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WORLD ECONOMIC FORUM

Biodiversity Credits: Demystifying Metrics for Nature Markets

COMMUNITY PAPER

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Contents

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Foreword

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Currently, human activity is driving nature loss and Earth's sixth mass extinction event. Scientists estimate that species extinction rates are up to 1,000 times higher than in the pre-human period,[1] with an average global 69% decline rate of wildlife population in the last 50 years alone.[2] Species and habitat loss accelerate the decline of ecosystem services, upon which more than half of the world's gross domestic product (GDP), $44 trillion, depends.

Measuring biodiversity and nature robustly is key to reversing their decline, supporting their recovery and maintaining the benefits they provide to humanity and the economy. Comprehensive, robust and locally appropriate measurement will enable governments, businesses and civil society to direct resources to address the drivers of nature loss. This promotes nature financing, which benefits Indigenous peoples and local communities (IPs and LCs) while managing trade-offs in an informed manner.

Commonly used metrics and measurement practices, quantifiable and comparable across regions, ecosystems and value chains, are thus a critical milestone for achieving a socioeconomic transition towards nature-positive outcomes. This paper aims to establish a foundation for developing comparable models for measuring nature outcomes. It focuses on the various methods being developed to support outcome-based projects that seek funding for biodiversity and nature improvement.

Given nature and biodiversity's local specificity, many methodologies have been developed to measure nature impacts. More than 35 methodologies have emerged in nascent biodiversity credit markets alone since the adoption of the Kunming-Montreal Global Biodiversity Framework in December 2022. To date, these methodologies employ several metrics and indicators, largely detached from typical corporate reporting and disclosure frameworks, causing high transaction costs on both the supply (project developer) and demand (corporate) sides.

Achieving a single, unified approach may be unrealistic and even undesirable. However, using frameworks to align and compare methods is essential for consistency and effectiveness. This paper synthesizes three broad models to support convergence by comparing metrics and measurement approaches. These models help all market actors choose the most suitable combination of metrics and measurement practices for their specific purposes. We invite both businesses and project developers to use this guide, put it to the test and lead the way in generating robustly quantified and tracked nature and biodiversity benefits.

Executive summary

What is measured can be treasured: the quantification of nature and biodiversity is a key success factor for the nature-positive transition.

The private sector has a crucial role in bridging the financing gap for nature and biodiversity conservation and restoration. Robust metrics are essential for financiers of nature-positive outcomes (such as buyers of biodiversity credits) to validate progress in nature, and agreement on these metrics is vital to scaling demand for nature-positive financing.

This paper outlines key decisions that nature-positive financiers, credit standard-setters and project developers must make in navigating nature and biodiversity metrics. Each actor must measure biodiversity and nature to select providers of credits or other instruments, set standards or decide which standards to adopt. The key decisions in this process are:

- Should practices or outcomes be measured?
- What type(s) of metric(s) should be used?
- How aggregated should the metrics be?
- How should change in the metric(s) be quantified?

With these decisions in mind, the paper focuses on biodiversity credit markets, analysing and comparing three emerging models under the established key decisions among existing credit methodologies and standards: the **comprehensive aggregate model**, using composite, direct measurements; the **critical indicator model**, taking higher-level and more ecosystem-specific views; and the **mosaic compilation model**, which includes a variety of measurements related to key decisions.

Additionally, the paper explores how metrics relate to disclosure frameworks, a particularly relevant topic for businesses engaging in nature-positive finance. Disclosure frameworks generally operate at a higher level – suggesting metric types rather than exact metrics – given their role in stakeholder engagement and transparency. Existing biodiversity credits tend to align with these frameworks and their respective types of metrics. Notably, the Taskforce on Nature-related Financial Disclosures (TNFD) and the Science Based Targets Network (SBTN) provide example metrics that overlap with those used by credits today.

In summary, while additional work is required to encourage standardization across nature and biodiversity metrics, this paper outlines essential considerations that financiers of nature-positive outcomes, credit standard-setters and project developers can apply to navigate biodiversity metrics effectively. The final objective is to stimulate robust and scalable nature-positive financing for a transition to a more sustainable future.

Introduction

Broad consensus on metrics that track progress on nature and biodiversity is essential to unlocking demand for nature-positive financing.

An additional

$700

billion

per year is required to halt and reverse the decline in biodiversity by 2030.

Background

Despite global commitments to protect nature and biodiversity, a large financing gap remains. Estimates suggest an additional $700 billion per year is required to halt and reverse the decline in biodiversity by 2030.[3] While most of this gap should be bridged by public finance and policy reforms, the private sector will play a key role in closing the financing gap and moving towards a nature-positive economy. Today, prevalent mechanisms for financing nature include nature and biodiversity credits and may extend to carbon credits generated by nature-based solutions (Box 2).

Biodiversity credits are certificates that represent a measured and evidence-based unit of positive biodiversity outcome that is durable and additional to what would have otherwise occurred.[4] This report uses this definition of biodiversity credits (although the exact definitions of "biodiversity", "credit" and "nature" are still evolving in the context of this market) because of its wide acceptance and its use in the Kunming-Montreal Global Biodiversity Framework (GBF). This is consistently supplemented with "nature-positive finance" to encompass financing positive nature outcomes beyond biodiversity credits.

Anyone engaged in improving any situation must be able to validate progress with relevant metrics. This holds true for nature and biodiversity and is therefore relevant for nature-positive financiers (including biodiversity credit buyers). Consensus on metrics is therefore essential to unlocking demand for nature-positive financing. The field of metrics in nature and biodiversity is not new, but its recent move from (primarily) academic to corporate contexts has exposed it to new challenges. For example, academic methods tend to tailor metrics to specific circumstances. By contrast, businesses tend to employ more standardized methods, given their vast value chains and large areas of activity. Differences such as these can make applying academic metrics in corporate contexts challenging. This paper arises from that challenge, as identified in workshops hosted by the World Economic Forum in partnership with the United Nations Biodiversity Credit Alliance (BCA).

Structure and relevance

The first chapter aims to assist those measuring nature and biodiversity in navigating the key decisions around metrics. It is intended for actors financing nature-positive outcomes, including biodiversity credit buyers, setters of biodiversity credit standards and project developers generating credits. The second and third chapters explore and compare biodiversity credits and relevant metrics, examining 32 current methodologies as well as emerging models. While specific to credit methodologies, these comparisons may also be informative to other actors as well as beyond biodiversity credits, as the core concepts of metrics are similar. The final chapter explores metrics in disclosure frameworks, which is primarily relevant to businesses measuring and disclosing effects on nature and biodiversity.

Various stakeholders can use this paper in the following ways:

- **Financiers of nature positive outcomes, including biodiversity credit buyers**, can use this guide to identify suitable metrics for quantifying the nature and biodiversity performance of their value chains and determine how credits may be of support (e.g. contributing to goals using comparable metrics).

- **Standard-setters** can use this guide to navigate key decisions and discover how their standards for crediting nature-positive interventions compare to others.

- **Project developers** can use this guide to select existing credit standards or develop bespoke methodologies for projects, ensuring they are adaptable to the needs of their target buyers while retaining high integrity.

BOX 1 | **Indigenous peoples and local communities**

An essential part of conservation and restoration is the inclusion of Indigenous peoples and local communities (IPs and LCs). This must involve an emphasis on full and effective participation, including in decision-making processes such as free, prior and informed consent, and fair and equitable benefit-sharing.[5] These principles are crucial to guarantee positive outcomes from biodiversity credits.

This paper reinforces the importance of IPs and LCs and supports the integration of local knowledge in measurement, reporting and verification systems. Considering the length and importance of the topic, readers should refer to specific publications that explore it, such as the *High-Level Governance and Integrity Principles for Emerging Voluntary Biodiversity Credit Markets*.

1 Breaking down and demystifying metrics for nature

The appropriate and robust quantification of nature and biodiversity involves a set of context-specific choices.

> Unlike CO_2 emissions, biodiversity loss in one area cannot be mitigated by improvement in another, so progress must be treated as inherently local.

Tracking changes in the state of nature and biodiversity involves two interrelated actions:

1. Identifying and selecting appropriate metrics
2. Measuring a baseline and change over time with the selected metrics

This produces relevant metrics that can be tracked, managed and reported over time. Although this paper primarily discusses metrics to measure the state of nature and biodiversity (and its improvement), scientifically robust metrics can and should be equally used to quantify impact and dependencies.

Identifying and selecting appropriate metrics for nature and biodiversity is inherently tied to local circumstances. While it may be tempting to think of biodiversity credits as equivalent or alternative to carbon credits, the geographically specific aspects of biodiversity limit fungibility – a limitation that does not exist for carbon dioxide (CO_2). Unlike CO_2 emissions,[6] biodiversity loss in one area cannot be mitigated by improvement in another, so progress must be treated as inherently local. However, using appropriate metrics may enable the comparison of biodiversity improvements across different areas.

While not all nature metrics are used by biodiversity credits, all biodiversity credits use nature metrics. Expert and stakeholder engagement by the World Economic Forum and the BCA highlighted three broad areas of consensus important to nature metrics and, therefore, inherently important to biodiversity credits:

1. **Global alignment**: Global frameworks are important for comparability and assurance of systemic improvement – but must be applied with local specificity.
2. **Stakeholder participation**: Collaboration, consideration and inclusion of all stakeholders are essential.
3. **Robust data**: Robust biodiversity metrics and credits require detailed, science-based, timely, cost-effective and transparent data. This helps ensure that metrics are reproducible, replicable and comparable.

The discussions also highlighted the need to guide potential credit buyers in connecting the metrics measuring their nature impact and dependencies to the metrics measuring the (change in) state of biodiversity or nature. The latter are critical for deciding which biodiversity credits to procure. The following key decisions aim to provide that guidance and extend to other nature-positive financing options, making them applicable to anyone measuring biodiversity or nature outcomes (e.g. standard-setters and project developers). The decisions are primarily taken at the project level because they must fit the relevant scale and ecosystem:

1. Should practices or outcomes be measured? (This is a prerequisite decision, after which the others follow.)
2. What type(s) of metric(s) should be used?
3. How aggregated should the metrics be?
4. How should change in the metric(s) be quantified?

These key decisions and the choices actors must make within them are not necessarily exhaustive. Rather, they attempt to discern the major decisions and useful categorizations of the options observed in the market. Furthermore, these categorizations help segment and compare market approaches, while the options may lie in between what is outlined here (e.g. key decision 3).

FIGURE 1 | **Four key decisions on nature and biodiversity metrics**

Prerequisite decision

Should practices or outcomes be measured?

Practices can be conserved area, time or allocated funds

Outcomes are the achieved uplifts in nature or biodiversity – which is the preferred option to prove real impact

If outcomes

What type(s) of metric(s) should be used?

Three primary types:

The **direct quality** of nature/biodiversity (e.g. species count)

Pollutants and novel entities that affect nature

Factors closely related to nature outcomes (e.g. IPs and LCs inclusion)

How aggregated should the metrics be?

Two main options:

Discrete (keystone) metrics (e.g. apex predator population) used as indication for the health of the wider ecosystem

Composite metrics – e.g. the Biodiversity Intactness Index – built from multiple measurements, together quantifying ecosystem health

How should change in the metric(s) be quantified?

Two main options:

Static point, e.g. a historical value

Dynamic pathway representing either what would have been the state of nature at any time without intervention, or the most recent measurements (being continually compared to)

1.1 Key decision 1 (prerequisite): Should practices or outcomes be measured?

Practices are the actions taken to improve nature and biodiversity, while outcomes are their results. An example of measuring practices is tracking the conserved area, while an example of measuring outcomes is tracking the increase in population of some species in that area.

Measuring practices is useful for estimating the impact of projects because it is simple, and practices generally correlate positively with nature and biodiversity improvements. For instance, the area conserved will often be proportional to the outcome achieved. The ease of measuring practices may also reduce barriers to nature-positive financing, eliminating the need to wait for nature to respond to interventions. Finally, simpler concepts such as conserved areas are easy to communicate, not least for businesses aiming to inform stakeholders. All these advantages may give practice-based measuring the benefit of expediting the flow of funds to nature-positive interventions.[7]

However, practice-based metrics alone are not enough, and actors should ensure a well-established link between the practice and the outcome to demonstrate that the practice positively affects nature. Choosing to measure outcomes represents, therefore, the prerequisite for the following decisions.

1.2 Key decision 2: What type(s) of metric(s) should be used?

Determining what metric(s) to use can be complex, as all options have benefits and risks. Broadly, metrics fall into three categories:

1. **Metrics that directly measure the quality of nature/biodiversity**: Direct measurement means measuring the state of the ecosystem in need of improvement. This could mean, for example, measuring specific flora and fauna. Species measurements (e.g. population sizes) are commonly used in academia, as they are generally easier to tie to ecosystem-level biodiversity. This varies, however, depending on the number of measurements taken and the degree to which local specificity is considered.

2. **Metrics that measure pollutants and novel entities that affect nature**: These include, for example, the number of specific chemicals released or invasive species introduced. For instance, measuring invasive species in a forest patch is crucial for restoration efforts aimed at their removal. Projects seeking to measure pollutant and novel entity levels must also prove the link between these and their tangible effects on nature. Measuring pollutants and novel entities can be easier than direct measurements of biodiversity, as units may be more consistent between projects and ecosystems (e.g. kilograms of nitrogen), and levels can be estimated from more readily available data (e.g. remote sensing or even economic reports from nearby companies).

3. **Metrics that measure factors closely related to nature outcomes**: These measurements can be useful in understanding a project's performance more holistically. Examples include measurements of natural resource extraction or socioeconomic effects such as community health and poverty. The latter can be integrated using social performance tools to measure project perception and inclusiveness and demographic analysis to measure community impacts. Since these often improve the effectiveness of nature recovery efforts via, for example, community participation in conservation, they act as indicative metrics for improving nature while ensuring the inclusion of communities. The practicality of such measurement is high, as qualitative aspects can be evaluated through surveys or with pre-existing sociodemographic data. However, these measurements should be used alongside direct measurements of the quality of nature, as they do not directly measure nature themselves.

Options 2 and 3 are similar to, but distinct from, the practices discussed in key decision 1. Both options can measure outcomes (such as reduced pollution or improved community health) that result from applied practices (such as land conservation) – even though those outcomes are not necessarily of nature or biodiversity.

1.3 Deep dive: Exploration and categorization of options 1 and 2 with metrics applied by biodiversity credits

This deep dive is based on expert discussions and a survey conducted by the Forum and BCA, where participants submitted biodiversity metrics they had used or planned to use. While it provides a helpful overview of metrics used by the survey respondents, **it should not be considered exhaustive nor prescriptive and does not establish a new standard or replace existing ones** (Table 1).

The submitted metrics fell into three categories: biotic, abiotic and combined metrics spanning land, water and air domains.

Specifically, although this method of categorization helps illustrate key decision 1 and draw conclusions that may be applicable to broader contexts (despite being based on a limited subset of biodiversity credit metrics), there remains a lack of consensus on the classification of certain metrics into the biotic, abiotic, and composite categories. Alternatively, metrics could also be categorized based on the structure, composition and function of biodiversity, which may be applicable in different contexts. Businesses and investors are encouraged to stay informed about the latest developments and guidelines provided by standards and disclosure frameworks concerning these metrics, such as TNFD.

> Abiotic metrics are physical or chemical characteristics of an environment that provide insight into ecological health and diversity.

1 Biotic metrics

Description: Biotic metrics include living organisms whose presence, abundance or health reflects an environment's ecological condition. This category can be subdivided into metrics for flora, fauna or both. Metrics on flora are traditionally used to indicate the state of overall habitat health, as they can be measured using field surveys, satellite imagery and drone assessments. Metrics on fauna, such as bird and invertebrate diversity, reflect ecosystem health but can be harder to measure.

Link to drivers of biodiversity loss: Biotic factors can be directly linked to all drivers of biodiversity loss. Invasive species directly affect the other living elements of an ecosystem, and all manners of environmental change (land, sea, resource, climate and pollution) are likely to affect organisms directly.

2 Abiotic metrics

Description: Abiotic metrics are physical or chemical characteristics of an environment that provide insight into ecological health and diversity. Land-based metrics are often larger-scale and area-based, with examples including soil nitrogen and habitat connectivity. Water-based metrics, such as water withdrawal or pH level, are also often larger-scale and area-based but are particularly suited to aquatic ecosystems. Air-based metrics are primarily related to chemicals or pollutants such as pesticides, greenhouse gases (GHG) and various non-GHG air pollutants.

Link to drivers of biodiversity loss: Abiotic attributes are linked to all drivers of biodiversity loss except invasive species. The link to pollution is strong, and the metrics may be related to climate change via, for example, particles in the air. Additionally, abiotic metrics can be linked to natural resource exploitation, sea-use change and land-use change. An example of the latter is excessive farmland conversion and logging, which can release pesticides and soil into streams, altering their turbidity.

3 Combined metrics

Description: Some metrics depend on deeply intertwined biotic and abiotic aspects. An example is a species' habitat area, which depends on the abiotic land or water making up the habitat and, for example, the biotic vegetation within and the preferences of specific species.

Link to drivers of biodiversity loss: As these metrics may include all aspects, they can be linked to all drivers of biodiversity loss.

TABLE 1 | Non-exhaustive overview of biodiversity metric categories

	Biotic metrics	Combined metrics	Abiotic metrics
Land	– Normalized difference vegetation index (NDVI) ■ Vegetation structure indicators (tree/canopy height, tree biomass) – Forest cover percentage – Ground cover – Woody plants functional diversity – Woody plants species diversity – Woody debris – Soil invertebrate presence	– UK Habitat Classification Structural Metric ■ Landscape connectivity ■ Forest landscape integrity index	■ Land/use change extent – Soil organic carbon – Soil nitrogen – Soil electrical conductivity – Extractable phosphorous ■ Amount of pesticides discharged ■ Amount of fertilizers applied
Water	– Number of aquatic macroinvertebrates – Reef rugosity	– Living rivers metric – Riparian extent	■ Freshwater/ocean use change extent ■ Water withdrawal – Level of water stress – Stream nutrient level – Salinity level – Water pH – Turbidity – Stream flow rate
Air	N/A	N/A	■ Non-GHG air pollutants
Two or more domains	■ Species extinction risk (STAR)/IUCN Red List of Threatened Species – Taxonomic diversity ■ Species diversity ■ Species richness ■ Mean species abundance ■ Wild species used/exploited – Population size – Organic litter – Phytoplankton biomass – Trophic function – Vegetation spatial diversity – Vegetation composition – Vegetation function – Mangrove forest cover ■ Primary productivity in area/ecosystem – Relative abundance and total arthropod species richness and biomass – Bird trait diversity	– Species area of habitat – Habitat area/extent – Habitat health/quality – Habitat connectivity – Ecological connectivity	■ Concentration of key pollutants ■ Pollutant quantity ■ Pollutants removed

Flora Fauna Both ■ Directly referenced by TNFD guidance

There are three key takeaways from the current state of biodiversity credits and their metrics:

1. **There are as many abiotic and combined metrics (19 and 10, respectively) as biotic (27) metrics already in use or being considered**.

   While the survey producing the list of metrics did not assess how often biodiversity credits applied to each metric, it indicated that abiotic metrics are often used even though biotic metrics more directly reflect the state of biodiversity. This may be due to pre-existing environmental disclosure frameworks, such as the Taskforce on Climate-Related Financial Disclosures (TCFD), focusing on abiotic parameters. It may also be because abiotic factors are generally easier to measure and are more standardized between ecosystems. For example, while measuring some species may require specific equipment, the pollution measurement is much more standardized.

2. **Abiotic metrics are best when combined with biotic metrics**.

   The use of a single biotic or abiotic metric is seldom sufficient to demonstrate positive impact on the ecosystem. The combination of a suite of abiotic and biotic metrics prevents documenting baselines and improvements that do not accurately represent the state of biodiversity. For example, two sites may have similar soil nitrogen levels but incomparable biodiversity. Physical characteristics indicate ecosystem health but should be used with biotic metrics to paint a holistic picture.

3. **Projects should consider how the environment may fluctuate with seasonality and other factors when monitoring these metrics**.

   Some metrics are based on counting, such as population sizes. However, because these metrics fluctuate based on environmental factors, resource availability, competition, predation and seasonality, it is important to take a longer-term view of biodiversity. Additionally, diversity can be measured not through population size but through functional[8] and phylogenetic diversity.[9] These can be used to supplement simpler population metrics.

1.4 Key decision 3: How aggregated should the metrics be?

Although biodiversity metrics exist on a continuum of possible aggregation levels, two major categories can be deduced: discrete metrics and composite.

Discrete (keystone) metrics use key indicators to estimate overall ecosystem health or other factors. **Composite metrics**, by contrast, aim to provide a more holistic assessment by weaving multiple measurements together into one. Table 2 highlights the distinction between these options, provides examples and proposes ideas that may help actors decide what is most appropriate for them. Note that there is an ongoing debate about the use of discrete versus composite metrics, in particular in the biodiversity credits market. While, in fact, discrete metrics are easier to implement due to the lower amount of datapoints needed, composite metrics offer a more comprehensive overview of the health of an ecosystem or landscape. This report does not set out to resolve this debate, but merely capture the current state of the art of biodiversity credits markets. Regardless of aggregation level, it is important to consider and adequately report any sampling bias in the underlying data.

TABLE 2 **Comparing discrete (keystone) metrics and composite metrics**

	Discrete (keystone) metrics	Composite metrics
Description	Discrete metrics use single or multiple key indicators to assess overall ecosystem health, relying on expertise and judgement to make estimates of biodiversity and ensure a linkage between a given metric and biodiversity across an ecosystem.	Composite metrics include multiple measurements of biotic and/or abiotic factors woven together to determine the health of an ecosystem. These may use scientific instruments to measure biodiversity or nature on the ground and cover multiple dimensions.
Examples	Assessing the population of keystone species or apex predator (e.g. panther) to estimate the overall health of nature and biodiversity in a region	Biodiversity Intactness Index (BII), the Species Threat Abatement and Restoration (STAR) metric, etc.
Considerations	– Simpler to implement – Used in isolation, might overlook the actors and factors that can influence the outcomes of management actions, potentially undermining the assumptions that connect these actions to their outcomes – Relies on expertise and judgement to determine and establish linkage between the action and the ecosystem-level biodiversity – Requires more resources to prove the link between outcomes and management actions and avoid double counting if multiple variables are used to measure the same ecosystem component – May be better for projects limited to specific areas and ecosystems	– More complex to implement – Requires more datapoints, making a better link between actions and outcomes – Some challenge on understanding the mechanistic drivers of composite indicators – Rigour is proportional to the data used, and may not translate to higher accuracy if data is not high quality – Can introduce greater measurement uncertainty – Work better for complex ecosystems and landscapes approaches – Composing multiple values into one metric risks losing nuances of the underlying, separate values (though they might not be collected at all in the discrete approach)

1.5 Key decision 4: How should change in the metric(s) be quantified?

Determining how to quantify change in nature-related metrics is essential to understanding and reporting impact. This includes critical decisions about setting a baseline, measuring against it and possibly defining a target state.

Setting a baseline

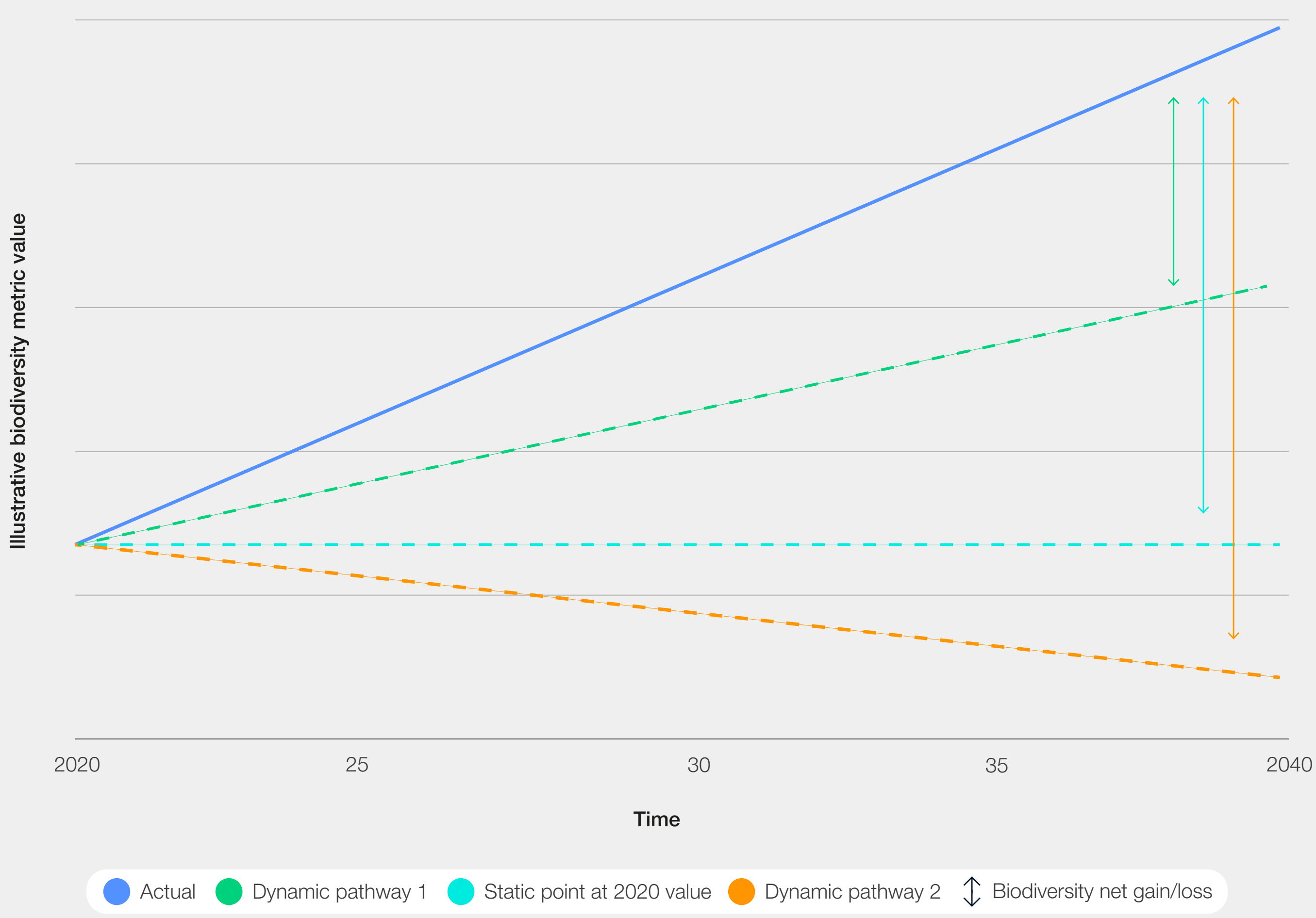
The primary options for a baseline are a static point or a dynamic pathway. While a **static point** tends to be a historical reference from which progress is measured, a **dynamic pathway** is a modelled scenario of a counterfactual – a reference that changes over time. Each can be based either on the area where interventions occur or a comparable area, often nearby. Table 3 provides an overview of each approach's considerations, benefits and risks.

TABLE 3 **Comparison of static and dynamic points to determine a baseline**

	Static point	Dynamic pathway
Considerations	A static point is a fixed point in time to which the current state of nature and biodiversity can be compared. It can be a historical measurement of the metric, or a measurement taken from a nearby comparable ecosystem where intervention has not taken place. Static points can and should be occasionally updated to reflect new research or changed ambitions.	A dynamic pathway is a moving reference to which the current state of nature and biodiversity can be compared. It may be a modelled pathway or observations from a nearby area without interventions, accounting for expected changes in biodiversity that would occur even without intervention. It can also include measuring continuous "internal" improvement, whereby current levels are compared to the most recent preceding measurements.
Benefit	– Easier to understand – Less resource-intensive – Requires fewer modelling assumptions and uncertainty – Better for comparability between projects	– More effectively considers the role of intervention – Potentially more suitable for areas where there is expected to be biodiversity loss regardless of human intervention (e.g. by extreme weather)
Risks	– Does not account for what would happen without intervention	– Complex to communicate – Resource-intensive – Introduces uncertainty from modelling assumptions

Whether the chosen baseline is static or dynamic can significantly affect the reported nature uplift or loss (as illustrated in Figure 2). A dynamic pathway has the potential to reward minimizing losses – but not fully reversing them – where a project operates more efficiently than the alternative pathway. This is a particularly important consideration for biodiversity, where declines cannot be made up elsewhere.

FIGURE 2 **Illustrative example of the differences that arise from choosing a static point or a dynamic pathway as a baseline**



Quantifying against a baseline

After establishing a baseline, one can consider how change is quantified. The two main options are **absolute improvements** or **relative improvements** – which may yield different magnitudes of change. For example, the absolute improvement would be the same when increasing the Biodiversity Intactness Index (BII) from 0.20 to 0.25 as it would when increasing from 0.80 to 0.85. A relative approach, on the other hand, would lead to diminishing results, as seen by a higher relative improvement from 0.20 to 0.25 (25%) than from 0.80 to 0.85 (6.25%). This consideration is especially relevant to biodiversity credit methodologies as it can be fundamental to how credits are awarded and, therefore, what they incentivize. This can further inform the decisions of potential credit buyers. Regardless of how a baseline is determined and measured, transparency in risks and assumptions is important.

Establishing a target state

Actors may also consider setting a target state for nature or biodiversity. This could be relevant to, for example, projects that aim to regenerate or use nature for adaptation.[10] Such a project could include planting mangroves that reduce erosion, allowing coastal communities and ecosystems to adapt to climate change.

Target states can vary over time and space and may benefit from being updated as research and ambitions develop. They can be customized by project and ecosystem and may include considerations such as disturbance, community interaction and allowed economic offtake. The latter may be particularly suited to managed ecosystems, such as agricultural areas, in which a clear human-driven activity occurs. Alternatively, the target state may be determined as a “pristine state”, representing what the quality of nature was or would have been without human intervention. This may provide a more intuitive goal, but defining the pristine state may be difficult as it may require locally specific research.

2

Emergent models for the selection of metrics

Three broad models for using metrics emerge from current nature and biodiversity methodologies.

Patterns are emerging across the key decisions and metric categories of biodiversity credits.

The following two chapters explore metrics as applied by biodiversity credit markets today. However, many of the insights may also be relevant beyond credits, as they are more focused on measuring nature and biodiversity and less on the credits themselves.

Patterns are emerging across the key decisions and metric categories of biodiversity credits. Mapping out credit methodologies reveals three models for using metrics, which – in this paper – are referred to as:

1. **Comprehensive aggregated model**: This model uses composite metrics based on many direct measurements to create a holistic and accurate view of biodiversity encapsulated in a single (or very few) metric(s). It can use static or dynamic baselines.

2. **Critical indicator model**: This model also uses direct measurements, but instead of making a composite, it relies on fewer discrete metrics that are representative of overall biodiversity. It predominantly uses static baselines.

3. **Mosaic compilation model**: This model uses multiple measurements and metrics that may measure biodiversity or other factors such as pollutants and socioeconomic factors to create a tailored and vastly encompassing view of an ecosystem and its surroundings (including, for example, nearby societies). It can use static or dynamic baselines.

While these models are non-exhaustive (given that a continuum of key decisions may lead to unique models), they help segment the space and facilitate discussion. The three models were derived from an assessment of 32 biodiversity credit methodologies. The methodologies were either defined by project developers measuring biodiversity for their own credits or (aspiring) credit standard-setters. Three of those 32 methodologies were excluded from further analysis because they were practice-based and did not progress beyond the prerequisite key decision (decision 1). This left 29 methodologies for examination.

This analysis primarily focuses on standard-setters, as they offer a broader representation of the methodologies landscape compared to individual project developers, who typically create customized, context-specific methodologies. This analysis does not aim to be exhaustive, nor does it aim to be prescriptive for further developments in the field. It is intended to clarify for potential credit buyers what their scope of decisions on metrics may be, based on the sample described. It may also inform the choice of methodology for project developers aiming to generate credits and may guide how future standards are set.

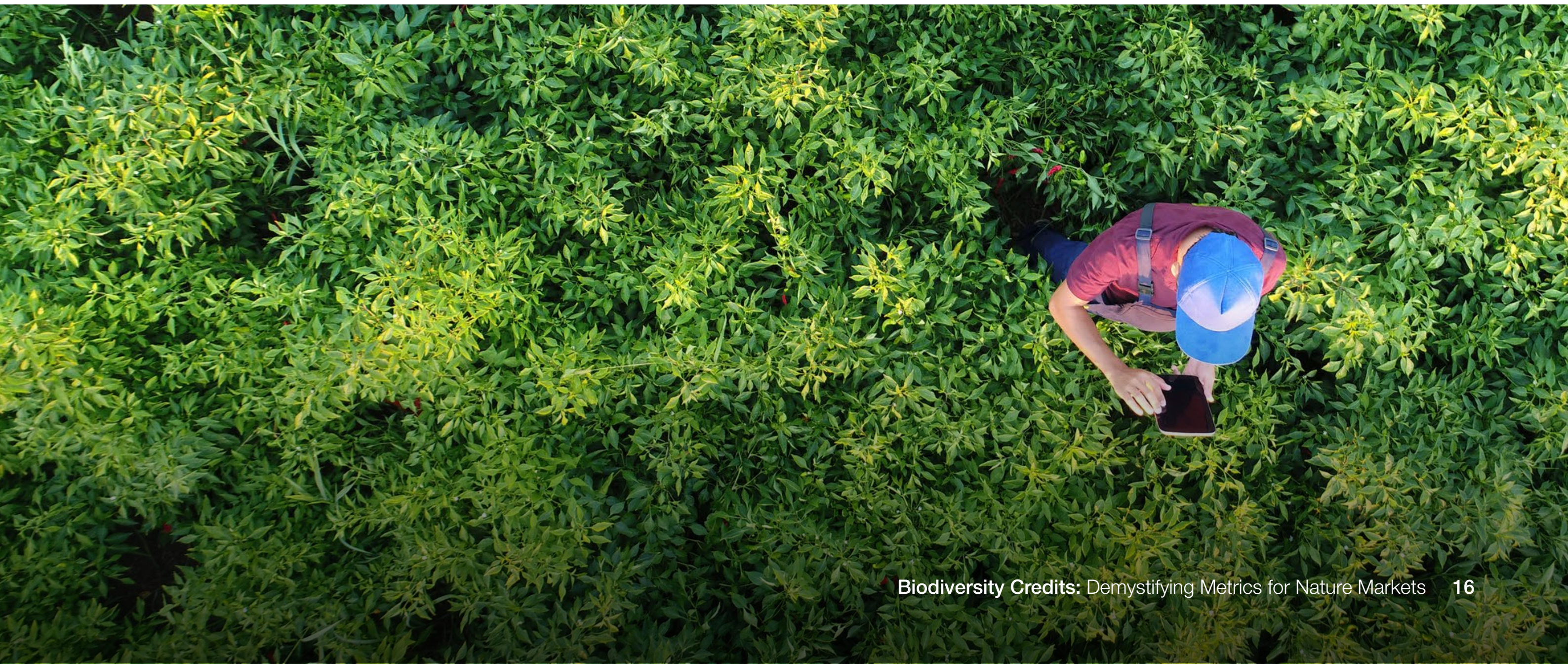
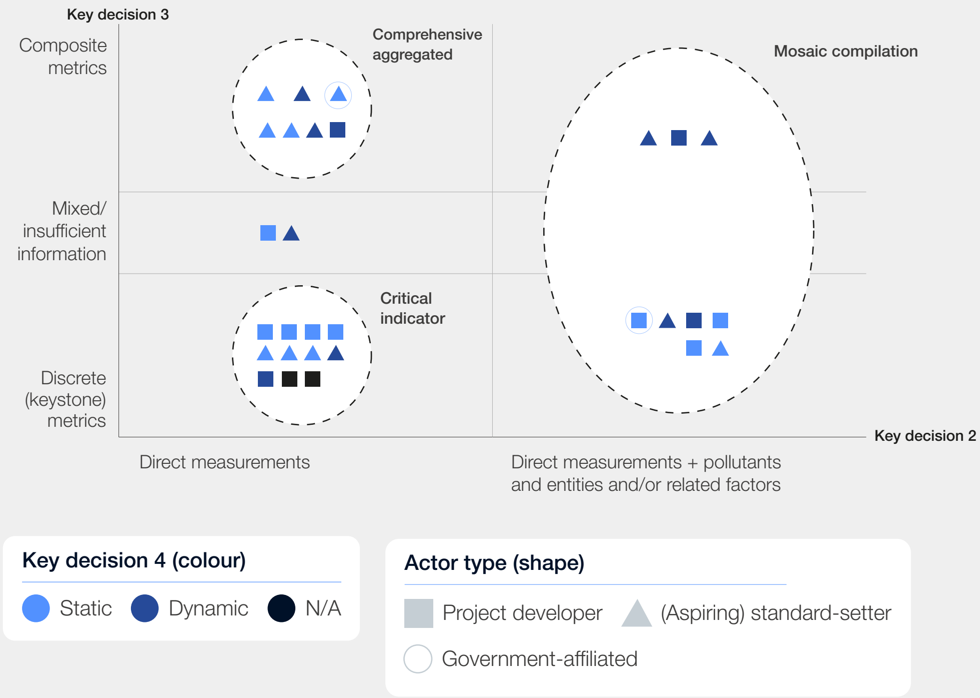


FIGURE 3 | Map of 29 outcome-based credit methodologies across the three key decisions



Key decisions

Key decision 1 (prerequisite): Should practices or outcomes be measured?

Key decision 2: What type(s) of metric(s) should be used?

Key decision 3: How aggregated should the metrics be?

Key decision 4: How should change in the metric(s) be quantified?

While key decision 4 is a distinguishing factor (mainly whether the baseline is static or dynamic), the decisions that more strongly drive model differences are key decisions 2 and 3 – namely, what types of metrics are used and how aggregated they are. Figure 3 reveals that while three types of metrics were identified in key decision 2, only the metrics arising from direct measurements of nature or biodiversity are used alone in practice. All other types appear together with direct measurements and potentially one more option. Finally, most methodologies use biotic variables, and many include abiotic variables as well. Two methodologies solely use abiotic metrics.

Figure 4 provides an overview of the key characteristics of each model.

FIGURE 4 | Overview of the three models across the key decisions

Key decisions and actor types	Comprehensive aggregated model	Critical indicator model	Mosaic compilation model
2 Metric type(s)	Direct measurements	Direct measurements	Direct measurements + activities + related factors
3 Level of metric aggregation	Composite metrics	Discrete (keystone) metrics	Discrete (keystone) and/or composite metrics
4 Baseline	Static or dynamic	Primarily static	Static or dynamic
Actor type	Primarily (aspiring) standard-setters	Primarily project developers	(Aspiring) standard-setters or project developers

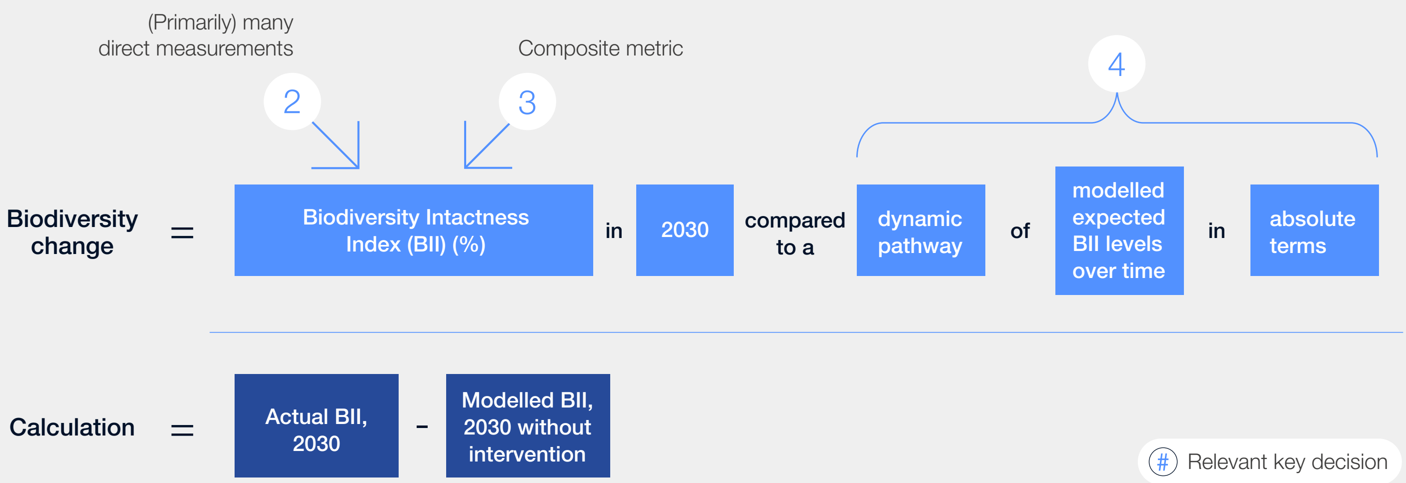
2.1 Comprehensive aggregated model

This model is most prevalent among (aspiring) standard-setters and tends to be more detailed and technical. The use of composite metrics allows flexibility between ecosystems, which aligns with standard-setters' goals of providing a methodology that many projects can follow.

Example 1: A project developer uses the UK's [Statutory Biodiversity Metric] to calculate the biodiversity value of a habitat for the purposes of biodiversity net gain. This tool uses direct combined measurements in key decision 2, like habitat condition, to construct a composite metric in key decision 3. This is compared to a dynamic pathway in key decision 4, as research suggests that soil erosion driven by climate change would degrade this habitat without intervention. Finally, the project developer chooses to measure the percentage of improvement relative to this moving baseline.

Example 2: A credit standard in the Amazon rainforest requires the use of the BII as a metric. The BII includes various biotic variables such as the abundance of native terrestrial species, aligning with direct measurements in key decision 2. It then combines them, which aligns with composite metrics in key decision 3. In key decision 4, the example standard requires modelling a dynamic pathway of BII expectations without intervention and relating to that in absolute terms.

FIGURE 5 **Illustration of example 2 of the comprehensive aggregated model**



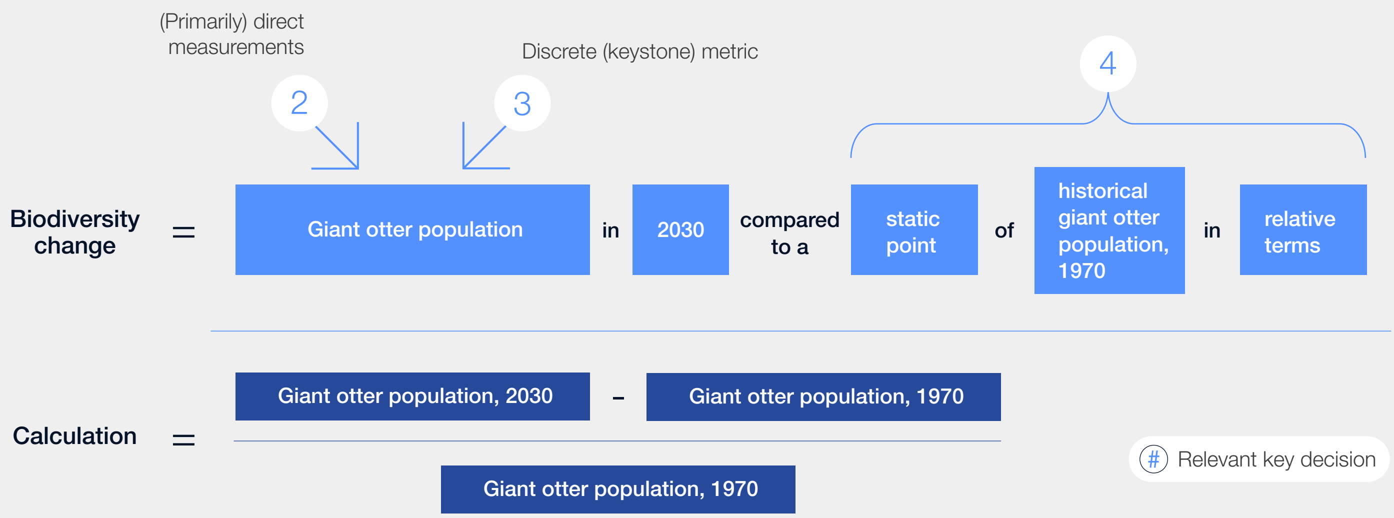
2.2 Critical indicator model

This model is most prevalent among project developers making their own methodologies. Their project-specific focus leads to the use of discrete variables that aim to be representative of ecosystem health and a static baseline since it requires less modelling than a dynamic pathway. This is likely to minimize costs and maximize specificity, which may explain why it is the most common model in the sample.

Example 1: A project developer measures forest cover as an indicator of overall ecosystem health, making the metric a direct measurement in key decision 1 and a discrete (keystone) metric in key decision 2. The project compares forest cover to a dynamic pathway – a forest with a similar composition in a neighbouring region where no interventions take place – and it measures progress in absolute terms (percentage points of forest cover cover).

Example 2: A project developer in the Amazon rainforest selects direct measurement and a biotic, faunal metric – the giant otter population – for key decision 2. This metric is used in isolation as a representation of ecosystem health and is, therefore, a discrete (keystone) metric in key decision 3. In key decision 4, the project selects the historical population in 1970 as a static baseline and measures progress in relative terms.

FIGURE 6 | **Illustration of example 2 of the critical indicator model**



2.3 | Mosaic compilation model

This model combines multiple metrics spanning direct measurements of nature or biodiversity, measurements of pollutants and novel entities and measurements of related factors to create a holistic view of ecosystem health. It can include discrete or composite metrics as well as static or dynamic references.

Example 1: A project developer in a coastal ecosystem uses metrics from all categories. In key decision 2, it uses plankton biomass (direct measurements), water pollution (pollutants and novel entities) and community participation (related factors). In key decision 3, these can include both discrete (keystone) and composite metrics depending on, for example, whether the water pollution and community participation metrics combine and weigh multiple values.

In key decision 4, the project developer uses a neighbouring coastal region with a similar composition as a dynamic baseline, measuring each variable in relative terms.

Example 2: A crediting standard in the Amazon rainforest uses three metrics, the Species Threat Abatement and Restoration (STAR) metric, metrics for the population of a keystone species (hummingbirds) and the local income generated by nature-related activities. In key decision 2, it selects direct measurements and related factors. The three variables span discrete (keystone) metrics and composites in key decision 3. In key decision 4, the standard selects a static baseline of each variable's value in 2020, and measures change in absolute terms.

FIGURE 7 Illustration of example 2 of the mosaic compilation model

(#) Relevant key decision

Biodiversity change =

Hummingbird population (number) ← 2 Direct ← 3 Discrete (keystone)

Species Threat Abatement and Restoration (STAR) ← 2 Direct ← 3 Composite

in 2030 compared to a static point of each variable in 2020 in absolute terms ← 4

Local income generated ← 2 Related factors ← 3 N/A

Calculation = Hummingbird population, 2030 – Hummingbird population, 1970 & STAR, 2030 – STAR, 1970 & Local income generated, 2030 – Local income generated, 1970

3 Comparing the models

Seven key evaluation factors can help users select the most suitable model for their specific context.

Anyone interested in measuring nature and biodiversity can use this comparison to better understand and evaluate potential approaches.

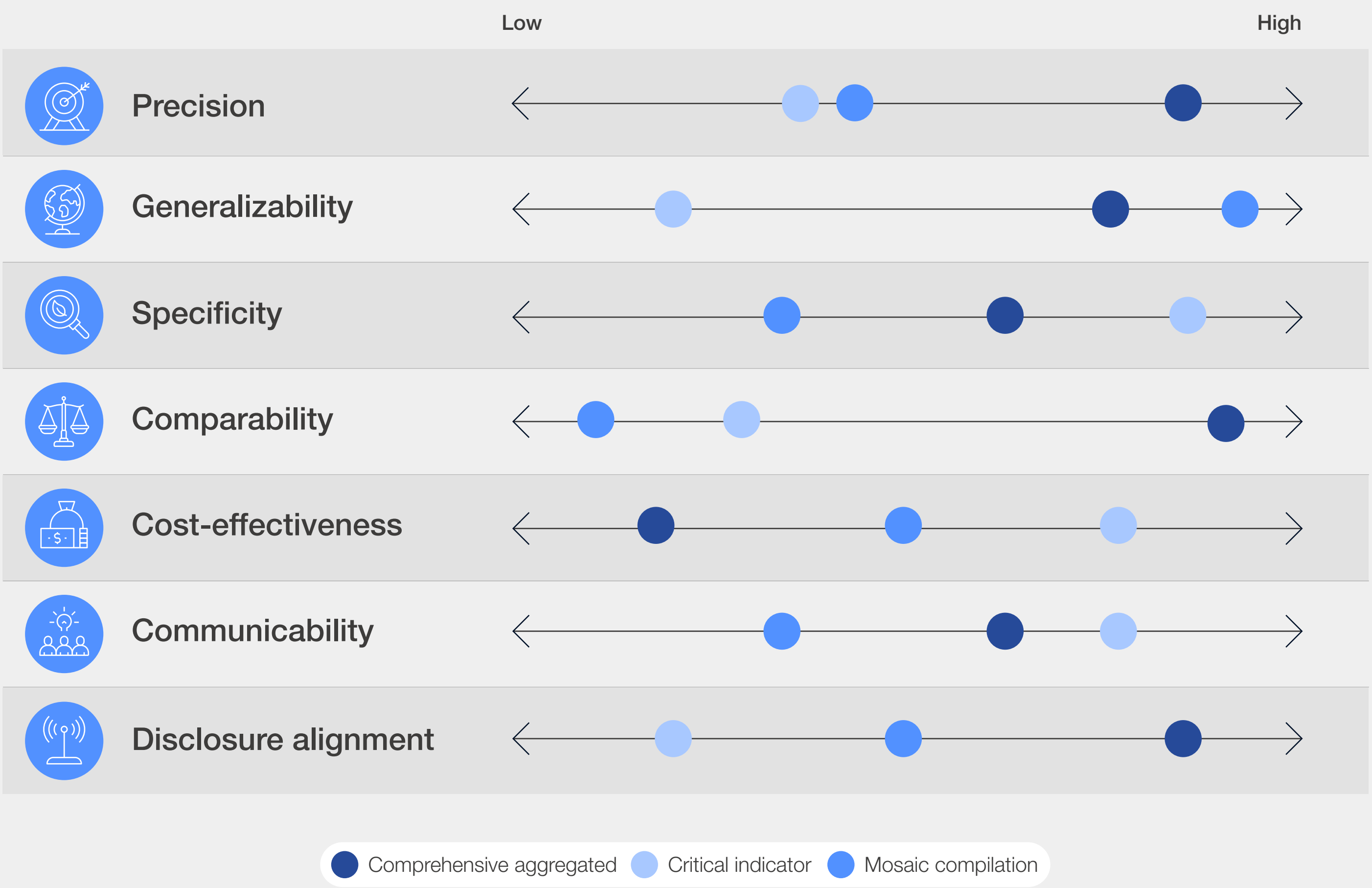
By considering their specific situation, nature-positive financiers can determine the most suitable model for their use case. These considerations may include, for example, the nature footprint of their operations and that of their value chain, as well as financial considerations such as budget. Similarly, project developers can identify the model that best aligns with their projects and objectives. Standard-setters may also evaluate which model to align with, how they compare to others and where they can develop unique, differentiating qualities. Finally, anyone interested in measuring the state of nature and biodiversity can use this comparison to better understand and evaluate potential approaches.

The following section examines each model under seven dimensions, chosen for their materiality to nature and biodiversity, and their relevance to companies' considerations. Although it is desirable to do well across all dimensions, there can be trade-offs in some scenarios in which metrics need to balance pragmatism, project scope and scientific robustness. The last dimension, alignment to disclosure frameworks, is touched on in relation to the models here and further elaborated in the next chapter.

TABLE 4 **Overview of seven evaluation dimensions for emergent biodiversity credit models**

	Comprehensive aggregated model	Critical indicator model	Mosaic compilation model
Precision (How precisely does the model measure biodiversity?)	**Most precise** due to direct, quantitative biodiversity measurements. Ideal for projects needing assurance of nature improvements across multiple factors	**Precise for specific indicators** but less so for overall ecosystem health, given it is reliant on indicator representativeness. It could be misleading if the wrong indicators are chosen	**Moderate precision**, accommodating various levels and types of metrics, potentially even qualitative ones
Generalizability (How comprehensive is the approach across ecosystems?)	**Generalizable** across various ecosystems using a composite metric that can be adapted for different contexts	**Limited generalizability** due to ecosystem-specific indicators	**Highly applicable** across different ecosystems and project types
Specificity (How comprehensive is the approach within an ecosystem?)	**Low specificity** giving the composite metrics may lead to lose local specifity in data aggregation	**Highly specific** to particular ecosystems, highlighting key local indicators	**Flexible**, allowing projects to choose relevant indicators, but not deeply specific
Comparability (How easily can results across credits and ecosystems be compared?)	High standardization of metrics enables **cross-ecosystem comparison**	**Limited comparability** across projects due to local specificity	**High flexibility complicates comparability** across projects
Cost-effectiveness (How time and resource-intensive is the model to implement?)	High precision and number of measurement requirements **increase time and cost**, though technological advancements (e.g. AI, eDNA, remote sensing) may mitigate this	**Reduced time and resource requirements** due to fewer metrics	**Moderate time and resource requirements**, based on which specific metrics are chosen
Communicability (How easy is the model to understand?)	**Potentially complex**, but can be understood if metrics are clearly and transparently defined	**Easily understood** with fewer, intuitive metrics	**Challenging** due to the combination of different metric types, which require high transparency
Disclosure alignment (How aligned is the model to disclosure frameworks?)	**Strong alignment** with frameworks focusing on species and habitat-specific metrics	**Limited alignment** due to narrower focus	**Varies based on metric selection** and transparency in reporting

FIGURE 8 High-level illustration of the relative positioning of models against the seven evaluation dimensions



Each of the three models offers distinct advantages and disadvantages that users must evaluate according to their specific needs. Due to the considerable variations in project size, geography and ecosystem, some degree of customization will likely be required regardless of the chosen model. Broad consensus on any of the models or on preferred versions of each model can enhance overall market efficiency.

4 Aligning nature and biodiversity metrics to reporting and disclosure frameworks

Aligning metrics with reporting and disclosure frameworks can help ensure investments in nature improvements are relevant to corporate strategies.

Disclosure frameworks support companies by providing guidelines and helping businesses enhance transparency and accountability.

Companies are increasingly encouraged to understand and disclose the impact and dependencies on nature and biodiversity of their operations and value chains to mitigate risks and seize opportunities. Disclosure frameworks support companies by providing guidelines and helping businesses enhance transparency and accountability.

Alignment on metrics across disclosure and crediting frameworks can help drive coherence across a company's work on nature. Under disclosure frameworks, companies should report impact and dependencies, at times set targets aligned with the mitigation hierarchy such as the one outlined in the SBTN's AR3T Framework (avoid, reduce, restore and regenerate, transform).[11] Ideally, the positive impact generated from financing nature improvements, not least from purchasing biodiversity credits, would be reported as part of these disclosure frameworks – meaning that metrics used for such financing would be aligned with disclosure metrics. More broadly, alignment across metrics used to report impact, dependencies and outcomes (negative and positive) can help ensure a coherent and comprehensive account and simplify companies' data collection and analysis.

A review of guidance from the Taskforce on Nature-related Financial Disclosures (TNFD), Science Based Targets Network (SBTN), Corporate Sustainability Reporting Directive (CSRD), IUCN and the International Financial Reporting Standards (IFRS), yields three key findings:

1. Disclosure frameworks generally operate at a higher level, providing guidance on types of metrics rather than specific metrics, with two important exceptions being TNFD and SBTN (see Figure 9). Disclosure frameworks align well with the metrics proposed for nature-positive financing and biodiversity credits. While these frameworks seldom prescribe exact metrics, they do suggest example applications.

2. Most disclosure frameworks emphasize the importance of stakeholder engagement and reporting transparency, which already aligns well with the approaches of nature-positive financing and biodiversity credits.

3. As disclosure frameworks evolve, more guidance on metrics is expected to emerge, in particular on how to connect the metrics reported for impact and dependencies with those used for outcome-based financing.

Overall, these findings mean that market actors must make their own judgements about the exact metrics they use and disclose. The breadth of existing frameworks should already enable companies to align across metrics used for impact disclosure and nature or biodiversity credits.

For example, the TNFD and SBTN have coordinated closely to ensure consistency of core definitions, data requirements and analytical outputs, enabling corporate use of both frameworks.[12]

A detailed analysis of guidance from the TNFD and SBTN illuminates optimal strategies for creating coherence across these frameworks and emerging approaches to metrics for nature and biodiversity (Figure 9).

FIGURE 9 | Overview of TNFD and SBTN guidance on nature and biodiversity metrics

	Level of guidance	Where to find the guidance	Areas of alignment	Areas of development
Taskforce on Nature-related Financial Disclosures	Guidance on metrics for nature and biodiversity, which can be applied to broad nature finance applications	Specific guidance can be found in *Recommendations of the Taskforce on Nature-related Financial Disclosures* (both "core" and "additional" metrics)	– Guidance links closely to abiotic and biotic categories, with a dimension of biodiversity loss drivers – Biodiversity metrics suggestions align with current credit standards	– Lack of exhaustive and detailed guidance for specific use cases
Science Based Targets Network	Biodiversity metrics are discussed within the broader framework, accompanied by non-exhaustive recommendations	Mentions of biodiversity can be found in the general guidance Technical guidance released in SBTN's short paper, *Biodiversity in the First Release of SBTs for Nature and an Approach for Future Methods*, with further information to be released	– Suggestions align with metrics discussed in this paper, including species richness, habitat quality, STAR and BII – Guidance also includes assessment of pressures on the ecosystem being examined	– Lack of specific guidance on biodiversity, though it is currently being developed

BOX 2 | Relevance to carbon credits and other climate-financing instruments

Businesses engaging in carbon credits have opportunities to incorporate nature-positive co-benefits. These are distinct from biodiversity credits, which focus on biodiversity protection and restoration and are not attached to carbon credits.

The guidance provided in this paper on the trade-offs and considerations of the key decisions can also apply to other forms of financing that include a nature component. This might involve, for example, carbon credit standards for nature-based solutions. For instance, Verra's Climate Community & Biodiversity Standards certify carbon credit projects that meet certain biodiversity requirements. In contrast, the IFRS and International Sustainability Standards Board's (ISSB) carbon crediting programme does not explicitly incorporate biodiversity beyond considerations for climate-related physical risks[13] – although this may change.

Businesses aiming to engage in projects with both carbon and biodiversity benefits should consult specific carbon credit standards to understand how to align the metrics. While some climate finance initiatives integrate nature and biodiversity, this is inconsistent across the board and should be evaluated on a case-by-case basis.

Conclusion

Defining appropriate metrics for tracking change the state nature and biodiversity supports investment in nature-positive finance and biodiversity credits. Breaking down what to measure and how to understand the key decisions that market actors need to take is an initial step towards appropriate metrics. Further identifying where patterns emerge among methodologies in the space of biodiversity credits – and comparing said patterns – helps delineate where the market may be converging even without established standards. Finally, clarifying how metrics can relate to disclosure frameworks helps support corporate incentives and uptake. Taking an even broader perspective, those interested in measuring nature and biodiversity could use this paper's key decisions and models to form their own approach to metrics.

This clarifies the current state and potential future developments of metrics in nature-positive finance in general and biodiversity credits specifically. Five key steps can further support the field's ongoing development.

1. **Further integrating nature and biodiversity metrics with established disclosure frameworks** such as that of the TNFD or CSRD, for example, could be useful. These frameworks can provide guidance on implementation and ensure transparency, thereby standardizing validation of positive nature outcomes across market actors and credits. This standardization can also support aligning nature-positive finance and biodiversity credits with broader nature strategies and encouraging broad acceptance and trust in these concepts.

2. **Establishing consensus on standardized nature and biodiversity metrics will require international collaboration** to harmonize best practices, data and technological approaches. This collaborative effort can help overcome regional challenges in biodiversity monitoring and ensure that metrics are scientifically rigorous and widely applicable.

3. **Implementing rigorous verification and audit protocols is crucial** to ensure accuracy of collected data and provide assurance to investors and stakeholders about the integrity of nature-positive financing instruments. Additionally, rigorous verification should be coupled with knowledge-sharing and training to ensure this complex space is understood by all relevant parties.

4. **Integrating advanced technologies** such as remote sensing (including satellite imagery), artificial intelligence and eDNA can revolutionize the scalability and efficiency of nature and biodiversity measurement. At scale, these technologies may provide unparalleled benefits in terms of data accuracy and coverage and should drive down costs over time.

5. **Continuing and deepening the paramount engagement of IPs and LCs**, which naturally extends into measurement processes, is a social responsibility and can enhance the effectiveness of conservation efforts. Engaging communities through public fora and direct involvement in planning, implementation and measurement can stimulate greater community buy-in and ensure that nature-positive projects align with local needs and values. Additionally, integrating socioeconomic data with ecological data can provide a more comprehensive view of the impacts of biodiversity conservation, promoting inclusivity and holistic development.

Overall, for nature-positive finance to truly drive change and contribute to global goals, it is essential that the metrics and measurement processes underpinning them are robust, transparent and aligned with established standards. By considering the above areas, the market can support the structure, credibility and impact of nature-positive finance – thereby accelerating the transition to a more sustainable future.

Appendix: terminology

Abiotic: Referring to all non-living entities and factors.

Baseline: The initial value of a measurement or metric from which developments are tracked.

Biodiversity: The variability among living organisms from all sources including inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Biodiversity is ingrained within nature.

Biodiversity credit: A certificate that represents a measured and evidence-based unit of positive biodiversity outcome that is durable and additional to what would have otherwise occurred.[14]

Biotic: Referring to all living organisms.

Data: Raw information collected – in this case about nature and biodiversity. Can be qualitative and/or quantitative.

Ecosystem: A dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit.

GBF: The Kunming-Montreal Global Biodiversity Framework adopted at the United Nations Biodiversity Conference of the Parties (COP15) in 2023.

IPs and LCs: Indigenous peoples (IPs) are the original inhabitants, or descendants of the original inhabitants of the land. Local communities (LCs) are comprised of people who live in a particular region but may or may not be the original inhabitants.

IUCN: International Union for Conservation of Nature (IUCN), a union concerned with biodiversity and nature conservation, protection and restoration.

Measuring/measurement: The process of collecting specific points of data, e.g. for constructing metrics, determining a baseline, or monitoring progress.

Methodology: A protocol to quantify or qualitatively characterize something. This could be an approach limited to measuring nature/biodiversity, or also extend to characterizing and quantifying biodiversity credits.

Metric: A quantified value used to assess, track changes and compare the health of nature, biodiversity, or related factors.

Nature: The phenomena of the physical world collectively, including plants, animals, the landscape, and other features and products of the earth.[15] This encompasses biodiversity through its inclusion of all living things.

Nature-positive: A global societal goal defined to "Halt and Reverse Nature Loss by 2030 on a 2020 baseline and achieve full recovery by 2050".[16] Applied in this paper, it refers to actors or actions contributing to that goal by making the state of nature better than it would have been without said actors or actions.

Nature-positive financier: An actor engaging in financing nature-positive outcomes by any means (e.g. businesses buying biodiversity credits).

Novel entities: Human-made substances such as plastics, endocrine disruptors (chemicals that can interfere with hormonal systems, affecting the health of wildlife and humans) and heavy metals, which can disrupt ecosystems and harm biodiversity when introduced into the environment.

Project developer: An organization developing projects that have a positive effect on nature and generate biodiversity or other credits.

Standard (for credits): An established methodology for crediting, which project developers can adopt in their projects to generate credits.

Turbidity: Cloudiness or haziness of a liquid caused by the presence of suspended matter or stirred-up particles. Used in various nature-related matters, such as the freshwater guidance from the Science Based Targets Network (SBTN).

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