A., Díaz, S., Echeverria-Londoño, S., Edgar, M. J.,

821   Feldman, A., Garon, M., Harrison, M. L. K., Alhusseini, T., … Purvis, A. (2015). Global effects of

822   land use on local terrestrial biodiversity. *Nature 2015 520:7545*, *520*(7545), 45–50.

823   https://doi.org/10.1038/nature14324

824   Nyström, J. (2024). *Large-scale biodiversity intactness estimation using Bayesian hierarchical models*

825   [Uppsala University]. https://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-538994

826   Panwar, R., Ober, H., & Pinkse, J. (2023). The uncomfortable relationship between business and

827   biodiversity: Advancing research on business strategies for biodiversity protection. *Business*

828   *Strategy and the Environment*, *32*(5), 2554–2566. https://doi.org/10.1002/BSE.3139

829   Pereira, H. M., Ferrier, S., Walters, M., Geller, G. N., Jongman, R. H. G., Scholes, R. J., Bruford, M. W.,

830   Brummitt, N., Butchart, S. H. M., Cardoso, A. C., Coops, N. C., Dulloo, E., Faith, D. P., Freyhof, J.,

831   Gregory, R. D., Heip, C., Höft, R., Hurtt, G., Jetz, W., … Wegmann, M. (2013). Essential

832   biodiversity variables. *Science*, *339*(6117), 277–278.

833   Phillips, H., De Palma, A., Gonzalez, R. E., & Contu, S. (2021). The Biodiversity Intactness Index -

834   country, region and global-level summaries for the year 1970 to 2050 under various scenarios.

835   *Natural History Museum Data Portal*. https://doi.org/10.5519/HE1EQMG1

836   Pyle, R. L., Barik, S. K., Christidis, L., Conix, S., Costello, M. J., van Dijk, P. P., Garnett, S. T., Hobern,

837   D., Kirk, P. M., Lien, A. M., Orrell, T. M., Remsen, D., Thomson, S. A., Wambiji, N., Zachos, F. E.,

838   Zhang, Z. Q., & Thiele, K. R. (2021). Towards a global list of accepted species V. The devil is in the

839   detail. *Organisms Diversity and Evolution*, *21*(4), 657–675. https://doi.org/10.1007/S13127-021-

840   00504-0/FIGURES/2

841   Ranger, N., Alvarez, J., Freeman, A., Harwood, T., Obersteiner, M., Paulus, E., Sabuco, J., Svartzman,

842   R., Althouse, J., Gabet, M., Hurst, I., Ladze, I., Millard, S., Sanchez Juanino, P., David Craig, T.,

843   McKenzie, E., Goldner, T., Dutt, N., Baker, L., … de Sousa Almeida, I. (2023). *The Green*

844   *Scorpion: the Macro-Criticality of Nature for Finance Foundations for scenario-based analysis of*

845   *complex and cascading physical nature-related financial risks Published as Oxford-NGFS*

Occasional Paper 2 Citation the Task force on biodiversity loss and nature-related risks (Task force Nature) of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS). We express our sincere thanks to. https://www.ngfs.net/en/the-green-scorpion-macro-criticality-nature-for-finance

Robinson, J. M., Annells, A., Cavagnaro, T. R., Liddicoat, C., Rogers, H., Taylor, A., & Breed, M. F. (2024). Monitoring soil fauna with ecoacoustics. *Proceedings of the Royal Society B*, *291*(2030). https://doi.org/10.1098/RSPB.2024.1595

Roslin, T., & Laine, A.-L. (2022). The changing fauna and flora of Finland – discovering the bigger picture through long-term data. *Memoranda Societatis pro Fauna et Flora Fennica*, *98*(Supplement 2), 40–53. https://journal.fi/msff/article/view/122353

Ronquist, F., Forshage, M., Häggqvist, S., Karlsson, D., Hovmöller, R., Bergsten, J., Holston, K., Britton, T., Abenius, J., Andersson, B., Buhl, P. N., Coulianos, C. C., Fjellberg, A., Gertsson, C. A., Hellqvist, S., Jaschhof, M., Kjærandsen, J., Klopfstein, S., Kobro, S., … Gärdenfors, U. (2020). Completing Linnaeus's inventory of the Swedish insect fauna: Only 5,000 species left? *PLOS ONE*, *15*(3), e0228561. https://doi.org/10.1371/JOURNAL.PONE.0228561

Roslin, T., Somervuo, P., Pentinsaari, M., Hebert, P. D. N., Agda, J., Ahlroth, P., Anttonen, P., Aspi, J., Blagoev, G., Blanco, S., Chan, D., Clayhills, T., deWaard, J., deWaard, S., Elliot, T., Elo, R., Haapala, S., Helve, E., Ilmonen, J., … Mutanen, M. (2022). A molecular-based identification resource for the arthropods of Finland. *Molecular Ecology Resources*, *22*(2), 803–822. https://doi.org/10.1111/1755-0998.13510

 SBTN. (2020). *SCIENCE-BASED TARGETS for NATURE Initial Guidance for Business*.

Seddon, N., Chausson, A., Berry, P., Girardin, C. A. J., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*, *375*(1794). https://doi.org/10.1098/RSTB.2019.0120

Seidl, A., Cumming, T., Arlaud, M., Crossett, C., & van den Heuvel, O. (2024). Investing in the wealth of nature through biodiversity and ecosystem service finance solutions. *Ecosystem Services*, *66*, 101601. https://doi.org/10.1016/J.ECOSER.2024.101601

Smith, T., Paavola, J., & Holmes, G. (2019). Corporate reporting and conservation realities: Understanding differences in what businesses say and do regarding biodiversity. *Environmental Policy and Governance*, *29*(1), 3–13. https://doi.org/10.1002/EET.1839

Spear, D., van Wilgen, N. J., Rebelo, A. G., & Botha, J. M. (2023). Collating biodiversity occurrence data for conservation. *Frontiers in Ecology and Evolution*, *11*, 1037282. https://doi.org/10.3389/FEVO.2023.1037282/BIBTEX

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., De Vries, W., De Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223). https://doi.org/10.1126/SCIENCE.1259855/SUPPL_FILE/STEFFEN-SM.PDF

Steenweg, R., Hebblewhite, M., Kays, R., Ahumada, J., Fisher, J. T., Burton, C., Townsend, S. E., Carbone, C., Rowcliffe, J. M., Whittington, J., Brodie, J., Royle, J. A., Switalski, A., Clevenger, A. P., Heim, N., & Rich, L. N. (2017). Scaling-up camera traps: monitoring the planet's biodiversity with networks of remote sensors. *Frontiers in Ecology and the Environment*, *15*(1), 26–34. https://doi.org/10.1002/FEE.1448

Swinfield, T., Shrikanth, S., Bull, J. W., Madhavapeddy, A., & zu Ermgassen, S. O. S. E. (2024). Nature-based credit markets at a crossroads. *Nature Sustainability 2024 7:10*, *7*(10), 1217–1220. https://doi.org/10.1038/s41893-024-01403-w

Stork, N. E. (2018). How Many Species of Insects and Other Terrestrial Arthropods Are There on Earth? *Annual Review of Entomology*, *63*(Volume 63, 2018), 31–45. https://doi.org/10.1146/ANNUREV-ENTO-020117-043348/CITE/REFWORKS

Takano, A., Cole, T. C. H., & Konagai, H. (2024). A novel automated label data extraction and data base generation system from herbarium specimen images using OCR and NER. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-023-50179-0Troudet, J., Grandcolas, P., Blin, A., Vignes-Lebbe, R., & Legendre, F. (2017). Taxonomic bias in biodiversity data and societal preferences OPEN. *Nature*. https://doi.org/10.1038/s41598-017-09084-6

Troudet, J., Vignes-Lebbe, R., Grandcolas, P., & Legendre, F. (2018). The Increasing Disconnection of Primary Biodiversity Data from Specimens: How Does It Happen and How to Handle It? *Systematic Biology*, *67*(6), 1110–1119. https://doi.org/10.1093/SYSBIO/SYY044

IPCC (2023) Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H.   Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647.

TNFD. (2024). *A roadmap for upgrading market access to decision-useful nature-related data.* https://tnfd.global/wp-content/uploads/2024/10/Discussion-paper_Roadmap-for-enhancing-market-access-to-nature-data.pdf?v=1730281144

TNFD. (2023). *Findings of a high-level scoping study exploring the case for a global nature-related public data facility*. https://wedocs.unep.org/bitstream/handle/20.500.11822/41335/state_

913   TNFD. (2024, December 10). *Over 500 organisations and $17.7 trillion AUM now committed to TNFD-*

914   *aligned risk management and corporate reporting.* Https://Tnfd.Global/over-500-Organisations-

915   and-17-7-Trillion-Aum-Now-Committed-to-Tnfd-Aligned-Risk-Management-and-Corporate-

916   Reporting/. https://tnfd.global/over-500-organisations-and-17-7-trillion-aum-now-committed-to-

917   tnfd-aligned-risk-management-and-corporate-reporting/

918   Troudet, J., Grandcolas, P., Blin, A., Vignes-Lebbe, R., & Legendre, F. (2017). Taxonomic bias in

919   biodiversity data and societal preferences. *Nature.* https://doi.org/10.1038/s41598-017-09084-6.

920   Van Klink, R., August, T., Bas, Y., Bodesheim, P., Bonn, A., Fossøy, F., Høye, T. T., Jongejans, E.,

921   Menz, M. H. M., Miraldo, A., Roslin, T., Roy, H. E., Ruczyński, I., Schigel, D., Schäffler, L.,

922   Sheard, J. K., Svenningsen, C., Tschan, G. F., Wäldchen, J., … Bowler, D. E. (2022). Emerging

923   technologies revolutionise insect ecology and monitoring. *Trends in Ecology & Evolution*, *37*(10),

924   872–885. https://doi.org/10.1016/J.TREE.2022.06.001

925   Van Klink, R., Sheard, J. K., Høye, T. T., Roslin, T., Do Nascimento, L. A., & Bauer, S. (2024). Towards

926   a toolkit for global insect biodiversity monitoring. In *Philosophical Transactions of the Royal*

927   *Society B: Biological Sciences* (Vol. 379, Issue 1904). Royal Society Publishing.

928   https://doi.org/10.1098/rstb.2023.0101

929   WEF. (2024). *World Economic Forum Global Risks Report*. www.weforum.org

930   White, T. B., Mukherjee, N., Petrovan, S. O., & Sutherland, W. J. (2023). Identifying opportunities to

931   deliver effective and efficient outcomes from business-biodiversity action. *Environmental Science &*

932   *Policy*, *140*, 221–231. https://doi.org/10.1016/J.ENVSCI.2022.12.003

933   White, T. B., Petrovan, S. O., Bennun, L. A., Butterworth, T., Christie, A. P., Downey, H., Hunter, S. B.,

934   Jobson, B. R., zu Ermgassen, S. O. S. E., & Sutherland, W. J. (2023). Principles for using evidence

935   to improve biodiversity impact mitigation by business. *Business Strategy and the Environment*,

936   *32*(7), 4719–4733. https://doi.org/10.1002/BSE.3389

937   Wilkinson, M. D., Dumontier, M., Aalbersberg, Ij. J., Appleton, G., Axton, M., Baak, A., Blomberg, N.,

938   Boiten, J. W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas,

939   M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., … Mons, B. (2016). The FAIR

940   Guiding Principles for scientific data management and stewardship. *Scientific Data 2016 3:1*, *3*(1),

941   1–9. https://doi.org/10.1038/sdata.2016.18

942   Wieczorek, J., Bloom, D., Guralnick, R., Blum, S., Döring, M., Giovanni, R., Robertson, T., & Vieglais,

943   D. (2012). Darwin Core: An Evolving Community-Developed Biodiversity Data Standard. *PLOS*

944   *ONE*, *7*(1), e29715. https://doi.org/10.1371/JOURNAL.PONE.0029715

945   Whitley, B. S., Abermann, J., Alsos, I. G., Biersma, E. M., Gårdman, V., Høye, T. T., Jones, L., Khelidj,

946   N. M., Li, Z., Losapio, G., Pape, T., Raundrup, K., Schmitz, P., Silva, T., Wirta, H., Roslin, T.,

947   Ahlstrand, N. I., & Vere, N. de. (2024). Harmonising digitised herbarium data to enhance

948   biodiversity knowledge: creating an updated checklist for the flora of Greenland. *BioRxiv*,

949   2024.12.01.626242. https://doi.org/10.1101/2024.12.01.626242

950   WWF. (2024). *WWF Position Voluntary Biodiversity Credits*.

951   https://wwfint.awsassets.panda.org/downloads/biodiversity-credits-position---october-2024---

952   final.pdf