Bloom or bust

Aligning technology and finance to address biodiversity challenges

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Authors:
William Nicolle (UBS)
Richard Mylles (UBS)
Kristy Deiner (ETH Zurich)
Leland Werden (ETH Zurich)
Miguel Fernandez (iDiv Germany)

Contributors
Susan Cook-Patton (TNC)
Peter Ellis (TNC)

Editor:
Juhi Singh

Project Management:
Jackie Bauer
Camila Kaiser
Stevica Levajkovski

Design:
Group Branding Solutions
(Agata Wacińska, Eliza Kowalska)

Reviewers:
Suni Harford (UBS), Michael Baldinger (UBS), Mike Ryan (UBS), Jackie Bauer (UBS), Christine Gugolz (UBS), Gillian Dexter (UBS), Veronica Weisser (UBS), Paul Donovan (UBS), Gregorie Muhr (UBS), Judson Berkey (UBS), Richard Morrow (UBS), Armin Peter (UBS), Maya Ziswiler (UBS), Nalini Tarakeshwar (UBS), Katharine Hayhoe (TNC), Lucy Almond (TNC), Rebecca Benner (TNC), Carl McGuinness (TNC), Kelley Hammick (TNC) Preston Welker (TNC), Melissa Gallant (TNC), Peter Benham (TNC), Sara Leavitt (TNC)

The authors thank the following people for their input: Dean Turner (UBS), Maria Dornelas (University of St Andrews), Will Evison (PWC), Thomas White (University of Cambridge)

Editorial

Colm Kelleher
Chairman of the Board of Directors

Sergio P. Ermotti
Group Chief Executive Officer

It is dawning on the global community that biodiversity loss requires just as swift action as climate change. The urgent need for a more holistic approach to confronting it is expressed in the Global Biodiversity Framework's goal of reversing biodiversity loss by 2030. Achieving this goal demands bold action.

Earlier successes in overcoming environmental crises were rooted in harnessing innovation, leveraging science, and implementing technology-driven solutions. These past technological lessons should serve as a guide toward a sustainable future, but they alone are not all that is needed. Responsible leadership and corporate commitment to action is essential to solving the biodiversity crisis.

The good news is that the technological tools needed to counteract biodiversity loss mostly exist today. The key to success is rolling them out faster and on a greater scale than ever before. This won't happen naturally. It demands a deliberate and concerted effort—a new wave of transition finance, governmental resolve, and stakeholder partnerships.

Finance is imperative to fuel the deployment of existing technologies at the speed and scale demanded by the 2030 goal. Government action—transcending rhetoric and manifesting in policies, regulations, and incentives—to promote the consideration of biodiversity in all economic decisions is indispensable. The current policy contradiction of subsidizing biodiversity-harming activities while setting targets for its improvement needs reversing.

No single entity can navigate this journey alone. Partnerships between governments, industries, academia, and communities are needed to accelerate progress. It's the convergence of minds, resources, and expertise that will unlock the reversal of biodiversity loss. This is why UBS has produced this report with experts in the field. Together, we take stock of where we stand on the problem, on existing solutions that can enable the initiation of nature's recovery, and the crucial role that finance, government action, and partnerships can play.

We hope you enjoy the read.

Executive Summary

Challenge: Biodiversity ignored for too long

Roughly 60% of global GDP is at least moderately dependent on nature. Acknowledging biodiversity's importance after decades of neglect, the global community reached a consensus on a "Paris Agreement for nature" in 2022—the Global Biodiversity Framework (GBF). Its two principal objectives are to reverse global biodiversity loss by 2030 and to achieve a nature-positive world by 2050. Now the challenge is delivery, and based on the targets, it will be a race against time, particularly to meet the 2030 deadline. Rapid transformation is required in three areas:

1. **We need better aligned economic incentives.** Subsidies should motivate the responsible use of resources, rather than the depletion of natural capital.
2. **We need to value nature to make it visible.** Coherent and internationally agreed methodologies to value nature would enable its inclusion in financial statements, and thus in decision-making throughout the economy.
3. **We need a clear direction of policy.** The GBF's targets should be quickly underpinned by national implementation plans, providing credibility in the direction of policy, which in turn can incentivize investments in the long-term transition to a nature-positive world by 2050.

Solution: Measurement at scale

Today global markets' appetite for precise, nature-related data is surging. This ranges from corporates seeking to report against new disclosure frameworks, to capital providers looking for usable biodiversity-related metrics to inform investment decisions. From 2024, countries will begin reporting on their implementation of the GBF's goals.

Measurement is a critical enabler to manage biodiversity loss. Nature's localized and complex features mean managing it on a global scale necessitates vast amounts of accurate, timely, and granular data. The pace of change demanded by the 2030 ambition requires sight of what is driving biodiversity's decline, how fast, and where. This informs which interventions can have the greatest impact. And yet, the world currently lacks the measurement infrastructure to track local ecosystems on a global scale.

Fortunately, new measurement technologies are not necessary. Today's "nature tech" toolbox already offers many of the necessary solutions to monitor the state of biodiversity. The task at hand is to deploy these technologies, faster and at greater scale than ever before.

Enablement: Finance, government, partnerships

The rapid deployment of measurement technologies will not happen organically. At present, biodiversity is not a profit issue for those whose activities are being measured, nor is it easy to factor into decision-making. As a result, private capital allocation, corporate actions, and consumer behaviors mostly ignore its value in their everyday activities.

This has resulted in a sizable gap between what we spend on biodiversity, around USD 130 bn, and what is required to meet the 2030 goal, roughly five-to-seven times the current expenditure.[1] This analysis is a few years old and continued underinvestment since its publication is likely to have widened the gap, making the task of reversing biodiversity decline by 2030 harder as time passes. As the bill grows, the question of who pays also becomes trickier. The GBF envisages a bigger role for private capital in funding nature restoration than for public financing.[2] This assumption sits uncomfortably next to the needs of institutional investors for stable returns and efficiency, which nature-related assets struggle to offer today.

Ultimately, meeting the GBF's 2030 ambition requires action from a diversity of stakeholders. With six years until the deadline, this report calls on the global community to do three things:

1. **Pursue a new wave of nature-focused transition finance:** Transition finance includes any investment, financing, insurance, and related products and services that are necessary to support an orderly real-economy transition to agreed sustainability objectives. It is not a panacea for managing biodiversity loss. However, done right, it offers a route for private capital to support the GBF by partially plugging the investment gap, and fueling the necessary scale and speed of measurement tool deployment. Given their scale, global capital markets can meaningfully influence behavior across the real economy. Linking financing directly to environmental outcomes or nature-positive behaviors could increase corporate demand for high-quality and timely nature-related data—creating pull factors for measurement technologies.

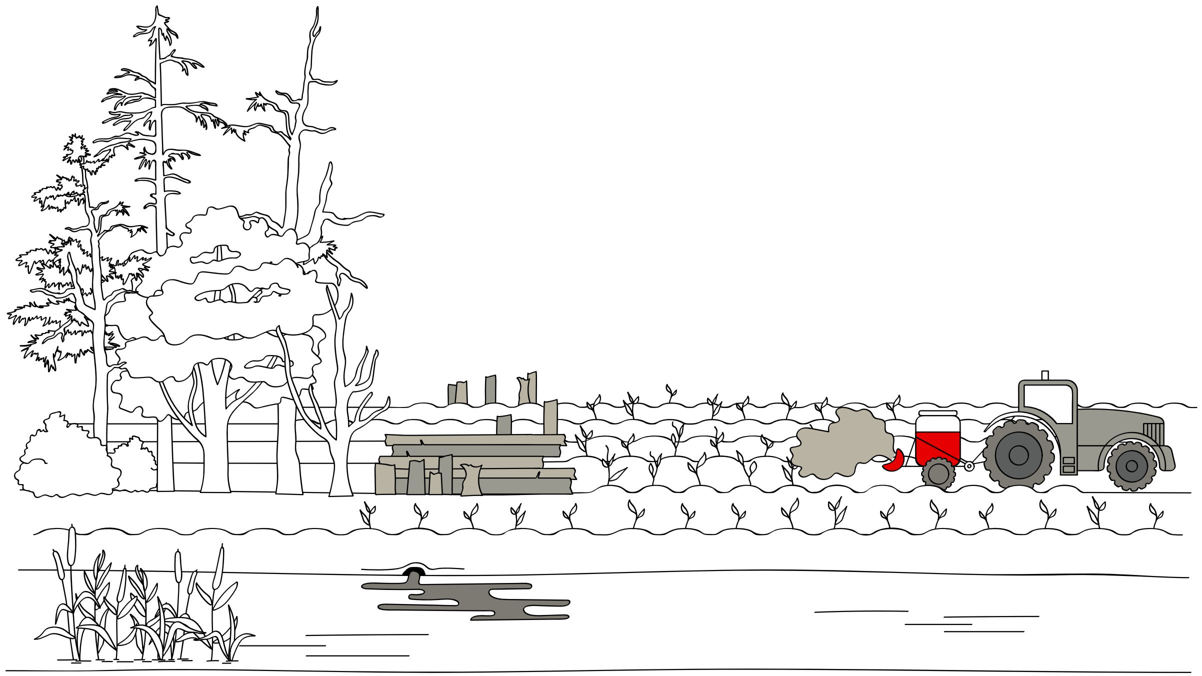
2. **Rapidly implement supportive government action:** Government action is crucial for encouraging the development and deployment of measurement technologies. One way it can help is by reducing the investment gap through innovative and concessional financing approaches. Another crucial action is to align fiscal expenditure with biodiversity goals; today, five times more subsidies flow to nature-harming activities than for activities that support nature.[3]

3. **Partnerships to achieve scale and boost innovation:** Partnerships will be key to rolling out measurement technologies, testing business models, and ensuring technologies meet end-user needs. Several of today's mainstream biodiversity measurement products directly emerged from partnerships between technology companies, academia, and conservation organizations. To meet the 2030 goals, this story needs to repeat, and on a much wider scale.

[1] Paulson Institute et al. (2020), *Financing nature: Closing the global biodiversity gap.*
[2] For instance, within the GBF text, high-income countries agreed to increase funding to low-income countries by USD 30bn per year by 2030, while "mobilizing" at least USD 200bn per year primarily through private finance.
[3] Organisation for Economic Cooperation and Development (2020), *A comprehensive overview of global biodiversity finance,* OECD.

Biodiversity under the radar

Efforts to tackle climate change outpace those regarding biodiversity loss. This is shortsighted, considering almost two thirds of the economy is at least moderately dependent on it. The first step to reversing biodiversity loss by 2030—in just six years—is measurement.



Global emissions are 55% off-track from achieving the Paris Agreement's goals.[4] Biodiversity's equivalent agreement, the Global Biodiversity Framework (GBF), remains too new to judge (Box 1). But its objectives of reversing biodiversity loss by 2030 (versus 2020) and achieving a "nature-positive" state by 2050 look increasingly optimistic considering long-term trends.[5]

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Never waste a crisis

History shows human ingenuity can thrive when individuals, businesses, capital, and governments are spurred by necessity to collectively focus on a single challenge. Take the Green Revolution; society overcame the widening gap between population growth and insufficient agricultural yields through the creation, application, and transfer of new technologies, which disrupted the status quo and led to improvements in yields.[6]

Box 1

Understanding nature, biodiversity, and ecosystem services

Nature is made up of many interlocking pieces, from the species that represent all the unique living organisms, to the genes that shape what they look like, to the ecosystems that provide habitats for them.

Biodiversity, short for biological diversity, describes the variety of living things in nature. Greater genetic diversity can support species persistence. Greater variety of species can lead to more stable ecosystems. The more diverse an ecosystem, the more species it can support.

Humans depend on and make use of nature through ecosystem services. These are the multitude of direct and indirect benefits ecosystems provide to society, from direct resources like clean water, to spaces for recreation.[7]

[4] 55% is the gap between the projected emissions in 2035 under a current policies scenario (56GtCO_2) and the required cuts in emissions to align with the median estimate of limiting global temperature increase to within 2°C with about a 66% likelihood; see PXXI in UNEP (2023), *Broken record: Temperatures hit new highs, yet world fails to cut emissions (again): Emissions gap report 2023.*

[5] Agreed by almost 200 countries, The GBF's main targets include halting and reversing biodiversity loss by 2030, becoming nature positive by 2050; Dunne, D. (2023), *Explainer: Can the world 'halt and reverse' biodiversity loss by 2030?* Carbon Brief; Leadley, P. et al. (2022), *Achieving biodiversity goals by 2050 requires urgent and integrated actions,* One Earth; Cuff, M. (2022), *COP15 target to reverse biodiversity loss by 2030 is 'unrealistic,'* New Scientist.

[6] Over the 20th Century, the global population doubled but production of cereal crops tripled, all while cultivated land increased by only 30%; Pingali, P. (2012), *Green revolution: Impacts, limits, and the path ahead,* Proceedings of the National Academy of Sciences.

[7] Millenium Ecosystem Assessment (2003), *Ecosystems and human wellbeing: A framework for assessment.*

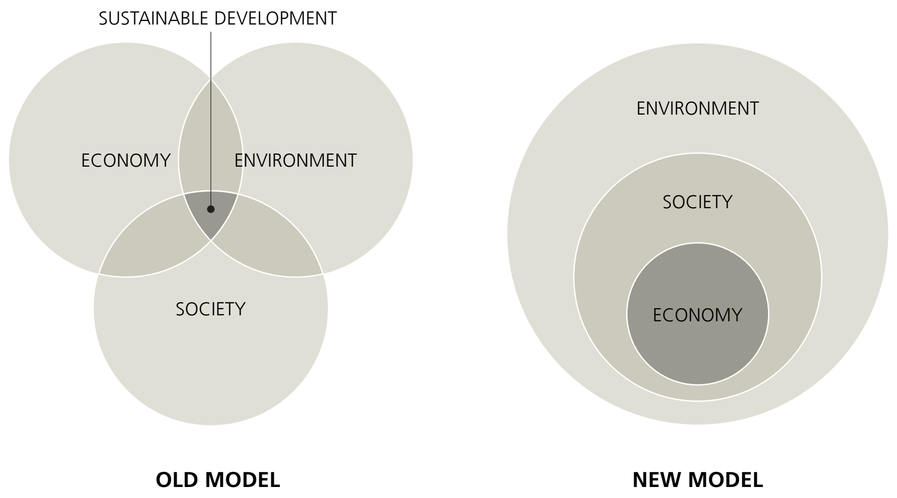
The same principle applies to ongoing environmental issues. While technology cannot be considered a cure-all for every problem—even the Green Revolution failed to solve global hunger or reduce food waste or spoilage[8]—the current biodiversity and climate challenges call for a new period of applying technology to meet sustainability goals.

> Historically, the environment and the economy were too often viewed as being part of a zero-sum game, where one could benefit only at the expense of the other.

Historically, the environment and the economy were too often viewed as being part of a zero-sum game, where one could benefit only at the expense of the other.[9] Today, more stakeholders from policy to business increasingly view environmental health as both a requirement and an increasingly important objective for economic activity (Figure 1).[10]

Figure 1: International biodiversity goals require a shift in our economic model

The Global Biodiversity Framework's headline targets of halting and reversing biodiversity loss imply the environment is the context for the economy and society (right), rather than the competition (left)



Sources: Locke, H. et al. (2021), *A Nature-Positive World: The global goal for nature; Folke, C. et al. (2016), Social-ecological resilience and biosphere-based sustainability science, Ecology and Society;* UBS

[8] FAO et al. (2022), *The state of food security and nutrition in the world 2023,* United Nations.
[9] This mainly applies to thinking in industrialized countries; many Indigenous Communities have long-held views on their interrelation.
[10] UBS Sustainability and Impact Institute (2023), *The rise of the impact economy: Evolving to the next level,* UBS.

Same road, different speeds

Biodiversity and climate change are two parts of the same challenge—failing on one means failing on both. Yet, global attention on climate change far outpaces that on biodiversity.[11] International diplomacy is less advanced on the biosphere;[12] and our understanding of how impacts on nature translate into commercial and financial risks and opportunities remains patchy.[13]

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However, new analyses that highlight the economic importance of biodiversity imply we could be approaching a turning point.[14] Financial institutions have begun paying more attention to their nature exposure. Recent reviews of their lending portfolios find between a third and three quarters have a high exposure to nature.[15] Real-economy exposure is large too; UBS analysis shows that roughly 60% of global GDP is at least moderately dependent on ecosystem services. And while some sectors may not be directly exposed to nature, they can have substantial indirect exposure through their supply chains. As shown in Figure 2, at least 25% of the economic value in the supply chain of nine industries is highly dependent on ecosystem services.[16]

Growing need for measurement

Demand for nature-related data is surging. The GBF requires governments to begin reporting their implementation of its goals from 2024. This demands high-quality data on the state of biodiversity at a national level, while also reflecting the complicated character of ecosystems at a local level. Appetite for precise data is also rapidly growing in the private sector, from corporates disclosing against new frameworks, to capital providers looking for usable biodiversity-related metrics (Interview 1).[17] These demands imply the need for vast quantities of data—including its aggregation, processing, maintenance, analysis, and access management—across a wide range of variables and places.[18]

[11] Directionally underway in the sense the world is paying increasing attention to the issue, but global emissions are still rising; IEA (2023), *Net zero roadmap: A global pathway to keep the 1.5oC pathway in reach: 2023 update.*

[12] It remains to be seen whether the Global Biodiversity Framework will generate the same momentum as Paris.

[13] The academic and private sector literature contains a wide range of quantitative analyses on climate-related physical and transition risks, and their commercial and financial implications, at global and more market-specific scales. The same literature on nature is growing but is far less extensive.

[14] Dasgupta, P. et al. (2021), *The economics of biodiversity: The Dasgupta Review,* HM Treasury.

[15] NGFS recently turned its attention to nature-related financial risks, see NGFS (2023), *Nature-related Financial Risks: A conceptual framework to guide action by central banks and supervisors;* Recent analyses of the exposure of financial institutions to nature include: European Central Bank (2023), *Occasional paper series: Living in a world of disappearing nature: Physical risk and the implications for financial stability*; De Nederlandsche Bank (2020), *Indebted to nature—Exploring biodiversity risks for the Dutch financial sector;* Calice, P. et al. (2021), *Nature-related financial risks in Brazil,* World Bank Group; Napier, M. et al. (2022), *Nature and financial institutions in Africa: A first assessment of opportunities and risks,* McKinsey & Company.

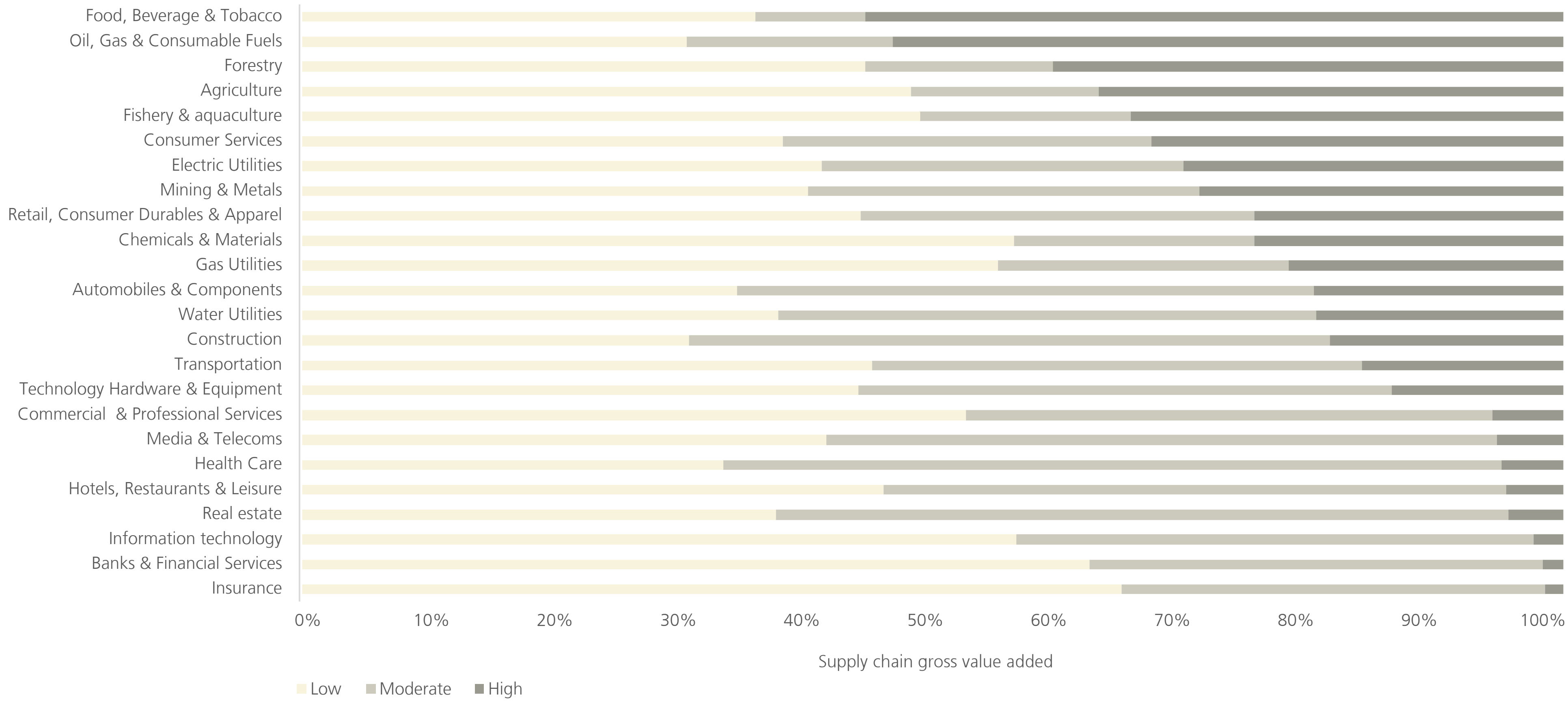
[16] See Appendix for methodology, which follows similar analyses by the European Central Bank (2023) and PWC (2023).

[17] TNFD is voluntary so there is no set implementation date, but some companies have already committed to a 2026 publication date, see TNFD (2023), *Final TNFD recommendations on nature related issues published and corporates and financial institutions begin adopting;* Layman, H. et al. (2023), *Short term solutions to biodiversity conservation in portfolio construction: Forward looking disclosure and taxonomy-based metrics,* SocArxXiv.

[18] TNFD et al. (2023), *Findings of a high-level scoping study exploring the case for a global nature-related public data facility.*

Figure 2: At least 25% of the economic value in the supply chain of nine industries is highly dependent on nature

Percentage of supply chain gross value added exhibiting low, medium, or high dependence on nature



Notes: Data for 2022; Nature dependence reflects the exposure of the economic value generated by business activities to disruption of the ecosystem services that underpin them. "High" means the activities could fail financially due to disruption from particular services; "Moderate" means the activities could experience a material reduction in financial returns due to disruption; "Low" means economic value comes from activities that may experience limited material financial effects from ecosystem disruption. See Appendix for methodology, which follows recent analyses from PwC (2023) and the European Central Bank (2023).

Sources: Exiobase; ENCORE database; UBS

Meeting these requirements in a short period will be challenging. It asks for the creation of a global monitoring system—which exists for climate, but not for nature[19]—to continually measure biodiversity trends. Moreover, developing this

> Reversing biodiversity loss by 2030 means deploying measurement solutions from the "nature tech" sector quickly.

system needs to occur well in advance of 2030, and in sync with ongoing management, to leave time to comprehensively implement solutions to reverse biodiversity loss. In effect, reversing biodiversity loss by 2030 means deploying measurement solutions from the "nature tech" sector quickly (Box 2).

Box 2

Defining "nature tech"

Definitions vary and evolve quickly,[20] but generally nature tech falls into four buckets:[21]

- **Deploying** of ecosystem interventions, such as drones to reforest areas, or genetic modification to modify species in line with conservation goals;
- **Monitoring, Reporting, and Verification (MRV)** to measure the state of ecosystems over time ranging from the global to the molecular level;
- **Transparency** along value chains to monitor environmental impacts and dependencies, such as through blockchain for transactions and registries in credit offset markets;
- **Connecting** stakeholders within projects and markets, e.g., dedicated apps to link smallholder farmers to global carbon markets.

Definitions of technology become fuzzy in the detail. A technology can be both climate and nature tech when it addresses shared drivers. And green-tech does not necessarily mean high-tech. Sometimes rudimentary interventions are the best "tech," such as simple chili fences to prevent elephants from eating crops.[22] This report focuses on technologies for measuring the state of biodiversity, which mostly fit into the MRV category.

[19] Gonzales, A. et al. (2023), *A global biodiversity observing system to unite monitoring and action*, Nature Ecology & Evolution.
[20] For instance, Nature4Climate substantially changed their definition of nature tech between their 2022 and 2023 reports from the one used here to one focused more on the application of technologies (e.g., land/food, ocean).
[21] Nature4Climate (2022), *What you can measure, you can manage: How Nature Tech can help us solve the climate and nature crises.*
[22] Chang'a, A. et al. (2016), *Scaling-up the use of chili fences for reducing human-elephant conflict across landscapes in Tanzania,* Tropical Conservation Science.

Interview 1

Nature presents both a risk and (so far) a missed opportunity

David Craig, Chair, Taskforce on Nature-related Financial Disclosures (TNFD)

What problem does the TNFD address?
Companies and their investors do not systematically understand their interface with nature and the ecosystems services their businesses or portfolios depend upon. It's almost impossible to find an industry value chain that doesn't rely on some sort of ecosystem service, somewhere. The TNFD framework provides a consistent and comprehensive way to assess a company's or investors' interface with nature. This allows for managing and disclosing nature-related risks and opportunities. As companies adopt TNFD, the assessment of nature dependencies and risks in supply chains will become easier.

How do you think about economic activity's dependence on nature?
What particularly interests me is the work of central banks on the dependence of the financial system on nature and ecosystem services. The Brazilian, French, Dutch, and British central banks have assessed the impact of nature and are coming to similar conclusions: that roughly one third to one half of bank portfolios have a high dependency on nature. Many companies taking part in TNFD pilots have found that their nature risk is larger and even more immediate than climate risk, and many find that the largest risks from climate change are to the natural system and services they depend upon.

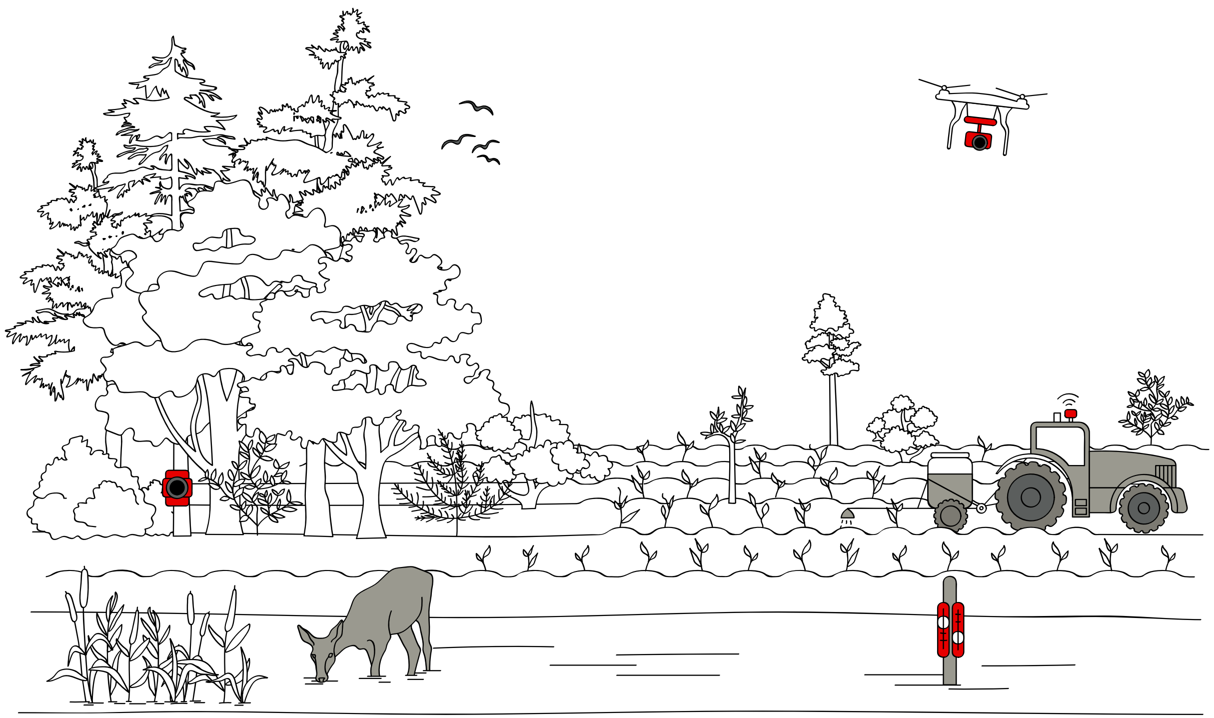
Who are the most important stakeholders to reduce pressure on the biosphere?
The TNFD often liaises with both environmental and treasury departments, such as in the UK, Japan, Australia, and Switzerland. As nature becomes a financial issue, we see our role as helping create the bridge between them. Central banks and central regulators are important via their risk analyses—to make sure we don't suddenly see a massive issue where things fall off together. Take food inflation: the war in Ukraine is one factor, but weak harvests and adverse weather conditions combined to create a scarcity of key products.

How do you see the private sector's approach to nature evolving between now and 2030?
Issues like water use have been on the agenda for many years, but the need for a holistic approach that integrates both climate and nature is now being recognized. Several firms are already merging their TCFD and TNFD assessment. On financial markets, my hope is that a move toward wider and better data availability and quality will allow capital providers to understand material nature risks and impacts and how they lead to either risk or opportunity, underpinning active dialogue and a hunt for new investment opportunities that offer both a lower footprint and sustainable financial returns.

TCFD = Taskforce on Climate-related Financial Disclosures

Scale at speed

Tracking the natural world is a formidable endeavor, driven by intensifying demands for nature-related data. Fortunately, many measurement technologies to track local biodiversity at a global scale already exist. The global community does not need blockbuster innovations. The focus should be on deploying existing solutions, faster and at greater scale, to achieve transformative results.



Unless we utilize a diverse portfolio of technologies, we are likely to miss the current biodiversity target—as in the past, where the Aichi Targets were missed due to lack of clear implementation mechanisms.[23] The to-do list is long, but we believe the top priority is to apply existing technologies in novel ways, from environmental DNA (eDNA) to sensors, to track global biodiversity, and synthesize vast quantities of data.

Applying novel technologies

The biodiversity space does not need significant technological breakthroughs, according to experts. Instead, progress will emerge from new applications of existing technologies (such as satellite-based remote sensing) or optimizing technologies that are already in use (Box 3).

Box 3

The biodiversity measurement "toolbox"

The current toolbox consists of technologies in 14 categories. The most prominent are:

1. **Remote sensing:** Gathering environmental data at a distance, e.g., through satellites or aircraft.
2. **New sensors:** Creating novel datasets by deploying camera traps, bioacoustics sensors (which "listen" to the ecosystems to infer their health), and biologgers (GPS and other trackers), often in combination.
3. **eDNA:** using genetic material in the environment, such as DNA fragments shed by some species in water or soil samples, to analyze ecosystems.
4. **Genetics:** Tools to monitor and maintain genetic variation in populations, such as mapping genomic families.
5. **Modelling:** Techniques to study and predict the behavior of environmental systems, such as population dynamics, habitat changes, and species interactions.
6. **Software / Packages:** Tools ranging from apps to computer packages, such as processing data in the cloud, or mobile apps for collecting field data that anyone can download.
7. **Artificial Intelligence (AI):** Algorithms for making predictions, recommendations, or decisions, particularly detecting species from vast quantities of data.

For the full list of technologies and further detail, please refer to Table A1 in the Appendix.

[23] The Aichi Targets were established in 2010 by the Convention on Biological Diversity (CBD), which also established the GBF, in an effort to protect and conserve biodiversity. They were the precursor targets to the GBF, running from 2011 to 2020. The targets encompassed 5 strategic goals, subdivided into 20 specific targets, as part of the UN's CBD's "Decade on Biodiversity." The targets were left to signatories to implement in their own countries. An assessment by the UN found that none of the 20 targets were met, which some analysts attribute to the lack of a pre-set and coherent implementation plan and standardized measures of success, low investment, as well as a lack of accountability in the voluntary framework.

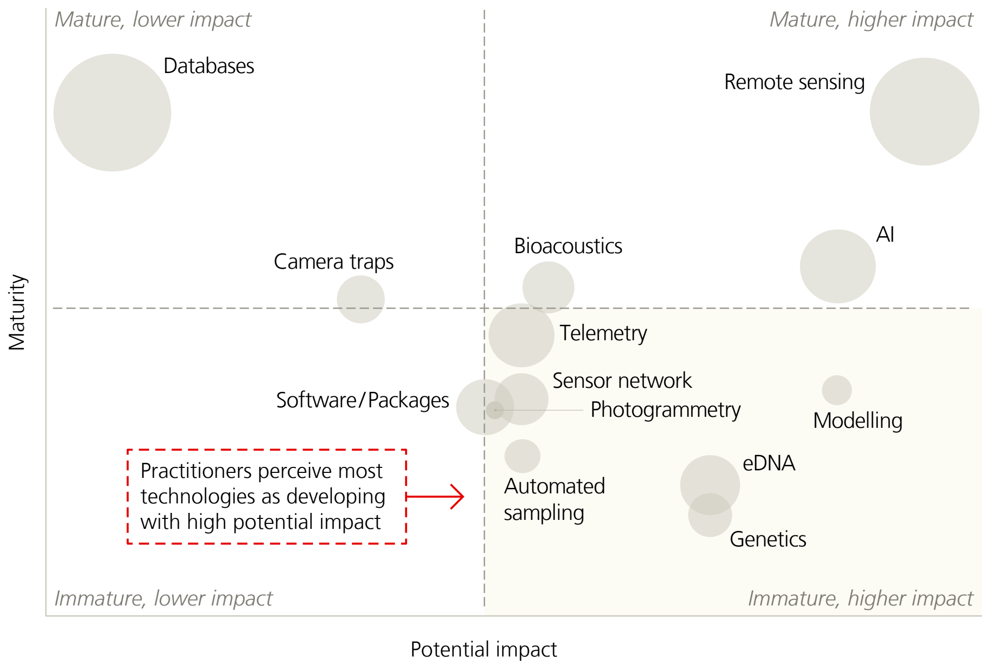
The challenge lies in applying many of the existing biodiversity measurement technologies better and more widely. Today's technologies sit across a wide spectrum of impact and maturity (Figure 3). Remote sensing has been used for years and has already made a significant impact on monitoring. It is becoming more valuable as spatial resolutions improve. On-the-ground data collection technologies are developing at pace, such as

> The challenge lies in applying many of the existing biodiversity measurement technologies better and more widely.

camera trapping, but they need deployment on a wider scale. Practitioners view eDNA and genomics with notably higher effectiveness and impact than other data collection technologies, and they are just starting to be used in new applications. AI and modelling are believed to have high impact potential, but they cut both ways. For instance, while AI is being used to identify trends, monitor ecosystems, and predict future distributions,[24] it could also make exploitation of nature more efficient, putting more, not less, pressure on biodiversity.[25]

Figure 3: Most existing conservation technologies are perceived as being high-impact, low-maturity

Conservation technologies organized by potential impact (the perceived current and potential future performance by practitioners) and maturity (Technology Readiness Level weighted by current use)



Notes: Potential impact is measured as the difference between practitioners' perception of current impact versus potential future impact; Maturity is based on practitioners' perceptions of each category's "Technology Readiness Level" (TRL) weighted by each technology's current use levels; Size of bubble reflects the number of methods within each technology category; A notable outlier is practitioners views on databases, which are seen as a mature solution with very low impact. It is hard to explain why, given the impact rating is based on survey data. One explanation is they are seen as enabling solutions for other technologies, and so deemed as having a lower impact themselves.

Sources: Dornelas, M. et al. (2023), *Novel technologies for biodiversity monitoring – Final Report,* EuropaBON; Speaker, T. et al. (2021), *A global community-sourced assessment of the state of conservation technology,* Conservation Biology; WildLABS (2021), *The state of conservation technology;* UBS

[24] Global Partnership on Artificial Intelligence (2022), *Biodiversity and Artificial Intelligence: Opportunities and Recommendations.*

[25] Ibid, P17-19.

Others have undertaken a comprehensive review of biodiversity-related technologies elsewhere.[26] This report highlights the most promising novel applications of existing technologies across three groups: remote sensing, on the ground (or "in situ") sensing, as well as novel data analysis and synthesis.

Group 1: Remote sensing

Two recent innovations in the world of satellite-deployed technologies show promise for improving biodiversity measurement:

1. **New applications of Light Detection and Ranging (LIDAR)** show it can usefully map different aspects of biodiversity from space.[27] Normally, sensors are attached to a plane or high-end drone, adding great expense, and limiting geographic coverage. NASA's Global Ecosystem Dynamics and Investigation (GEDI) program[28] recently demonstrated LIDAR could be used from the International Space Station, enabling global measurement of environmental features at granular resolutions. The sensor needs further development and a long-term plan, but it shows tremendous potential to facilitate research across large scales—such as quantifying tree biomass.
2. **Satellite-based telemetry** shows promise to advance species tracking through the joint German-Russian ICARUS project (currently paused for geopolitical reasons).[29] A satellite sweeps the area of interest once a day, retrieving signals from miniature emitters. The key innovation is detecting weak signals at a global scale. It means the emitters require little power, extending their deployment lifespan, and making them much smaller than similar hardware—so small they could even be attached to insects.[30] Uses include the biocontrol of invasive species—a driver of biodiversity loss that current technologies are poor at addressing (Table A1)—or tracking endangered and poached species.

Group 2: On the ground sensing

Of the various on the ground sensors in use today, eDNA shows the most promise.[31] Currently, it is advancing from measuring species presence to quantifying biomass.[32] This could enable it to measure species' relative abundance, distributions, and even interaction webs—all nuanced questions central to gauging ecosystem health.[33] It is one of the few highly scalable biodiversity monitoring technologies that can survey multiple measures of biodiversity (genetic, species, community) within one sample. The main barriers include the lack of recognized ISO standards,[34] and difficulties obtaining important equipment for genetic analysis due to tariffs and logistics, [35] particularly in the Global South.[36]

[26] Such as Nature4Climate (2023), *The state of nature tech: Building confidence in a growing market.*
[27] Müller, J. et al. (2017), *LiDAR-derived canopy structure supports the more-individuals hypothesis for arthropod diversity in temperate forests,* Oikos.
[28] See Global Ecosystem Dynamics Investigation website for more information.
[29] DLR (2023), ICARUS: technology demonstration – research on animal migrations.
[30] ICARUS Global Monitoring with Animals (2023), *Animals on the air;* for a deeper dive see Krondorf, M. et al. (2022), *ICARUS—Very low power satellite-based IoT,* Sensors.
[31] See Figure 3.
[32] Yates, M. et al. (2022), *Interspecific allometric scaling in eDNA production among northwestern Atlantic bony fishes reflects physiological allometric scaling,* Environmental DNA.
[33] Pereira, C. et al. (2023), Future-proofing environmental DNA and trait-based predictions of food webs, American Institute of Biological Sciences.
[34] International Organization for Standardization.
[35] Such as cold storage transport, which is necessary to preserve eDNA samples, and as an issue was partly solved during the COVID pandemic. This infrastructure could now be repurposed to facilitate an expansion of eDNA, among other genomic use cases.
[36] For instance, cold storage transport was partly solved during the COVID pandemic, but now the infrastructure needs repurposing.

While work remains to solve logistical challenges, international standards for eDNA are developing[37] and regional efforts have already culminated in best practices.[38]

> Existing and new technologies create an abundance of biodiversity data but also usability challenges, which could grow as more data becomes available.

Group 3: AI, software, and data ingestors
Existing and new technologies create an abundance of biodiversity data but also usability challenges, which could grow as more data becomes available. Three areas of innovation are imposing structure on the growing pool of biodiversity data:

1. **Integrated data platforms**[39] are seeing a frenzy of research driven by the XPRIZE Rainforest Challenge, with finalists presenting their technology readiness levels in late-2024.[40] These, combined with data ingestors (software that combines multiple streams of information into usable outputs), will advance near real-time biodiversity monitoring systems soon by helping make sense of the growing pool of biodiversity-related data.

2. **AI and machine learning algorithms** can now detect species' presence from sound and image data. A technique called Convolutional Neural Networks can detect specific bird, mammal, amphibian, and insect species from sound recordings, enabling tracking across sites.[41] The obvious strength here is the ability to detect presence within enormous volumes of data. But several questions remain, such as data-syncing in offline settings and ongoing teething problems with model training, but solutions are advancing steadily.

3. **Interspecies money** is a concept, currently being developed in Rwanda and India. It seeks to allow nonhuman lifeforms to hold and spend money.[42] An AI represents the interests of these lifeforms by evaluating their preferences. The nonhuman—animals, trees, eventually plants and insects—enabling them to pay poor local communities in return for simple services that the AI judges is in their interest. For instance, if an animal's local habitat is under pressure, the AI might decide to pay a local farmer with digital currency to stop converting local forest into farmland, easing pressure on local biodiversity. Similarly, if the AI determines too little is known about a local species, it might pay local communities to collect up-to-date data on species presence. Essentially, these functions create a digital market for actions that support biodiversity. The idea is too novel to have produced any results, but it shows promise for extending certain new technologies to nature and creating new funding streams via incentives.

[37] For more information see International eDNA Standardization Task Force's website.
[38] Bruce, K. et al. (2021), *A practical guide to DNA-based methods for biodiversity assessment;* De Brauwer, M. et al. (2023), *Best practice guidelines for environmental DNA biomonitoring in Australia and New Zealand,* Environmental DNA.
[39] Integrated data platforms look to synthesize the data coming from sensors to create a complete measure of biodiversity.
[40] See the XPRICE website for more details.
[41] Norouzzadeh, M. et al. (2018), *Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning,* PNAs.
[42] Ledgard, J. (2021), *Interspecies money.*

Technologies need focus

The real challenge to using these technologies lies in their application. The global community can learn from the failure of the Aichi Biodiversity Target by focusing new technological solutions on three strategic needs:

1. **Tracking global biodiversity:** An integrated observation system exists for quantifying the state of the climate—the Global Climate Observing System[43]—and something similar is urgently needed for biodiversity.[44] Proposals already exist to track and understand biodiversity using Essential Biodiversity Variables (EBVs).[45] These serve as a set of minimum required metrics to monitor multiple dimensions of biodiversity, like vital signs used to detect health issues in patients.[46,47]

2. **Synthesizing data:** Meeting the GBF's goals means shifting from a search for more information, to synthesizing the many existing data pools. For instance, no integrative metric exists that evaluates the three core dimensions of biodiversity (genetics, species, and ecosystems). Innovation is underway, such as the Crowther Lab's SEED Biocomplexity Index.[48] It combines the outputs of a variety of technologies and models to reflect biodiversity and ecosystem structure in a standardized, integrated metric.[49] This kind of streamlined information is key to enable the use of biodiversity data in fast-moving areas, such as financial markets.

3. **Enhancing traceability and accountability:** Combining novel monitoring technologies with blockchain offers a framework for measuring and tracking biodiversity outcomes across projects, products, and environments. This helps conservation projects function more like assets into which investment can flow. Many asset classes are being built in the Web3 space, such as the "asset layers" for blockchain technology which ensure the fundamental immutability of data.[50] Within this asset layer, data from eDNA technologies can be used to create immutable "banks of genetic codes" based on a credible and trustworthy data layer, unlocking further downstream applications.[51] By using these digital technologies, far greater accountability is possible, such as by tracking key performance indicators, which ultimately helps to promote investibility.

[43] See Global Climate Observing System website.
[44] see Gonzales, A. et al. (2023), *A global biodiversity observing system to unite monitoring and action*, Nature Ecology & Evolution.
[45] Jetz, W. et al (2019), Essential biodiversity variables for mapping and monitoring species populations, Nature Ecology & Evolution.
[46] see Gonzales, A. et al. (2023), *A global biodiversity observing system to unite monitoring and action*, Nature Ecology & Evolution.
[47] Walters, M. and Scholes, R. (2017), *The GEO Handbook on Biodiversity Observation Networks.*
[48] SEED is the first generation of a flexible framework that can estimate the current state of biocomplexity of any terrestrial ecosystem relative to its undisturbed condition.
[49] Fournier de Lauriere, C. et al. (2023), *Assessing the multidimensional complexity of biodiversity using a globally standardized approach,* preprint available online.
[50] Ecofrontiers (2023), *Asset layer: The market objects of protocols.*
[51] See SimplexDNA (2022), *The Franklin: Digital eDNA tokens to better preserve diverse life on Earth.*

While the GBF includes 43 headline indicators,[52] much of the data and even methodologies to support those indicators remain undeveloped.[53] Of the data that exists, their time coverage and empirical scope can be thin, particularly in developing countries. Focusing technological deployment on these goals through different means, such as government-sponsored programs, would help to guide progress in the right direction (Box 4).

> Much of the data and even methodologies to support the GBF's 43 headline indicators remain undeveloped.

Box 4

Strategic management required

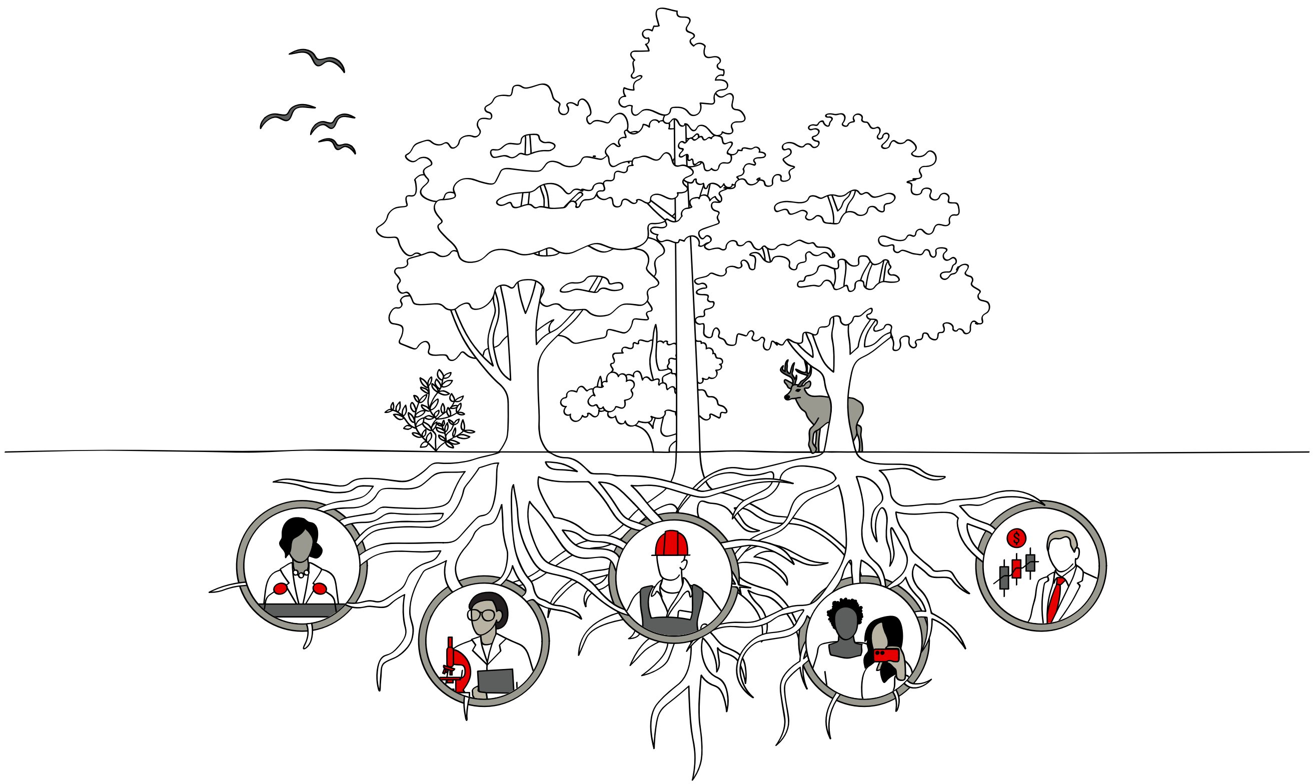
The interconnected nature of biodiversity and climate means action on each needs to be strategically coordinated. Failing on one means failing on both. In this light, better strategic management of biodiversity should be a key element of the global strategy to deliver international sustainability goals—the GBF, as well as the Paris Agreement.

One set of promising interventions are Natural Climate Solutions (NCS), which can reduce global carbon emissions and, in some instances, avert biodiversity loss. While they must adhere to a strict definition to uphold credibility, they can offer substantial near-term emission benefits,[54] and often considerably lower unit costs than some climate technologies.[55] UBS, together with The Nature Conservancy, plans to explore these further in a follow up report.

[52] Implement through their National Biodiversity Strategies and Action Plans—the GBF's equivalent of Nationally Determined Contributions under the Paris Agreement.
[53] United Nations Environment Programme-World Conservation Monitoring Centre (2023), *Indicators for the Kunming – Montreal Global Biodiversity Framework.*
[54] The Nature Conservancy (2023), *Natural Climate Solutions.*
[55] The Nature Conservancy (2022), *New Approach to Forest Carbon Accounting Aims to Enhance Accuracy and Transparency.*

Finance, government, partnerships

Private capital allocation, corporate actions, and consumer behaviors historically overlooked nature's economic importance, thereby endangering biodiversity goals. The investment gap is widening, and private finance alone will not plug it. The global community should act strategically in three areas: transition finance, governmental resolve, and partnerships.



By themselves, markets are unlikely to scale the necessary technologies with the breadth and speed needed to meet the GBF's 2030 goal. Several barriers hold them back: the invisibility of nature's value, counterproductive economic incentives, and an unclear direction of policy.

Barriers to scaling measurement technologies

The seminal 2021 Dasgupta Review set out how ecosystem services underpin large chunks of global production, but their exploitation—while not inherently problematic if done sustainably—goes unvalued.[56] In today's system, wealth rises when crop yields increase through greater use of fertilizers. However, the silent damage to the soil remains unaccounted for. The result is that nature and biodiversity have a value but no price.[57]

> In today's system, wealth rises when crop yields increase through greater use of fertilizers. However, the silent damage to the soil remains unaccounted for. The result is that nature and biodiversity have a value but no price.

While the recent uptick in analyses of financial exposure to nature is positive, it still does not represent nature's value in a systematic way. Nature's attributes make this tricky: Ecosystems are complex, and their condition is reflected across many metrics, from land-use change to water consumption. In turn, this makes it difficult to capture nature's health and value in a few metrics. New disclosure frameworks and efforts to bring credibility to biodiversity credits and offsets are welcome, but without nature on the books, they incentivize investment in solutions only up to the bar set by compliance.[58]

Furthermore, not only is most natural capital excluded from balance sheets, but its depletion is actively encouraged through subsidy regimes. At around USD 500bn, nature-harming subsidies are estimated to be five times larger than funding supporting it.[59] This is particularly true for poorly targeted agricultural subsidies—the World Bank linked agricultural subsidies to 14% of global deforestation.[60] Consequently, private sector participants have little incentive to integrate biodiversity into their own planning, operations, and reporting. It also ensures that the economics of "bankable" biodiversity projects remain poor.[61]

[56] Dasgupta, P. et al. (2021), *The economics of biodiversity: The Dasgupta Review,* HM Treasury.
[57] World Bank Group (2020), *Mobilizing private finance for nature: A World Bank Group paper on private finance for biodiversity and ecosystem services,* World Bank Group.
[58] UBS Sustainability and Impact Institute (2023), *Taking Root: Mainstreaming natural capital accounting to meet global biodiversity goals,* UBS.
[59] Organisation for Economic Cooperation and Development (2020), *A comprehensive overview of global biodiversity finance,* OECD.
[60] Damania, R. et al. (2023), *Detox development: Repurposing environmentally harmful subsidies,* World Bank; Agricultural subsidies can distort the decisions of farmers, such as incentivizing them to expand into areas previously devoted to forests or other natural habitats.
[61] Kyriakopoulou, D. (2023), *Commentary: Finance at the nature frontier,* LSE Grantham Research Institute on Climate Change and the Environment and the LSE Business Review.

Lastly, we need a clearly defined roadmap to reach the targets. The GBF made great strides by achieving consensus on high-level goals for nature; however, its implementation remains a gray area. Governments cannot fully report progress yet, given large parts of the data and methodologies underlying its agreed indicators remain undeveloped.[62] Most of the Aichi Targets failed due to unclear implementation paths.[63] A lingering fear that history could repeat itself undermines confidence in the direction of policy and the business case for investing in measurement technologies. The forward-looking investment gap to reach international sustainability goals reflects the stark reality: meeting the GBF's 2030 objective requires five-to-seven times more than currently spent.[64] While estimates vary, private capital contributes less than 20% today, implying room for a much stronger role going forward.[65]

Overcoming these barriers, and thereby galvanizing the deployment of existing measurement solutions, requires three essential ingredients: transition finance (Box 5), complementary government action, and new partnerships.

Box 5

What is transition finance?

Broadly, transition finance can be defined as any investment, financing, insurance and related products and services that are necessary to support an orderly real-economy transition to agreed sustainability objectives.[66] The objectives can include the goal to halt and reverse biodiversity loss under the Global Biodiversity Framework, as well as Net Zero under the Paris Agreement. One example is green bonds, where raised funds go toward specific climate-related or environmental projects.

The market lacks a more detailed definition of transition finance, such as its goals, who can access it, and on what terms. Recently there have been calls for transition finance to only fund corporate transition plans, which could help to bring further some standardization to its meaning.[67]

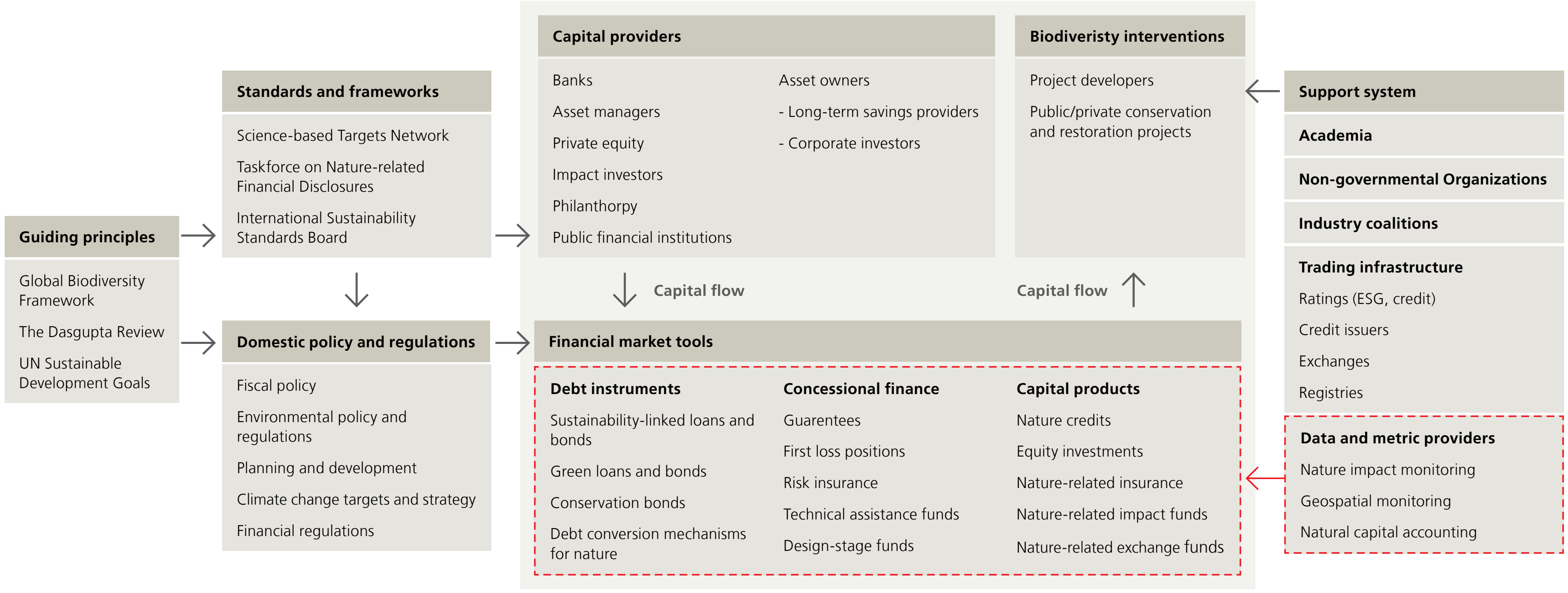
[62] United Nations Environment Programme-World Conservation Monitoring Centre (2023), *Indicators for the Kunming – Montreal Global Biodiversity Framework*.
[63] The Aichi Targets agreed in 2010; WWF (2020), *World fails to meet decade long biodiversity targets as unequivocal loss of biodiversity loss reported.*
[64] Paulson Institute et al. (2020), *Financing nature: Closing the global biodiversity gap.*
[65] Ibid, P49; This is a conservative estimate calculated by the authors, and it likely reflects the upper bound of private capital's share of investment in biodiversity; It was arrived at by assuming several categories of the Paulson Institute's flows are 100% financed by private capital (in reality, there will also be some public funding in there): nature-based solutions and carbon markets, green financial products, sustainable supply chains, and biodiversity offsets are dominated by private sector capital; other recent estimates put the current investment by private capital in nature based solutions at 14%; UNEP et al. (2023), *The state of finance for nature in the G20,* P9.
[66] This paper expands the Glasgow Financial Alliance for Net Zero's (GFANZ) definition to include sustainability objectives beyond climate; see GFANZ (2023), *Scaling transition finance and real-economy decarbonization: Supplement to the 2022 Net-zero transition plans report,* P2.
[67] Harnett, E. et al. (2023), *Defining transition finance: Exploring its purpose, scope, and credibility,* Rocky Mountain Institute.

Nature-focused transition finance needed

Almost all economic activity interacts with capital markets at some point. This puts capital providers in a position to promote the development and use of nature-related data through nature-focused instruments (Figure 4). Green loans can require certain conditions as part of their financing terms, such as a requirement to report against disclosure frameworks (e.g., TNFD). This increases the use of frameworks, standards, and datasets over time. As a result, the data produced by biodiversity measurement technologies is increasingly "pulled" into markets, improving the business case of the technologies themselves.

Figure 4. Capital markets can use their cross-value chain position to embed biodiversity-related data across the economy

Capital providers, through market tools and direct engagement, tie together the outputs of measurement technologies, the methods for using their data, and the frameworks to guide actions, from voluntary initiatives to the Global Biodiversity Framework



Sources: Adapted from the City of London and PwC (2023), *A global centre for nature finance;* UBS

Today, capital providers can create demand for nature-related data through a range of instruments (Table 1). In order of their potential effectiveness:

1. **Nature-focused transition finance** offers the strongest way for private capital to create demand for nature-related data. These tools tie financing terms to criteria that promote better environmental outcomes, such as credible transition plans.[68] They mostly focus on loans and bonds, which are already widely used in financial markets.[69] Thus, capital providers can apply them in similar ways and at similar scales to "traditional" debt instruments, such as to the financing of global companies' operations.

2. **Investments in underlying ecosystem health** also offer opportunities for private capital to advance measurement and management of biodiversity loss, but on a smaller scale. Take conservation bonds and debt conversion mechanisms for nature. They tie financial mechanisms directly to specific environmental actions, enabling capital providers to shape environmental outcomes with those they lend to. However, these instruments are a niche part of global financial markets, and they may remain so if incentives fail to motivate markets to account for biodiversity.

3. **Tools to internalize costs or risks** are welcome, but they provide fewer opportunities for advancing measurement and thus management of biodiversity loss. Biodiversity offsets and land-based carbon markets are likely to remain niche due to credibility issues. Voluntary risk disclosure frameworks and environmental, social, and governance standards create welcome demand for nature-related data. Yet, they incentivize private stakeholders to engage with them only up to the bar determined by frameworks.

Transition finance for nature doesn't have all the answers (Box 6).[70] Most of its instruments are debt, and they remain a small share of "sustainable debt" markets. Far fewer green bond tranches issued in 2022 ringfenced funds for biodiversity compared to renewable energy (around 160 versus 1200).[71] Their impact could be even lower; recent analysis suggests only around half of green bonds with a biodiversity label result in spending on biodiversity interventions.[72] Such low figures partly reflect biodiversity's implicit inclusion across other activities where it is not the primary aim, such as sustainable farming and water management.[73]

However, these are issues that any new area suffers from. The wrinkles will iron out over time. As more companies disclose against TNFD, agreement on industry-standard metrics to measure biodiversity outcomes, which is needed to issue biodiversity-focused green bonds, may emerge. Out of all the nature-related instruments available to private capital today, transition finance arguably offers the strongest transmission channel for private finance to promote better biodiversity outcomes in the real economy.[74]

[68] Schumacher, J. (2023), *Transition finance and its relationship to green finance,* EconPol Forum.
[69] See Figure 2.2, OECD (2022), *OECD guidance on transition finance: Ensuring credibility of corporate climate transition plans: Chapter 2: What is transition finance?*
[70] Jessop, P. (2022), *Insight: Bankers bet billions on new wave of debt-for-nature deals*, Reuters; Cumulative value of swap deals was USD 3.7bn in December 2022, a fraction of the global public debt market (USD 91trn in 2022); IMF (2023), *2023 Global Debt Monitor,* Table 2.
[71] Data compiled by UBS Global Banking, based on Bloomberg and Bloomberg NEF, as of April 2023 for the financial year 2022.
[72] Webb, D. (2023), *Biodiversity in use-of-proceeds bonds 'skewed towards carbon focus',* Responsible Investor.
[73] Sustainable Fitch (2023), *Biodiversity in ESG: State of the Sustainable Finance Market.*
[74] Caldecott, B. et al. (2022), *Sustainable finance and transmission mechanisms to the real economy,* Oxford Sustainable Finance Group, Smith School of Enterprise and the Environment, University of Oxford, Working Paper No. 22-04.

Table 1: Private finance offers a range of nature-related instruments

1 Nature-focused transition finance (Green bonds or loans; Sustainability-linked bonds/loans; Debt conversion mechanisms for nature; Conservation bonds; Biodiversity credits)

2 Investments in ecosystem health (Debt conversion mechanisms for nature through Land-based carbon markets)

3 Tools to internalize risks/costs (Biodiversity offsets through Risk disclosure frameworks)

Instrument	Description	Financing structure: Private	Public	Blended	Instrument's aim
Green bonds or loans	Debt instruments where proceeds are "ringfenced" for funding specified green activities.	✓	✓		Finance transition to green business
Sustainability-linked bonds/loans	Debt instruments whose attributes (for example, interest payments) are linked to the achievement of pre-defined sustainability targets. Proceeds are not ringfenced. If a sustainability target is met, investors receive a lower return, which can present inverse incentives.	✓	✓		
Debt conversion mechanisms for nature	Public debt restructuring transaction in which a portion of debt is forgiven in exchange for local investments in conservation initiatives.			✓	Investments in underlying ecosystems; finance trasnition to green business
Conservation bonds	Debt instruments in which proceeds finance development projects that generate a return. Interest payments directly finance conservation activities instead of being paid directly to investors. If positive conservation impacts are achieved, investors receive a success payment at maturity.			✓	
Biodiversity credits	Payments made to a stakeholder to finance actions that result in measurable positive outcomes for biodiversity. Carbon credits can also have positive impacts on biodiversity, although they mostly focus on reducing emissions.	✓			
Payment for Ecosystem Services (PES)	Beneficiaries of environmental goods pay conditionally for actions taken to ensure the provision of those goods. In practice, PES programs have typically been structured as publicly funded transfer payments to landowners.	✓	✓		Investments in underlying ecosystems
Biodiversity offsets	Payment made by a stakeholder to compensate for damaging impacts on biodiversity that result from their activities.	✓			Internalize costs/risks of environmental damage; investments in ecosystem health
Land-based carbon markets	Payments made by stakeholders to compensate for their residual greenhouse gas emissions, used to support land-based measures to reduce or remove emissions (e.g., reduce deforestation).	✓			
Tradable permits	Regulatory agency sets a limit on overall environmental damages and allocates rights to firms, who can then trade their allocations in the market.	✓	✓		Internalize costs/risks of environmental damage
Broader sustainability standards	A set of sustainability-related risks that can be identified using a broad range of environmental, social and/or governance indicators.	✓			
Risk disclosure frameworks	A set of voluntary standards that enable stakeholders to identify, measure, manage, and disclose their exposures to nature-related business and financial risks.	✓			

Notes: Some instruments overlap categories due to the diversity of the practices they encompass.

Sources: Adapted from Kedward, K. et al. (2023); UBS

Box 6

Transition finance's teething problems

While transition finance offers a mechanism for finance to effect change in the real economy, it still faces limitations, mainly in two areas:

1. **Credibility struggle:** Transition finance relies on recognizing harmful behaviors, identifying ways to improve them, and metrics to track this improvement. However, there are no frameworks to coordinate across different products via universal guidelines, standards, or definitions.[75] Compounding this uncertainty are the unique difficulties in measuring sustainability performance. Plus, identifying if an organization has met its commitments and, by extension, the role transition finance played, remains a challenge to developing credible products.

2. **Greenwashing risk:** Transition finance carries a higher greenwashing risk as it provides capital to those with undesirable social or environmental behaviors, risks, or impacts, with the idea that they reduce these over time. As the space works through the challenges of the credibility gap, greenwashing risks will persist.

Progress is emerging. In some jurisdictions, the definition of transition finance is becoming more standardized. For instance, the European Commission recently set out recommendations on transition finance, providing more clarity on standard practices. The UK has said it plans to make transition plans mandatory for large companies and others.[76] Investor collaborations are also working to standardize nature within transition plans, notably the Glasgow Financial Alliance for Net Zero.[77] As credibility emerges, a better sense of "what good looks like" will take shape.

[75] Schumacher, J. (2023), *Transition finance and its relationship to green finance,* EconPol Forum.
[76] UK HM Treasury (2021), *Fact Sheet: Net Zero-aligned financial centre;* Mandatory transition plans for some market participants is expected to be mandatory in the UK's upcoming Sustainability Disclosure Regime, based on the outputs of the Transition Plan Taskforce.
[77] Gambetta, G. (2023), *GFANZ set to announce work on incorporating nature in transition plans,* Responsible Investor.

Transition finance and biodiversity data

A new wave of transition finance would create pull factors for existing biodiversity measurement technologies, through financing and targeted engagement, helping to drive their deployment. We envisage a three-step process:

1. **Biodiversity-related data becomes a norm in markets through two channels:** The first is debt financing, such as raising funds using biodiversity-focused green bonds. These can require companies to report to investors how they have used their funds, which relies on biodiversity data. The second is targeted engagements, which center around debt or equity instruments.[78] For instance, discussions between fixed income capital providers and their clients could focus on transparent nature-related key performance indicators and thus increase accountability.

2. **Demand for high quality data products:** These trends are already underway, such as through the TNFD, and transition finance should accelerate their speed. Crucially, higher demand for data needs to be met with high-quality data, that is both accessible and affordable. Otherwise, a skew in reporting could be introduced toward large companies, who are more likely to be able to afford costly measurement approaches.

3. **Pull factors for existing measurement technologies:** Biodiversity risks and opportunities are local and defined at the asset level, requiring large quantities of granular data. We have the toolbox to gather this information already; rising demand for data in every sector, driven by global capital markets, could rapidly increase the deployment of measurement technologies and decision-critical data.

A new wave of transition finance would create pull factors for existing biodiversity measurement technologies, through financing and targeted engagement, helping to drive their deployment.

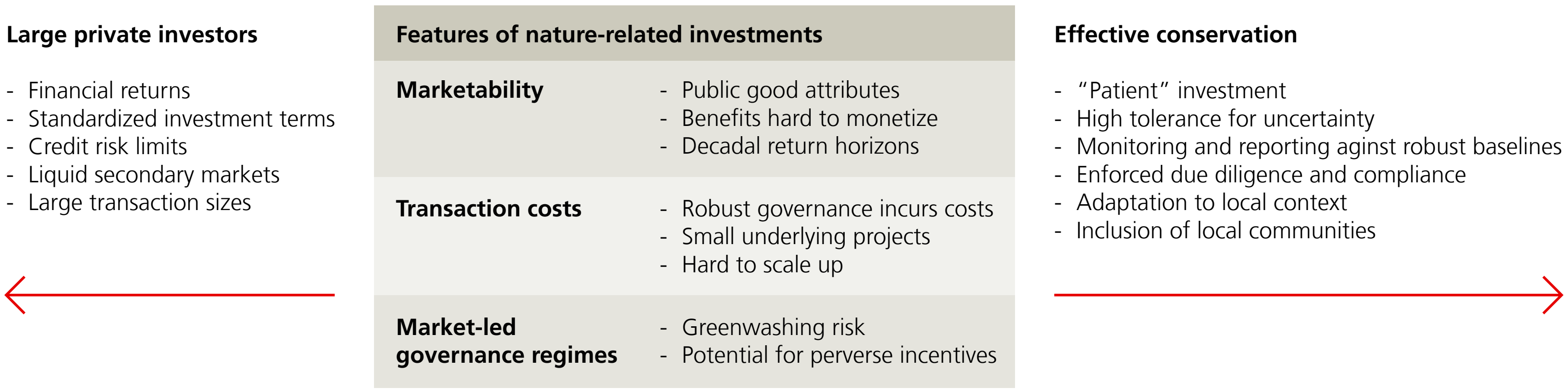
[78] Hawker, E. (2022), *Bondholders begin to flex their muscles,* ESG Investor.

Overreliance on private sector finance may be a miscalculation

An assumption that private sector finance will fill most of the nature investment gap seems unrealistic. Nature-related assets present substantial investibility challenges (Figure 5).[79] The characteristics of nature-related asset classes are misaligned with institutional investors' need for stable returns. For instance, measurement challenges and a small pipeline for nature-related projects (such as biodiversity credits), together with more general risks,[80] can lead to high costs of capital for many investees.[81] Of course, private investors can play a role through early-stage investors, thematic funds, philanthropic capital, or blended finance, but the scale of the investment gap requires institutional investors who are willing to fund the void.

Figure 5: Friction between investor needs and effective conservation

Nature-related investments present investibility challenges when seen in terms of the needs of large-scale investors



Sources: Adapted from Kedward, K. et al. (2023); UBS

[79] Kedward, K. et al. (2023), *Heavy reliance on private finance alone will not deliver conservation goals,* Nature Ecology & Evolution.

[80] Most biodiversity projects exist in developing countries where much of the world's remaining biodiversity exists in 'hotspots', which means the cost of capital for projects can be further pushed up by country and currency risks.

[81] Climate Champions, Centre for Global Commons, and Systemiq (2023), *Mobilizing private capital for nature to meet climate and nature goals,* Race to Resilience and Race to Zero, P13; Finance for Biodiversity et al (2022), *Nature loss and sovereign credit ratings.*

Complementary government action needed

Summarizing an exact playbook for governments to meet the GBF's 2030 goal is a tall order. Interventions that work in one location may not translate to another, because biodiversity and the drivers of its decline are defined locally. Similarly, some of the decisions that need to be made are deeply political. It is up to governments to decide on the best mix of taxes, subsidies, and regulations.

At a high level, we believe there are four actions governments can take to encourage stakeholders to take account of biodiversity, increase demand for biodiversity data, and advance the GBF's goals:

1. **Provide suitable economic incentives:** Governments can provide carrots and sticks, and in some places they already do. For instance, agriculture is the largest driver of biodiversity loss globally, and several countries have set out plans to link agricultural subsidies to positive environmental outcomes.[82] Doing so rapidly increases demand for biodiversity data and the technology that provides it. It could also expand the pipeline of investible opportunities to improve biodiversity, which could help to expand nature as an asset class that private capital can invest in at scale.

2. **Send clear signals:** Governments can help by sending clear signals, at home through clearcut biodiversity strategies that prioritize measurement, and internationally when they report their progress to the GBF in 2024. Doing so will help create the necessary buy-in to meet both global biodiversity and climate goals, given 37% of the required emission cuts to align with the Paris Agreement by 2030 can be met with natural climate solutions alone.[83]

3. **Crowd-in private capital:** The investment gap on biodiversity implies large roles for both public and private capital to fund projects that deploy measurement technologies.[84] Nature's investibility challenges mean innovative and concessional approaches to finance will be required for projects without clear revenue streams and savings in the near term.[85] Where appropriate, governments should provide concessional capital arrangements and guarantees, known as blended finance. Funding models can take different forms,[86] but the common thread should be increasing the total capital used to deploy measurement technologies, creating the necessary datasets to advance the GBF's 2030 goal.

4. **Mainstream better data and methodologies:** Currently 70% of investors believe a lack of data is a key barrier to investing to support nature.[87] Key actions for government include prioritizing standardized disclosure through supporting take-up of TNFD in the private sector, and the creation of a public TNFD data facility.

[82] Benton, T. et al. (2021), *Food system impacts on biodiversity loss,* Chatham House; The UK has set out a plan to link agricultural payments to the provision of certain environmentally-friendly activities; see DEFRA (2023), Policy paper: Environmental Land Management (ELM) update; In Brazil, the government has suggested linking low-cost loans to farms and municipalities to reduced deforestation; Paraguassu, L. (2022), *Lula eyes 'green' farm loans to tackle deforestation.*
[83] Griscom, B. et al. (2017), *Natural Climate Solutions,* PNAS; According to the analysis, Natural Climate Solutions could provide 37% of the "cost-effective" emissions reduction needed by 2030, (under assumptions about the social cost of carbon) to have a good change of limiting warming to below 2°C.
[84] We focus on measurement given its upstream relevance for progressing the GBF's goals, but the same point applies to solutions that manage biodiversity loss.
[85] Kyriakopoulou, D. (2023), *Commentary: Finance at the nature frontier,* LSE Grantham Research Institute on Climate change and the Environment and LSE Business Review.
[86] City of London and PwC (2023), *A global centre for nature finance, P22.*
[87] Taskforce on Nature Markets (2023), *Making nature markets work.*

This would widen access to nature data on the premise it is a public good.[88] Similarly, governments can improve the use of data by advocating for science-based targets, which better data enables. However, even with more data, the value of nature remains invisible without new methodologies. Governments can also address this problem by developing national environmental datasets in line with emerging methodologies, such as natural capital accounting.[89] UBS sees its role as leading by example in the financial sector (Box 7).

Box 7

UBS partnerships to scale and develop solutions and maximize their impact

UBS and TNFD

The Taskforce on Nature-related Financial Disclosures (TNFD) was formed in 2021 to produce disclosure recommendations and guidance for organizations to report and act on evolving nature-related dependencies, impacts, risks, and opportunities. UBS is one of the 40 Taskforce Members, which include financial and non-financial companies. UBS supported the formulation of the final version of the TNFD recommendations, which were published in September 2023, and chaired the financial-sector-specific working group of the TNFD. UBS is part of the TNFD early adopters, as announced by TNFD at the World Economic Forum conference in 2024. This means we will align our nature related disclosures with the final TNFD framework.

UBS and Restor

UBS has provided funding for the development of Restor, a platform that promotes transparency around restoration projects and their outcomes. The UBS Optimus Foundation is also looking to include its work on the platform, helping Restor to build a pipeline of projects.

UBS and Finance Earth

Finance Earth, in collaboration with UBS, is piloting a new methodology from Verra for generating verifiable Nature Credits through a Tanzanian community forest project. If shown to be feasible, Verra's framework, called the SD VISta Nature Framework, could be used to raise funding for outcomes-based biodiversity conservation through the sale of credits.

[88] TNFD et al. (2023), *Findings of a high-level scoping study exploring the case for a global nature-related public data facility.*
[89] UBS Sustainability and Impact Institute (2023), *Taking root: Mainstreaming natural capital accounting to meet global biodiversity goals.*

Partnerships needed

Biodiversity touches every sector, and so by necessity any strategy to manage it relies on a diversity of stakeholders. For instance, a company trying to assess and reduce its exposure to water-related risks will need to engage with its direct suppliers regarding their policies, data providers to assess risks in the markets in which they operate, ecologists to restore nature in their own assets, or public bodies if subsidies are available.

> Biodiversity touches every sector, and so by necessity any strategy to manage it relies on a diversity of stakeholders.

Blended finance illustrates the importance of partnerships. In these approaches, private capital typically takes the upfront risk—normally philanthropic funds—and public capital is provided if or when some conditions are met. Finance can be structured in a variety of ways,[90] such as guarantees of repayment against risks (e.g., natural hazards, or political events). By spreading risk based on different risk-return appetites, blended finance can crowd-in private finance, enabling previously unbankable projects to attract financing.[91] The impact can be substantial: risk mitigation and credit enhancement solutions can increase private sector involvement over concessional lending by five times.[92] Similarly, philanthropic capital can address local barriers that transition finance alone may struggle to resolve. Today, 80% of the world's remaining biodiversity exists in land managed by indigenous peoples.[93]

Successfully deploying measurement technologies in the most biodiverse areas thus hinges on effective engagement indigenous peoples and local communities. Philanthropic capital, deployed with a high precision in early-stage projects, can play a crucial role in building trust and technical capacity among local stakeholders. These partnerships, created through small tranches of catalytic capital, can therefore support a pipeline of investments that eventually attract larger public and private sector investments.[94]

The necessary technological push on biodiversity measurement will not happen organically. Partnerships involving academia, corporates, governments, and philanthropic organizations will be instrumental in propelling progress. We draw out the idealized roles of individual stakeholders and promising partnerships in Table 2. A precedent already exists: the combination of governments and big technology firms was central to developing modern remote-sensing technologies that enabled global analysis of the drivers of biodiversity loss, for example.[95] The same needs to happen to meet the 2030 biodiversity goals, but on a much wider scale.

90 One Planet Lab (2021), *Blended finance for scaling up climate and nature investments,* LSE Grantham Research Institute on Climate Change and the Environment.
91 For instance, the UBS Optimus Foundation alongside partners provided a USD 3.5 mn investment to support a pipeline of over 500 investable mangrove projects, with the potential to mobilize up to USD 100 mn additional capital; see UBS (2023), *Philanthropists driving the impact economy.*
92 Climate Champions, Centre for Global Commons, and SystemIQ (2023), *Mobilizing private capital for nature to meet climate and nature goals,* Race to Resilience and Race to Zero, P26.
93 United Nations Environment Programme (2017), *Indigenous Peoples: The unsung heros of conservation.*
94 UBS Sustainability and Impact Institute (2023), *Beyond giving: New ways to channel philanthropic funding that drive increased investment into the Sustainable Development Goals.*
95 For instance, the United States Geological Agency scaled Landsat satellites over the late 20th Century, making all the data public in 2008, which Google rapidly democratized through its *Google Earth Engine; see* USGS (2023), *Fifty years of exploration and innovation: How Landsat launched the remote sensing era*; *Liang, J. et al. (2018), Applications and impacts of Google Earth: A decadal review (2006–2016),* ISPRS Journal of Photogrammetry and Remote Sensing*;* Google (2023), *Earth Outreach: Nature Conservation;* Microsoft (2023), *AI for Earth.*

Table 2: Idealized roles and partnerships

Stakeholder	Idealized roles to advance biodiversity measurement in support of the GBF's 2030 goal	Promising partnerships
Governments	**Clearly implement the GBF's goals in national plans,** applying new technologies through large-scale public environmental programs. **Fix fiscal regimes** that motivate intensive consumption of nature resources. Some countries are tying public money to public good provision in high-impact sectors, notably agriculture.[96] **Promote methodologies to put nature on balance sheets**, such as natural capital accounting.[97] **Develop national environmental datasets to create a global monitoring network**, which exists for climate but not nature.[98]	Blended finance alongside private capital. Developing data sets alongside academia (for domain expertise) and corporates (to ensure the output meets end-user needs).
Central Banks	**Innovate on new methodologies to quantify nature-related risk**, particularly how disruptions reverberate through markets.	Analyzing nature risks and opportunities alongside financial institutions (to understand systemic risks).
Development Banks	**Perhaps the best placed stakeholders to address the funding gap.** MDBs typically have non-financial goals attached to lending, such as positive outcomes for nature. They also focus more on development work in lower- and middle-income countries, which disproportionately contain biological hotspots.	Working with national governments—particularly those with high biodiversity resources—to fund nature projects, ad hoc or via debt financing arrangements.
Banks	**Conduct analyses and set targets** to understand exposure to risks, dependencies, and impacts to nature, particularly for high impact sectors and innovate on these methodologies over time. These could include footprint analyses, which many French banks have pioneered following regulatory requirements. Targets could be informed by the latest United Nations Environment Program Finance Initiative guidance.[99] **Integrate the GBF's targets into business-as-usual risk management,** such as expanding due diligence requirements to new areas (such as deforestation).[100] **Expand transition finance offerings,** through blended finance, sovereign lending, "green" and "blue" bonds, and biodiversity-focused index solutions. Where possible, products should align with established frameworks, such as the IFC Biodiversity Finance Reference Guide, or the ICMA Green Bond Principles. **Educate and engage with clients** on nature-related issues and promoting nature-positive impacts from an investment perspective.	Engagement with high-impact sectors on transition plans and adequate financing. Working with central banks to improve understanding of systemic risks, impacts, and dependencies on biodiversity.

[96] Such as the UK's developing Environmental Land Management scheme, which links and scales agricultural subsidies to environmentally-friendly activities, see DEFRA (2023), *Policy paper: Environmental Land Management (ELM) update: How government will pay for land-based environment and climate goods and services.*
[97] UBS Sustainability and Impact Institute (2023), *Taking root: Mainstreaming natural capital accounting to meet global biodiversity goals.*
[98] Gonzales, A. et al. (2023), *A global biodiversity obs*erving system to unite monitor*ing and action*, Nature Ecology & Evolution.
[99] UNEP-*FI et al (2023), PRB nature target setting guidance.*
[100] *UNEPFI and PRI (2023), Banking on nature: What* the Kunming-Montreal Global Biodiversity Framework means for responsible banks.

Private Capital	**Focus on transition finance** via a range of instruments. **Nature-related engagements**, particularly for high-impact and/or nature-dependent sectors. **Encourage the adoption of new disclosure and risk management frameworks**—TNFD and SBTN. Provider specific: • **Institutional investors** focus on maturing the field of nature-related financial instruments, particularly transition finance. Ensure today's instruments generate truly additional environmental outcomes and avoid over-claiming impact. • **Philanthropists** focus on and scale blended finance initiatives. Some analyses point to blended finance's higher costs than direct public funding.[101] However this is not always the case, and the current lack of public funding, coupled with the GBF's fast-approaching deadlines, mean blended finance will play a critical role in financing projects. • **Venture capital, impact funds, and early-stage funds** play key roles in funding nature techs, which are typically early on in their commercialization lifecycle due to the early-stages of the broader nature market.	Engaging with investees to promote best practices, particularly corporates on disclosure and target setting. Innovative approaches to financing nature techs, such as blended finance models, and nature-focused transition finance instruments. Analyze own exposure to nature risks and opportunities alongside data providers (for novel datasets, given biodiversity has no single metric like climate).
Corporates	**Establish nature-related reporting** early-on to get ahead of regulations (e.g., the EU's CSRD). **Pilot methodologies** that integrate nature into balance sheets.[102] **Explore shifts to nature-positive business strategies where economic and feasible,** particularly for corporates in high-impact sectors like agriculture, forestry, and fishing. Recent guidance exists.[103]	Work with NGOs, academia, and intermediary firms to pilot methodologies for integrating nature onto balance sheets (i.e., natural capital accounting). Establish new products to streamline the data processing pipeline to meet growing demand for corporate reporting of nature-related information.
Intermediary Firms	**Provide products and services that connect disparate ends of the value chain**. For instance, Payment for Ecosystem Service platforms act as the interface between Indigenous Communities that manage land containing 80% of the world's biodiversity, and global markets.[104] **Provide products and services that enhance the usability of new nature-related information,** particularly geospatial data.	Produce data products in conjunction with corporates and other private sector end users of data (to ensure complex biodiversity data meets end user needs).
NGOs	**Facilitate partnerships across value chain silos and borders.** Corporate involvement helps to directly link nature tech with end-user needs, which is important as market demand for environmental data products accelerates.	Deployment of measurement technologies and knowledge alongside governments (to access public natural assets) and corporates (to promote take up and best practices).
Academia	**Ensure the messages of real-world environmental trends are translated throughout markets**. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) will prove crucial to translate scientific reality into digestible trends as efforts under the GBF progress. **Leverage new technology to create solutions for markets, particularly via corporate partnerships that link them with end user needs.** ETH Zurich's SEED index is a good example, digesting a wide range of environmental data into a market-facing format.	Provide domain expertise in partnerships with technology firms and governments to link ecological knowledge with modern measurement technologies.

ICMA = International Capital Markets Association; CSRD = Corporate Sustainability Reporting Directive; TNFD = Taskforce on Nature-related Financial Disclosures; SBTN = Science Based Targets Network.
Source: UBS

[101] Kedward, K. et al. (2023), *Heavy reliance on private finance alone will not deliver conservation goals,* Nature Ecology & Evolution; European Court of Auditors *(2018), Public Private Partnerships in the EU: Widespread shortcomings and limited benefits*; IMF (2015), Making Public Investment More Efficient.
[102] UBS Sustainability & Impact Institute (2023), *Taking root: Mainstreaming natural* capital accounting to achieve global biodiveristy goals.
[103] *World Business Council for Sustainable Development et al (2023), Roadmaps to nature positive.*
[104] Convention on Biological Diversity (2022), *News headline: Indigenous communities protect 80% of all biodiversity.*

Tomorrow’s green shoots

Biodiversity underpins economic activity—given almost 60% of global GDP is at least moderately dependent on ecosystem services. With the Global Biodiversity Framework in place, the international community acknowledges that biodiversity deserves more attention from individuals, corporates, and governments alike. Yet, its objectives are highly ambitious in light of long-term trends. While the goal is better management of biodiversity to reverse its loss, the first step is the necessary deployment of measurement technologies, faster and at a greater scale, than ever before.

The GBF’s assumption that private capital will increasingly and automatically flow toward nature-centric projects is overly optimistic. Markets need to be motivated to account for biodiversity, ultimately expanding private capital’s ability to invest in biodiversity assets at scale. These realities create crucial roles for both private and public effort in meeting the GBF’s 2030 ambitions. With six years until milestone one, this report calls on the global community to do three things:

1. **Pursue a new wave of nature-focused transition finance:** While private capital has played a marginal role in funding solutions for halting biodiversity loss so far, closing the investment gap will require its increased and direct involvement. Capital providers, through market tools and direct engagement, tie together the outputs of measurement technologies, the methods for using their data, and the frameworks to guide actions, from voluntary initiatives to the GBF. Transition finance—linking financial levers to more sustainable outcomes—remains a small share of global financial markets, but is possibly the best tool to promote better biodiversity outcomes in the real economy.

2. **Rapidly implement complementary government action:** Government resolve is crucial for promoting the development and deployment of measurement technologies. High-impact levers include fixing subsidy regimes, so that they work with, rather than against, nature. Subsidies as well as taxes and regulatory guidelines should provide a clear sense of direction and speed of travel for various industries.

3. **Partnerships to drive innovation and scale:** Every sector will need on-demand information on its exposure to nature if the global community is to meet its 2030 goals. This will require vast amounts of high-quality data, as well as new working relationships across the economy. Partnerships will be key to roll out measurement technologies, test business models, and ensure the output of technologies meets end-user needs (such as corporate reporting). Several of today’s mainstream biodiversity measurement products directly emerged from partnerships between technology companies, academia, and conservation. This story needs to repeat on a much wider scale to meet the GBF’s 2030 goal.

Appendix

A1: Overview of the technology toolbox vs. IPBES drivers of biodiversity decline

	Description	**Land/sea use change** Urbanization, agricultural expansion, and coastal development, together driving global habitat conversion, fragmentation, and degradation	**Direct exploitation** Overfishing, hunting, logging, and harvesting, generating declines in population abundance and diversity	**Climate change** Changes ecological processes and disrupts organisms by shifting spatially-defined ecological niches	**Pollution** Pollution including chemicals, physical waste, and nutrient pollution (e.g., nitrates), directly harming biodiversity and disrupting ecosystem functions	**Invasive species** Non-native species enter new environments, disrupting existing food webs and competing with native species
Telemetry	Combinations of sensors, transmitters, and receivers to gather data on the movements (location and depth), behaviors and other parameters (such as temperature) of wildlife.					
Software/Packages	E.g., field data collection systems (such as mobile apps for habitat assessments), spatial/GIS software, moving processing to the cloud, and citizen science platforms.					
Sensor network	Collection of specialized sensors deployed in the natural environment to gather periodic or real-time environmental data (such as environmental conditions, species presence, and disturbances).					
Remote sensing	Technologies for gathering data on environments at a distance, typically through satellites, aircraft, or drones, such as wildlife monitoring, vegetation cover and condition, and detection of illegal activity.					
Photogrammetry	Technique to obtain measurements and 3-D information on objects, structures, or landscapes by reconstructing their shape and position from a series of images. Used mostly to build nuanced pictures of habitat structures.					
Modelling	Simulation, mathematical, or computational-based techniques to study and predict the behavior of environmental systems, such as population dynamics, habitat changes, and species interactions.					
Genetics	Tools to maintain genetic variation within a population, which is crucial for its long-term viability and adaptability anthropogenic drivers. Examples include genome mapping, genetic barcoding, and modifying genes (CRISPR technology).					
eDNA	Organisms release genetic material into their environment (such as DNA fragments, cells, or traces) which can persist over time, providing a synthesized pool of information on presence, abundance, and sometimes individual identity.					
Databases	Databases focused on information relating to the natural world, including species distributions, population trends, habitat characteristics, genetic data, and more.					
Camera traps	Cameras with triggerable sensors that remotely record wildlife in their natural habitats, using different empirical channels such as visible light or infrared					
Bioacoustics	The scientific study of sounds produced by living organisms to understand species presence and behavior, and infer an ecosystem's 'health', such as the relative abundance of species.					
Biologging	The use of advanced electronic devices (such as GPS and accelerometers) to monitor movement, behavior, and other physiological traits. It is particularly useful for fine-scale data (i.e., individual level)					
Automated sampling	Automatic collection and sometimes processing of environmental information from a wide range of devices, sensors, and systems					
Artificial Intelligence	Encompasses any computer algorithm that makes predictions, recommendations, or decisions from environmental data based on pre-set objectives. Mostly used to sort and classify species and landscapes from data generated by other tech.					

Relevance: Low — High

Notes: IPBES = Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; CRISPR = Clustered Regularly Interspaced Short Palindromic Repeats.
Drivers of biodiversity loss from Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; relevance rating based on an aggregated score of three areas: frequency in the literature (inferred from a rapid evidence search across two databases of technology-focused search strings combined with biodiversity driver strings from Jaureguiberry, P. et al. (2022)), versatility, and effectiveness (both qualitative assessments, based on current deployment in the field); Technology categories adapted from Dornelas, T. et al. (2023).

Source: UBS

A2: Methodology to estimate the nature exposure of GDP and supply chains

We follow established methodologies used by recent analyses regarding the exposure of economic activity to nature-related risks, which include the global economy, supply chains, the loan books of financial institutions, and companies listed in stock exchanges.[105] Our methodology includes two steps.

1. **Classifying the nature dependence of activities**
   We used the Exploring Natural Capital Opportunities, Risks, and Exposure (ENCORE) database to classify 163 economic activities into three categories of nature dependence—low, moderate, and high—based on each economic activity's underlying processes, and the ecosystem services that underpin them.[106] We arrived at a dependency score for each economic activity, allocating each to a dependency rating based on their rank (e.g., those in the lowest third are "low," while those in the highest third are "high"). The dependency score was arrived at through equal weighting three factors,[107] with the final score an aggregate of each: the number of dependencies; the mean strength; and the maximum strength.

2. **Assessing the nature exposure of the economy**
   We used an environmentally extended multi-regional input-output (MRIO) model, called Exiobase, to produce a first-order approximation of the nature dependence of economic activity.[108] This required several steps:

- ENCORE and Exiobase use different business classification; we manually mapped between the ENCORE classification (which uses GICS) and Exiobase (which uses NACE), where possible using the publicly available mapping published for the EU Taxonomy.[109]

- We analyzed the gross value added (GVA) created by different sectors and countries using the multi-regional input-output model. Aligning the sector level nature dependency ratings enabled us to aggregate GVA by low, moderate, or high exposure.[110] The exposure of global GDP to each nature risk category was calculated by removing selected taxes, which are excluded from the sector-level GVA figures.

- We aggregated industry GVA based on the sum of GVA generated in different sectors and countries, bucketing each by the sector's nature dependence (low, moderate, or high). ENCORE provides a single dependence rating on a global level, providing only a first order approximation of nature dependence. As the data improves, regional dependence ratings may emerge.

- We assessed the nature dependence of supply chains by using MRIO to assess the direct and indirect input requirements needed to produce a given unit of output in a given sector and country. The indirect nature dependence of all suppliers in the value chain can then be grouped by their nature dependence and share of inputs. In effect, the same industry in two different countries will have the same dependency (due to ENCORE's global focus), but different indirect dependencies. We summed the GVA generated by all sectors in the purchasing sector's supply chain, in proportion to the demand from the purchasing sector for inputs as a share of demand from all other sectors. The nature dependence of GVA was aggregated based on the nature-dependence rating of each sector in the supply chain.

[105] World Economic Forum (2020), *Nature risk rising: Why the crisis engulfing nature matters for business and the economy;* PwC (2023), *Managing nature risks: From understanding to action;* European Central Bank (2023), *Occasional paper series: Living in a world of disappearing nature: physical risk and the implications for financial stability.*
[106] See ENCORE (2023), *Methodology.*
[107] PwC (2023), *Managing nature risks: From understanding to action.*
[108] The ECB (2023) provide a fuller explanation of Exiobase and its use in Appendix 3 of their assessment.
[109] Available online as EU Commission (2022), *EU taxonomy NACE alternate classification mapping.*
[110] Exiobase 3, based on 2022 version for industries.

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P.O. Box
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