Discussion paper on
# Biodiversity footprinting approaches for financial institutions

December 2023

For market consultation and feedback

In partnership with PBAF

tnfd.global

Partnership for Biodiversity Accounting Financials

Taskforce on Nature-related Financial Disclosures

# Contents

# Executive summary

The inherent complexity of nature creates measurement challenges for financial institutions, which strive for clear, relevant, accessible and comparable data, often distilled into single, comparable metrics. Unlike carbon emissions classification and accounting using the well established Greenhouse Gas (GHG) Protocol, there is currently no widely accepted equivalent accounting standard for impacts on nature and biodiversity. There is also no single metric for nature impacts comparable to carbon dioxide-equivalent for greenhouse gas emissions. Given the many dimensions of nature, it is not possible to create one metric that is meaningful and decision useful. This means that financial institutions need to work with a range of indicators and metrics when integrating nature into financial assessments and decision-making processes.

To reconcile the large number of indicators associated with nature-related issues, and the needs of market participants for a relatively small set of indicators that can provide the basis for comparability across and within sectors, the Taskforce on Nature-related Financial Disclosures (TNFD) has adopted a leading indicators approach. It has worked closely with knowledge partners over two years to scan the indicators in use today and develop a small set of core disclosure indicators and metrics, including global metrics for all sectors and specific sector metrics, including those for financial institutions. A larger set of additional and assessment metrics are recommended, where relevant, to best represent an organisation's material nature-related issues, based on their specific circumstances.

The TNFD recognises the initiatives now underway to develop aggregate indicators associated with nature-related issues – dependencies, impacts, risks and opportunities – and encourages further innovation and market testing. Among these, a number of different approaches to biodiversity footprinting have become a focus of attention and development efforts. These approaches provide a quantitative, indirect assessment of impacts on biodiversity by measuring the complex relationships between impact drivers and biodiversity impacts. They aggregate different impacts on nature and express them in a standardised output.

While the concept of a biodiversity footprint is not new, their use by financial institutions is nascent. As a result, there is a lack of understanding about the different approaches and methodologies available, their limitations, and the appropriate use and interpretation of each approach's quantitative outputs.

In recognition of this, the TNFD additional guidance for financial institutions includes biodiversity footprinting approaches as additional disclosure metrics that financial institutions may consider using for disclosure, noting some important considerations and limitations. The TNFD continues to monitor and evaluate existing and new biodiversity footprinting methodologies and their appropriate role in the measurement architecture it has developed. To that end, this discussion paper explores current developments in biodiversity footprinting and the utility of these approaches in the context of TNFD-aligned corporate reporting and risk management.

This paper also aims to inform the role that biodiversity footprinting methodologies could play in other initiatives and frameworks created by TNFD partners, such as the target setting methods under development by the Science Based Targets Network (SBTN), UNEP FI and the Finance for Biodiversity Foundation, and the measurement work of the Nature Positive Initiative.

The TNFD developed this discussion paper in partnership with the Partnership for Biodiversity Accounting Financials (PBAF). It builds on the significant work on biodiversity footprinting by PBAF, the Align project, the Finance for Biodiversity Foundation and others to help companies and financial institutions make informed decisions on where to start and the approaches to use as they navigate this area.

Through this discussion paper, the TNFD aims to achieve four objectives:

- To inform the ongoing development of the TNFD's measurement architecture, including the TNFD's metrics for financial institutions, which were presented in draft in the TNFD additional guidance for financial institutions;
- To assess the decision utility of biodiversity footprinting methodologies, and to help market participants understand which decisions such methodologies can and cannot inform, and decide where to start and which approaches to use;
- To present draft guidance on biodiversity footprinting approaches for market feedback that could inform future TNFD guidance on best practice using these methodologies; and
- To stimulate further innovation by developers and data providers in nature-related methodologies, tools and analytics services by highlighting areas of development for footprinting approaches.

To achieve these objectives, this paper:

- Presents a definition of biodiversity footprinting;
- Provides an overview of the current landscape of footprinting approaches;
- Summarises the limitations of existing approaches to footprinting; and
- Sets out six steps to help market participants select and disclose biodiversity footprinting approaches appropriate for their requirements.

This paper does not delve into technical detail and avoids duplicating the existing work of others on biodiversity footprinting, pointing to other relevant publications where possible.

As with any set of assessment methodologies, there are limitations associated with the use of biodiversity footprinting. Broadly, these relate to technical capabilities, consistency, consensus, capacity and contextualisation. The TNFD and PBAF have set out a six-step approach in this paper to help users improve their understanding of the current footprinting approaches available and their limitations. This can help users to select appropriate approaches for a particular requirement and to contextualise the results.

Financial institutions are encouraged to familiarise themselves with current footprinting methodologies while simultaneously seeking enhancements to these approaches. This includes:

- Adopting, where relevant, supplementary methods to address shortcomings;
- Emphasising the procurement of precise, location-specific and credible data, involving biodiversity experts throughout the process to interpret findings and contextualise results; and
- Engaging in collective efforts with industry counterparts to foster agreement and enhance the robustness and consistency of these measures.

It is clear that biodiversity footprinting can help financial institutions to assess their impacts on nature, including ecosystem extent and condition, and species population and extinction risk. But the selection and use of different footprinting approaches should be grounded in a clear understanding of how they are constructed and what insights they do and do not provide. This necessitates more emphasis on what an end user is trying to achieve and mapping back from these objectives to the selection of the appropriate data, tools and analyses to ensure that the use of these approaches improves decisions, manages risks and shifts finance towards nature-positive outcomes.

As part of its ongoing open innovation approach, the TNFD welcomes feedback from market participants, data, tool and metrics providers and other stakeholders on this discussion paper. The Taskforce will update its draft financial institution metrics based in part on the feedback received on this paper and on progress by TNFD knowledge partners and members of the Nature-related Data Catalyst. The TNFD may also develop additional guidance on footprinting approaches using the six-step approach in this paper, based on market demand and feedback received.

# Preamble

The TNFD developed this discussion paper in partnership with the Partnership for Biodiversity Accounting Financials (PBAF). It builds on the significant work on biodiversity footprinting by PBAF, the Align project, the Finance for Biodiversity Foundation and others to help companies and financial institutions make informed decisions on where to start and the approaches to use as they navigate the area of biodiversity footprinting.

This discussion paper reflects insights collected from the Nature-related Data Catalyst, established by the TNFD. Data Catalyst participants include nature-related data, analysis and tool providers that are supporting the development and adoption of the TNFD framework. The Data Catalyst was launched after the release of v0.3 of the TNFD beta framework to help address nature-related data issues facing all end users. The comments of participants in the Data Catalyst on biodiversity footprinting approaches are reflected in this discussion paper. The Nature-related Data Catalyst is convened by the TNFD and facilitated by PwC, a TNFD member organisation, which also helped the TNFD to prepare this discussion paper.

# 1. Introduction

## 1.1. Background

In recent years, the finance industry has seen the introduction of greenhouse gas (GHG) emissions accounting as a necessary tool to help financial institutions assess: their contribution to climate change; the alignment of their capital portfolios to the global goals of the Paris Agreement; and the risks of climate change to their business model. The link between GHG emissions and climate change is direct, and aggregated reporting of emissions of the various GHGs is achieved using the carbon dioxide-equivalent metric ($CO_2e$). This aggregates the emissions of each gas, weighted by their global warming potential relative to carbon dioxide.

While climate reporting is focused on a handful of gases and benefits from the universal acceptance of a single unit of measurement, assessing impacts and risks in relation to other aspects of nature is more complex. The other aspects of nature – across the realms of land, freshwater, ocean and atmosphere – cannot be measured by a single, common unit of measurement. Unlike the relatively straightforward GHG assessments, the effects of financial activities on nature involve multifaceted and intertwined elements, which resist simplification into one standardised unit of measurement.

As financial institutions aim to understand, manage and report their impacts on nature – through financed, facilitated, insured and investment activities – the concept of a 'biodiversity footprint' has gained traction as a potential solution. Biodiversity footprint approaches seek to simplify and clarify the environmental impact of these activities. Financial institutions are seen as a particularly important potential user of these approaches given the complexity of their assessment task across portfolios, assets classes, sectors and geographies.[1]

While there is interest in biodiversity footprinting among scientific, data and user communities (including financial institutions), the TNFD is also hearing a growing recognition that biodiversity footprinting might be applied too simplistically. Overly reductive applications could lead to misconceptions among financial institutions that use biodiversity footprinting methodologies to support internal assessment of their nature-related issues, aligned to the recommendations of the TNFD, and/or misrepresentation of their meaning to end users of sustainability reports about an organisation's impacts on biodiversity.

There are a growing variety of biodiversity footprinting methodologies available, with significant innovations. Nevertheless, the lack of standardisation and transparency in defining what constitutes a footprint is a considerable challenge. PBAF has taken an important step towards standardisation and transparency with the publication of the 2022 PBAF Standard on Biodiversity footprinting, but there is still a lot of ground to be covered. The path forward requires a consensus on fundamental definitions and a commitment to clear and transparent methodologies.

Although these challenges associated with biodiversity footprinting exist, there are significant risks for financial institutions that do not start to understand and report impacts on nature. Financial institutions can use the footprinting approaches currently available, even if they do not provide a perfect solution.

1 This discussion paper primarily focuses on financial institutions, but the principles discussed here also extend to companies across various sectors.

For financial institutions that are new to the topic of biodiversity footprinting and biodiversity impact assessment more generally and would like to gain a better understanding of what it means and how it can be used, the Partnership for Biodiversity Accounting Financials (PBAF) provides introductory information. The PBAF Q&A document Introduction to biodiversity impact assessment may be particularly helpful.

### 1.2. TNFD's measurement architecture

In recognition of the challenges in measuring and reporting nature-related issues in the absence of an accounting standard equivalent to the GHG Protocol, the TNFD has spent the past two years developing a set of leading indicators with knowledge partners and market participants that sits at the heart of the measurement architecture for the TNFD's recommended disclosures. In doing so, the TNFD built on existing standards and initiatives, including:

- The indicator framework of the Kunming-Montreal Global Biodiversity Framework;
- The UN System of Environmental-Economic Accounting – Ecosystem Accounting;
- Widely accepted measures of nature and biodiversity loss developed by leading statistics, science and conservation organisations such as the UN Statistics Division and IUCN;
- The Science Based Targets Network (SBTN) methods;
- Existing corporate sustainability standards, including those of the GRI and the International Sustainability Standards Board (including SASB standards); and
- PBAF and CDP questionnaires.

The TNFD's metrics approach includes different categories of metrics for disclosure:

- A small set of core global metrics that apply to all sectors and core sector metrics for each sector to be disclosed on a comply or explain basis; and
- A larger set of additional metrics, which are recommended for disclosure, where relevant, to best represent an organisation's material nature-related issues.

Financial institutions adopting the TNFD recommendations are expected to disclose, on a comply or explain basis, the five core global risk and opportunity disclosure metrics. Considering the current data limitations that financial institutions face when reporting the TNFD core global metrics for their portfolios, the Taskforce has proposed an adaptation of the TNFD disclosure metrics architecture for financial institutions. When data limitations apply, the financial institution-specific impact and dependency metrics are:

- Exposure to a defined set of sectors considered to have material nature-related dependencies and impacts (in absolute amount or percentage of lending volume); and
- Exposure to companies with activities in sensitive locations (in absolute amount or percentage of lending volume).

Financial institutions are also expected to disclose the nine core global dependency and impact disclosure metrics for their portfolios and direct operations where possible and material.

Recognising that footprint metrics may be relevant for financial institutions, given their potential to aggregate across different impact drivers in different industries using a common unit of measure, the TNFD additional disclosure metrics for financial institution include biodiversity footprint metrics. The TNFD additional guidance for financial institutions notes that it is important for financial institutions using biodiversity footprint metrics to consider:

- The specific scope of these metrics;
- The difference between modelled impacts and actual impacts that may deviate or require further analysis; and
- That not all impact drivers may accurately be covered by existing footprinting approaches.

### 1.3. Objectives and outline of discussion paper

Through this discussion paper, the TNFD aims to:

- Inform the ongoing development of the TNFD's measurement architecture, including the TNFD's metrics for financial institutions, which were presented in draft in the TNFD additional guidance for financial institutions;
- Assess the decision utility of biodiversity footprinting methodologies, including helping market participants understand the decisions such methodologies can or cannot inform, where to start, and which approaches to use;
- Present draft guidance on biodiversity footprinting approaches for market feedback that could form future TNFD guidance on best practice using these methodologies; and
- Stimulate further innovation by developers and data providers in nature-related methodologies, tools and analytics services by highlighting areas of development for footprinting approaches.

To achieve these objectives, this paper:

- Presents a definition of biodiversity footprinting;
- Provides an overview of the current landscape of footprinting approaches;
- Summarises the limitations of existing approaches to footprinting; and
- Sets out six steps to help market participants select and disclose biodiversity footprinting approaches appropriate for their requirements.

The overview of the biodiversity footprinting landscape provided in this paper is non-exhaustive, but is intended to prompt further input from, and discussion with, market participants. Feedback from this discussion paper will serve as a useful input into the ongoing work of the Taskforce, including the Nature-related Data Catalyst established by the TNFD in August 2022 to help address nature-related data shortcomings facing end users, such as financial institutions. The TNFD's ultimate objective is to monitor and encourage further innovation in biodiversity footprint methodologies and tools and to evaluate how they can be incorporated into future updates to the TNFD's measurement architecture for the assessment, management and reporting of nature-related issues.

Further detailed information is provided in the following annexes:

- Annex 1 includes a shortlist of existing biodiversity footprinting approaches;
- Annex 2 includes a list of stand-alone databases;
- Annex 3 includes a list of stand-alone pressure–impact models;
- Annex 4 describes the methodology used to identify and collate the shortlist for inclusion in this paper; and
- Annex 5 includes a list of reference materials used to inform this paper and identify existing biodiversity footprinting approaches.

## 1.4. Open for consultation

As part of its ongoing open innovation approach, the TNFD welcomes feedback on this discussion paper from market participants, data, tool and metrics providers and other stakeholders. The Taskforce will update its draft financial institution metrics, based on the feedback received on this paper, wider consultation and progress by TNFD knowledge partners and members of the Data Catalyst. The TNFD may also develop additional guidance on footprinting approaches using the six-step approach in this paper, based on market demand and feedback received.

Comments can be provided to the Taskforce until 29 March 2024 through its website.

**Feedback questions on the proposed biodiversity footprinting approaches**

- Has this discussion paper improved your understanding of the intent, limitations and appropriate interpretation of different biodiversity footprinting approaches?
- Do you find the suggested steps for selecting biodiversity footprinting approaches useful?
- What additional guidance, if any, from the TNFD on biodiversity footprinting methodologies and tools would be useful to you as you consider their relevance to your nature-related assessment and reporting activities?
- Do you agree with the overview of the limitations of biodiversity footprinting approaches? How could these limitations be addressed by methodology developers and data providers? As a user of these methodologies and tools, what more would you like to see from developers?
- Given the strengths and limitations of existing footprinting methodologies, should footprinting approaches be incorporated more centrally into the TNFD measurement architecture, and if so, how, and with what conditions or guidance, if any?

# 2. TNFD's approach to measuring the state of nature

There are different options for measuring the state of nature. The TNFD recommends ecosystem extent, ecosystem condition, species population size and species extinction risk as the key indicators to include.[2] The TNFD proposes that organisations use a dashboard of multiple indicators and metrics to capture the various dimensions of changes to the state of nature in an attempt to provide a more complete assessment. Examples of metrics that can be used to assess different components of the state of nature are listed in Table 1. Further details are provided in Annex 2 of the TNFD LEAP approach on measuring changes in the state of nature.

**Table 1: State of nature metrics[3]**

| State of nature category | State of nature indicator | Definition | Indicator / metric | What it measures |
|---|---|---|---|---|
| Ecosystem extent | Land/ freshwater/ ocean-use change | The area change of a particular ecosystem, usually measured in terms of spatial area | Total spatial footprint (TNFD core global indicator) | Total spatial footprint (km$^2$) (sum of):<br>• Total surface area controlled/managed by the organisation, where the organisation has control (km$^2$);<br>• Total disturbed area (km$^2$); and<br>• Total rehabilitated/restored area (km$^2$). |

2 Ecosystem condition and extent follow the UN System of Environmental-Economic Accounting Ecosystem Accounting. All these indicators follow the recommendations of the Align project.

3 This table summarises the state of nature indicators (at both species and ecosystem level) and their components (e.g. ecosystem condition) including any sub-components (e.g. chemical, physical etc.).

| State of nature category | State of nature indicator | Definition | Indicator / metric | What it measures |
|---|---|---|---|---|
| Ecosystem extent | Land/ freshwater/ ocean-use change | The area change of a particular ecosystem, usually measured in terms of spatial area | Extent of land/ freshwater/ ocean-use change (TNFD core global indicator) | Extent of land/freshwater/ocean ecosystem use change ($km^2$) by:<br>• Type of ecosystem; and<br>• Type of business activity.<br>Extent of land/freshwater/ocean ecosystem conserved or restored ($km^2$), split into:<br>• Voluntary; and<br>• Required by statutes or regulations.<br>Extent of land/freshwater/ocean ecosystem that is sustainably managed ($km^2$) by:<br>• Type of ecosystem; and<br>• Type of business activity. |
| Ecosystem condition (TNFD placeholder core global indicator)[4] | Compositional state | The composition/ diversity of ecological communities at a given time/location<br>Best practice metrics should consider changes in the composition of species, regardless of their rarity, threat status or value, compared to an intact reference state | Mean Species Abundance (MSA) | MSA estimates ecosystem condition (i.e. intactness) as a function of select anthropogenic pressures on terrestrial and freshwater ecosystems. It measures condition in terms of the average abundance of species in selected groups compared to a natural reference state. |

4 United Nations et al. (2021) System of Environmental-Economic Accounting – Ecosystem Accounting.

| State of nature category | State of nature indicator | Definition | Indicator / metric | What it measures |
|---|---|---|---|---|
| Ecosystem condition | Functional state | Summarises the biological, chemical and physical interactions between ecosystem components | Potentially Disappeared Fraction of Species (PDF) | PDF of species is a metric developed for life cycle impact assessments (LCA) as a measure of local loss of ecosystem condition caused by specific anthropogenic pressures.<br><br>While PDF is often considered an ecosystem metric, some applications of it are actually more closely related to measures of species extinction risk. |
| | Landscape and seascape characteristic | Describe the spatial scales of ecosystems (e.g. landscape diversity, connectivity, fragmentation) | Proportion of Land Degraded (PLD) | PLD is a composite metric of complementary, non-additive sub-indices: land cover class change, land productivity and carbon stocks. The output of the method produces a binary classification of degraded or not degraded. The metric is designed so that countries can use their own definition of degraded and their own datasets. It has been calculated globally and for a subset of regions and continents. |
| | | | Keystone species | Measure changes to populations of priority identified species (keystone species) that have an impact on an ecosystem disproportionate to their abundance. Keystone species have low functional redundancy; therefore the presence of keystone species can be used to indicate functional state. |

| State of nature category | State of nature indicator | Definition | Indicator / metric | What it measures |
|---|---|---|---|---|
| Ecosystem condition | Structural state<br><br>Contribution to extinction risk | Aggregate properties, including physical (e.g. water availability) and chemical (e.g. air pollutant concentrations) of the whole ecosystem or its main biotic components (e.g. total biomass, canopy coverage)<br><br>Estimates how different activities at a location may drive species extinctions globally | Forest Structural Condition Index | Available for the humid tropics, the Forest Structural Condition Index (FSCI) combines data on forest extent with data on forest structure (canopy height) and measures of previous forest loss to estimate the structural condition of forests across the tropics.<br><br>Building on this dataset, the Forest Structural Integrity Index (FSII) adds to this metric information on human pressures. This allows structurally complex habitats with low human pressure to be identified. |
| Species extinction risk (TNFD placeholder core global indicator) | Contribution to extinction risk | Estimates how different activities at a location may drive species extinctions globally | Species Threat and Restoration Metric (STAR) | STAR allows quantification of the potential contribution to species threat, abatement and restoration activities towards reducing extinction risk across the world. |
| | Structural state | Aggregate properties (e.g. mass, density) of the whole ecosystem or its main biotic components (e.g. total biomass, canopy coverage) | Global Extinction Probability (GEP) | GEP is a scaling factor that adjusts the PDF estimates of localised impacts to estimate global extinction risk. It uses species range sizes, global status on the Red List and species richness to indicate the extent that localised impacts may contribute to global species extinction risk. |

| State of nature category | State of nature indicator | Definition | Indicator / metric | What it measures |
|---|---|---|---|---|
| Ecosystem condition | Physical state | Physical descriptors of the abiotic components of the ecosystem (e.g. soil structure, water availability) | Persistence Score (PS) | Uses species-specific habitat suitability models to link land-use changes with changes in the likelihood that species populations will persist (i.e. not become extinct), based on maps of current Area of Habitat compared to historical Area of Habitat, and summed across species. Limited to terrestrial realm and fully assessed species groups with mapped Areas of Habitat. |
| Species population size (TNFD additional disclosure indicator) | Number of individuals in a species | Measures the number of individuals of a species of interest in a specific area | Occurrences | This data can be collected through use of eDNA, bioacoustics, surveys and other 'on the ground' data collection methods.<br><br>IUCN Red List of threatened species lists the occurrences of species using a system for classifying species in terms of extinction risk. It divides species into nine categories: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct. |

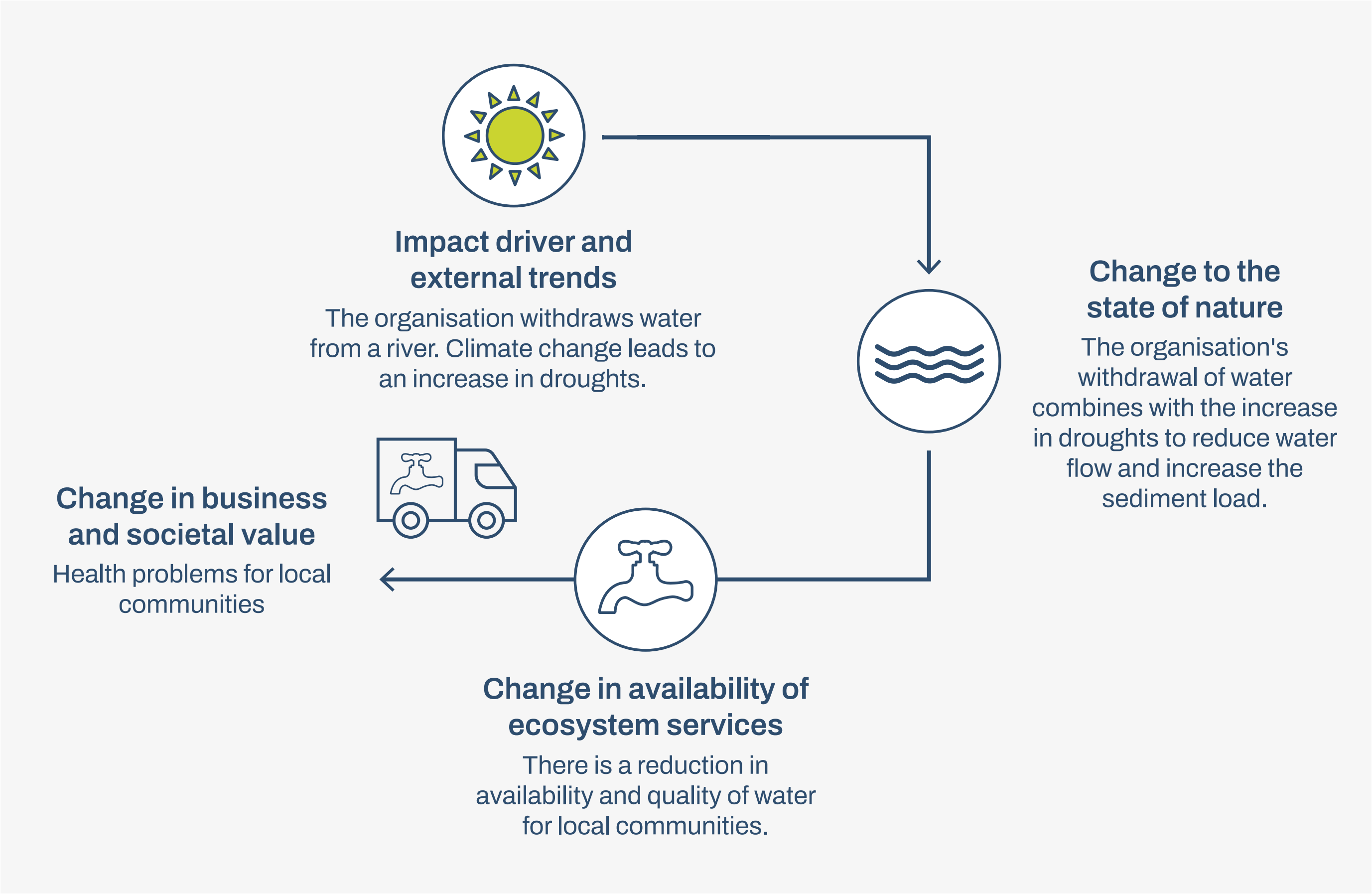
Metrics and indicators can be confused. The TNFD defines a metric as *'a system or standard of measurement'* and an indicator as 'a quantitative or qualitative factor or variable that provides a simple and reliable means to measure performance'.

The TNFD does not currently specify one metric to use for the state of nature as there is no single metric that will capture all relevant dimensions of changes to the state of nature and a consensus is still developing. Each metric can provide valuable information for specific purposes and in specific contexts. The TNFD recommends using multiple metrics that complement each other to address the limitations of individual metrics. For example, using a biodiversity footprinting approach that measures ecosystem condition together with another approach that measures species extinction risk would be considered complementary, and by capturing different aspects of nature, offer a more comprehensive view of nature impacts.

# 3. The role of footprinting

Footprinting aims to collapse the complex relationships between impact drivers and the state of nature – represented as impact pathways (Figure 1) – in a single metric.

**Figure 1: Example of an impact pathway**




Footprint metrics are particularly attractive to financial institutions given the scale and complexity of their capital allocation portfolios. Footprinting metrics present the opportunity to assess the state of nature in a way that works around the practical difficulties of measuring changes in the state of nature, including the complexity and cost of collecting *in situ* state of nature data for every location in every client's entire value chain.

Footprinting allows impact on nature to be calculated using site-level data (or existing databases when site-level data is not possible or feasible) and then aggregated to be expressed in a standardised output. The result is a measure of biodiversity impact, expressed as a metric, that can be interpreted and contextualised.

Despite its appeal, there is not yet a single, universally agreed definition or methodology for biodiversity footprinting. Biodiversity footprinting has various definitions and meanings depending on the specific context and purpose of the assessment. For example, the Partnership for Biodiversity Accounting Financials (PBAF) defines a biodiversity footprint as the 'quantified impact of a portfolio, asset class, project or company measured in terms of biodiversity change as a result of production and consumption of particular goods and services'.[5] PBAF adapted this definition from the Institute for European Environmental Policy (IEEP) definition to specify the importance of a quantified impact. The lack of consensus on the definition of biodiversity footprinting creates ambiguity for those trying to understand the landscape.

Second, and perhaps more importantly, biodiversity footprints are just one way to provide decision useful insight into an organisation's interface with nature. Ecological and ecosystem service footprints can also provide insight into this relationship and can feed into or complement biodiversity footprints.

In this broader context, this discussion paper refers to the definitions of different types of footprints provided by the IEEP:

- **Ecological (area-based) footprints:** The impact on the environment, expressed as the amount of land with a global average yield required to sustain the use of natural resources. Ecological footprints can measure land degradation, resource depletion and carbon, and are often used as part of a biodiversity footprint.
- **Biodiversity footprints:** The impact on global biodiversity, measured in terms of biodiversity change, as a result of production and consumption of particular goods and services. Most current methods tend to use a combination of land/freshwater/ocean use change (i.e. ecological footprint) and impact drivers (e.g. nitrogen and phosphorus in rivers).
- **Ecosystem service footprints:** The impact measured by calculating the effects that particular goods and services have on the provision of the benefits (or ecosystem services[6]) nature provides (i.e. how activities are potentially affecting ecosystem services). Footprints for individual ecosystem services can also be assessed, particularly carbon and water, but some services such as cultural ecosystem services do not lend themselves to footprint assessment.[6]

As outlined above, these different types of footprints should be set in the context of all the indicators, metrics, data, analytical tools and methods in the TNFD's recommendations, additional guidance and Tools Catalogue. The TNFD's additional guidance provides a wider set of indicators and metrics that can provide useful insights on an organisation's nature-related dependencies, impacts, risks and opportunities, and its responses to those issues, as outlined in the TNFD recommendations and guidance on the LEAP approach.

The most important takeaway is that a biodiversity footprint is an indirect measurement or proxy for the likely actual impact on biodiversity, with biodiversity itself being a proxy for the actual impact on nature as a whole. This holds true for even the highest quality input data, such as direct or site-level measurement data. Therefore, it is critical to understand what different approaches to biodiversity footprinting aim to measure and how to contextualise the results. The first step is to learn what biodiversity footprinting is and what approaches exist today.

5 PBAF (2022) Taking Biodiversity into account, PBAF Standard v2022 - Biodiversity impact assessment - Footprinting.

6 IEEP (2021) Biodiversity footprints in policy and decision-making: Briefing on the state of play, needs and opportunities and future directions.

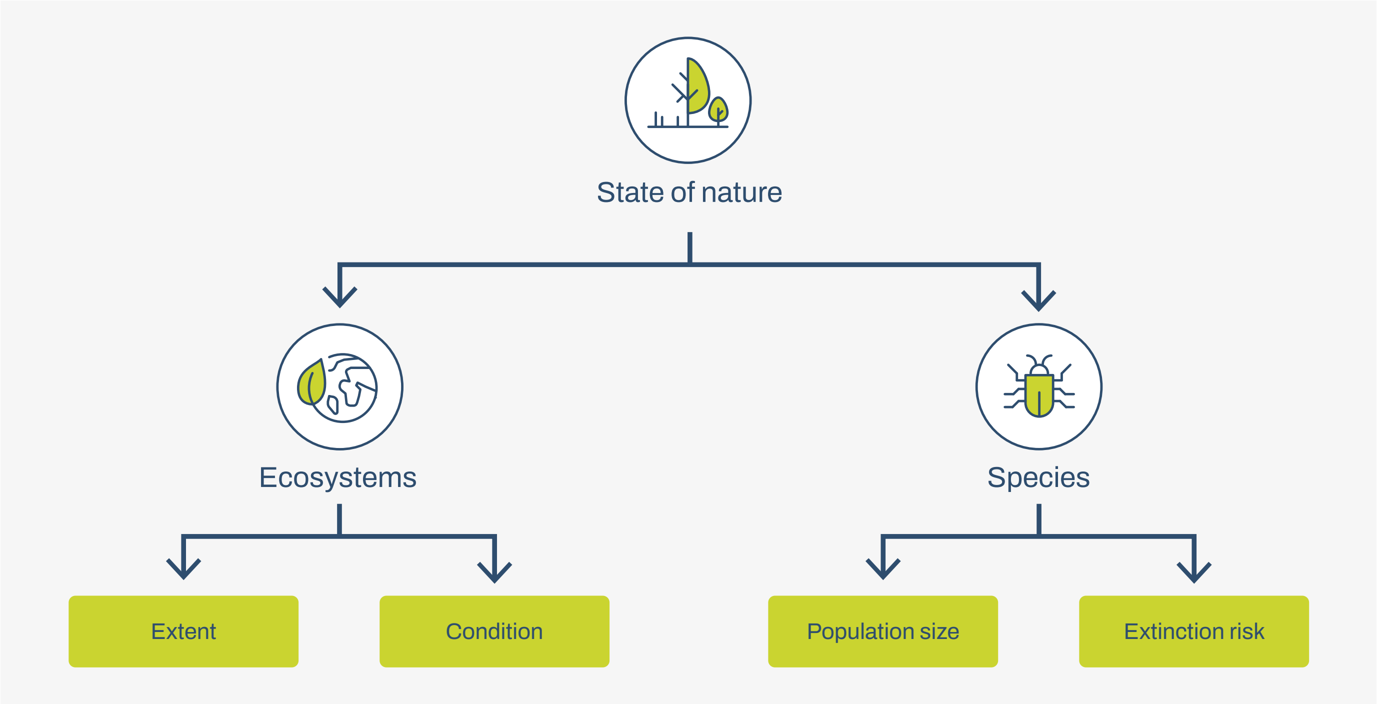
## 3.1. Biodiversity footprinting approaches

Financial institutions will use different approaches to biodiversity footprinting depending on what they are trying to achieve. Biodiversity footprints can be used to measure changes to the state of nature (following the Evaluate phase of the TNFD's LEAP approach) and to disclose changes to the state of nature when reporting material impacts and dependencies (following the TNFD recommendations). The state of nature, as defined by the TNFD, includes the condition and extent of ecosystems and species population size and extinction risk (see Figure 1). Changes to the state of nature can include both positive and negative changes. Following the dependency and impact pathway approach outlined in the Evaluate phase of LEAP, it is important for organisations to measure changes to the state of nature as part of any assessment of their dependencies and impacts. To evaluate both dependencies and impacts, as described in the Evaluate phase of LEAP, biodiversity footprints should be considered in conjunction with ecosystem service footprints.

As illustrated in Figure 2, measuring changes to the state of nature requires the assessment of:

1. Changes to ecosystem condition[7] and the extent of ecosystem assets on which the organisation has a dependency or impact; and
2. Changes to species population size and extinction risk within the ecosystem assets on which the organisation has a dependency or impact.

**Figure 2: Components of state of nature measurement**



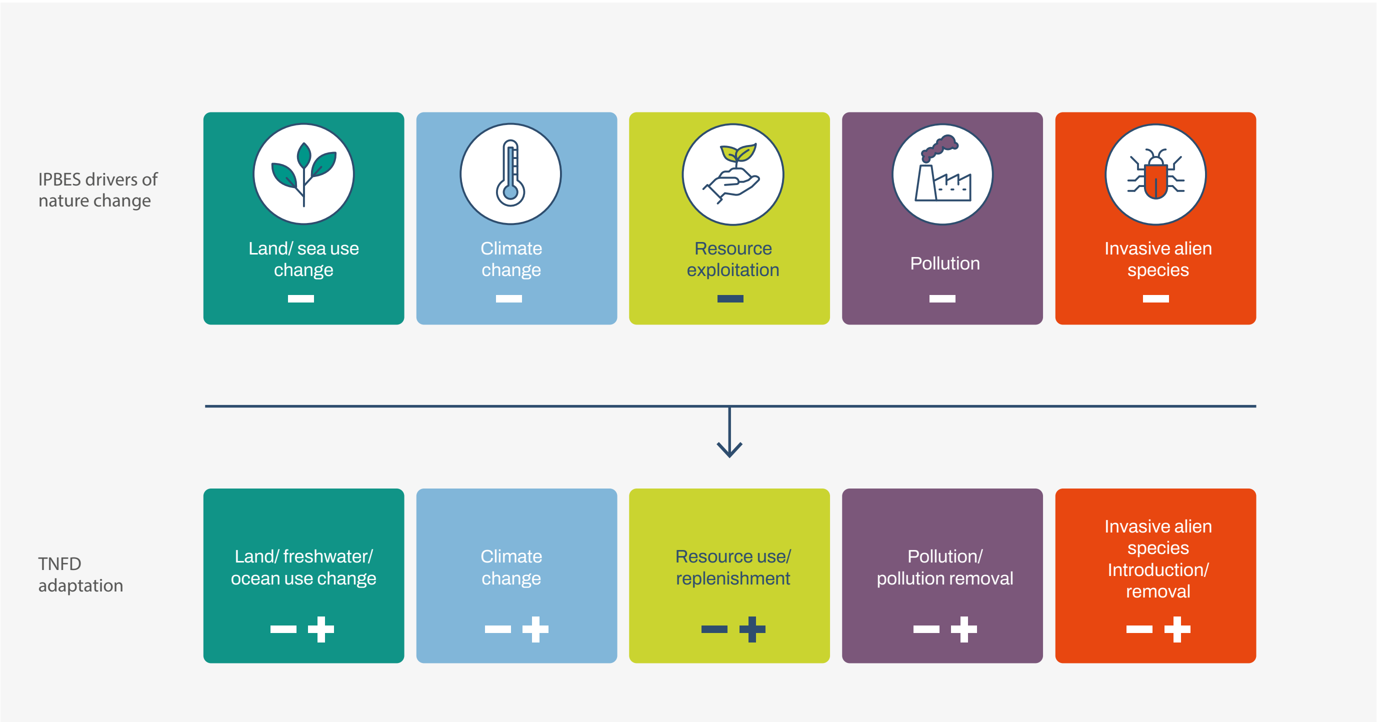

7 The contributions of ecosystems to the benefits that are used in economic and other human activity. United Nations et al. (2021) System of Environmental-Economic Accounting – Ecosystem Accounting.

Having a clear understanding of why a biodiversity footprint is needed will enable organisations to select the right footprinting approach for its needs. Section 4.1 provides more details on defining the purpose of a biodiversity footprint.

There are many potential combinations of tools, methodologies, databases (corporate, private and public), and pressure–impact models that can provide a biodiversity footprint. For example, some biodiversity footprinting approaches utilise the data from specific databases in their methodology to assess biodiversity impacts. However, some stand-alone biodiversity databases would not be considered an approach by themselves because they do not calculate a footprint or assess impact. This paper only includes existing approaches to biodiversity footprinting that have been identified in the reference materials in Annex 5.

Pressure–impact models are often used to assess environmental pressures/impact drivers and obtain an output of the impact on biodiversity (and/or human health, and potentially other factors). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) identifies the five drivers of nature change as land/sea use change, climate change, resource exploitation, pollution and invasive alien species. As illustrated in Figure 3, the TNFD has adapted the five drivers of nature change from IPBES to reflect drivers of both positive and negative impacts on nature.

**Figure 3: The drivers of nature change**



## 3.2. Limitations of biodiversity footprinting approaches

Existing approaches to biodiversity footprinting have varying limitations that affect their use and the conclusions that can be drawn from their outputs. These limitations present challenges to financial institutions trying to select or use an approach. A summary of the key common limitations follows in this section, beginning with Table 2. A description of the limitations of specific footprinting approaches is outlined in Annex 1.

**Table 2: Overview of key limitations of the biodiversity footprinting approaches listed in Annex 1 and the resulting implications**

| Limitation category | Limitation | Description of limitation | Implication |
|---|---|---|---|
| Technical capability | Lack of spatial resolution and location-specificity | When input data is lacking in spatial resolution the output also lacks resolution. There can also be a lack of location-specific considerations in the output metrics (e.g. metrics that give the same scores to impacts in areas with low and high biodiversity significance). | This can limit a financial institution's ability to infer locally specific mitigation activities or account for local realities.<br><br>A lack of specificity can also mean the output metrics are conservation-agnostic, resulting in impact scores that do not reflect the relative significance of biodiversity between areas. |
| | Lack of temporal specificity | Biodiversity footprinting data has not been tracked or disclosed by organisations in the past, resulting in a lack of historical data. | This can limit an organisation's ability to track progress or monitor change since there is a lack of baseline data to compare results to. |

| Limitation category | Limitation | Description of limitation | Implication |
|---|---|---|---|
| Technical capability | Narrow scope of Essential Biodiversity Variables (EBVs) assessed | EBVs can be used to identify indicators for biodiversity that reflect responses.[8] The EBV class 'community composition', which measures multiple species within an ecosystem (rather than the number of individuals within a single species), is most commonly used in footprinting approaches.[9]<br><br>Other EBV classes include:<br>• Ecosystem functioning;<br>• Ecosystem structure;<br>• Species population;<br>• Species traits; and<br>• Genetic composition. | Given the strong focus of biodiversity metrics on community composition, other EBV classes are often not captured, and thus overlooked, in the analysis of an ecosystem's biodiversity.<br><br>Most metrics also only relate to one EBV, restricting the scope of impact an organisation is able to capture, resulting in footprinting approaches that use those metrics having limited applicability. |
| | Narrow scope of impact drivers assessed | The most common impact driver assessed during biodiversity footprinting is land use in terrestrial ecosystems. Other impact drivers are often not incorporated or considered, due to difficulty in measurement. Common impact drivers that can affect ecosystems, but are not often covered in footprinting assessments, include invasive alien species, overexploitation of species and aquatic ecosystem use. | This can severely limit the applicability of a footprinting approach across a financial institution's portfolio, especially in cases where land use alone would provide an incomplete view of relevant impact drivers. |

8 GEO BON (no date) Essential Biodiversity Variables.

9 UNEP-WCMC et al. (2022) Recommendations for a standard on corporate biodiversity measurement and valuation.

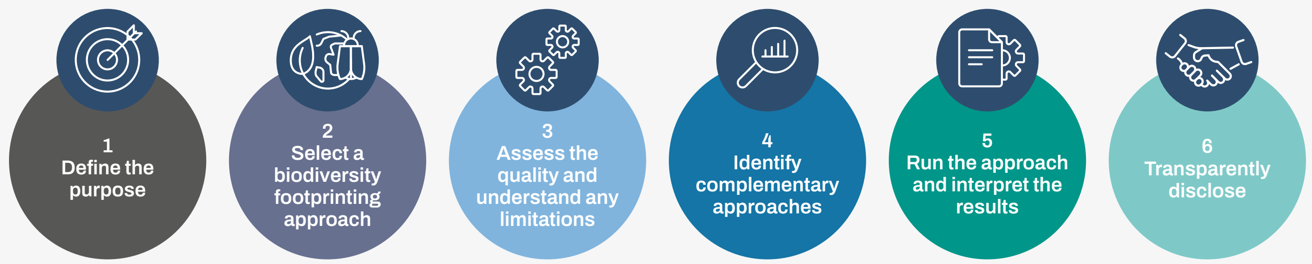
| Limitation category | Limitation | Description of limitation | Implication |
|---|---|---|---|
| Technical capability | Narrow scope of taxonomic groups included | The taxonomic groups most frequently included in footprinting assessments are mammals, birds, amphibians, reptiles and plants. Taxonomic groups that are either less understood or more challenging to measure, but that are strong indicators of biodiversity and ecological function are often underrepresented. For example, invertebrate groups associated with specific ecosystem services, such as pollinators and soil biodiversity, are often excluded due to a lack of data. | A strong focus on some taxa over others results in the exclusion of taxa, including those that deliver or support important ecosystem services from analysis. |
| Consensus | Lack of consensus over which metrics to use | Metrics in this case refer to the output metrics (or results) of the footprinting approach. These metrics are used as proxies for the impact an organisation is having on biodiversity. | Without broad consensus on which metrics are best for use by financial institutions, a variety of different output metrics of footprinting could be disclosed without appropriate consideration of the limitations/gaps in the assessment. |

| Limitation category | Limitation | Description of limitation | Implication |
|---|---|---|---|
| Consistency | Lack of reference states | Footprinting assessments often incorporate the use of a reference state, but how this is presented can vary depending on the approach used (e.g. naturalness, potential natural vegetation, pristine undisturbed state). Or dramatically different scenarios can be represented (e.g. reflecting the state of a natural ecosystem before human perturbation vs before additional human perturbation after a reference year). | This inconsistency in reference states can lead to difficulty comparing reference states across different approaches and combining outputs to infer a full assessment of biodiversity impact. It can also present challenges when comparing results across organisations. |
| Capacity | Limited biodiversity capacity in financial institutions | Different biodiversity footprinting assessments vary greatly in price, but usually require considerable investment. Common costs include gathering primary data (e.g. surveys), hiring external expertise, costs associated with license fees and purchasing data. | The costs and resources required to complete a footprinting assessment may outstrip the capacity of a financial institution in the short term. This may limit the ability of financial institutions to perform comprehensive biodiversity footprinting exercises. |
| Contextualisation | Lack of translation of the outputs of footprinting approaches into strategic business insights | A translation of the outputs of footprinting approaches into strategic business insights, such as real and potential dependencies, impacts, risks and opportunities, is a critical gap identified in the footprinting approaches that are currently available. | Without this translation, the insights generated by biodiversity footprinting approaches cannot be incorporated into a financial institution's investment and business strategies and decisions. This limits the usefulness of footprinting to disclosures and makes it less useful for meaningful and effective action. |

# 4. Steps to select and disclose a biodiversity footprinting approach

Six steps have been identified to support financial institutions as they navigate how to use biodiversity footprinting (Figure 4).

**Figure 4: Steps to select and disclose a biodiversity footprinting approach**




## 4.1. Define the purpose

### Guiding questions

- What question are you trying to answer with footprinting?
- Which phase and component of the TNFD LEAP approach are you trying to inform? On which TNFD recommended disclosures are you aiming to report?
- What should the scope of the approach be?

**Footprinting can be used for various use cases, such as:**

- High-level assessments of impact (e.g. high impact sectors/funds/companies/assets);
- Conducting impact materiality assessments;
- Understanding effectiveness of different risk mitigation strategies;
- Assessing and tracking potential biodiversity loss/gain year on year; and
- Informing investment strategies and decisions.

Footprinting could be used to inform some of the components of LEAP when conducting a LEAP assessment, depending on the context and specific purpose(s). Footprinting could be useful to:

- Generate working hypotheses in the scoping phase, such as where there are likely to be material nature-related dependencies, impacts, risks and opportunities;
- Inform L2 in the Locate phase to see which sectors, value chains and direct operations are associated with potentially moderate and high impacts and dependencies on nature (e.g. mapping the impact of lending operations);
- Inform E3 and E4 in the Evaluate phase to understand where material impacts exist;
- Translate impacts and dependencies into risks and opportunities in the Assess phase and assess mitigation measures; and/or
- Set targets and track performance in P2 of the Prepare phase.

### Figure 4: Where footprinting can be used in the TNFD LEAP approach

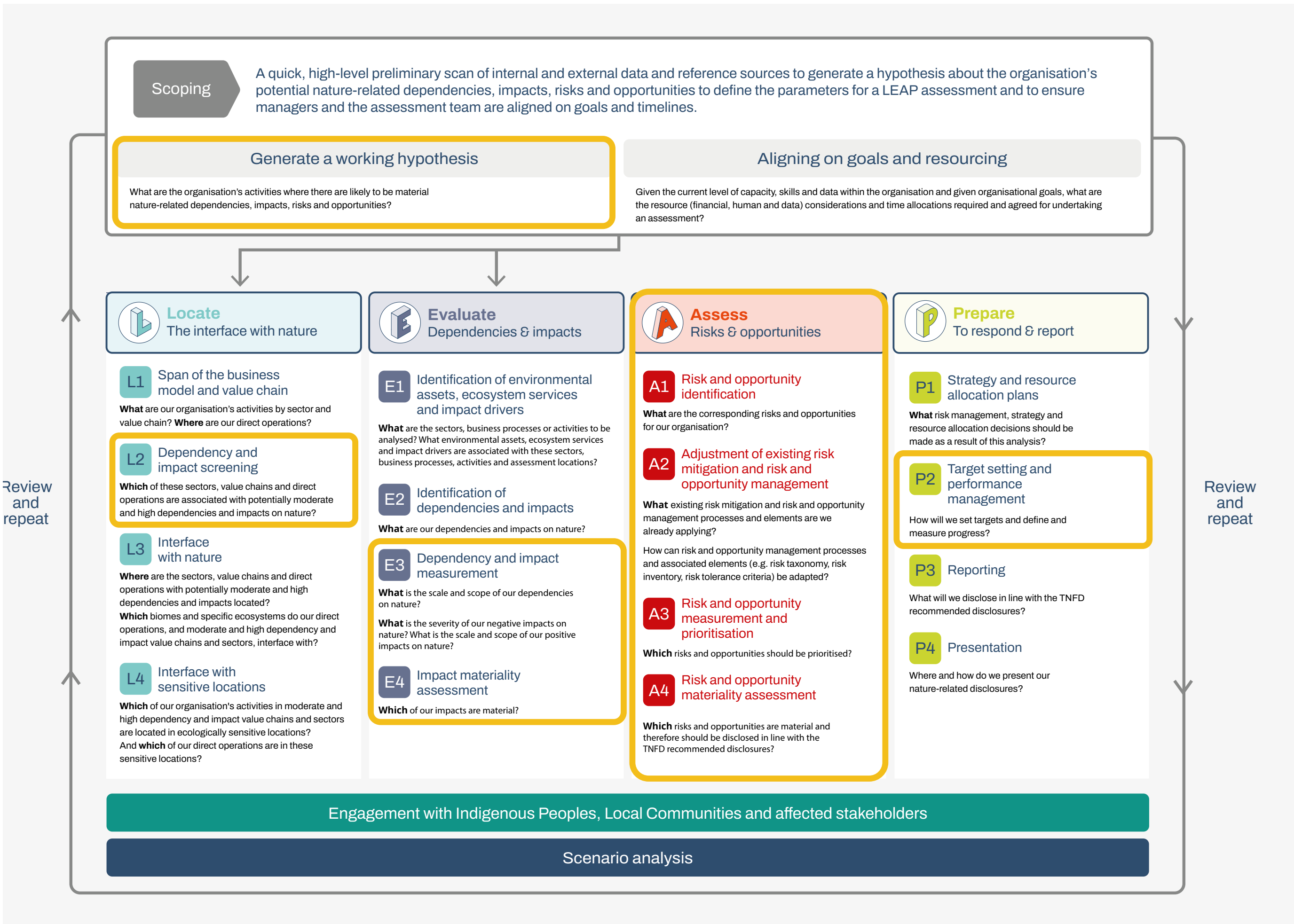


Table 3 provides some examples of how financial institutions have used biodiversity footprinting for different purposes, the relevant phase of LEAP and the hypothetical next steps.

Before beginning a biodiversity footprinting assessment, a scoping exercise is recommended. Scoping can help to define the parameters for a biodiversity footprinting assessment and to ensure managers and the assessment team are aligned on goals and timelines. The TNFD's LEAP approach provides scoping guidance and defines scoping as a quick, high-level preliminary scan of internal and external data and reference sources to generate a hypothesis about an organisation's potential nature-related issues.

**Table 3: Examples of how financial institutions using footprinting approaches**

| Purpose(s) | Phase of LEAP | Case study | Footprinting approach used | Pressure-impact methodology used | Metric(s) used | Hypothetical next steps |
|---|---|---|---|---|---|---|
| Conducting impact materiality assessment to identify the most material aggregated impacts within a portfolio/asset type/sector | E4 | Formue and UBS | GIST Impact | LC-IMPACT and EXIOBASE | MSA (0-100) | Identified material impact drivers could be further explored and inform strategies to reduce impacts as well as mitigate potential risks |
| Measuring how different risk mitigation activities affect Potentially Disappeared Fraction (PDF) | A2 | | | | PDF (0-1) | Inform which risk mitigation actions are most effective and should be prioritised in resource allocation planning |
| Assessing and tracking financial impact year on year | P2 | | | | Natural Capital Impact ($m) | Inform target setting and inform investors of progress |

| Purpose(s) | Phase of LEAP | Case study | Footprinting approach used | Pressure-impact methodology used | Metric(s) used | Hypothetical next steps |
|---|---|---|---|---|---|---|
| Understanding which funds have higher potential impacts on biodiversity | A4 | ASN Bank[10] | Biodiversity Footprint for FIs (BFFI) | ReCiPe and EXIOBASE | PDF ($m^2$ per $ invested) | Inform investment strategies e.g. new policies |
| Understanding which impact drivers are driving biodiversity loss | E4 | | | | PDF (impact per invested euro) | Material impact drivers could be explored and inform strategies to reduce impacts as well as potential risks |
| Comparing biodiversity footprint annually to measure progress | P2 | | | | PDF (total $m^2$) | Inform target setting and inform investors of progress |

10 ASN Bank (2022) ASN Bank Biodiveristy Footprint.

| Purpose(s) | Phase of LEAP | Case study | Footprinting approach used | Pressure-impact methodology used | Metric(s) used | Hypothetical next steps |
|---|---|---|---|---|---|---|
| Calculating the biodiversity footprint of a financial asset portfolio to measure progress | P2 | La Banque Postale[11] | Global Biodiversity Score for FIs (GBS-FI/ GBS-BIA) | GLOBIO and EXIOBASE | MSA (MSA/ $km^2$) | Inform target setting and inform investors of progress |
| Comparing the extent of biodiversity impact of various asset types (depending on underlying asset type and data e.g. equity and corporate bonds use Biodiversity Impact Analytics (BIA) while other asset types need corporate/third party data) | A4 | | | | MSA (MSA/ $m^2$ per invested euro) | Inform investment decisions and due diligence processes |

11 La Poste Groupe (2022) Commitment to preserving biodiversity.

| Purpose(s) | Phase of LEAP | Case study | Footprinting approach used | Pressure-impact methodology used | Metric(s) used | Hypothetical next steps |
|---|---|---|---|---|---|---|
| Assessing companies' impact on biodiversity and comparing any individual incremental impact | E3 | Ossiam's 'Food for Biodiversity ETF' | Corporate Biodiversity Footprint | Iceberg Data Lab's Environmentally Extended Input Output tables (EEI/O) | MSA (MSA/km²) | Material impact drivers could be explored and inform strategies to reduce impacts as well as potential risks e.g. to mobilise capital and engage corporates[12] |
| Benchmarking at corporate/ asset level (equity, bonds, corporate loans, real assets, commodities, project finance etc.) and financial portfolios (by comparing issuers within sectors)[13] | A4 | | | | | Understand asset level/ portfolio level exposure to risk to inform investment strategies and decisions |

12 Finance for Biodiversity (2021) Guide on biodiversity measurement approaches.

13 Iceberg Data Lab (2021) Ossiam taps Iceberg Data Lab's biodiversity expertise in building "Food for Biodiversity" ETF.

| Purpose(s) | Phase of LEAP | Case study | Footprinting approach used | Pressure-impact methodology used | Metric(s) used | Hypothetical next steps |
|---|---|---|---|---|---|---|
| Measuring potential biodiversity gain for real asset investments | A1 | abrdn[14] | Biodiversity Intactness Index (BII) | PREDICTS | BII (%) | Prioritise the opportunities based upon which ones have the most positive impact on biodiversity |
| Measuring how different risk mitigation activities affect BII | A2 | | | | | Inform which risk mitigation actions are most effective and should be prioritised in resource allocation planning |
| Mapping the potential impact on biodiversity of lending operations | L2 | SMBC Group, UNEP-FI and MS&AD Insurance Group[15] | Integrated Biodiversity Assessment Tool (IBAT) | Eora | STAR (Numerical value or mapping with 'very low' to 'very high' rating) | Understand where material deforestation is occurring, highlighting priority locations for biodiversity strategy and action plans |
| Quantifying the impact of lending operations on forests and biodiversity and analysing the impact | E4 | | | | | Material impact drivers could be explored and inform strategies to reduce impacts as well as potential risks |

14 abrdn (2022) Measuring biodiversity and alignment to TNFD – a real asset perspective.

15 SMBC (2023) TNFD Report 2023.

## 4.2. Select a biodiversity footprinting approach

### Guiding questions

- Which approaches have outputs that will help you address your purpose?
- What relevant data is available to you?

Based on the purpose of the footprinting exercise, consider which footprinting approaches provide the output or results that will help you achieve that purpose. Some biodiversity footprinting approaches may perform differently in different environments, or may only be relevant at certain scales, so consider the specific ecosystem or location in which the biodiversity footprint is required. For example, if a biodiversity footprinting approach provides outputs based on a specific biome, you should make sure the area you are assessing for impact is located in that biome.

You should also consider the type of input data available. Finance for Biodiversity[16] describes the types of input data that biodiversity footprinting approaches can use:

- **Economic measures**: e.g. a company's turnover, raw material use or volumes of produced goods;
- **Biodiversity impact drivers**: e.g. a company's greenhouse gas emissions, resource use or area of land/marine/freshwater use change;
- **The state of nature**: e.g. the population size of a particular species; and
- **The state of ecosystem services**: e.g. a forest's carbon sink capacity.[17]

The Align project recommends considering the following factors when selecting a footprinting approach: spatial precision, accuracy, responsiveness to change and feasibility to apply at scale.[18]

> The Align project was established with the objective to co-develop recommendations for a standard on corporate biodiversity measurements and valuation. Align is a three-year project aimed at providing businesses and financial institutions with principles and criteria for biodiversity measurement and valuation. The Align project was funded by the European Commission and led by UNEP-WCMC, the Capitals Coalition, Arcadis and ICF, with the support of WCMC Europe.

16 Finance for Biodiversity (2022) Guide on biodiversity measurement approaches. Second edition.

17 This type of data is usually used for ecosystem service footprints. However, it can also serve as an indirect measure of biodiversity loss in some cases.

18 UNEP-WCMC et al. (2022) Recommendations for a standard on corporate biodiversity measurement and valuation.

Table 4: Methodology characteristics (Align project)

| Methodology characteristics | Definition | 'High' level of characteristic | 'Medium' level of characteristic | 'Low' level of characteristic |
|---|---|---|---|---|
| Spatial precision of state measurement | Refers to whether the resulting measure considers the geographic location of the activity and the biodiversity within the area. | Biodiversity state at specific location is measured. | Biodiversity state across a wider area than a specific location represented (e.g. ecoregion). | Biodiversity state measure has no spatial specificity (e.g. results are globally applicable). |
| Accuracy of measurement | Refers to how well the measurement reflects changes that are occurring on the ground. This should include both positive and negative changes resulting from all impact drivers.[19] | Measure estimates actual state change 'on the ground'. | Reflects on the ground changes but changes are not ground-truthed e.g. using company impact driver data, where possible, to cover numerous impact drivers. | Estimates state change based on impact drivers, e.g. using sector-average data or limiting the scope of impact drivers covered. |
| Responsiveness of measurement to mitigation | Refers to whether the approach produces a metric that can change over time in response to changes in company management interventions. | Metric responds to site-level mitigation interventions at the appropriate temporal scale. | Metric responds to broad-level reductions in impact drivers (e.g. reduced land intensity). | 'Snapshot' metric that does not reflect company management interventions but may change based on avoidance of areas. |
| Feasibility to apply at scale | Refers to the relative feasibility of applying the approach over: A) multiple sites within an organisation or B) across value chains or C) across portfolios of companies. | Able to be replicated across business activities rapidly and does not necessarily require location data. | Able to be applied rapidly at scale but requires location data. | Involves *in situ* data collection so often that it is unfeasible to apply at scale. |

19 All impact drivers should be considered, including positive and negative impacts. This wording has been added to all of Align's definitions of 'Accuracy of measurement' to ensure that all drivers are considered in financial institution assessments. PBAF (2022) Taking Biodiversity into account, PBAF Standard v2022 - Biodiversity impact assessment - Footprinting.

As an example of how the methodology characteristics in Table 4 can be used, a financial institution using footprinting to understand impacts across an investment portfolio should select a footprinting approach where the 'feasibility to apply at scale' is high. However, if an organisation wants to explore the potential impacts of a specific company within a specific sector of their portfolio, a footprinting approach with a high accuracy of measurement and 'spatial precision of measurement' might be more important than its 'feasibility to apply at scale'. A footprinting approach that scores high across all of the methodology characteristics in the Align approach is unlikely, given the current capabilities of existing approaches, and the conflicting requirements of 'accuracy of measurement' and 'feasibility to apply at scale'.

## 4.3. Assess the quality and understand any limitations

### Guiding questions

- What is the accuracy, scalability, spatial precision and scope of the approach, following the Align methodology?
- What potential gaps exist between the outputs and the information you are seeking?

The Align methodology can also help an organisation understand the limitations of selected footprinting approaches. For example, if a financial institution aims to use a site-level assessment with observed, user-derived data (such as bioacoustics data), the spatial precision, accuracy of measurement and responsiveness to mitigation would be considered high. However, it would be challenging for the organisation to collect this type of data across its portfolio, so the feasibility of it applying the approach at scale would be considered low. A modelled approach (using sector averages in place of direct impact driver data, for example) would score high for feasibility to apply at scale, but low for spatial precision, accuracy and the responsiveness of measurement to mitigation.

A financial institution should clearly disclose identified limitations and the steps taken to address any low scoring characteristics (e.g. the use of complementary approaches or comparing with accurate site level data). If possible, financial institutions should validate biodiversity footprinting results against actual biodiversity data such as field surveys and bioacoustics surveys, a concept known as ground-truthing, to ensure accuracy and reliability.

From an input data quality perspective, the collection of primary data or the use of existing corporate data can lead to higher quality results from footprinting approaches and should be prioritised where possible. For example, to improve the accuracy of footprinting results, a financial institution can substitute sector averages with direct consumption data from corporate public disclosures on impact drivers, where available. Improving the quality of input data is a longer term objective, especially for financial institutions just beginning with biodiversity footprinting. Nevertheless, it is important to assess the quality of the input data for the selected approach, and therefore the quality of the output data, to understand the limitations of the results.

## 4.4. Identify complementary approaches

### Guiding questions

- What information would help to address the limitations of the chosen approach?
- What information might complement gaps in the chosen approach?

Whenever possible, combining and/or comparing multiple approaches can create a more comprehensive result. Consider what the results of the selected approaches reveal about biodiversity, and what they fail to address, to help identify what complementary approaches could be used in combination to cross-validate the results. For example, complementary footprinting approaches could focus on delivering results at various scales (e.g. local versus global), rely on various pressure–impact models, or combine quantitative and qualitative assessment approaches, especially where impact drivers cannot be assessed by quantitative means.

## 4.5. Run the approach and interpret the results

### Guiding questions

- What is the context of the results?
- What assumptions are being made?
- What conclusions can be drawn from the results?

Contextualising the results and drawing conclusions for disclosure and business decisions can be challenging, yet this is a key step in the footprinting process. The results should identify the impact on the state of nature and what is causing the impact, but this information needs to be interpreted to determine what actions need to be taken. For example, the presence or absence of indicator species (e.g. lichen) may provide insights on specific abiotic factors (e.g. impacts or levels of pollution), which can inform the level of impact an organisation is having on ecosystem services in the assessed area.

Integrating the results with corporate data, where possible, can provide further context. For example, comparing the results of the assessment on lichen with qualitative data related to an organisation's involvement in pollution incidents could provide additional insights. Finally, engaging biodiversity experts and ecologists in the process of selecting and interpreting biodiversity footprint data and outputs can alleviate the challenges of interpreting and contextualising results.

## 4.6. Transparently disclose

### Guiding questions

- What has and has not been assessed?
- What are the key features of the approach?
- What are the limitations of the assessment and how are those limitations addressed?

Key components recommended for disclosure include:

- The purpose of the approach(es);
- The scope of the approach(es);
- A quality assessment of the biodiversity footprinting approach(es) used in accordance with the Align principles;
- Any limitations, such as those discussed in Section 3.3 and detailed in Annex 1;
- The metrics used (refer to Section 3.2 for more detail);
- The pressure–impact model(s) used (refer to Annex 1 for more detail);
- The data used, data collection timeframes and general data collection practices followed;
- Other relevant key features, such as assumptions made, use of characterisation factors or concordance tables, the scale at which the biodiversity footprinting was done, and any information about aggregation; and
- Actions being taken to address the results, targets that have been set and an explanation of progress over time.

# 5. Improving the utility of biodiversity footprinting

As financial institutions begin using biodiversity footprinting to assess their impact on nature, there will be lessons learned along the way. Obtaining the maximum benefit from biodiversity footprinting and improving the outputs can be achieved by:

- **Reviewing usage:** Regularly review and update the biodiversity footprinting approach being used to ensure it is still relevant and accounts for technological and scientific developments;
- **Collecting data:** Engage with companies in priority sectors and locations, and local stakeholders, to encourage the collection of primary data and the collection of qualitative data that address specific local realities and the limitations of footprinting approaches;
- **Establishing monitoring:** Establish long-term monitoring to discern trends, build local knowledge and understand the impacts of changes to investment criteria on biodiversity;
- **Using in conjunction with measures of ecosystem services:** Use approaches that measure the organisation's reliance and impact on ecosystem services to provide a comprehensive view of the state of nature and the organisation's dependencies and impacts. (Refer to additional guidance on measurement of changes in the state of nature in the TNFD LEAP approach for more information);
- **Facilitating comparability:** Engage with other financial institutions to align biodiversity footprinting approaches used within the same sub-sector, geography or biome to enable comparability; and
- **Collaborating with peers:** Encourage open discussion and collaboration with other financial institutions to support broader adoption of biodiversity footprinting to facilitate progress in this space.

## 5.1. Areas of further development for biodiversity footprinting approaches

There are a number of important ways in which current approaches to biodiversity footprinting could be further developed and improved:

- **Increase the quality and accessibility of data:** Public databases and pressure–impact models need to be updated regularly and incorporate the latest scientific literature. Many databases rely on data that were collected for different purposes or are outdated and updating these databases would improve the quality of the biodiversity footprinting approaches that rely on them. There are a number of new data sources such as bioacoustics (for measuring the presence/absence or abundance of specific species) and remote sensing satellite imagery (for measuring landcover change, net primary productivity and ecosystem structure) that could also alleviate some of the data quality challenges that currently exist. For example, hyper-spectral analysis, which uses satellite data to assess how plant species and functional biodiversity respond to different practices, is expected to become more accurate and more widely available following the launch of the Surface Biology and Geomorphology (SBG) satellite by NASA in 2027 and the Copernicus Hyperspectral Imaging Mission for the Environment (CHIME) satellite by the

European Space Agency in 2028.[20] Increasing the availability and comparability of standardised reference states is also critically important within this broader data category, as is innovation to help financial institutions to increase the location-specificity of their results, despite the complexity of large portfolios.

- **Develop more detailed assessment guidelines:** The Align criteria could be extended to indicate where individual footprinting approaches fall in its assessment criteria. This would help financial institutions to use the Align methodology to assess and compare approaches.
- **Expand the scope of footprinting capabilities:** Current footprinting approaches are biased towards terrestrial ecosystems as they are easier to measure (e.g. through remote sensing). There is a need to improve the empirical (not modelled) measurements of the drivers of biodiversity loss and increase the coverage of all components of the ecosystem, from genetic composition to ecosystem structure, function and composition. This includes increasing temporal and geographic coverage, taxonomic coverage and the Essential Biodiversity Variables (EBVs) assessed.
- **Establish consensus on key components of footprinting:** Consensus is needed on what biodiversity footprints should cover. This includes which pressures to incorporate and whether direct operations and upstream or downstream value chain impacts should be considered. Consensus is also needed on how to address revenue data gaps (e.g. revenue data generated while changing land use and revenue data by sector and by geographical distribution) so that this data can be used in models to understand the impact to a company based on their revenue. One solution to overcome revenue data gaps would be the creation of an open-source facility for key data sets. The PBAF Standard on Biodiversity Footprinting, defining requirements and recommendations for biodiversity footprinting methodologies in the financial sector is an important step in this respect. The standard contributes to building consensus on the minimum requirements regarding biodiversity footprinting and the disclosure of footprinting results.

20 Ustin, S. L. and Middleton, E. M. (2021) Current and near-term advances in Earth observation for ecological applications.

# 6. Conclusion

Biodiversity footprinting can be used by financial institutions to assess and disclose their impacts on nature, including ecosystem extent and condition and species population and extinction risk. The approaches to biodiversity footprinting that are currently available have technical, consistency, consensus, capacity and contextualisation limitations. Financial institutions can begin to use them with the help of the six-step approach outlined in this paper. These steps can help financial institutions improve their understanding of how to use current biodiversity footprinting approaches and their existing limitations. These steps can also support organisations when using footprinting as part of assessments of nature-related issues following the LEAP approach, and disclosures aligned with the TNFD recommendations.

It is important for financial institutions to consider ways to improve biodiversity footprinting by using complementary approaches to fill gaps, prioritising accurate and reliable data sources as inputs, leveraging biodiversity expertise to contextualise results, clarifying what decisions they can inform, and collaborating with peers to increase consensus and improve comparability. Financial institutions are encouraged to begin using the biodiversity footprinting approaches that are currently available to begin to understand their interface with nature, to learn how to use these tools, to identify remaining gaps and limitations, and to signal to the market what is needed to improve them over time.

# 7. Annexes

## Annex 1: Examples of footprinting approaches

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Spatial precision of state measurement** | **Accuracy of measurement** | **Responsiveness of measurement to mitigation** | **Feasibility to apply at scale** | | | |
| Adaptation, Biodiversity, and Carbon mapping tool (ABC-map) | Assesses environmental impact of National Policies and Plans and investments in agriculture, forestry and other land use (AFOLU) sectors via satellite imagery based on Google Earth Engine. | • MSA/km$^2$<br>• Land use change in protected areas and key biodiversity areas<br>• Natural capital ($) | • Biodiversity state measure at specific location using spatial polygons (requires technical GIS skills) | • Estimates state change based on one impact driver, land use, but changes are not ground-truthed (i.e. only uses satellite imagery) | • Metrics respond to broad-level reductions in impact drivers, e.g. land management practices and the impacts of National Policies, Plans and investments | • Able to be applied rapidly at scale but requires location-specific data from organisations (polygons of Area of Influence and Intervention need to be drawn via the platform)<br>• Specific to AFOLU sector | Publicly available | Food and Agriculture Organization of the United Nations (FAO) and The International Fund for Agricultural Development (IFAD) | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| Biodiversity Footprint for FIs (BFFI) | Assesses the environmental pressures and the biodiversity impact of investments, at the level of a portfolio, an asset class, a company, or project. | • PDF/ha/yr<br>• PDF/m²/$ | • Biodiversity state measure with no spatial specificity (based on financial data, except for climate change, which uses emissions data) | • Estimates state change based on four impact drivers related to climate change, air/ freshwater/marine pollution, land use and freshwater resource extraction using the ReCiPe pressure–impact model and Exiobase sector-average data. World LCA database and Ecoinvent databases can be used to reflect on the ground changes to a greater extent<br>• Results are complemented by in-built qualitative analysis | • Metrics respond to broad-level reductions in impact drivers, e.g. reduced land use intensity, with year on year comparison based on changes in portfolios/activities | • Able to be replicated across business activities rapidly and does not necessarily require location data | Publicly available. However, to calculate a footprint, (LCA) software is needed. Access to the software is paid. | CREM and PRé Sustainability, together with ASN Bank | Link |
| Biodiversity Footprint method and calculator | Assesses impact drivers across the supply chain to calculate a biodiversity footprint for multiple scenarios. | • MSA/ha | • Biodiversity state measure with no spatial specificity (based on financial data, except for climate change, which uses emissions data) | • Estimates state change by focusing on two impact drivers (land use and climate change using the GLOBIO pressure–impact model) but changes are not ground-truthed and rely on sector average data from Exiobase | • “Snapshot” metric (i.e. reflection of the state of nature at various temporal points) that does not reflect company management interventions but may change based on avoidance of areas for three parts of the value chain: raw materials, production process and transport | • Able to be replicated across business activities rapidly and does not require location data | Publicly available | Plansup and Wageningen Environmental Research | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| Biodiversity Impact Metric (BIM) | Assesses and tracks how a business's sourcing affects nature, through calculating the biodiversity lost as a result of land and habitat transformation for agricultural production and the intensity of land use. | • Impact/tonne<br>• Impact-weighted hectares | • Biodiversity state measure across a wider area than specific location represented, e.g. agricultural region | • Estimates state change by assessing one impact driver, land use (including habitat transformation) | • "Snapshot" metric that does not reflect company management interventions but may change based on avoidance of areas related to supply chain sourcing | • Able to be applied rapidly at scale but requires commodity-specific data from organisations<br>• Specific to AFOLU sector | Publicly available | Cambridge Institue for Sustainability Leadership (CISL) and Natural Capital Impact Group | Link |
| Biodiversity Trends Explorer | Assesses projected future global change in Biodiversity Intactness Index (BII), which is an estimated percentage of the original number of species that remain and their abundance in any given area, despite human impacts. | • Quantitative:<br>  • MSA/ha and MSA+<br>  • Social value ($)<br>• Qualitative RAG ratings for:<br>  • Impact on KBA<br>  • Impact on PA<br>  • Impact on threatened species<br>  • Risk of alien species<br>  • Impact on water use | • Biodiversity state measure across a wider area than specific location represented, although less reliable when filtering for shorter time periods or smaller areas, particularly in regions where there were fewer data observations (as data is extrapolated from 48,000 sites) | • Estimates state change by assessing species abundance and species richness in comparison to historical datasets. It uses this data to estimate future state changes as a result of impact drivers such as land use and human population density<br>• It is a taxonomically representative set of 58,000 plant, animal and fungal species | • "Snapshot" metric that does not reflect company management interventions but may change based on avoidance of areas<br>• It can be used for scenario analysis since it projects future global changes in BII based on varying scenarios of human impact such as global policies, but this requires specialist technical skills with the underlying pressure–impact model (PREDICTS) | • Able to be replicated across business activities rapidly but requires location data | Publicly available | Natural History Museum, London | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| The Biodiversity Integrated Assessment and Computation Tool (B-INTACT) | Assesses the impacts of projects, programmes and policies implemented in the AFOLU sector on biodiversity through a land-based accounting system. | • Score between 0 and 1 for MSA<br>• MSA/km² metric | • Biodiversity state measure at a specific location (makes use of various geo-referenced maps and tools to increase accuracy and account for the ecological value and biodiversity sensitivity of project sites) | • Estimates state change based on one impact driver, land use (including habitat fragmentation, infrastructure and human encroachment)<br>• Takes social value into consideration | • Metric responds to site level mitigation interventions, e.g. land management practices | • Able to be replicated across business activities rapidly but requires location data<br>• Specific to AFOLU sector | Publicly available under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (not available for use by corporates or FIs) | Food and Agriculture Organization of the United Nations (FAO) and Agence Française de Développement | Link |
| Biodiversity Net Gain Calculator (BNGC) | Assesses land use-related biodiversity impacts at operational sites. | • MSA<br>• MSA/km² | • Biodiversity state measure at specific location | • Estimates state change focusing on one impact driver, land use | • Metric responds to site level mitigation interventions and assesses potential (i.e. not just actual) biodiversity value of sites | • Able to be replicated across business activities but requires location-specific data and an experienced ecologist to assess the spatial unit/ understand local biodiversity | Publicly available | Arcadis | Link |
| BioScope | Assesses impacts on biodiversity arising from the supply chain or financial products. | • PDF/m²/yr (terrestrial)<br>• PDF/m³/yr (marine and freshwater) | • Biodiversity state measure with no spatial specificity (specific to supply chain or financial products) | • Estimates state change by assessing impact drivers relating to climate change, pollution, land use and water consumption using the pressure–impact model ReCiPe but changes are not ground-truthed and rely on sector-average data from Exiobase | • "Snapshot" metric that does not reflect company management interventions but may change based on avoidance of commodities or financial products | • Able to be applied rapidly at scale and does not necessarily require location data | Publicly available | Platform biodiversiteit, ecosystemen & economie (BEE), PRé Sustainability, Arcadis and CODE web development bureau | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| Corporate Biodiversity Footprint (CBF) | Assesses the impact of activities of corporates, FIs, real assets and sovereign entities on global and local biodiversity, based on the impact generated from the products purchased or sold calculated across the value chain. | • $MSA/km^2$<br>• $MSA/km^2$ per financial unit or physical Key Performance Indicator | • Biodiversity state measure with no spatial specificity (based on financial data, except for climate change, which uses emissions data) | • Estimates state change by assessing impact drivers relating to land use, climate change, pollution and resource use (hunting and freshwater) using the pressure–impact model GLOBIO, but changes are not ground-truthed and rely on sector-averages from Exiobase<br>• Disclosure Quality Level (DQL) attached to each data point indicates uncertainty | • Metrics respond to broad-level reductions in impact drivers, e.g. reduced land use intensity, with year on year comparison based on changes in portfolios/activities | • Able to be applied rapidly at scale and does not necessarily require location data | Private access, but methodological guide publicly available on IDL website | Iceberg Datalab and I Care & Consult | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| GIST Impact Biodiversity Assessment Tool | Assesses exposure to companies that have a negative impact on biodiversity. | • PDF/m²/yr (terrestrial)<br>• MSA/m³/yr (freshwater and marine)<br>• Natural capital impact ($) | • Biodiversity state measure across a wider area than a specific location is possible using public facing disclosures (when this is not possible it relies on country level data from Exiobase) | • Can be possible to reflect on the ground changes by assessing impact drivers relating to land use, climate change, pollution and resource use (freshwater and mineral resources) using the pressure-model LC-IMPACT and company data from public disclosures but changes are not ground-truthed<br>• Analysis is based on publicly reported data so there are likely data gaps which require use of modelled data (GIST Impact uses machine learning to improve accuracy of the model) resulting in more of an estimate of state change due to use of sector averages | • Metrics respond to broad-level reductions in impact drivers, e.g. reduced land use intensity, with year on year comparison based on changes in portfolios/activities<br>• Responsiveness of measurement to mitigation is possible with additional scenario analysis from technical experts to explore the impact drivers in the LC-impact model and their resulting impact on PDF (potentially disappeared fraction of species) | • Able to be applied rapidly at scale and does not necessarily require location data | Private access | GIST Impact | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | **Spatial precision of state measurement** | **Accuracy of measurement** | **Responsiveness of measurement to mitigation** | **Feasibility to apply at scale** | | | |
| Global Biodiversity Score for FIs (GBS-FI or BIA-GBS) | Assesses the biodiversity footprint of economic activities. The GBS-FI combines the GBS and the Biodiversity Impact Analytics database (BIA) to measure the biodiversity impact of companies for various FI applications. | • MSA ppb per EUR million (revenue/ invested)<br>• MSA/km$^2$ | • Biodiversity state measure has no spatial specificity (based on financial data, except for climate change, which uses emissions data) | • Estimates state change by assessing impact drivers relating to land use, climate change, pollution and resource use (hunting and freshwater) using the pressure–impact model GLOBIO and sector average data from Exiobase. More granular data can be included to reflect on the ground changes, i.e. using the GBS tool independently of BIA | • Metrics respond to broad-level reductions in impact drivers, e.g. reduced land use intensity, with year on year comparison based on changes in portfolios/activities | • Able to be applied rapidly at scale (for various asset types) and does not necessarily require location data | Private access | Caisse Des Dépôts (CDC) Biodiversité and Carbon4Finance | Link |
| Global Impact Database (GID) | Assesses the biodiversity impact by measuring the reduction of species compared to an habitat undisturbed by human activities. It also monetises these impacts using the True Price method to value nature. | • Monetised biodiversity impacts ($PPP) | • Biodiversity state measure has no spatial specificity (based on financial data, except for climate change, which uses emissions data) | • Estimates state change by assessing impact drivers related to climate change, land occupation, pollution using ReCiPe and GLOBIO pressure-impact models and sector-average data from Eora, Exiobase, GTAP and GHGB databases | • Metrics respond to broad-level reductions in impact drivers, e.g. reduced land use intensity, with year on year comparison based on changes in portfolios/activities | • Able to be applied rapidly at scale (for various asset types) and does not necessarily require location data | Private access | Impact Institute | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| Integrated Biodiversity Assessment Tool (IBAT) including the Species Threat Abatement and Restoration Metric (STAR) | The Species Threat Abatement and Restoration Metric (STAR). STAR allows quantification of the potential contributions that species threat abatement and restoration activities offer towards reducing extinction risk across the world. nSTAR (non-normalised Species Threat Abatement and Restoration) was developed by IBAT and FairSupply to combine STAR with global data on economic transactions across a company's supply chain (tier 10 and beyond).<br>IBAT also includes the IUCN Red List of Threatened Species, the World Database on Protected Areas (WDPA) and the World Database of Key Biodiversity Areas (KBAs), allowing organisations to geographically assess potentially sensitive locations. | • Number of protected areas and KBAs within a specified buffer of each project<br>• Total species (by species taxonomic group, threatened etc.)<br>• STAR<br>• nSTAR | • Biodiversity state at specific location (5km and 1km grid cells for STAR across all biomes while IBAT's biodiversity maps with a 10km buffer for each site/location of interest) | • Reflects on the ground change of species extinction risk as a result of impact drivers acting on it (both positive and negative) with a rarity-weighted indication of species richness | • Metrics respond to broad-level reductions in impact drivers (related to species threat and restoration activities) | • Able to be applied rapidly at scale but requires location data | Private access | IBAT Alliance (BirdLife International, Conservation International, IUCN and UNEP-WCMC) | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| LIFE Methodology | Assesses organisations against three steps that are interconnected: state, pressure and response. | • Biodiversity pressure index (BPI)<br>• Biodiversity minimum performance (BMP)<br>• Biodiversity positive performance (BPP) | • Biodiversity state across an ecoregion, characterising national fragility of the ecoregion | • Reflects on-the-ground changes by assessing impact drivers including climate change, land use and resource use (biomass use, waste and water) using company information on quantity and severity for each to inform the overall BPI. Changes are not ground-truthed<br>• Does not cover potential indirect, downstream or cumulative impacts | • Metric of Biodiversity Positive Performance (BPP) evaluates conservation actions and initiatives with greater potential for maintenance of ecosystem services of suppliers<br>• Establishes minimum criteria for approval of suppliers and criteria for continuous supplier risk evaluation | • Able to be applied rapidly at scale but requires location data | Publicly available | LIFE Institute | Link |

| Name | Description | Output | Considerations when assessing of biodiversity footprinting approaches against the Align criteria | | | | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|---|---|---|---|
| | | | Spatial precision of state measurement | Accuracy of measurement | Responsiveness of measurement to mitigation | Feasibility to apply at scale | | | |
| Site Biodiversity Footprint (SBF) | Assesses site-level impacts on biodiversity. Initially developed at product level and called product biodiversity footprint (pbf), it has been applied successfully at project/site level and renamed SBF, standing for Site Biodiversity Footprint. | • PDF<br>• PDF/km$^2$ eq | • Biodiversity state measured at site level (treats specific information regarding local context to adjust impact computations based on information entered by the users) | • Reflects on-the-ground changes by assessing impact drivers including land use, pollution, climate change, overexploitation (hunting, poaching or overfishing), invasive species and species management with semi-quantitative values for invasive species and species management. These are assessed using company data but are not ground-truthed.<br>• Further levels of specification can be considered in this module, especially regarding land use types, with a focus on certification schemes, such as from the Forest Stewardship Council (FSC)<br>• Includes positive actions regarding 'species management', e.g. installation of pollinators, use of various breeds, follow up of endangered species | • Metric responds to site-level mitigation interventions with the results enabling the user to visualise and quantify the benefits of a chosen practice/location, and compare various scenarios for a given product | • Involves location-specific data with the potential for incorporation of addition in-situ data regarding the local biodiversity context | Publicly available | I-Care & Consult and Sayari | Link |

## Annex 2: Examples of biodiversity databases

| Name | Description | Output | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|
| Eora | Global Multi-Regional Input Output (MRIO) table documenting indirect life cycle assessment (LCA) data among 15,909 sectors for 190 countries and 2720 line item environmental indicators including GHG emissions and labour inputs. | $ value of footprint for:<br>• Materials<br>• Land use<br>• Phosphorus<br>• Wages<br>• Value added<br>• Embodied GHG emissions (Mt)<br>• Embodied water footprint ($m^3$) | Full version (i.e. not demo) only available to academic users with email registration; other users will need to purchase a license. | World MRIO | Link |
| EXIOBASE | Global MRIO table documenting indirect LCA data for 163 sectors on a country-specific basis for 44 countries (covering 90% of the world's economy), covering 200 products, 417 emission categories, and 662 material and resource categories. | Environmental impacts for net trade of products:<br>• Euros (EUR million)<br>• Carbon (kt)<br>• Water ($m^3$)<br>• Land ($km^2$)<br>• Material (kt)<br>• % consumption of goods by sector or geography | Publicly available | EXIOBASE consortium of Norwegian University of Science and Technology (NTNU) Trondhei, Netherlands Organization for Applied Scientific Research (TNO), Sustainable Europe Research Institute (SERI), Universiteit Leiden, Vienna University of Economics and Business (WU), and 2.-0 LCA Consultants | Link |

## Annex 3: Examples of pressure–impact models

| Name | Description | Output | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|
| Global Biodiversity Model for Policy Support (GLOBIO) | Calculates the impacts of anthropogenic pressures on MSA based on scientifically underpinned pressure-impact relationships. GLOBIO has separate models for assessing terrestrial and freshwater biodiversity intactness. GLOBIO-Species can be used for assessing the distribution and abundance of vertebrate species, GLOBIO-ES for assessing various ecosystem services, including provisioning services, regulating and maintenance services and cultural services. IPBES impact drivers assessed: climate change, land use, resource extraction (hunting), pollution (nitrogen deposition). | • MSA (terrestrial and aquatic biodiversity can be represented separately) | Publicly available | Planbureau voor de Leefomgeving Netherlands Environmental Assessment Agency and partners (see link for full list) | Link |

| Name | Description | Output | Publicly available/ private access | Developers | Link |
|---|---|---|---|---|---|
| Impact World+ | Calculates the impacts of anthropogenic pressures on human health, ecosystem quality, water and carbon based on an estimation of the total annual anthropogenic emissions and extractions at the global scale. IPBES impact drivers assessed: climate change, land use (terrestrial, freshwater), pollution (freshwater, marine and air), resource extraction (mineral resources and freshwater). | • $PDFm^2/yr$ / (capita x year)<br>• $PDFm^3/year$ / (kg emitted) | Private access | The International Reference Center for Life Cycle Assessment and Sustainable Transition (CIRAIG), École Polytechnique Fédérale de Lausanne (EPFL), Technical University of Denmark (DTU), Poly. Montréal, Ann Arbor Michigan | Link |
| LC-Impact | Calculates the impacts of anthropogenic pressures on global levels of human health, ecosystem quality and natural resources. IPBES impact drivers assessed: climate change, pollution (air, freshwater, marine), land use and resource extraction (freshwater). | • DALY (Daily adjusted life years)<br>• PDF (terrestrial, freshwater and marine biodiversity can be represented separately)<br>• kg ore | Publicly available | Life Cycle (LC) Impact/ Eidgenössische Technische Hochschule Zürich (ETH) Zurich. Part of the European Union (EU) 7th Framework Programme (FP7) in collaboration with 14 partners | Link |
| Projecting Responses of Ecological Diversity In Changing Terrestrial Systems (PREDICTS) | The PREDICTS project analyses ecological studies from around the world to understand how human activities – especially those related to land use change and intensification – are changing biodiversity. TNFD species-level state of nature indicators assessed: Species abundance and species richness in comparison to historical data (4.9 million data observations from over 48,000 sites in over 100 countries, covering a taxonomically representative set of 58,000 plant, animal and fungal species). | • % (estimated percentage of the original number of species and their abundance that remains in any given area) | Publicly available | Natural History Museum London, United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC), and UK universities | Link |
| ReCiPe | Calculates the effects of emissions and resource extractions on local levels of ecosystem quality, damage to human health and resource scarcity, based on scientifically underpinned pressure-impact relationships. IPBES impact drivers assessed: climate change, pollution (air, freshwater, marine), land use and resource extraction (freshwater). | • DALY (Daily adjusted life years)<br>• PDF (terrestrial, freshwater and marine biodiversity can be represented separately)<br>• kg ore | Publicly available | Dutch National Institute for Public Health and the Environment (RIVM), Radboud University Nijmegen, Leiden University, PRé Consultants and Norwegian University of Science and Technology (NTNU) Trondheim | Link |

## Annex 4: Methodology used to assess the biodiversity footprinting landscape

To develop this paper, an assessment of the biodiversity footprinting landscape was conducted with a literature and desktop review and stakeholder engagement.

### Literature review

A number of recent papers that outline key biodiversity footprinting approaches and relevant case studies were considered. Annex 5 lists the reference material used.

### Desktop review of footprinting approaches in use today

An initial list of databases, tools, methodologies and models that could form part of a biodiversity footprinting approach was developed using the results of the literature review. The identified approaches and their underlying metrics were assessed individually to gain an understanding of their approach, purpose, input/output, scale, strengths and limitations.

A non-exhaustive list of footprinting approaches in use today was developed as an output of the desktop review (see Annex 1). Over 70 biodiversity footprinting approaches were cited in the various existing papers or by Data Catalyst participants. The following criteria were used to identify the approaches to include in the summary table:

1. Relevance to financial institutions;
2. Availability for use today;
3. Availability of key information, including organisation name, developers, website link, description and capability;
4. Applicability to biodiversity footprinting, excluding approaches that were more relevant to ecosystem or ecological footprinting approaches; and
5. Transparency of the assessment approach and interpretability of the output.

### Stakeholder engagement

This paper also reflects the insights collected from the Nature-related Data Catalyst. A virtual workshop was conducted with approximately 50 Data Catalyst participants in July 2023 and a roundtable workshop with approximately 40 Data Catalyst participants was held during New York Climate Week in September 2023. Organisations that have developed a bespoke approach to biodiversity footprinting or have used at least one existing biodiversity footprinting approach in practice were represented, as were financial institutions. The workshop uncovered key insights on biodiversity footprinting. Feedback on draft versions of this paper was also gathered by the TNFD from knowledge partners, experts, stakeholders and Data Catalyst members.

### Summarising key insights and drafting the paper

The insights and observations gathered during the literature and desktop reviews and stakeholder engagement informed this discussion paper. The TNFD acknowledges the substantial work of other organisations, initiatives and groups that have previously conducted and published thorough reviews of the footprinting landscape. The TNFD has drawn heavily on this work to characterise the existing biodiversity footprint landscape.

## Annex 5: References

These materials informed this discussion paper. A number of internal documents and proprietary inventories from TNFD knowledge partners were also inputs to this paper but are unavailable for sharing publicly.

Agence Française de Développement (2023) Preliminary comparative analysis of biodiversity measurement approaches for public development banks.

Damiani, M. et al. (2023) Critical review of methods and models for biodiversity impact assessment and their applicability in the LCA context. Environmental Impact Assessment Review 101, 107134.

EU Business @ Biodiversity Platform (2019) Assessment of biodiversity measurement approaches for businesses and financial institutions.

Finance for Biodiversity Foundation (2022) Guide on biodiversity measurement approaches (2nd edition).

Institute for European Environmental Policy (2021) Biodiversity footprints in policy- and decision-making: Briefing on the state of play, needs and opportunities, and future directions.

Marques, A. et al. (2021) A research perspective towards a more complete biodiversity footprint: a report from the World Biodiversity Forum.

Partnership for Biodiversity Accounting Financials (PBAF) (2022) Taking biodiversity into account: PBAF Standard v2022, Biodiversity impact assessment – Footprinting.

Partnership for Biodiversity Accounting Financials (PBAF) (2020) Paving the way towards a harmonised biodiversity accounting approach for the financial sector.

United Nations Environment Programme (2023) Nature Risk Profile – A methodology for profiling nature related dependencies and impacts. UNEP-WCMC, Cambridge, UK.

United Nations Environment Programme (2023) Towards a robust measurement of business dependencies on nature. UNEP-WCMC, Cambridge, UK.

UNEP WCMC, Capitals Coalition, Arcadis, ICF, WCMC Europe (2022) Recommendations for a standard on corporate biodiversity measurement and valuation, Aligning accounting approaches for nature.

Taskforce on Nature-related Financial Disclosures

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